REPORT

PIONEER PROPERTY TRUST LIMITED

WESTERN ROAD, NGONGOTAHA

GEOTECHNICAL ASSESSMENT REPORT

Volume 1 of 2

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PIONEER PROPERTY TRUST LIMITED

Report prepared by:

TONKIN & TAYLOR LTD

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1 Introduction

1.1 Background

This report details the geotechnical engineering aspects affecting the development of a large residential subdivision at Western Road, Ngongotaha (see Figure 1 – Site Location Plan).

The developer, Pioneer Property Trust Limited ('PPT'), commissioned MTEC Consultants Ltd ('MTEC') to undertake the engineering design, surveying and certification of a subdivision of Lot 17, DP 336769. A Scheme Plan was submitted to the Territorial Authority, Rotorua District Council ('RDC'), in March 2005.

Development of the subdivision was planned to take place in four stages, albeit with the majority of the bulk earthworks being undertaken concurrently to satisfy the cut to fill requirements and therefore minimise the amount of imported material. Completion of Stage Four was initially dependent upon works within the adjacent Lot 16, DP 377169, being finalised by Everard Developments Limited ('EDL'), but the development was subsequently revised to permit access through Stage Three.

The overall layout of the subdivision has not changed significantly from the Scheme Plan, with the exception of the north-east section of Stage Three, where a loop road has been incorporated in place of the original proposal for a linear access. It should be noted that some of the lots in Stages Two and Three have been renumbered, so care is required when comparing the Scheme Plan with the as-built conditions referenced in this report.

A brief description of the current status of each of the stages, as we understand them, is presented below. The general layout of the subdivision, showing the locations of the different stages and lot numbers, is presented as Figure 2 – Site Layout Plan.

1.1.1 Stage One

Stage One was the first area to be completed and includes 21 residential lots located along the northern side of Western Road.

The Earthworks Completion Report for this stage was submitted to RDC (by MTEC) in November 2006. Individual titles were issued on 25 May 2007 and to date dwellings have been constructed on 14 of the lots. It is our understanding that RDC are awaiting the findings of this review before considering building consent applications on the remaining lots.

1.1.2 Stage Two

Stage Two comprises 25 residential lots and a reserve area (Lot 87) which contains a sanitary sewer pump station and stormwater overland flow path. It is located to the north of Stage One on the eastern side of the subdivision.

MTEC submitted the Earthworks Completion Report to RDC in August 2007. Individual titles were issued on 20 November 2007 and to date one property (Lot 72) has been developed and building consent applications for at least two further lots (15 and 64) have been submitted. It is our understanding that RDC are awaiting the findings of this review before considering building consent applications on the remaining lots.

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1.1.3 Stage Three

Stage Three includes a total of 39 residential lots with two reserve areas (Lots 31 and 88), which provide an overland flow path. It is located to the north of Stage One and occupies the western side of the subdivision.

Although largely complete, MTEC have not submitted an Earthworks Completion Report for this stage, for the reasons detailed in Section 1.1.5 below.

1.1.4 Stage Four

Development of Stage Four has not yet been completed. The bulk earthworks for this area were undertaken concurrently with development of Stages One to Three in order to provide site won fill materials. The main infrastructure works have been partially completed, included installation of some services and preparation of the ground for the road pavement construction.

Stage Four is located at the top of the slopes to the north of Stage Three. As a result, it is largely unaffected by the issues relating to the presence of compressible silt and seasonally high groundwater levels. Further development of this area is however affected indirectly by the issues concerning Stages One to Three, since much of the infrastructure, including the roads and services, is shared and therefore satisfactory completion of these is a requirement for final certification of Stage Four. The development of Stage Four is not addressed as part of this assessment, other than the impact of the geotechnical issues affecting the remaining stages.

1.1.5 Additional Site Investigations and Assessment

Subsequent to submission of the Stage Two Earthworks Completion Report in August 2007, Coffey Geotechnics (NZ) Limited ('Coffey') were engaged by Baywide Construction Limited ('Baywide') to undertake site investigations at two lots within Stage Two (64 and 72). In order to determine the bearing capacity of the ground to assist with the design of suitable foundations, two hand auger boreholes were sunk on each lot to depths of 2m below ground level within the footprints of the proposed single-storey residential dwellings.

The investigations undertaken at Lot 64 identified the presence of soft organic silt/clay deposits containing decaying roots from around 1m below ground level. The Coffey report, dated 22 August 2007, highlighted concerns regarding the settlement characteristics of the organic soils and indicated that further evaluation of the suitability of the site should be undertaken. The hand augers undertaken at Lot 72 did not encounter similar organic silts/clays. The report for this site, dated 13 September 2007, recommended that an ultimate bearing capacity of 300kPa may be adopted for design of shallow foundations in accordance with NZS 3604[1].

During February and March 2008, MTEC undertook further ground investigations which revealed the presence of deposits similar to those identified at Lot 64 beneath much of Stages Two and Three (no further investigation of Stage One was undertaken at this time). In April 2008, MTEC engaged Tonkin & Taylor Ltd ('T&T') to undertake a review of the existing information and provide preliminary advice regarding the potential impact on

[1] New Zealand Standard 3604:1999 – Timber Framed Buildings.

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Stages Two and Three of the subdivision and outline the scope of further investigations and assessment required, if deemed appropriate.

The results of this assessment are presented in a report dated 22 May 2008[2]. The report concluded that the presence of a variable thickness of very soft to soft, compressible silt deposits, when combined with the variable depth of placed fill and any future foundation loads, could cause significant total and/or differential settlements to occur, and that these settlements could impact on the integrity of and the existing infrastructure and future buildings. The report highlighted the need for further investigations and monitoring to permit a more detailed assessment. The report also highlighted the presence of seasonally high groundwater levels not previously identified as a potential issue.

1.2 Terms of Reference

Following submission of the preliminary review in May 2008, T&T were engaged directly by PPT to undertake a detailed assessment of the settlement-related issues affecting Stages Two and Three of the subdivision. The assessment was also to provide recommendations for ground treatment and/or specific foundation designs to permit future development of the site to proceed. T&T were not at that time engaged to undertake an assessment of the Stage One area or the lot on Stage Two which has a house constructed on it (Lot 72).

Following a meeting with RDC and their peer reviewer, Terrane Consultants Ltd ('Terrane') on 14 October 2008, it was agreed that T&T would prepare a Geotechnical Completion Report for Stage Three, addressing the settlement-related issues and a separate report detailing the site conditions and recommendations pertaining to both Stages Two and Three, including an assessment of the impact of the seasonally high groundwater levels. RDC also requested T&T undertake a review of the existing condition of the infrastructure within Stage Three, and the sewer and stormwater services within Stages One and Two into which the Stage Three systems connect and therefore rely upon for satisfactory performance.

At a subsequent meeting with RDC/Terrane and MTEC, with their appointed geotechnical advisor, Babbage Consultants Limited ('Babbage'), on 19 December 2008, it was further agreed that T&T would include within the Stage Three Geotechnical Completion Report a review of the land stability aspects affecting the slopes in the northern area of Stage Three, in order to maintain a clear distinction of responsibility with regards to certification for the site. MTEC were to provide certification for all other aspects, including the earthworks and civil engineering design/construction. RDC also requested that T&T include within the Geotechnical Assessment Report for Stages Two and Three, the requirements for future development of the lots within Stage One that have not yet been built on, to assist them with processing building consent applications. PPT subsequently agreed to T&T including these additional aspects within their scope of works.

T&T have not been engaged by PPT, MTEC, RDC or any other organisation / private individuals, to comment on the lots on which dwellings have already been constructed. However, to assist with the review of the remaining areas of the site and to provide

[2] Tonkin & Taylor Ltd 'Pioneer Property Trust – Western Road, Ngongotaha, Stage 2 and 3 Residential Development, Preliminary Geotechnical Review (Revision 1)' ref: 851090. 22 May 2008.

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information for any future assessment, further intrusive investigations and settlement monitoring of some of these lots has been undertaken.

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2 Sources of Information

The principal sources of information that have been reviewed in compiling this report are outlined below.

2.1 Previous Investigations and Reports

The following ground investigation data and earthworks reports have been provided by MTEC.

2.1.1.1 Preliminary Site Investigation

MTEC Consultants Ltd, Western Road, Ngongotaha – Preliminary Site Investigation (October 2004).

This includes the logs for 18 hand auger holes sunk to around 2m below ground level in October 2004. Three of the holes were continued to depths of between 5 and 6m (BH4, BH17 and BH18). In addition, 18 Scala Penetrometer Tests were advanced to depths of around 2m below ground level. The approximate locations of these exploratory holes are shown on Drawing 175781-R-E-D001 Sheet No. 02, Issue A. The positions of the Scala Penetrometer Tests are not indicated but it has been assumed that these were located immediately adjacent to the equivalent numbered hand auger holes.

2.1.1.2 Recent Site Investigations

MTEC Consultants Ltd, Western Road, Ngongotaha – Recent Site Investigation (February and March 2008).

Following indications of possible poor ground conditions in August 2007, a total of 28 hand auger holes were advanced to 3m below ground level on lots located within Stage Two and 17 Cone Penetration Tests (CPTs) were carried out to around 20m below ground level. These were spread across Stages Two and Three. The hand augers and CPTs were undertaken in February and March 2008. The positions of these exploratory holes are shown on Drawings 175781-R-E-D007 Sheet No.16 Issue A and 175781-R-E-D010 Sheet No.26 Issue A, for Stages Two and Three, respectively.

2.1.1.3 Stage One Earthworks Completion Report (November 2006)

MTEC Consultants Ltd, Earthworks Completion Report for Stage 1 – Oaklands Residential Subdivision at Western Road, Ngongotaha for Pioneer Property Trust Ltd. Ref: 175781_R-E-C170 (27 November 2006).

The report indicates that all topsoil and any unsuitable material was removed prior to filling and replaced with site won or imported clean fill, which was placed in thin layers (up to 0.2m deep) and compacted with motorscrapers. The earthworks varied from 0.5m cut to 2.0m of fill with an average depth of around 0.3m cut and 1.0m of fill. The works were undertaken between February and November 2006 with little or no earthworks completed between March and September due to heavy rainfall and the winter shutdown period.

A total of 53 Scala Penetrometer Tests were conducted, two or three per lot, following completion of the earthworks. The positions and results of these tests are presented in the report.

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2.1.1.4 Stage Two Earthworks Completion Report (August 2007)

MTEC Consultants Ltd, Earthworks Completion Report for Stage 2 – Oaklands Residential Subdivision at Western Road, Ngongotaha for Pioneer Property Trust Ltd. Ref: 175781_R-E-C239 (20 August 2007).

This report also indicates that all topsoil and any unsuitable material was completely removed prior to filling and replaced with site won or imported clean fill, which was placed in thin layers (up to 0.2m deep) and compacted with motorscrapers. The earthworks varied from 1.5m cut to 2.5m of fill with an average depth of around 0.5m cut and 1.0m of fill. The works were undertaken between January and March 2007.

The existing open drains (see Section 3.1) were cleaned to remove all unsuitable material. Prior to placing bulk fill the invert of the drains was filled with a 500mm layer of pumice on a 300mm deep layer of 60mm clean metal (draincore).

As required under Condition 18 of the Stage 2 subdivision consent, building platforms were constructed on Lots 84, 85 and 86. The platforms were filled with imported Pumice/Rhyolite fill to form a nominal building platform area of 350m^2 (25m x 15m) to an elevation of 285.30m above Moturiki Datum (AMD).

A total of 50 Scala Penetrometer Tests were conducted, two per Lot, following completion of the earthworks. The positions and results of these tests are included in the report.

2.1.1.5 Scala Penetration Test Results for Stage Three

Though the Earthworks Completion Report for Stage Three is not currently available, MTEC have provided a copy of the Scala Penetration Tests and location plan undertaken for certification of the individual lots.

Copies of the October 2004 and February /March 2008 ground investigations and the Scala Penetration Test results conducted for Stages One, Two and Three, are included in Appendix B, for ease of reference.

The Earthworks Completion Reports detailed in Sections 2.1.1.3 to 2.1.1.4 above are included in the appendices to the T&T May 2008 report.

2.1.1.6 As-Built Drawings for Stages One, Two and Three

MTEC have also supplied T&T with copies of as-built drawings for all three stages detailing the layout and levels of sanitary sewer, stormwater and water reticulation systems. Autocad files containing this information and the pre-development, as-built contours and cut/fill depths were also received. This information has been used in the production of several of the figures contained in Appendix A.

T&T cannot provide any guarantee as to the accuracy of the information detailed in Section 2.1 above.

2.2 Published Data

The following topographic and geological plans cover the area in which the present site is located:

- Topographic Map 260-U15 Ngongotaha 1:50,000 published by Land Information New Zealand (2000).

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- Geological Map of New Zealand, 1:250,000, Sheet 5 – Rotorua, published by New Zealand Geological Survey (1964).

These have been inspected and relevant details regarding the site conditions are described in Section 3.

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3 Site Location and Description

3.1 Location

The site is located on the northern side of Western Road, Ngongotaha, approximately 5km south of Rotorua (see Figure 1). It is situated within the wide, roughly east-west orientated valley of the Ngongotaha Stream, which flows immediately to the rear of the properties on the south side of Western Road and Te Manga Place, before discharging into Lake Rotorua approximately 1.5km to the east.

The Ngongotaha Stream has its headwaters approximately 20km south-west, rising at an elevation of around 650m on the Mamaku Plateau.

3.2 Description

3.2.1 Pre-Development Landform

Prior to development of the subdivision, the site occupied relatively level ground, generally varying between 284 and 287m AMD, up to the base of the natural slopes that occupy the northern part of Stage Three, the whole of Stage Four and the area immediately to the north of Stage Two, which rise steeply to in excess of 310m AMD. The pre-development landform is shown on Figure 3.

The southern boundary, bordering Western Road, was at an elevation close to 287m AMD. The ground level reduced rapidly to the north, away from Western Road, which appears to be raised, possibly to protect against surface water flooding. The majority of the site was at an elevation of less than 286m AMD, with much of the south-east corner below 285m AMD. There was a raised area passing through the southern end of Stage Three into the north-west side of Stage Two, reducing from around 287.5m AMD in the west to 286m AMD at the eastern side of Stage Two. With the steep slopes to the north, this central ridge defined two prominent 'low spots', one occupying the central portion of Stage Three, centred around Lot 88, but also including Lots 44 to 46, 51 to 54, 57 and 58 (which are generally below 286m AMD) and the majority of Stage One and the south-east portion of Stage Two, much of which was below 285m AMD. This general pre-earthworks topography is reflected in the cut/fill thicknesses across the site, as detailed below and illustrated on Figure 4 – Cut/Fill Plan.

Further details regarding the topography and geomorphology of the site are provided in Section 5.1.2.

Open drains were present within both of these low areas. The more southerly of these ran roughly west to east across the site, passing through Lots 1 to 13 in Stage One and 15, 16, 66 and 87 in Stage Two, reducing ground levels to around 284m AMD within Stage Two. The remaining drain originated from in the low spot (at around 285m) located within Lot 88, before following a west to east course along the back of the northern Stage Two properties (Lots 74 to 84). From here it connected with the southerly drain on Lot 87 that discharges to the adjacent property to the east (Lot 16 DP 336769), before being culverted beneath Western Road and discharging into the Ngongotaha Stream. These drains were backfilled as part of the development, as detailed in Section 3.2.6 below.

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3.2.2 Subdivision Development

In order to provide a more consistent level across the site suitable for subdivision and to raise the lower areas for stormwater protection, extensive earthworks were undertaken. This included cut material from Stage Four being spread in the low areas, particularly Stage One, and cut to fill operations within Stages Two and Three, winning material from the central ridge. The as-built contours indicate a general fall from west to east across the site, with elevations typically between 286.5 and 287m AMD in Stage Three and the western end of Stage One, reducing to between 285.5 and 286.5m AMD in Stage Two and the eastern end of Stage One. There are some lower areas which we understand are required for stormwater drainage, as detailed in Section 3.2.6 below. Final contours and cut/fill depths are shown on Figures 2 and 4, respectively.

Further description of the site is provided below for each of the three stages.

3.2.2.1 Stage 1

Stage One covers a total area of approximately 2.35 hectares and includes 21 residential lots (numbers 1 to 14 and 17 to 23), located along the northern side of Western Road.

The Earthworks Completion Report for Stage One was submitted to RDC (by MTEC) in November 2006. This indicates that a depth of up to 2m of fill was placed in this area (see Figure 3) between February and November 2006. This comprised a combination of site won fill taken from the Stage Four area and imported Rhyolite material, as dictated by the poor weather conditions.

Individual titles were issued on 25 May 2007 and to date dwellings have been constructed on 14 of the lots (excluding numbers 1 to 3, 11, 14, 17 and 20).

3.2.2.2 Stage 2

Stage Two covers an area of approximately 3.3 hectares and includes a total of 26 lots (numbers 15, 16 and 64 to 87), located to the north of Stage One at the eastern side of the subdivision. Lot 87 is a reserve which contains a sanitary sewer pump station and stormwater overland flow path, with the remaining 25 lots allocated for residential development. Lots 15 and 16 are accessed via a right of way from Western Road (Lot 91) with the remaining 23 lots located either side of a cul-de-sac with a turning head at the western end (Road 2, Lot 93).

The Earthworks Completion Report for Stage Two was submitted to RDC (by MTEC) in August 2007. The as-built cut / fill contours indicate that the majority of the lots located in the north-west half of Stage Two are in cut (up to 1.5m depth), whilst the south-east portion contains up to 1m of fill. The general site earthworks were completed between January and March 2007. Fill was won predominantly from the cut areas of Stages Two and Four, with a limited quantity of imported Rhyolite/Pumice.

Existing open drains passing through Lots 15 and 16, 74 to 84 and 87, were cleaned to remove unsuitable material and backfilled with a 300mm deep layer of 60mm drainage metal followed by 500mm of pumice, prior to the placement of bulk fill. We understand from speaking with the Contractor, Goodrick Contracting Ltd ('Goodrick'), that Novaflo drainage pipes were also placed in the backfilled drains and connected to the subdivision stormwater reticulation.

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Individual titles were issued on 20 November 2007 and to date one property (Lot 72) has been developed and building consents for at least two further sites (Lots 15 and 64) have been submitted to RDC. It is our understanding that RDC are awaiting the findings of this review before considering building consent applications on the remaining lots.

Easements are included on Lots 15, 16, 65 to 69 and 72 to allow overland flow to drain back towards the Ngongotaha Stream via Lot 87 and a drainage ditch on the adjacent property to the east.

3.2.2.3 Stage 3

Stage Three covers an area of approximately 6.74 hectares and includes a total of 41 Lots (numbers 24 to 63 and 88), located to the north of Stage One at the western side of the subdivision. Lot 88 comprises a reserve area and Lot 31 provides a stormwater overland flow path. The remaining 39 Lots have been allocated for residential development.

The main access road (Road 1, Lot 92) extends for approximately 370m north from Western Road and continues for a further 70m or so into the Stage Four area. A Loop Road (Lot 89) is located at the northern end of Stage Three, providing access to Lots 38 to 45 and 48 to 50. A right of way (Lot 90) extends from the Road 1 in an easterly direction, servicing Lots 55 to 61.

Easements are included on Lots 24, 26, 27, 58 to 61 and 63, to permit stormwater overland flow from the adjacent site (to the west) to drain back towards the Ngongotaha Stream via Stage Two.

3.2.3 Surface Water Flow Paths

Prior to development of the subdivision, two existing open drains crossed the site from west to east before discharging into the Ngongotaha Stream via a 450mm diameter culvert passing beneath Western Road. These assisted with stormwater drainage originating from within the site itself, the adjacent rural catchment and conveyed stormwater flows originating from the adjacent property to the west, Lot 2 DPS 39870. These drains were backfilled as part of the subdivision development. A piped system has been installed to convey stormwater flows generated within the subdivision and from the upstream undeveloped catchment up to a 2% Annual Exceedance Probability (AEP).

In order to convey out of bank flows originating from the Ngongotaha Stream at Brake Road during 1% AEP events, overland stormwater flow paths have been created through Stages Two and Three, with easements on individual lots as detailed above. The approximate routes of these flow paths are indicated on Figure 5. As part of these works, the 450mm diameter culvert beneath Western Road has been replaced with a 1200mm diameter pipe.

We understand that some ponding of surface water is expected on the property to the east and Western Road following 1% AEP events up to a level of 285.30m AMD. As a result, three lots located in the south-east corner of the site (Lots 84, 85 and 86) were constructed with platform levels at this elevation to satisfy Condition 18 of the Stage Two consent.

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4 Recent Investigations and Monitoring

4.1 Ground Investigations

Following a review of the site conditions as revealed by the investigations detailed in Section 2.1, which culminated in the T&T Preliminary Geotechnical Review report of May 2008, a number of further investigations were undertaken in June 2008 to provide additional information regarding the nature and variability of the ground and groundwater conditions across Stages Two and Three. This included the installation of groundwater monitoring standpipes.

T&T had not at that time been engaged to investigate or provide an assessment of the conditions relating to Stage One of the subdivision. However, given that an understanding of the conditions across Stages Two and Three would be assisted by information obtained from the adjoining Stage One area, and at the request of PPT in anticipation of future requirements (and the efficiencies to be gained), a number of exploratory holes were also positioned on the empty lots in Stage One.

Following a meeting with RDC, MTEC and their respective geotechnical advisors on 19 December 2008, it was agreed that T&T would include in their brief an assessment of the land stability issues affecting Stage Three of the subdivision to provide a clear distinction of roles between T&T and MTEC in preparing the respective Earthworks Completion Report (MTEC) and the Geotechnical Completion Report (T&T). In order to complete this assessment, T&T undertook a number of window sample holes with groundwater monitoring installations located on the slopes at the northern end of Stage Three in January 2009. Details of these investigations, the results and the implications with regards to land stability and erosion of the affected lots, are detailed in the T&T Stage Three Geotechnical Completion Report (March 2009). The information obtained is of limited relevance to the present issues and therefore the results of these additional investigations are not detailed further in this report.

4.1.1 Fieldwork

The fieldwork described below was undertaken by Perry Drilling Ltd ('Perry') and Geotechnics Ltd ('Geotechnics'), under the direction of T&T.

4.1.1.1 Cone Penetration Testing

A total of 26 Cone Penetration Tests were undertaken on the 19 and 20 June 2008. The CPTs were advanced to depths ranging from 7 to 15m below ground level in order to prove the full depth of the compressible silt horizon. The exact locations and elevations were subsequently surveyed and this information is contained on the plots included in Appendix C. These were located across all three stages of the subdivision, which along with the previous CPTs undertaken in March 2008, provide a comprehensive coverage of the entire site, as shown on Figure 5 – Exploratory Hole Location Plan. The results of these investigations, including summary tables of the materials encountered, are detailed in Section 5.1.

As the CPTs were advanced, a total of 18 dissipation tests were undertaken within 11 of the CPTs (between 1 and 3 tests per hole), in order to provide an indication of the coefficient of consolidation of the materials encountered. The results of these tests are detailed in Section 6.2.

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Upon completion of each of the CPTs and at the end of the day, groundwater levels were recorded in each of the holes and the recorded depths are included on the plots. In addition, slotted pipes were installed to the maximum possible depths (between 2.5 and 6m below ground level) in six of the holes to allow future monitoring of groundwater levels at these locations. The results of the ongoing monitoring of groundwater levels are detailed in Section 5.2.

4.1.1.2 Boreholes

In order to provide some calibration of the large number of CPTs, to perform further in situ tests and to obtain open tube ('undisturbed') samples of the compressible silt horizon materials for inspection and subsequent laboratory testing, three machine-drilled boreholes were drilled to recover continuous cores to depths of 15m below ground level between 24 and 26 June 2008. These were each positioned close to one of the previously sunk CPTs so that as they were advanced, push tube samples could be collected and falling head permeability tests conducted at specific identified horizons. The exact locations and elevations were subsequently surveyed and this information is contained on the logs included in Appendix C.

As the boreholes were advanced, a total of six falling head permeability tests were conducted (two per hole) within the upper and lower sections of the compressible silt horizon. This was done primarily to assist with the assessment of the coefficient of consolidation (c_v) of the silt materials to assist with determining the time required for primary consolidation to occur. The results of this testing are outlined in Section 6.2.

After completion of drilling, two standpipes were installed in each of the boreholes. The installation details are provided with the logs in Appendix C, but essentially comprised 1m response zones (screens) within the upper and lower sections of the compressible silt horizon, with bentonite seals above and below. The results of the subsequent monitoring are detailed in Section 5.2.

Note that the numbering procedure for the T&T ground investigations and monitoring, i.e. BH2-64 and SMP1-17, references to the type of investigation (i.e. borehole or settlement monitoring point) and the stage and lot that it is located on. Some of the laboratory test results refer to boreholes BH1, BH2 and BH3. These correspond with the renumbered boreholes BH2-64, BH2-79 and BH3-58.

4.1.1.3 Groundwater Monitoring Installations

The ground investigations undertaken by MTEC, particularly the October 2004 hand augers, and the more recent investigations by T&T in July 2008, identified seasonally high groundwater levels at a number of locations within the subdivision. For reasons detailed in Sections 5.2 and 8.1, a further 17 standpipes were installed in window sample holes advanced to 3m below ground level in December 2008. The locations of these additional monitoring points, along with the standpipes installed in the boreholes and slotted pipes in the CPT holes, are shown on Figure 6 – Groundwater Monitoring Locations.

The depth to groundwater within these standpipes has been recorded on a number of occasions and the results are detailed along with the other monitoring points in Section 5.2.

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4.1.2 Laboratory Testing

Samples of the compressible silt horizon materials taken from the open tubes recovered from each of the three boreholes, have been subjected to a range of laboratory tests, as summarised in Table 4.1 below. These were undertaken by Opus International Consultants Ltd ('Opus'), Geotechnics and SGS New Zealand Ltd ('SGS'). The results are included in Appendix D and discussed in Section 6.2.

In addition, to assist with the design of the subsoil drainage for Stage Three, two samples of the near surface silty sands / sandy silts were tested for particle size distribution, as detailed in the table below.

Test	Test Procedure	Testing Laboratory (No. of Samples Tested)
Natural Moisture Content	NZS 4402: 1986 Test 2.1	Geotechnics (x3) Opus (x2)
Atterberg Limits • Liquid Limit • Plastic Limit • Plasticity Index	 NZS 4402: 1986 Test 2.2 NZS 4402: 1986 Test 2.3 NZS 4402: 1986 Test 2.4	 Geotechnics (x3) Opus (x2)
Organic Matter Content	NZS 4402: 1986 Test 3.1.2	SGS (x3)
Particle Size Distribution	NZS 4402: 1986 Test 2.8.1 NZS 4402: 1986 Test 2.8.4	Geotechnics (x2)
One-Dimensional Consolidation	NZS 4402: 1986 Test 7.1	Geotechnics (x3) Opus (x3)

Table 4.1: Summary of laboratory testing completed.

4.2 Monitoring

4.2.1 Settlement Markers

In order to assess whether any ongoing settlement is occurring at the site, and if so, the rate and magnitude of these movements, a total of 39 settlement markers were installed across the three stages in July 2008. These are located on the roads and individual lots and include areas that have received fill, areas in cut and areas roughly at-grade, with variable thicknesses of compressible materials. This includes four markers installed around the perimeter of the recently constructed dwelling on Lot 72 in Stage Two. The markers, as well as those installed on the trial loads, as described in Section 4.2.2 below, have been

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monitored on a monthly basis by Geomatic Surveys Ltd ('Geomatics') using precise levelling, with a reported accuracy of ±1mm.

Further settlement markers were installed around two dwellings located within Stage One (Lots 9 and 18) in October 2008, increasing the total number of survey points to 47.

The positions of the settlement markers are indicated on Figure 7 – Settlement Monitoring Locations. The results of this monitoring, including an estimate of the depth of the earthworks (cut/fill/at-grade) at each location, are presented on Table 7.1.1 in Appendix F.

The results of this monitoring are discussed in Section 7.1, which includes reference to a number of figures depicting the results in graphical form.

4.2.2 Trial Loads

In order to assess the response of the ground to imposed loads, such as those resulting from the placement of fill and/or future buildings, three large-scale trial loads were established in July 2008. These are located on individual lots, two within Stage Two and one in Stage Three (see Figure 7). No trials were undertaken in Stage One as at that time, T&T had not been engaged to assess any parts of that area.

Summary details of the trial loads are provided in Table 4.2 below:

Trial Load Number	Location	Depth of Trial Load Fill	Estimated Depth of Cut / Fill	Dimensions (length x width)
		(m)	(m)	(m)
1	Lot 64, Stage Two	1.4	+0.50 to +0.75	24 x 14
2	Lot 79, Stage Two	1.3	-0.50 to -0.75	14 x 14
3	Lot 58, Stage Three	1.0	-0.25 to -0.50	14 x 14

Table 4.2: Summary information for trial loads.

Notes:
1. Trial load fill had a typical placed bulk density of around 18Mg/m^3.
2. Topsoil was stripped from the footprint of the trial loads prior to placement of fill and stockpiled away from the immediate area to avoid additional loading.
3. Dimensions relate to the top of the trial load. Side slopes are typically at 45°, increasing the overall footprint by an amount roughly equal to the depth of the fill around the perimeter of the central portion.

A total of 13 monitoring points were located on and around each trial load. These are positioned at the centre, midway along the top and bottom of the batter slopes and offset approximately 2.5m from the toe of the slopes on all sides (see typical detail included on Figure 7). These points were monitored using precise levelling, on several occasions in the first few days, reducing gradually to monthly intervals. The results of this monitoring are presented on Tables 7.2.1 and 7.2.2 in Appendix G.

The rates and magnitudes of the observed settlements recorded at each trial load and the associated ground conditions are discussed in Section 7.2. This includes reference to a number of figures depicting the results in graphical form.

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4.2.3 Infrastructure Level Survey

In order to assist with determining whether significant settlement of the ground has occurred in response to the earthworks undertaken, and to provide some indication as to the impact of such movements on the site infrastructure, including the roads and buried services, a detailed survey of the sewer and stormwater manhole lid and pipe invert levels across all three stages was completed between November and December 2008. The levels recorded were then compared with the manhole lid and pipe invert levels recorded on the MTEC as-built drawings, based on surveys undertaken on the following dates:

- Stage One – 08 December 2006
- Stage Two – 17 July 2007
- Stage Three – 12 June 2008

The results of this survey, including the as-built levels and an indication of the depth of the earthworks at each manhole, are presented on Tables 8.5.2 to 8.5.4, included in Appendix H. The results of the survey and comparison with the MTEC as-built levels, are discussed in Section 8.5.

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5 Ground and Groundwater Conditions

5.1 Ground Model

5.1.1 Published Information

The geological map for Rotorua and the surrounding areas indicates that the entire western side of Rotorua Lake, extending for up to 10km, is underlain by post-glacial undifferentiated lake terrace and fan deposits. These are, in turn, underlain by older fluviatile sands and silts deposited during the last glacial period and further fluviatile terrace deposits, including silts, sands and gravels, originating during the last interglacial.

Where large active valleys formed by rivers, such as the Ngongotaha Stream, it is likely that they have cut down through the most recent post-glacial and glacial deposits, exposing these in the valley sides, and incising into the underlying interglacial terrace deposits, but with a superficial cover of recent alluvium.

The Ngongotaha Stream drains an area dominated by the Mamaku Ignimibrite at the southern end of the Mamaku Plateau. These are described on the geological map as comprising principally of pale pink to grey ignimibrite, containing plagioclase and minor quartz. It is anticipated that the majority of the superficial deposits described above, including the recent alluvial materials, would have originated predominantly from these host rocks and more recent volcanic tephras.

5.1.2 Geomorphology

The extensive ground investigations undertaken at the site, including those within the valley floor of Stages One, Two and low lying areas of Stage Three, and the findings of exploratory holes located on the slopes at the northern end of Stage Three, can be related to the general geological and topographical setting, to reveal the likely depositional setting.

Fluviatile terrace and fan deposits laid down at a time when the level of Lake Rotorua was much higher than today, have subsequently been eroded by the Ngongotaha Stream, in response to a general lowering of the lake level. The size of the Ngongotaha Stream during the post-glacial period is likely to have been much greater than today, resulting in erosion and undercutting of the valley slopes, with a braided river system occupying the wide valley floor. A subsequent rise in the lake level, close to that existing today, would have resulted in the deposition of organic marine muds, with occasional influxes of river alluvium and/or slope wash materials and airfall deposits, including coarser silts and sands. Continued deposition of river alluvium from flooding of the Ngongotaha Stream would have eventually buried the soft, organic silts.

5.1.3 Ground Conditions

5.1.3.1 Cut and Fill

The extent of cut and fill across the site, undertaken primarily to produce a more consistent elevation above the assumed 1% AEP flood level, has been described in Section 3.2 and is shown on Figure 3.

In general, the deepest areas of fill occur in Stage One (up to 1.5m thick), the south-east portion of Stage Two (up to 1m), and Lot 88 (up to 2.5m), the reserve area of Stage Three. Fill placed along the northern edge of Stage Two is related primarily to backfilling of the

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former open ditch. The fill in the western side of Stage Three is typically less than 0.5m thick. The central parts of Stage Three and the majority of the north-west half of Stage Two are at-grade or in cut typically less than 0.5m deep, but locally up to 1.5m. There is a small area of cut in the north east area of Stage Three, but this is generally away from the thick compressible silt horizon and therefore of less significance.

5.1.3.2 Fill

The majority of the general fill placed across Stages One to Three originated from the adjacent cut areas and slopes to the north of Stage Three (future Stage Four); although we understand a limited amount of Pumice and Rhyolite fill was imported during wet periods. The materials originating from adjacent cut areas comprise recent alluvial fine sands and silts, as described below for the near-surface in-situ materials. These are essentially identical to the underlying in-situ materials and therefore difficult to distinguish from them. The fill materials originating from the upper slopes include lake terrace and fan deposits, comprising predominantly sands and silts. It is possible, with some interpretation, to delineate these from the underlying in situ materials where samples have been retrieved and logged (i.e. hand augers and machine-drilled boreholes), but these are largely restricted to the Stage Two area. For the purposes of this assessment however, we are interested primarily with the presence of the soft compressible organic silt horizon, and therefore the fill materials have been included with the in-situ alluvial silts and sands and are referred to as the 'cover' layer, indicating the depth of the in situ materials plus any fill, where present, to the upper surface of the compressible silt horizon.

For the purposes of designing specific foundations at individual lots, it will be necessary to take account of the different characteristics of the fill and in-situ materials, where applicable.

5.1.3.3 In Situ Materials

5.1.3.3.1 Near-Surface Silts and Sands

The original ground investigation undertaken by MTEC in October 2004 provides the most reliable indication of the nature of the near-surface in-situ materials in their undisturbed state, as little or no earthworks had been undertaken at this time. This included a total of 18 hand augers spread across the three stages, typically advanced to 2m below ground level, but extended to between 5 and 6m at BH4, 17 and 18. Augers BH17 and BH18 were located at the northern end of Stage Three on the rising ground and BH4 is positioned at the present junction of Road 2 with Western Road.

The materials encountered are generally described as comprising slightly sandy to sandy silts containing occasional pumice gravel (often in distinct narrow bands). The silts are typically yellow/brown to orange/brown, with some bands/pockets containing brown and black staining, occasionally associated with wood fibres. The silts were encountered beneath a thin layer of topsoil to the base of most of the augers, and generally included some horizons which grade to silty fine and medium sands. The thickness of the sand horizons generally increases away from Western Road, particularly at the northern end of Stage Three.

Scala Penetration Tests (SP1 to SP18), presumably located adjacent to the equivalent numbered hand augers, were also advanced to around 2m below ground level. Each test recorded penetrations in excess of 300mm per 5 blows, with a large number reporting

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>500mm, and up to a maximum of 820mm for 5 blows. These high penetrations were recorded at all depths in the upper 2m, not just close to the surface. Where sandier horizons are recorded on the logs, the equivalent penetrations generally drop to below 200mm per 5 blows and often below 100mm.

Following the identification of soft silts at greater depths in August 2007 by Coffey, MTEC sunk a further 28 hand augers within the Stage Two area in February and March 2008, extending to depths of around 3m below ground level. These reported fill materials in all areas where fill is indicated on the cut/fill contour plan, with the exception of Lot 86, where the sand reported beneath the topsoil may have been mistaken for in-situ material. The fill here is generally described as comprising orange-brown, fine sand with traces of silt and occasional pumice gravel to a maximum depth of 1.8m below ground level, but typically around 1m deep. Where no fill was present, the near-surface materials are described as predominantly light brown, medium-grained sands with some silt, ranging in thickness from 0.4 to 2.1m, with an average thickness of 0.8m. Six of the auger holes, all located in the area of cut in the north-west part of Stage Two, encountered a horizon of light brown fine gravel beneath the sands of between 0.5 and 1.8m thick, with an average of 1.1m. The pumice gravels may have been deposited from the adjacent steep slopes through landslide or slope wash mechanisms.

5.1.3.3.2 Compressible Silt Horizon

In the MTEC investigations of February and March 2008, the silty sands and gravels were found to be underlain by compressible silt deposits which may be divided into a narrow, typically 0.3 to 0.5m thick, upper horizon which are described as firm, light brown, moist with some sand and a lower, very soft, wet, dark brown layer, encountered to the base of the augers. The depth to the top of the silts varied from around 0.9 to 2.9m below ground level, with an average of around 1.9m.

The CPTs undertaken on behalf of MTEC in March 2008 provided further indication of the depth of the 'cover' materials and the first indication of the full thickness of the compressible silt horizon. Of the 17 test locations, nine were located within Stage Two and the remaining eight across Stage Three. Each of these, with the exception of CPT15 located at the far northern end of Stage Three, encountered the soft compressible silts. These are readily identified by very low cone resistances (generally below 0.3MPa and often reducing to 0.1MPa and occasionally offering no measurable resistance), and excess dynamic pore pressures.

The very soft to soft silt horizon is punctuated by one or more narrow (typically <0.5m thick) medium-dense to dense sand horizons. Towards the base of the soft silts there appears to be a small transition zone where the silts are interbedded with fine sand horizons. These are underlain by sands which increase from relatively loose to medium-dense and dense with depth. An annotated plot of cone resistance against depth for CPT5, located on Lot 64 in the Stage Two, is presented as Figure 5.1.1 included in Appendix C, which indicates the typical layering encountered.

As detailed in Section 4.1.1, a further 26 CPTs and three machine drilled boreholes were undertaken in June 2008 on behalf of T&T. The results of these investigations, along with the other exploratory holes described, have been used to provide a summary of the ground conditions in terms of the thickness of the cover materials, the depth and elevation to the top and bottom of the silt horizon, its overall thickness (including the sand horizons) and the thickness of the compressible silt materials (i.e. excluding the sand

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bands) across the entire subdivision and within the three stages. This is presented as Table 5.1.1 below.

		All	Stage 1	Stage 2	Stage 3
Depth of Cover (m)	Count	48	6	17	25
	Maximum	5.20	5.20	4.40	4.20
	Minimum	0.90	2.20	0.90	0.90
	Average	2.62	3.72	2.46	2.47
	Median	2.75	3.75	2.60	2.50
Top of Silt Horizon (m AMD)	Count	48	6	17	25
	Maximum	285.90	283.90	284.60	285.90
	Minimum	281.10	281.40	281.10	281.82
	Average	283.67	283.12	283.14	284.16
	Median	283.80	283.25	283.20	284.10
Bottom of Silt Horizon (m AMD)	Count	41	6	15	20
	Maximum	285.80	278.70	278.70	285.80
	Minimum	273.10	273.20	273.10	275.02
	Average	277.01	275.35	275.27	278.82
	Median	276.80	275.05	274.50	278.70
Thickness of Silt Horizon (m)	Count	41	6	15	20
	Maximum	10.70	10.60	10.70	9.80
	Minimum	0.10	5.20	5.00	0.10
	Average	6.62	7.77	7.87	5.35
	Median	6.60	7.30	8.00	5.20
Thickness of Silts Excluding Sand Bands (m)	Count	44	6	15	23
	Maximum	10.20	10.20	10.00	7.60
	Minimum	0.00	2.60	4.10	0.00
	Average	4.93	6.55	7.13	3.08
	Median	5.05	6.05	7.50	2.90

Table 5.1.1: Summary of ground conditions encountered.

Note: This table is based primarily on the results of the CPT and machine-drilled boreholes, but the depth of cover and elevation to top of the compressible silt horizon includes the results of some of the shallower investigations also. The elevation data is based on surveyed ground levels for the recent T&T investigations and ground levels estimated from the pre-development contour plan for the MTEC investigations.

The CPT and machine-drilled boreholes provide the most useful data in this respect as they penetrate the full depth of the silt horizon, whereas some of the shallower investigations only indicate the thickness of the cover materials. A breakdown of this information is provided in Table 5.1.2 included in Appendix C.

Tables 5.1.1 and 5.1.2 are based on our interpretation of the CPT information and the borehole logs / cores, in order to provide an indication of the overall distribution of the compressible silt horizon across the site. The ground conditions as recorded in the CPT plots have also been used to produce Geological Cross Sections A to C (see Figures 8 to 10) at the positions shown on Figure 5. The individual CPT plots and borehole logs should be referred to when considering in detail the ground conditions at any particular location. The interpreted depths of the silt horizon shown on the cross sections should not be relied upon. Additional investigations may be required to define the ground conditions at any particular lot.

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It can be seen from the tables, cross sections and individual exploratory hole logs, that the thickness of cover materials across the site varies from around 0.9 to 5.2m, with an average of around 2.7m. The thickness in Stage One is generally the greatest, with an average of 3.7m. Within Stage Two the difference between the maximum and the minimum thickness of cover material is greater than Stage One. The difference is partly the result of the greater average thickness of fill materials placed in Stage One, whereas the cut and fill depths partially cancel each other out in the two remaining stages. Note also that the minimum depth to the top of the silt horizon in Stage One is around 2.2m, but only 0.9m in Stages Two and Three.

The interpreted top of the silt horizon varies from 281 to 286m AMD, with an average of around 283.7m AMD across the three stages. The average elevation is very similar in Stages One and Two at around 283.2m AMD, increasing slightly in Stage Three, with an average just above 284m AMD. Local variations in the surface elevations would be anticipated given the assumed environment of deposition and the upper surface would be expected to increase slightly away from Lake Rotorua.

The variation in elevation of the base of the silt horizon is much greater than its top surface, as would be expected, this being controlled by the existing topography of the valley prior to its deposition in the shallow waters of the elevated lake. This varies from 273 to 286m AMD with the lowest elevations concentrated around the south-east corner of the subdivision within Stages One and Two, where minimum elevations of 273.2 and 273.1m AMD, respectively, are observed. The base of the silts generally increases towards the north and west with a minimum elevation in Stage Three of 275m AMD.

The difference in elevation between the interpreted upper and lower surfaces of the compressible silt horizon varies from virtually nothing to 10.7m, with an average of around 6.6m across the site. This includes the presence of any sand horizons and therefore does not represent the thickness that is susceptible to significant settlements/swelling. The overall thicknesses are greatest in Stages One and Two, particularly the south-east area of the site. The thicknesses in the southern and central parts of Stage Three are also considerable, but rapidly reduce towards the north, resulting in an overall average of around 5.3m.

When the thickness of the sand horizons is excluded, the difference between Stages One and Two compared with Stage Three becomes even more apparent. The maximum thickness of compressible silts within Stages One and Two is around 10m, with an average of around 6.5 to 7.5m, compared with a maximum 7.6m and an average of close to 3m in Stage Three. Again, the greatest thicknesses are observed in the south-east area of the site, reducing towards the north and west.

The thicknesses of the lower sand horizons observed in the CPTs located towards the northern part of the site is also significant. These would appear to indicate the presence of materials emanating from the slopes to the north, either through landslippage and/or slope wash.

5.1.3.3.3 Loose to Dense Sands at Depth

Each of the CPTs and machine-drilled boreholes recorded loose to medium-dense, becoming dense sands beneath the compressible silts, often following a short transition zone where soft silts are interbedded with loose sands. These are considered to be representative of the interglacial or glacial derived fluvial deposits, as discussed in Section 5.1.1.

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This lower horizon is of little significance to the engineering issues at the site and is therefore not discussed in detail further in this report. However, should the option of piles be considered at any location, then the CPT records should be referred to when determining the likely end-bearing capacity and shaft resistance that can be mobilised in these materials. Additional investigations may also be required.

5.2 Groundwater Conditions

As detailed in Section 4.1.1, slotted pipes were inserted into five of the CPT holes upon completion and two standpipes were installed in each of the three machine-drilled boreholes completed as part of the T&T investigations in July 2008. A further 17 standpipes were subsequently installed in window sample holes advanced to 3m below ground level in December 2008. The 25 monitoring points are spread across all three stages, as shown on Figure 6.

The monitored elevations / depths to groundwater level recorded at each position are provided in Tables 5.2.1 to 5.2.4 included in Appendix E.

5.2.1 Historic Information

During the initial ground investigations undertaken by MTEC in October 2004, which comprised of hand auger holes to around 2m below ground level, standing water was recorded at 11 of the 18 positions. Depths ranged from less than 0.2m to 1.4m below ground level, eight of which were less than 1m deep. It should be noted that the observed depth to standing water may not represent the actual groundwater level at that location. The infiltration rate of the silty sands / sandy silts may have prevented the recently excavated holes to equilibrate. The actual groundwater level could therefore be higher than the observed level.

Materials recovered from six of the remaining seven auger holes where groundwater was not recorded, are described on the logs as 'wet' at depths ranging from 1.3 to 4.5m below ground level and may be indicative of the groundwater level at these locations. The greater depths to apparent groundwater level were recorded at hand augers BH17 and BH18, both of which were located on the elevated sloping ground in the northern part of Stage Three. Standing water levels recorded on the lower lying areas, which covers the majority of the site, typically varied between 0.2 and 1.5m below ground level, with an average depth of less than 1.0m.

Neither the coordinates or ground levels were recorded at the hand auger locations. It has not therefore been possible to relate these depths accurately to elevation. However, using the pre-earthworks contours and the approximate hand auger locations, it is possible to estimate the elevation of the standing water recorded at each of these positions. This information, along with the depth below ground level, location and approximate subsequent depth of earthworks at these positions, is presented on Table 5.2.1.

This information suggests that the elevation of the groundwater across the site varies from around 283.5 to 286.3m AMD. The highest estimated elevations occur along the western side of Stage Three and Stage One within the valley floor, reducing towards the east across Stages One and Two. This would suggest hydraulic gradients and therefore groundwater flows in a west to east direction along the valley floor, rather than from the high ground to the north under normal conditions.

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Unlike the preliminary investigations described above, which were undertaken in mid-October 2004 at the end of the winter period, the more recent hand auger holes completed by MTEC were undertaken in late-February / early-March 2008, towards the end of the summer period. These were all located within the Stage Two area (see Figure 5).

Standing water was recorded at four of the 28 locations, at depths ranging from 2.2 to 2.8m below ground level (Lots 15/16 and 79/81), respectively. Materials logged as 'wet' were encountered at all but three of the remaining 24 positions, with depths ranging from 1.7 to 2.9m below ground level.

No coordinates or ground elevations were recorded for these exploratory holes. However, estimating the approximate ground level from the MTEC as-built contours and the pre-earthworks contours, the standing water and 'wet' horizons correspond with depths below original ground level (pre-earthworks) of between 0.5 and 3.5m, with an average depth of a little over 1.5m. This compares with an average level of around 0.75m recorded in the four auger holes completed in this area in October 2004. Whilst the data set is very limited, this would suggest a possible seasonal variation in groundwater levels within the Stage Two area of between at least 0.5 to 1.0m between October and February/March.

5.2.2 Recent Monitoring

As detailed in Section 4.1.1, standpipes and slotted pipes have been installed in a number of CPT holes, the machine-drilled boreholes and recent window sampling holes. The results of this monitoring are presented on Tables 5.2.2 to 5.2.4 and in graphical form (in terms of depth below ground level and elevation with time) on Figures 5.2.1 to 5.2.6 included in Appendix E. Note that the figures have been plotted to a common scale for easy comparison between results.

Of the recent groundwater level monitoring, the results for the open tubes installed in six of the CPT holes completed in June 2008, provide the most useful data (see Figure 6 for locations). The open tubes penetrate well into the top of the compressible silt horizon and therefore reflect groundwater conditions in both this layer and the overlying near-surface materials.

As can be seen from Figures 5.2.3 and 5.2.4, groundwater levels recorded within Stages Two and Three at these locations varied from 0.15 to 0.58m below ground level in July 2008 (excluding monitoring at points located on Lot 36 and Lot 49, which were not recorded). These vary from around 285.2 to 286.9m AMD, with the highest elevations recorded along the western side of Stage Three, reducing towards the east. Similar levels were observed at the end of August 2008 and since then have generally reduced to between 1.5 and 2.0m below ground level. The results suggest that groundwater levels typically dropped below around 1m below ground level towards the end of October. The depth to groundwater recorded at Lot 36 towards the northern end of Stage Three is generally around 3.0 to 3.5m below ground level over this same period, but with a similar elevation to the other two points located on the western side of Stage Three (Lots 31 and 26). This is in accordance with the view that groundwater baseflow is occurring from west to east along the valley floor, rather than from the high ground to the north.

The borehole standpipes are installed with response zones entirely within the compressible silt horizons; one at a relatively shallow depth (5 to 6m below ground level) and the other at a deeper level (around 9 to 11m below ground level). Boreholes BH3-58 and BH2-79 are both located within the trial load areas on these lots and BH2-64 is located a short distance from Trial Load 1, the stripped topsoil for which was placed very close to the borehole. For this reason, the groundwater levels recorded in the first few months do

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not accurately reflect the equilibrium groundwater levels as some excess pore water pressures would be expected during the primary consolidation phase of the trial load fill being placed in July 2008. The results of this monitoring are presented as Table 5.2.2 and plotted as elevation with time and depth with time on Figures 5.2.1 and 5.2.2.

The boreholes show a similar pattern to the CPT monitoring with groundwater elevations generally reducing beyond the end of September with current elevations between around 284 and 284.8m AMD, the highest levels being recorded in BH3-58 (see Figures 5.2.1 and 5.2.2). The levels recorded in the shallow and deep standpipes at BH3-58 and BH2-64 are reasonably similar, but the deeper standpipe installed in BH2-79 appears to vary more than the shallower piezometer, often with higher elevations being recorded. We suspect that this may be the result of a greater permeability of the materials within or close to the response zone in the lower standpipe, which along with the greater head of water, would result in a greater fluctuation in groundwater level.

The levels recorded in the boreholes towards the end of 2008 and early 2009 are reasonably similar to those observed in nearby CPT monitoring locations.

Standpipes installed within window sample holes drilled to a depth of 3m below ground level in December 2008 were installed partly to assist with assessing the variability of the groundwater level across the site to assist with the design of the subsoil drainage and to permit ongoing monitoring of groundwater levels. The data collected so far provides useful information regarding groundwater levels and its response with time at different locations. As can be seen from Table 5.2.5 and Figure 5.2.5, groundwater levels recorded across the site in the middle of December 2008 varied from 1.2 to 3.0m below ground level, with an average depth of 1.9m. Groundwater levels showed a small rise in early January 2009, but continued below the December levels by late January.

The rise in groundwater levels recorded on 08 January 2009 is likely to be a response to fairly heavy rainfall recorded during the end of December and early January. Some locations recorded a much greater increase in levels than most, particularly SP2-67 and SP2-70, located in the central part of Stage Two, where levels increased by around 1.0m (to between 1.1 and 1.5m below ground level) and SP3-46, within the Loop Road area of Stage Three, where a rise of 0.7m was recorded to 1.5m below ground level. Similar rises, albeit of lesser magnitude, were also recorded in the boreholes and CPTs, particularly CPT3-26. The rainfall occurred principally around the end of December and early January. It is possible therefore that the actual rise in groundwater levels could have been greater than that recorded on 08 January. The different magnitudes of response observed at the different locations could be related to differences in the permeability of the ground surrounding the standpipes and/or local topographical variations.

In summary, the various ground investigations and limited monitoring data, whilst showing some variability, clearly indicate seasonal variation. High groundwater levels were recorded in all areas of the subdivision, with the exception of a few lots located on the rising ground at the northern end of Stage Three. There appears to be a general flow from west to east across the site, but local variations in the permeability of the ground and/or springs result in some areas experiencing higher levels and responding to inputs from beyond the subdivision and from direct precipitation differently to others. It is possible that the average annual mean groundwater levels will be greater than 1m below ground level. However, if no measures are taken to control the seasonally high groundwater levels they are likely to rise to within 1m of the ground surface, and potentially to ground level, in some areas, for several months during an average winter.

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The presence of seasonally high groundwater levels may have a significant impact on the damp-proofing requirements for habitable buildings, the utility of garden areas and severely limit the capacity of the ground to absorb and attenuate rainfall during storm events. The installation of subsoil drains are therefore recommended to limit the rise of groundwater levels during seasonal highs. This issue is further discussed in Section 8.1 below.

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6 Material Properties

As detailed in Section 4.1.2 and summarised on Table 4.1, a range of laboratory tests have been conducted on samples recovered from the three machine-drilled boreholes. The results of this testing, along with the CPT data and in situ testing, have been used to provide an indication of the material characteristics, as outlined in the following sections.

6.1 Fill and Upper Sands/Silts

As detailed in Section 5.2, between approximately 1 and 5m of 'cover' materials, comprising placed fill and in situ silty sands/sandy silts, are present beneath the topsoil overlying the compressible silt horizon.

6.1.1 Density/Strength

The stiffness of the 'cover' materials is of particular significance for foundation designs as this will transfer any loads imposed on the ground to the underlying soft compressible materials (where present). Figures 6.1.1 and 6.1.2 (see Appendix C) illustrate the cone resistance (q_c) measured at each of the CPT locations in areas of fill and at-grade/cut, respectively. As can be seen, the values recorded in the upper 1m or so for the filled areas indicate typical cone resistance of between 4 and 14MPa. The in situ silts and sands, encountered from the surface in areas at-grade/cut and below the fill materials elsewhere, show typical q_c values in the range 2 to 8MPa. Where fill is present, this may generally be regarded as medium-dense to dense with some compaction of the upper in situ materials, but where the in situ materials are encountered immediately beneath the topsoil, these are typically loose, occasionally medium-dense. This has particular implications for the design of foundations in the cut/at-grade areas compared with areas where fill has been placed.

This information is presented as a general guide to the difference between the cut and fill areas. Reference should be made to the individual CPT data and/or the Scala Penetration Testing conducted at each lot by MTEC.

6.1.2 Particle Size Distribution

In order to assist with the design of the subsoil drainage system which is required to lower the seasonally high groundwater levels, as detailed in Section 8.1.1, samples of the in-situ silty sands/sandy silts were taken from the cut area in Stage Three and subjected to laboratory gradings analyses. The results of this testing are included in Appendix D.

The particle size distributions indicate that the in situ materials comprise relatively uniformly graded (uniformity coefficients, U_c, of around 7) very silty sands. The silts are predominantly medium to coarse and the sands almost entirely fine. The fill materials are expected to have similar gradings where these have been won from adjacent cut areas, particularly for Stages Two and Three. The fill placed in Stage One, which originated principally from the lake terrace deposits in Stage Four and from imported Rhyolite, is likely to have a smaller silt proportion.

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6.1.3 Hydraulic Conductivity

On the basis of the particle size distribution (D_{10} of around 0.01mm) of the in situ silty sands described above, a hydraulic conductivity of around 1 x 10^{-06}m/s[3]. This would be considered typical of silty fine sands.

Falling head tests were conducted in two augered boreholes sunk to depths of around 1.5m below ground level in January 2009. Despite the auger holes being advanced below the standing groundwater level and a head of water at least 1m above ground level, virtually no infiltration occurred through the base of the hole over the two hour test period. This would suggest much lower hydraulic conductivity than indicated above, but we consider that some smearing of the base of the hole during drilling and/or settling of fine particles may have prevented the tests providing an accurate result.

6.2 Compressible Silt Horizon

A detailed examination of the compressible silt materials recovered from the three machine-drilled boreholes indicates that these are reasonably consistent across the subdivision, but contain some bands that are particularly sandy and pockets/layers which are particularly fibrous/organic.

The laboratory tests detailed below were undertaken on open tube samples obtained from the boreholes.

6.2.1 Undrained Shear Strength

An assessment of the undrained shear strength of the compressible silt materials may be ascertained from the cone resistance of the CPTs. As indicated on Figure 6.1.1, q_c values generally fell well below 0.3MPa within this horizon, suggesting undrained shear strengths below 30kPa. However, many of the CPTs also showed q_c values below 0.1MPa for significant thicknesses of this horizon, and dropping to zero (i.e. beyond the detectable limit of the cone) in places. This can only be seen by reviewing the raw CPT data as the scale of the plots is not sufficient to show this level of detail.

These results suggest the silt materials to be very soft to firm, but typically soft (i.e. c_u between 12 and 25kPa). The materials recovered in the machine-drilled boreholes are generally described as very soft to soft.

6.2.2 Natural Moisture Content and Plasticity

The natural moisture content and Atterberg limits of five samples have been determined, the results of which are summarised in Table 6.2.1 below.

Note that the samples taken from BH2-79 and BH3-58 are recorded as non-plastic as it was not possible to roll the samples to a thread of 3mm diameter, unlike the samples taken from BH2-64. During our examination of the cores, we determined that most of the materials are plastic, as indicated by the tests undertaken by Opus.

The natural moisture contents are all very high, ranging from 108 to 206% and the liquid limits suggest that the materials have extremely high plasticity (liquid limits in excess of 90%, as defined by the British Soil Classification System) and would plot well below the

[3] Where the coefficient of permeability, k, is roughly equal to $(D_{10})^2$, as proposed by Hazen's Formula.

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A-line on the plasticity chart, indicating them to be highly organic silts with liquidity indices approaching 1.

Sample	Depth	Natural Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Organic Content
	(m bgl)	(%)	(%)	(%)			(%)
BH2-64	4.10 to 4.60	206	68	80	148	0.85	
BH2-64	5.95	123	127	88	39	0.89	
BH2-79	4.70 to 4.90	108	146	-	-	-	6.5
BH2-79	6.75 to 6.95	254	182	-	-	-	7.6
BH3-58	5.70 to 5.90	165	143	-	-	-	7.4

Table 6.2.1: Summary of Natural Moisture Content, Atterberg limits and Organic Content laboratory tests.

6.2.3 Organic Content

Three of the samples subjected to natural moisture content and Atterberg limit testing were also screened for organic content, the results of which are included on Table 6.2.1 above. These indicate around 6 to 8% organic content, which is considered quite high for a predominantly silt material. This relatively high organic content is also suggested by the fibrous/peaty texture of the materials.

6.2.4 One-Dimensional Consolidation

The same five samples tested for natural moisture content, Atterberg limits and organic content described above, plus a further sample taken from BH2-64, were tested to determine their one-dimensional consolidation properties using the Oedometer apparatus, with between six and eight load stages and one unload cycle. Three of these tests, conducted by Geotechnics, comprised two hour load cycles, whilst the tests undertaken by Opus were continued for 24 hours. The longer loading stages were scheduled to gain a better understanding of the long-term, secondary compression, characteristics of the materials.

The results of this testing are summarised in Table 6.2.2 below.

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Sample	Depth	Initial Water Content	Initial Void Ratio	Coefficient of Volume Compressibility (m_v)	Coefficient of Consolidation (c_v)	Coefficient of Permeability (k)
	(m bgl)	(%)		(m^2/MN)	(m^2/yr)	(m/s)
BH2-64	4.10 to 4.60	206	5.28	0.8 to 1.4	30 to 51	$2.1x10^{-08}$
BH2-64	5.71 to 5.73	112	2.79	0.5 to 0.9	35 to 60	$2.1x10^{-08}$
BH2-64	5.95 – 5.97	123	3.07	0.8 to 1.3	41 to 108	$2.0x10^{-08}$
BH2-79	4.78 – 4.83	108	2.67	0.9 to 1.3	22 to 37	$9.3x10^{-09}$
BH2-79	6.85 to 6.90	254	6.35	0.9	21 to 35	$8.1x10^{-09}$
BH3-58	5.80 to 5.85	165	4.12	0.9	15 to 22	$4.8x10^{-09}$

Table 6.2.2: Summary of One-Dimensional Consolidation Test Results.

Notes:

1. The m_v values given relate to the load stages which represent the typical stress ranges most relevant to the compressible silt horizon. This includes the 50 to 100kPa and 100 to 200kPa increments for BH2-64 samples and for the 30 to 60kPa and 60 to 120kPa increments for BH2-79 and BH3-58 samples.
2. The range of c_v values given is that obtained for all load increments.
3. The k value given is the average for all load stages. This is derived from $k = m_v.c_v.\gamma_w$.
4. The typical t_{90} intercept was typically around 0.5 minutes, occasionally 1 minute, for all tests.

The results of this testing are discussed below and detailed further with reference to the results of the trial loads in Section 7.2.

6.2.4.1 Primary Consolidation Characteristics

As can be seen in Table 6.2.2, there is a wide variation in the void ratios between the samples, but the higher void ratios do not appear to translate into higher compressibility.

6.2.4.1.1 Coefficient of Volume Compressibility (m_v)

For the typical in situ stresses which the compressible silt horizon is subject to, the coefficient of volume compressibility (m_v) varies from around 0.9 to 1.3m^2/MN, which indicate it to be highly compressible. This is typical of normally-consolidated alluvial deposits. Much higher values (up to 3.8m^2/MN) were recorded at lower stress increments, but these are generally below the estimated in situ stresses, and are likely to be influenced by sample disturbance.

6.2.4.1.2 Compression Index (C_C)

We have made an assessment of the preconsolidation stress (σ_c') utilising the results obtained for the three samples taken from BH2-64, which were subjected to 24 hour load cycles. These have been corrected for sample disturbance, in accordance with the method

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recommended by Schmertmann (1955)[4]. This assessment is presented as Figures 6.2.1 to 6.2.3 (see Appendix D) for the three samples.

The preconsolidation stresses are difficult to estimate with a high level of accuracy due to the gently curved nature of the e-log σ′ curves. However, the results suggest these to be around 38kPa for the sample taken from around 4.0m below ground level and 55kPa at close to 6m below ground level. These values are not dissimilar to the assumed maximum in situ stresses given the likely bulk densities of the natural materials and a relatively shallow groundwater level (<2.0m).

These results indicate adjusted C_c values in the range 0.9 to 1.6. This translates to a compressibility coefficient C (where $C = C_c/1+e_0$) of around 0.22 to 0.27.

6.2.4.1.3 Coefficient of Consolidation (c_v)

The coefficient of consolidation (c_v) values obtained from the laboratory tests typically vary from around 15 to 60m²/yr, with a few higher values (maximum of 108m²/yr).

As part of the July 2008 CPT investigations, a total of 18 dissipation tests were conducted, ten of which were located within the compressible silt horizons away from any obvious sand horizons. The results of this testing and derived c_v values[5] are presented in Table 6.2.3 below:

CPT No.	Ground Level	Test No.	Test Depth	Test Depth	t_{50}	Estimated c_v
	(m AMD)		(m bgl)	(m AMD)	(Minutes)	(m^2/yr)
CPT1-01	287.50	1	5.24	282.26	0.26	126
CPT1-17	286.30	1	4.00	282.30	4.8	7
CPT1-17	286.30	2	6.00	280.30	0.5	72
CPT2-16	285.40	1	4.00	281.40	8.2	4
CPT2-16	285.40	2	6.00	279.40	4.5	7
CPT2-68	285.80	1	5.00	280.80	3.1	11
CPT2-71	286.10	1	7.00	279.10	3.7	9
CPT2-74	285.90	1	4.00	281.90	9.8	3
CPT3-24	287.20	1	5.00	282.20	0.47	72
CPT3-61	286.90	1	5.00	281.90	1.1	30
Maximum					9.8	126
Minimum					0.26	3
Average					3.6	34

Table 6.2.3: Summary of Dissipation Test Results and Derived c_v values.

[4] Schmertmann, J. H. (1955). "The Undisturbed Consolidation Behaviour of Clay", ASCE Transactions, Vol. 120, p. 1201-1233.

[5] In accordance with the procedure given by Lunne et al. in *Cone Penetration Testing in Geotechnical Practice* (1997).

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These provide a range of c_v values similar to the laboratory test results, with an average of around 35m²/yr, but with greater variation.

6.2.4.2 Secondary Compression ('creep') Characteristics

As a result of the peaty texture and organic content of the compressible silts it was considered that the materials may undergo potentially significant secondary compression or 'creep' settlements. Although the 24 hour load cycle tests provide better information, the 2 hour tests also provided useful data regarding the speed of the primary consolidation. The thin tests samples also indicate that a linear portion was obtained over one log cycle for these tests following virtual completion of primary consolidation.

A plot of settlement against log time for each of the seven load stages conducted for the sample taken from between 4.1 and 4.6m below ground level of BH2-64 is illustrated on Figure 6.2.5. A similar plot, but presenting the data for the 50 to 100 or 60 to 120kPa load stage of each of the six tests, is provided as Figure 6.2.6. Values of the coefficient of secondary compression in terms of vertical strain ($c_{\alpha\varepsilon}$) have been derived from this data, using either the 10 to 100 minute log cycle and/or the 100 to 1000 minute stage for the 24 hour tests. The results of this assessment are provided in Table 6.2.4 below.

24 Hour Load Cycle Test Results

Load Stage Pressure Range (kPa)	BH2-64		4.1-4.6m	BH2-64		5.71- 5.73m	BH2-64		5.95-5.97m
	10-100	100-1000	Average	10-100	100-1000	Average	10-100	100-1000	Average
0 to 2.5				0.001	0.001	0.001			
2.5 to 5.0	0.003	0.003	0.003	0.001	0.003	0.002	0.001	0.001	0.001
5 to 10	0.007	0.006	0.006	0.004	0.004	0.004	0.002	0.003	0.003
10 to 25	0.009	0.009	0.009	0.005	0.004	0.005	0.006	0.006	0.006
25 to 50	0.011	0.011	0.011	0.006	0.006	0.006	0.012	0.011	0.012
50 to 100	0.012	0.013	0.012	0.012	0.008	0.010	0.013	0.012	0.012
100 to 200	0.014	0.014	0.014	0.009	0.009	0.009	0.014	0.013	0.014
200 to 400	0.016	0.016	0.016	0.010	0.010	0.010	0.015	0.014	0.014
400 to 800				0.011	0.011	0.011			

2 Hour Load Cycle Test Results

Load Stage Pressure Range (kPa)	BH2-79		4.78-4.83m	BH2-79		6.85 - 6.90m	BH3-58		5.80-5.85m
	10-100	100-1000	Average	10-100	100-1000	Average	10-100	100-1000	Average
7.5 to 15	0.002		0.002	0.001		0.001	0.001		0.001
15 to 30	0.003		0.003	0.002		0.002	0.002		0.002
30 to 60	0.004		0.004	0.004		0.004	0.005		0.005
60 to 120	0.006		0.006	0.008		0.008	0.010		0.010
120 - 240	0.007		0.007	0.010		0.010	0.009		0.009

Table 6.2.4: Summary of laboratory derived coefficient of secondary compression values.

Both the figures and tabulated results indicate that the value of $c_{\alpha\varepsilon}$ is load dependent, increasing with applied load, particularly at low stresses, but becomes more constant at higher stresses. The results also show a reasonable difference between the three samples taken from BH2-64, but all of these have $c_{\alpha\varepsilon}$ around 0.01 for the 50 to 100kPa stress increment. The remaining samples, taken from BH2-79 and BH3-58, are generally less

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than 0.01 for the slightly higher stress range of 60 to 120kPa. The range of values obtained are typical of normally-consolidated, organic alluvial deposits.

The results for the 24 hour cycles generally indicate similar $c_{\alpha\varepsilon}$ value for the 100 to 1000 minute log cycle as the 10 to 100 minute period, suggesting that the log time approximation is reasonably valid for these materials.

6.2.4.3 Hydraulic Conductivity

In order to assist with determining the likely speed of primary consolidation settlements associated with the compressible silt horizon, a total of six variable (falling) head permeability tests were carried out, two in each of the three boreholes. These were completed at depths ranging from 3.0 to 6.5m, and involved a test length of approximately 1m, by withdrawing the drill casing after drilling to the required test depth. These in situ tests were in addition to the CPT dissipation tests and laboratory consolidation tests which provide a direct measure of the coefficient of consolidation.

Studies have shown that c_v values calculated using $m_{v(lab)}$ results and field permeability, often provide a more reliable indicator of the speed with which excess pore water pressures dissipate, by testing the infiltration capacity of the soils macro-structure, including horizontal seepage, rather than purely vertical drainage through the very small disc of soil used in the Oedometer test.

Analysis of the results of these tests gave reasonably consistent results with estimated hydraulic conductivities of around 2×10^{-06}m/s, but ranging from 3×10^{-07}m/s to 6×10^{-06}m/s. These are at least one order of magnitude higher than the estimated values determined from the laboratory tests and those that were inferred from the CPT dissipation tests, as detailed in Section 6.2.4.1.3 above, as is often the case. These values do nonetheless appear quite high for an organic silt and it may be that some water could have escaped through the borehole casing joints or up the annulus between the casing and the borehole. Any such losses would have a potentially significant impact on such low permeability materials.

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7 Settlement Monitoring and Trial Load Results

7.1 Settlement Monitoring

As detailed in Section 4.2.1, a total of 39 settlement markers were established across the three stages (6, 14 and 19 in Stages One, Two and Three, respectively) in July 2008, with a further eight added to monitor two properties within Stage One in October 2008. The positions of these are indicated on Figure 7. The results of this monitoring are provided on Tables 7.1.1 and 7.1.2 in Appendix F (in terms of elevation and cumulative settlement, respectively) and are illustrated graphically on Figures 7.1.1 to 7.1.3 for Stages One to Three, respectively. Note that the figures are plotted to a common scale for ease of comparison.

It is apparent from the tables and figures that following establishment of the monitoring points in early July 2008, the majority of the survey markers showed a small rise during the remainder of July which continued until around the end of August, albeit limited to a maximum of 8mm. The greatest rise in elevation appears to have occurred where the underlying compressible silt horizon is thickest, particularly in the south-east corner of the site (i.e. SMP1-17 and SMP1-20 in Stage One, Road 2-2, SMP2-85, Road 2-3 and SMP2-16 in Stage Two and SMP3-24, SMP3-31 in Stage Three). All of these points are located in areas where fill has been placed. The majority of the remaining points also show some increase in elevation, but to a lesser degree. The only points that show no effective rise are located in the north of Stage Three where little or no compressible silt materials are present.

During late August and September 2008, the monitoring points appeared to stabilise somewhat before showing a general ongoing reduction in elevation from October until the most recent survey data available in late January 2009. The greatest reduction was recorded at SMP2-16, located in an area of fill overlying thick compressible materials in the south-east corner of the site. At the end of January the settlement marker was recorded as being 8mm below the start elevation and a total of 12mm from its maximum of plus 4mm in mid-August. It is notable that the points recording the greatest rise in elevation during July and August generally then showed the largest reduction from October onwards, these being concentrated in the south-east of the site where reasonably deep fill has been placed over thick compressible materials.

The changes in elevation of the survey points appear to correlate quite closely with the seasonal variation in groundwater levels, as detailed in Section 5.2. The period during which a rise in elevation was recorded for many monitoring points (July to August) roughly coincides with the time that groundwater levels were shown to be at their highest level across the site. The general fall in survey levels from late-September onwards corresponds with a gradual reduction in groundwater levels across the site.

The seasonal variation in groundwater levels will result in significant changes in the effective stress within the compressible silt horizon. The lower effective stress present during periods of high groundwater levels appears to be resulting in some swelling of the compressible silt horizon. The magnitude of this swelling is determined by the thickness of the silt horizon, but also by the amount of fill that has been placed. It has been noted that the swelling is generally greater in the fill areas.

It is worth noting that whilst the monitoring data available for the three house sites is fairly limited, particularly for the building on Lot 9 due to damage of the survey markers,

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the difference in the magnitude of change between lots located in areas of fill compared with those in cut (both on thick compressible materials) is potentially significant. The house on Lot 72 has shown very little change (2 to 3mm) over the 6 month monitoring period, whilst the property on Lot 18, where up to 1.5m of fill has been placed, has shown 4 to 7mm of change in three months (October to January). Assuming Lot 18 would have responded in a similar fashion to the adjacent Lot 17 during July and August, the total change could be over 10mm for the same period at that lot.

Given the compressibility characteristics of the silt horizon, as suggested by the laboratory testing results and trial load data, a 1m or so change in groundwater level (i.e. a change in effective stress of around 10kPa) could result in settlements of around 50 to 100mm for a strictly normally-consolidated material. The actual settlements recorded are considerably less than this, indicating pre-consolidation due to previous seasonal groundwater level changes.

7.2 Trial Loads

7.2.1 Description

As indicated in Section 4.2.2, three trial loads were established in July 2008, two within Stage Two and one in Stage Three, at the locations shown on Figure 7. Summary details of these are provided in Table 7.2.1 below:

Trial Load Number	Stage	Lot	Depth of Trial Load Fill	Depth of Cut / Fill	Depth to Compressible Horizon	Thickness of Compressible Horizon (excluding sand bands)	Maximum Settlement Recorded
			(m)	(m)	(m below ground level)	(m)	(mm)
1	2	64	1.4	+0.50 to +0.75	2.6	7.6	218
2	2	79	1.3	-0.50 to -0.75	3.6	4.1	41
3	3	58	1.0	-0.25 to -0.50	4.2	5.9	25

Table 7.2.1: Summary details of trial loads.

Notes:

1 – Trial load fill had typical placed bulk density of around 18Mg/m^3.

2 – Maximum recorded settlement relates to period from mid-July 2008 to mid-January 2009 (approximately 6 months).

Three trial loads were adopted as a minimum in order to assess the variation in rate and magnitude of settlements that would result from different applied loads (i.e. the depth and area of the trial load fill), depth of 'cover' materials to the top of the compressible horizon, thickness of compressible horizon and any sand layers present, effect of preconsolidation pressures (i.e. resulting from cut/fill operations and historic seasonal changes in groundwater level) and any natural variability in the nature of the compressible silts (i.e. plasticity, organic content).

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The trial loads were each monitored at 13 positions, as shown on Figures 7.2.1 to 7.2.3 for Trial Loads 1 to 3, respectively. These include one at the centre of the load, four points around the top of the side slopes midway along the sides and then equivalent points at the toe of the batter slopes, and also offset approximately 2.5m from the toe of the slopes.

7.2.2 Results

The raw survey data is provided on Tables 7.2.2 and 7.2.3 in Appendix G (relating to elevation and cumulative settlement, respectively), and is depicted in graphical form on Figures 7.2.4 to 7.2.9. Additional plots are included to illustrate the estimated speed of primary consolidation and to assess the magnitude of total settlements using a hyperbolic model, are presented as Figures 7.2.10 and 7.2.11, respectively. The tables and figures are included in Appendix G.

As can be seen from Table 7.2.1, the overall magnitude of the maximum settlements recorded at the three trial loads varied by almost an order of magnitude, with a total of 41 and 25mm recorded at Trial Loads 2 and 3, compared with 218mm at Trial Load 1, despite the reasonably similar thickness of compressible silts at these locations. The main controlling factor governing this response is considered to be the variation in depth of cut/fill present at each site and therefore the present level of stress on the compressible silt horizon relative to the preconsolidation stress. Trial Load 1 is located in an area where fill has been placed and Trial Loads 2 and 3 are within areas of shallow cut. The range in depth of cut/fill given in Table 7.2.1 reflects both the uncertainty in the accuracy of the cut/fill contours and the actual variation in depths across the footprint of the trial loads.

It can be seen from the plot of settlement against time for Trial Load 1 (Figure 7.2.4) that the greatest change occurred at the centre of the load, followed by the points located around the top edge of the batter slopes, reducing further to the points along the toe of the slopes and with relatively little or no settlement at the markers offset 2.5m. This is consistent with a Boussinesq-style assumed pressure distribution, as illustrated on Figure 7.2.12, in which the applied pressure reduces both with depth and distance from the centre of the applied load. The settlements occurring at the points located around the top edge of the trial load are roughly between 50 and 65% of that recorded at the centre, which is proportional to the level of load that would be predicted. The settlement at the base of the batter slopes is roughly 50% of that observed at the tops of the slopes (or 25% recorded at the centre). This is important when considering the potential differential settlements that might be anticipated across large raft foundations. It should be borne in mind however that the trial loads are largely flexible, whereas a raft would have a finite stiffness. The stiffness of the raft would tend to even out the differential settlement between the centre and edges/corners.

The remaining two trial loads did not show a similar pattern, with some points around the edges of the loaded areas showing greater settlement than the centre marker. This is likely to be the result of a combination of local variations in the thickness of the trial load fill placed, the depth of cut which varies across the width of the trial loads and the local thickness of the silt horizon.

As can be seen from Figures 7.2.4 to 7.2.6, each trial load shows an initial, almost immediate compression, followed by a relatively rapid primary consolidation (similar to the laboratory test results). Some of the initial compression will include immediate settlement of the 2 to 3m of 'cover' materials and there may be some lateral spreading /undrained distortion, as suggested by the small rise recorded at some of the peripheral points following the initial reading. However, the similarity of the curves with those

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obtained with the laboratory specimens, that are laterally confined, would suggest a large component of this initial compression may be a result of the organic nature of the silt, the applied load causing any peaty/fibrous material to partially collapse.

Following on from the approximate end of primary consolidation, a reasonably linear curve was observed for a couple of months, which may be assumed to be representative of secondary compression ('creep'), with some ongoing primary consolidation. This is illustrated on the settlement against log time plots presented as Figures 7.2.6 to 7.2.8. This period coincides with reasonably static groundwater levels observed during August and September 2008. The remaining settlement markers located away from the trial loads, as detailed in Section 7.1 above, showed little change in elevation during this period, so it is unlikely that this ongoing movement is purely a result of any limited changes in groundwater level. Beyond the end of September however, there appears to be a steepening of the settlement curve, unlike that observed in the laboratory test samples, which continued at a near linear rate. This is likely to be the result of additional primary consolidation occurring in response to a lowering of the site groundwater level. As indicated in Section 6.2.4, the magnitude of the coefficient of secondary compression ($c_{\alpha\varepsilon}$) appears to be stress dependent and therefore it may be assumed that the increased stress could also result in a larger $c_{\alpha\varepsilon}$ value, which would also cause a steepening of the curve. Given the limited magnitude of any ongoing creep settlements that would be anticipated over the short period of the monitoring, any additional primary consolidation settlements could result in a significant distortion of the apparent secondary compression curve.

7.2.3 Significance for Settlement Prediction

The following sections provide an indication of the impact of the trial load results on predicting the rate and magnitude of settlements under different conditions present at the subdivision. The discussion includes the results of laboratory testing, where relevant.

7.2.3.1 Primary Consolidation

7.2.3.1.1 Rate

Values of the coefficient of consolidation (c_v) determined from the laboratory samples typically ranged from around 15 to 60m^2/yr, with a few higher values (maximum 108m^2/yr) and similar results were obtained from the CPT dissipation tests (average around 35m^2/yr). An assessment of t_{90} from the Trial Load 1 data (Figure 7.2.10) suggests around 20 to 30 days for 90% primary consolidation of the 6m or so thick upper silt horizon (above the dense sand layer). Assuming two-way drainage this would indicate a $c_{v(field)}$ value slightly higher (around 125m^2/yr), but not dissimilar to, the upper laboratory values. The higher $c_{v(field)}$ value is likely to be representative of the macro-structure of the organic silts and the presence of reasonably laterally persistent coarser silt and fine sand layers, as would be expected for this type of deposit. Evidence of such is seen in the boreholes cores.

7.2.3.1.2 Magnitude

As detailed in Section 6.2.4, estimates of the compressibility coefficient C (where $C = C_c /1+e_0$) and coefficient of volume compressibility (m_v) from the laboratory test data, are typically in the range 0.20 to 0.25 and 0.9 to 1.3m^2/MN, respectively (for the typical stress ranges involved).

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For the ground conditions encountered at Lot 64 where Trial Load 1 is located, the settlements derived from laboratory test m_v and C values are of a similar order to the monitoring data. Estimates based on $m_{v(lab)}$ and $C_{(lab)}$ suggest primary consolidation settlements of around 125mm would occur beneath the centre of Trial Load 1. The monitoring data indicate around 120mm, which corresponds to a typical $m_{v(field)}$ value of around 1.1m^2/MN.

Assuming a stiff raft foundation with an imposed load of 10kPa was placed on Lot 64 instead of the trial load of around 25kPa, primary consolidation settlements of the order of 40mm would be anticipated from the back-analysed $m_{v(field)}$ values (taking account of the load spreading effect of the raft). These are of a similar magnitude to the rapid settlements occurring beneath the edges of the Trial Load 1, which would be imposing a similar level of stress on the ground.

The loads imposed at the two remaining trial loads, which are in areas of cut, are unlikely to have exceeded the preconsolidation stresses and therefore determination of the anticipated primary consolidation settlements would use values of m_v or C_C taken from the over-consolidated portion of the e-log σ' curve. The laboratory derived values appear to correlate well with those determined from the trial loads, with $C_C/1+e_0$values typically in the range 0.1 to 0.2.

7.2.3.2 Secondary Compression

As detailed in Section 6.2.4, the laboratory tests using 24 hour load cycles suggested $c_{\alpha\varepsilon}$ values of around 0.01 (in terms of vertical strain) for the relevant stress range being considered. Figures 7.2.7 to 7.2.9 show the results of the trial load monitoring settlement against log time onto which the linear portion of the assumed secondary compression curve has been extended to a period of 50 years (that derived from the data occurring after the majority of primary consolidation had occurred and during a period when groundwater levels were relatively stable). This provides an estimate of the potential magnitude of settlement resulting from initial compression, primary consolidation and ongoing secondary compression for the design life of any future dwellings. It also allows an estimate of the $c_{\alpha\varepsilon}$ value at each of the settlement marker positions, which correspond to different loadings.

In common with the laboratory test results, these indicate that $c_{\alpha\varepsilon}$ vary with stress level. This information is most readily inferred from the results of Trial Load 1, partially because the greater settlements allow a more accurate estimate of the ongoing trend, but also because the ground at this location, being in an area of fill, is likely to be closer to or above its preconsolidation stress, whereas those in cut may be below this level.

In the following discussion, the change in stress level which is being imposed on the compressible silt horizon, resulting from the trial load fill, has been adjusted to reflect the fact that the groundwater level was still at a high level during the early stages of the trial load period. Following substantial completion of the bulk earthworks in Stage Two during late 2007, the groundwater level would have fallen to a summer low in early 2008. Assuming the groundwater level reduced to a similar level to that reached in previous years, the placement of fill would have caused an increase in the preconsolidation stress. The weight of the trial load fill placed when the groundwater level was quite high would not therefore load the ground to the same magnitude. Although we do not have groundwater level data for the 2007-8 summer period, the current (February 2009) level would suggest a potential variation in groundwater elevation of around 0.5 to 1.0m (i.e. a change in vertical effective stress on the compressible horizon of up to 10kPa).

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The trace of the central point on Trial Load 1, with an imposed trial load of around 25kPa, the $c_{\alpha\varepsilon}$ appears to be around 0.01 and would predict a total settlement over 50 years of around 350mm (see Figure 7.2.7). The pressures around the edge of the trial load, of about 10 to 12kPa, give $c_{\alpha\varepsilon}$ ranging from around 0.006 to 0.003, for settlement markers at the top and at the bottom of the edge batter respectively, corresponding with total settlements of between roughly 100 and 200mm. This plot allows a quick estimate of the total amount of settlement that will occur at any point from the application of the load to the end design life of the structure. At the end of the monitoring period (roughly six months after application of the trial load fill), approximately 180mm of settlement has occurred at the central point and between 50 and 100mm at the peripheral points.

In reviewing this data it should be noted that around 0.75m of fill (around 13kPa) had already been placed (at least 12 months ago) and so some secondary compression will have already been completed (approximately 50% occurs in the first 12 months of the 50 year period). The trial load and placed site fill is therefore effectively representing an imposed load of 38kPa (13 +25) on the natural ground at the centre and similarly higher values elsewhere. It would be very difficult to identify the creep settlements resulting from the fill placement 12 months ago and then add on to that the trial load induced settlements, with any reasonable degree of accuracy. In any case, it is not necessary to attempt this, as the measured creep settlement from the trial loads incorporates the effect of both the pre-existing fill and the trial load.

At Trial Loads 2 and 3, low $c_{\alpha\varepsilon}$ values are suggested, with 0.002 for the central point on Trial Load 2 (Lot 79), reducing to a maximum around 0.001 at the edge of the main load area and no appreciable ongoing settlement recorded at the toe of the slopes. No significant (discernible) ongoing secondary compression is evident at Trial Load 3 (Lot 58).

In general, we consider that the trial load data provides a more accurate reflection of the rate of ongoing secondary compression, despite the complications represented by varying groundwater levels, partly because it is testing the actual ground conditions (including the presence of the cover materials), rather than small samples, but also because the imposed stresses are of a similar level. We consider that the field results are therefore likely to provide a more accurate indication of the actual response of the ground to loading compared with the laboratory test results.

On the basis of the $c_{\alpha\varepsilon}$ values estimated from Trial Load 1, creep settlements of the order of 200 – 250mm over 50 years are estimated for a 25kPa load in addition to the existing fill depth ($c_{\alpha\varepsilon}$ = 0.01), with predicted total settlements of around 350mm. At the likely loads imposed by a new dwelling and foundations of up to 10kPa ($c_{\alpha\varepsilon}$ = 0.003 to 0.006), creep settlements of the order of 50 to 150mm over 50 years are possible, with total settlements of around 100 to 200mm.

We have also assessed the settlement data using the hyperbolic model approach. This makes use of the fact that settlement curves (primary + secondary) are generally hyperbolic in shape. The trial load settlement curves have a near vertical section at the start (initial compression) and from that point tend towards a hyperbolic curve (see Figure 7.2.11 and explanatory sheet in Appendix G). For our settlement predictions using this method, we have added the vertical portion representing initial compression to the result obtained. Using the hyperbolic model to estimate the total long term settlement at Trial Load 1, estimates of around 250 to 300mm at the centre of the load and 150 to 200mm at the edge are indicated. These are of a similar order to those quoted above.

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In Trial Load 2, the total primary plus secondary occurring over 50 years which can be predicted from the settlement graphs is as follows: 55mm at centre and 20 to 30mm at edge. Values of $c_{\alpha\varepsilon}$ of around 0.002 or less have been assessed from the trial load data. This area has been cut by 0.5 to 0.75m and is underlain by 4.1m of soft silt. No hyperbolic assessment has been carried out on this settlement data as the curves are not hyperbolic in shape.

The Trial Load 3 results do not correlate well with the Trial Load 2 results. Between 0.25 and 0.5 m of cut has occurred at the Trial Load 3 location and it is underlain by 5.9m of compressible silt. Though the depth of fill is somewhat less than in Trial Load 2 (1 m compared with 1.3m), greater settlement would be expected. However, considerably lower primary settlement and practically no creep movement has been recorded. The reasons for this are unclear. Lot 58 is located adjacent to the reserve area where up to 2.5m of unsuitable fill materials has been placed. It is possible that this material may once have been temporarily placed on Lot 58 and thus resulted in considerable preconsolidation. Note that the q_c values recorded in the CPT3-58 are higher than those for Trial Load 2 and significantly larger than for Trial load 1.

7.3 Conclusions Regarding Settlement Assessment

Bringing together the results of the laboratory testing, trial loads and groundwater monitoring, our conclusions regarding the potential for significant ongoing settlements are as follows:

- Due to the time that has lapsed since the earthworks operations were completed (at least 12 months and up to 24 months for Stage One), virtually all immediate and primary consolidation settlements resulting from the placement of fill in some areas of the site will now be complete.
- The seasonal variation in groundwater level prior to the site development will have resulted in some preconsolidation of the silt horizon, when the groundwater is higher than its annual minimum level. When the groundwater is at the lowest annual level (this probably occurs towards the end of summer), the soil is close to being in a normally consolidated condition. The seasonal variation in groundwater level causes minor swelling and settlement to occur.
- In areas of cut, this effective over-consolidation was increased by the removal of load and some swelling is likely to have occurred.
- The immediate effect of the placement of a reasonable depth of fill (>~0.5m) would have depended on the groundwater level at the time the fill was placed. If the groundwater level was close to its lowest annual level then the loading would have brought the silt horizon into the normally-consolidated range. Large settlements would have occurred quickly. If the groundwater was close to its highest annual level, the loading would have been substantially within the over-consolidated range and minimal settlement would have occurred. The subsequent lowering of the groundwater level would have brought the soil into the normally-consolidated range and significant settlement would then have occurred.
- Where surcharging of house sites is proposed, the likely groundwater level will need to be taken into account in assessing the amount and period of the preload. Surcharge placed during the winter months when groundwater levels are high

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will have limited effect, unless additional load is placed to overcome the effect of the high groundwater levels.

- Where fill has been placed, any future loads could result in settlements which are on the virgin compression line and may include significant ongoing creep settlements. The amount of settlement will depend on the thickness of the compressible soil at that location.
- In areas of cut, loads resulting from the construction of a conventional house are unlikely to exceed the preconsolidation stress and therefore relatively minor settlements will result.
- For areas at-grade, settlements caused by the loads from a conventional house are likely to be within tolerable limits provided care is taken to limit differential settlement.
- For areas at-grade and in cut, the preconsolidation stress could be exceeded during an extremely dry summer if the groundwater level drops close to or below that previously experienced, particularly when combined with the loads from a conventional house. In this situation, primary consolidation within the normally-consolidated range could occur with the settlements potentially significant.
- The seasonal variation in groundwater levels will cause some settlement/swelling to occur in all areas, but the magnitude will be greatest on those areas within the thickest compressible silt horizon.
- Where conventional brick clad dwellings with tiled roofs are constructed in areas where a reasonable depth of fill has been placed and are underlain by more than 3m of soft compressible silts, there is a significant risk of potentially damaging settlements to occur within the lifetime of the building. The use of specifically designed cellular raft foundations could reduce the impact of the settlements, but pre-loading of the house site will also be required to reduce this to an acceptable level of risk. It may be possible to construct lightweight dwellings founded on specifically designed cellular raft foundations at these locations without a pre-load, subject to site specific assessment.
- In areas where fill has been placed overlying less than 3m of soft silt, pre-loading is unlikely to be required, provided a specifically designed cellular raft foundation is adopted and allowance is made for the anticipated settlement. This conclusion is subject to site specific assessment.
- In areas of cut and at-grade, regardless of the thickness of the compressible silt layer, pre-loading is unlikely to be required, provided a specifically designed cellular raft foundation is adopted and allowance is made for the anticipated settlement. This conclusion is subject to site specific assessment.

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8 Implications for Future Development

8.1 Groundwater Levels

As detailed in Section 5.2, seasonal groundwater levels have in the past risen close to or at ground level, even in areas where fill has been placed. RDC RCEIS[6] Clause 3.7 indicates that fill should be placed to ensure that building platform ground levels are not less than 1m above the mean groundwater level and at least 1.5m above the finished floor level. No precise definition of what is meant by 'mean' groundwater level is provided. It may be reasonably interpreted however that the mean level refers to the 'typical' or 'equilibrium' condition, i.e. the normal level excluding short-term rises resulting from rare or extreme events. Any other definition, such as the mean annual groundwater level or the mean groundwater level across the site, would suggest it acceptable for the subdivision to be exposed to high groundwater levels for some reasonably extended periods (i.e. in excess of that resulting from a rare or extreme event, such as the winter months) or for parts of the site to have typically higher groundwater levels than other areas. Either of these latter definitions may be considered contrary to the Building Act, since high groundwater levels even for relatively short periods could result in rising damp and unsanitary conditions in amenity areas, including gardens. The requirements of the Building Act would therefore prevail in these conditions.

The monitoring data obtained over the past six months would suggest that the mean annual groundwater level at any location within the subdivision, and certainly the mean annual level across the entire subdivision, may be greater than 1m below ground level, although monitoring up until July 2009 would be required to confirm if this was the case over a single 12 month period. We do not consider this particularly relevant, for the reasons detailed above.

Whilst it may be possible to protect habitable buildings from the effects of rising damp through the use of a capillary break and damp proof membrane (DPM), such as indicated in Figure 12, such measures would have little or no impact on maintaining lower groundwater levels. Further measures are therefore considered necessary to assist in maintaining groundwater to an acceptable level in those areas where levels are likely to rise close to the ground surface, which includes most of the subdivision, except for the northern part of Stage Three.

Methods may be considered to maintain groundwater levels down specific to habitable buildings on individual lots, such as the use of a ring drain around the perimeter of the building with an outlet connected to the stormwater system. These drains may not however maintain groundwater levels to an acceptable depth away from the buildings, with the potential for garden areas to become saturated, and these works would need to be undertaken on a piecemeal, lot by lot basis, and would only be installed as the individual lots were developed. Alternatively, subsoil drains or open ditches could be installed to maintain groundwater levels across the subdivision or within specific areas, protecting both the buildings and surrounding amenity areas.

[6] Rotorua District Council – Rotorua Civil Engineering Industry Standard.

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A network of subsoil drains have therefore been proposed within Stages Two and Three and those lots not yet built on in Stage One. Details of the subsoil drains are outlined in Section 8.1.1 below.

8.1.1 Subsoil Drainage

For the reasons outlined in Section 8.1 above, we have proposed the installation of subsoil drains across all areas of the subdivision where high groundwater levels have been observed, prior to any further development. Figure 12 indicates the proposed scope of this subsoil drainage system for Stage Three. This comprises the installation of subsoil drains in narrow trenches excavated to a minimum depth of 1m below ground level around the full perimeter of all lots within the areas of seasonally high groundwater levels. The depths of the subsoil drains are generally limited to around 1m below ground level because of the pipe invert levels of the existing stormwater system into which these connect.

A similar design for Stage Two and the vacant Stage One lots is currently being advanced. At the time of the preparation of this report, the installation of the subsoil drains in Stage Three was ongoing.

Given the relatively low permeability of the near surface silty sands and fill materials, arching of the piezometric surface between the drains is likely to occur. Based on the assumed permeability of the silty sands derived from the gradings detailed in Section 6.1.2, we estimate that subsoil drains installed to 1m below ground level located at 20m centres (the typical width of most lots), groundwater would be likely to rise to within 0.5m of the ground surface midway between the drains. This assessment is very sensitive to the assumed permeability of the ground. A small reduction in the assumed permeability of the ground and the groundwater level could rise close to the ground surface. Therefore, even with the proposed subsoil drainage in place, the subdivision may not comply with our interpretation of the RDC requirement set out in RCEIS.

We therefore recommend that all habitable buildings are provided with a capillary break and an enhanced DPM, to limit the impact of potentially high groundwater levels in areas located some distance from the proposed subsoil drains. Details of the proposed construction are indicated on Figure 11. For the larger lots located in areas of high groundwater levels, where the arching between subsoil drains installed close to the lot boundaries could rise close to the ground surface, we recommend the use of an additional subsoil drain through the centre of the lots to reduce this arching effect. This requirement includes Lots 15 and 16 in Stage Two and 55 to 61 in Stage Three. It is intended that this will be included as part of the subdivision subsoil drainage works with no requirement for further works to be placed on individual titles.

8.1.1.1 Roads

The proposed subsoil drainage has been extended along all lot boundaries bordering the roads within Stages Two and Three. These will assist with lowering the groundwater levels within the sub-grade beneath the road construction and therefore improve the long-term performance and lifetime of the road pavements.

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8.1.1.2 Monitoring

Periodic monitoring of the water levels is recommended to assess the effectiveness of the subsoil drains. This monitoring can coincide with the monitoring of services recommended in Section 8.5.2.

8.1.1.3 Future Maintenance

In order to ensure the long-term performance of the subsoil drainage, rodding eyes have been included at regular intervals to allow future maintenance. These will be located within easements included on each of the lot titles. It is understood that RDC will perform the ongoing maintenance works rather than this being the responsibility of individual lot owners to ensure a consistent level of maintenance.

The inclusion of a specifically designed filter material, compatible with the protected natural soil, around the perforated subsoil pipe instead of a filter cloth, should ensure that very limited silt infiltration occurs and provide better performance in the long-term.

8.2 Foundation Designs

As a result of the presence of soft compressible silts across the majority of the subdivision and the extent of seasonal variation in groundwater levels, virtually all lots will require specific engineering design (SED) of the foundations by a suitably qualified geotechnical engineer.

A limited number of lots located at the far northern part of Stage Three, where little or no compressible silts were encountered and seasonal groundwater levels do not rise close to the ground surface, may not require SED. There are, however, other restrictions on these lots associated with construction on steep slopes, including Building Restriction Areas, debris fences and erosion protection measures that need to be taken into account, which dictates that several of these lots will require SED. Refer to the Stage Three Geotechnical Completion Report for further details. As stated previously, this report deals specifically with the soft ground and seasonally high groundwater issues.

As detailed in Sections 2.1 and 4.1, there have been extensive investigations undertaken, with deep exploratory holes located on approximately 50% of the lots within Stages Two and Three and the majority of those in Stage One which have not yet been developed. In addition, at least two Scala Penetration Tests were completed on each lot by MTEC, the results of which are included in Appendix C for convenience. It is envisaged however that further investigations of each lot may be required to assist the SED. These may be limited to relatively shallow investigations to determine the nature and depth of the cover materials within the actual footprint of the proposed dwellings, with the depth of compressible materials being estimated from adjacent existing deep exploratory holes.

Where lots are located some distance from existing deep exploratory holes, further investigations may be prudent to determine the thickness of the silt horizon, particularly in areas of fill, as this will have a significant impact on the foundation options, as explained below. Where a raft foundation option is adopted, as is envisaged for most lots, the investigations should be sufficient for the geotechnical engineer to provide an assessment of the modulus of subgrade reaction (k_s) in order to permit the detailed design of the raft

In order to provide some assistance with determining the likely foundation requirements at individual lots, we have proposed four zones, based on the estimated thickness of the compressible silt horizon and the depth of cut/fill, as detailed in Table 8.2.1 below. These

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recommendations are general in nature and the particular recommendations for each 'zone' are provided as a guide only. Further investigations may reveal ground conditions at a particular lot that are more suited to a different solution to the one recommended for that zone. Some lots have varying amounts of cut/fill and therefore the exact position of the building would need to be taken into account in the assessment. This should be determined by the geotechnical specialist investigating the particular property.

Zone	Cut/Fill Depths (m)	Thickness of Compressible Silt Horizon (m)	Lot Numbers
A	>0.5 Fill	>3.0	Stage One: 1, 2, 3, 11, 14, 17 and 20
			Stage Two: 15, 16, 64, 65, 66, 67, 68, 74, 75, 82, 83, 84, 85 and 86
			Stage Three: 24, 25, 26 and 63
B	0.0 to 0.5 Fill	<3.0	Stage One: N/A
			Stage Two: N/A
			Stage Three: 28, 29, 30, 32, 33, 34, 45, 46, 47, 50, 51, 52, 53, 54 and 57
C	Cut	Any	Stage One: N/A
			Stage Two: 69, 70, 71, 72, 73, 76, 77, 78, 79, 80 and 81
			Stage Three: 27, 43, 44, 55, 56, 58, 59, 60, 61 and 62,
D	Any	Negligible	Stage One: N/A
			Stage Two: N/A
			Stage Three: 35, 36, 37, 38, 39, 40, 41, 42, 48 and 49

Table 8.2.1: Summary of foundation zones for individual lots.

Notes:

1. There are specific requirements for the three lots on which the trial loads were located, as detailed in Section 8.2.5 below.

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8.2.1 Zone A

This covers areas where a reasonable depth of fill (generally greater than 0.5m thick) or a mixture of cut/fill is present overlying relatively thick compressible silt materials (>3.0m), where total and/or differential settlements could be significant. This includes all of the Stage One properties that have yet to be built on, lots in the southeast part of the Stage Two (including Lots 15, 16, 64, 65, 66, 67, 68, and 82 to 86), Lots 74 and 75 in the northwest corner of Stage Two and Lots 24, 25, 26 and 63 in the southwest portion of Stage Three.

The lots in Zone One include fill depths of up to 1.5m and a compressible silt thickness of up to 10m. The 'worst' case, for example, is possibly represented by Lot 14, where up to approximately 1.5m of fill is underlain by around 9m of compressible silts, assuming the ground conditions here to be similar to those encountered on the neighbouring property (Lot 17), as revealed by CPT1-17. The lots in Stage One do benefit however from the fact that the fill was placed over two years ago, such that all primary and a proportion of the anticipated secondary compression resulting from the placed fill will already have occurred, but the primary and additional secondary compression resulting from a house load could still be high. As the fill in Stage Two and Three was placed more recently, the lots in these stages will have a greater proportion of ongoing residual settlements, compared with Stage One.

For the lots in Zone A, preloading of the house site is likely to be the preferred option. This would be designed to force out the majority of the primary consolidation and reduce significantly the amount of secondary compression by loading the sites to more than the anticipated final house loads. An approximately 1 to 1.5m deep surcharge left in place for around 2 to 3 months should be sufficient to eliminate the majority of primary consolidation and to limit creep settlements to an acceptable level. This should be combined with the use of a heavy stiffened or cellular raft foundation, specifically designed to enable the structure to withstand the anticipated total and/or differential movements resulting from a combination of settlement and/or heave associated with the seasonal variation in groundwater levels and any long-term creep settlements. Seasonal variation in groundwater level will need to be taken into account. Additional surcharge will be required if it is placed during periods of high groundwater level to counter the reduction in effective stress in the compressible silts from the high groundwater level.

The design of a heavy or cellular raft would comprise a grid pattern of stiffened beams to improve the rigidity of the raft. The beams should be extended across the full width of foundation and ideally be located under load-bearing walls to provide maximum rigidity at these points, or secondary beams included where this is not possible.

Alternative solutions would include the use of piled foundations or a compensated raft to ensure that no net load is imposed on the ground, thereby preventing any additional primary or secondary compression. The latter option may be quite expensive if a specific voided raft needs to be designed and constructed, but it may be possible to use a proprietary system such as a Ribraft foundation as manufactured by Firth Industries Ltd, in combination with lightweight construction and/or some over-excavation of the existing fill replaced with a lightweight material.

We do not consider it necessary to undertake detailed monitoring of either levels or porewater pressures, during the preload stage as the information gained from the trial loads gives sufficient confidence in the response of the ground. The costs of undertaking detailed precise levelling and a porewater pressure monitoring survey would be

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disproportionate and the results difficult to interpret given the limited timeframe and effects of varying groundwater levels.

8.2.2 Zone B

This includes areas where there is a limited depth of fill (<0.5m) overlying a more restricted depth of compressible silts (<3m) and includes Lots 28 to 30, 32 to 35, 37, 45 to 48, 50 to 54 and 57, all located within Stage Three.

At these lots it may be anticipated that some residual creep will be ongoing as a result of the fill placed, but this is likely to be limited due to the restricted thickness of compressible materials and the time since the fill was placed. Any new loads will cause some primary consolidation and some additional ongoing creep settlements. When estimating the likely amount of ongoing creep settlements resulting from the placement of fill, the elapsed time should be taken into consideration using the trial load data detailed in Section 7.2. Some lots may not be developed for several years, by which time the amount of ongoing residual creep movements will have reduced further.

We recommend the adoption of a specifically-designed heavy or cellular raft, as detailed for Zone A above, but without the need for a preload.

Other options may also be considered, including the use of lightweight construction and a standard raft, replacement of the near-surface fill and/or in situ materials with a lightweight fill to achieve a limited or zero increase in net load with a standard raft or piled foundations. The possible effects of post-construction settlements on the dwelling and the surrounding ground will need to be addressed with regard to the minimum floor levels required for flood protection and the possible effects on services entering the building.

8.2.3 Zone C

The lots included in Zone C relate to shallow cut areas up to -1.5m deep. The thickness of the compressible silts is of little significance in terms of the anticipated magnitude of the primary consolidation and creep settlements, but the varying seasonal groundwater level could result in potentially significant heave where thick compressible materials are present. However, because of several unknowns, including the variability of the ground conditions, our confidence in the accuracy of the cut/fill contours and the strength of the placed fill and near surface in situ materials and for the reasons detailed in Section 8.3 below, we recommend the use of a stiffened raft.

8.2.4 Zone D

Our investigations in this area indicate very limited or no soft compressible silt materials at these lots. These may, following further investigations of the proposed house sites, adopt standard shallow foundations providing the near-surface fill or in situ materials have adequate bearing capacity, as assessed by a geotechnical engineer. Should thick compressible materials be encountered at any of the lots, then a raft foundation or similar shall be adopted.

8.2.5 Filling

It is recommended that filling around the outside of dwellings located within Zones A to C, for patios, decks or similar, should be restricted to a maximum depth of 150mm above

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existing ground level due to the risk of additional differential settlements. Specific design may indicate that the placement of a greater thickness of fill is acceptable.

8.2.6 Lots 58, 64 and 79

Part of these lots have been utilised for trial load areas, as shown on Figure 7. A depth of between approximately 1 to 1.5m of fill has been placed over an area of approximately 15m x 15m (15m x 25m for Lot 64) with resulting settlements as detailed in Section 7.2. To limit the risk of unacceptable differential settlements resulting from any future house loads, any dwelling to be constructed on these lots should remain entirely within or completely outside of the footprint of the loaded area (see coordinates on Table 8.2.2 below). If a structure is designed which spans this area then the specific design of foundations should take this effective 'preload' into account when determining the likely magnitude of differential settlements and design the foundations accordingly.

For Lot 64, any dwelling constructed within the coordinates provided may be considered to have been pre-loaded in accordance with the recommendations given for Zone A lots detailed in Section 8.2.1 above.

Position	Eastings	Northings
Lot 64 (Trial Load 1)		
South East Corner	376957.17	764272.37
South West Corner	376958.13	764259.58
North West Corner	376982.35	764259.50
North East Corner	376980.50	764275.00
Lot 79 (Trial Load 2)		
South East Corner	376927.295	764388.148
South West Corner	376927.163	764374.269
North West Corner	376940.467	764373.610
North East Corner	376940.773	764387.258
Lot 58 (Trial Load 3)		
South East Corner	376797.575	764308.576
South West Corner	376782.805	764308.466
North West Corner	376783.193	764322.952
North East Corner	376797.063	764322.792

Table 8.2.2: Coordinates of trial loads.

8.3 Liquefaction

The presence of saturated silty fine sands close to the ground surface dictates that there is a potential for liquefaction to occur at this site, as a result of a seismic event. The proposed subsoil drainage and recommended raft foundations should help to limit the effects of such an occurrence but the house building materials and superstructure should be chosen to limit the potential effects of liquefaction.

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8.4 Land Stability

As detailed in Section 1.2, following a meeting between MTEC, RDC and their respective geotechnical advisors, T&T were asked to undertake an assessment of the land stability for the Stage Three area. T&T has undertaken an assessment of the slope stability and erosion issues concerning the northern end of Stage Three. The result of this assessment, which includes Building Restriction Areas and erosion control measures, is detailed in the Stage Three Geotechnical Completion Report (March 2009). When dealing with Lots 35 to 42, reference should be made to the requirements detailed in that report.

8.5 Infrastructure

8.5.1 Roads

In order to assess the existing condition and likely future performance of the roads within Stage Three, with regards to the presence of the underlying soft compressible horizon and seasonally high groundwater levels in some areas, retesting of the roads was completed in November 2008. This comprised Geobeam Testing at 10m centres along Road One (0.37km) , the Loop Road (0.26km) and the ROW servicing Lots 55 to 61 (0.14km). The results have been compared with the Benkelman Beam tests undertaken in March 2008 (and some retesting of a section of the Loop Road conducted in May 2008, following completion of remedial works to rectify short sections that had failed to achieve the required standard).

The results of the original Benkelman Beam and Geobeam Testing are included in Appendix H, along with Table 8.5.1, which provides a summary of the results with some interpretation.

The RCEIS sets the following requirements for acceptance of pavements with reference to Benkelman Beam tests (clause 4.3.8.1):

a) Not more than five percent (5%) of the tests shall exceed the deflection of 3.5mm.

b) No single result shall exceed 3.5mm by more than thirty percent (30%) (i.e. 4.55mm).

c) No two adjacent readings shall vary from each other by more than twenty-five percent (25%) of 3.5mm (0.875mm).

It notes that deflections well below the maximum are normally possible with reasonable compaction and therefore consistency as required under c) will generally govern.

The results of the original testing indicate that requirements a) and b) were satisfied (following retesting of the Loop Road), with all but a single deflection being less than 3.5mm. However, we note that both Road 1 (Chainage 60 to 80) and the Loop Road (Chainages 40 to 60 and 140 to 160), readings varied by more than 0.875mm. Similarly, the recent testing indicated compliance with requirements a) and b) for both roads, but failed to meet the standards of consistency required by c). The number of locations at which the variation was greater than 0.875mm is higher for the recent tests (five for Road 1 compared with two for the original tests and four for the loop road compared with two previously).

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MTEC indicate that the large variations recorded around Chainage 60 on Road 1 may be related to the transition from Rhyolite fill that was placed from the junction with Western Road, grading into site won material. The remaining sections where high variations were recorded are generally located in areas where there is a limited thickness of compressible silts at depth and where groundwater levels are typically lower. This would suggest that it is the pavement construction itself and/or the near surface subgrade materials (silty sands/sandy silts) that is the controlling factor rather than the influence of the deeper soft silts and high groundwater levels present in some areas of the site.

The pavement has not been significantly trafficked to date. It is possible that the roads will continue to 'settle down' under further trafficking and may achieve the required performance. We recommend that the road is retested in twelve months or after approximately 5,000 Equivalent Standard Axles (ESAs). Assessment of road construction issues is outside the brief of this report. It is recommended that RDC should make its own judgement on the results of the pavement testing.

The majority of the roads within Stage Three are located in areas of relatively shallow cut/fill (typically <0.5m). The sections crossing fill are, with the exception of the junction with Western Road, within Stage One, located in areas where the thickness of the compressible silt horizon is relatively limited (<3.0m). The road construction would have occurred sometime after the main earthworks were completed, by which time the majority of any primary consolidation settlements would have occurred. Given the time that has lapsed since completion of the road pavement, a significant proportion of any ongoing creep settlements will also have occurred. There are no obvious signs of significant damage to the road pavements and kerbs in Stage Three and we do not expect further damage will result from differential movements associated with settlement/swelling of the compressible silt horizon. Future resurfacing works should adequately deal with any minor differential movements. We note from observations in Stage Two that heavy vehicle movements crossing the kerb lines and adjacent concrete footpaths to gain access to the Lots, has resulted in significant cracking.

The proposed subsoil drainage within Stage Three should help to lower the winter groundwater levels. This will not only benefit the long-term performance of the pavement by limiting the depth and period of time that saturation of the subgrade occurs, but may also reduce the magnitude of the seasonal settlement/swelling of the compressible silt horizon.

8.5.2 Services

As detailed in Section 4.2.3, a complete resurvey of all sewer and stormwater reticulation manhole lids and pipe invert levels was undertaken in October 2008. These have been compared with the as-built records to identify whether any significant vertical movement has occurred in the period between the surveys.

It should be noted that some post-construction settlement/swelling could have occurred prior to the as-built surveys being completed. Any apparent difference in the surveyed levels does not therefore provide a record of the total amount of post-construction movements at these locations, just the ongoing movements between surveys. The re-surveyed levels also provide a check on the existing gradients between the manholes. These have been compared with the design and as-built gradients, in Sections 8.5.2.1 and 8.5.2.2 below.

The results of this recent survey and the as-built records are summarised on Tables 8.5.2 to 8.5.4 (see Appendix H). These include a rough guide as to the depth of earthworks at

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each manhole, taken from the cut/fill contours, along with other pertinent information. The general layout of the entire subdivision sewer and stormwater systems relative to the earthworks contours are shown on Figure 10 – Layout of Sewer and Stormwater Systems. Schematic drawings showing the simplified design gradients and layout of the sewer and stormwater systems is presented on Figures 8.5.1 and 8.5.2 included in Appendix H.

The RCEIS[7] requires that surveyed levels of manhole lid levels and pipe inverts have an accuracy of not less than ±30mm and we understand that the as-built survey was completed to this level of accuracy. Whilst the recent survey was undertaken using precise levelling equipment and therefore provides a higher degree of accuracy, there remain some difficulties in comparing the two sets of readings, since the exact position on the lid and pipe inverts selected would have differed. It is therefore considered that any apparent movements of less than about 50mm should be treated with caution. The difficulties associated with comparing the levels is further highlighted by the fact that the levels recorded for the lids or one of the pipe inverts, often vary significantly from those recorded at another pipe invert at the same manhole. Similarly, some manholes located very close to one another show differing amounts of change. By themselves the results at any one manhole should therefore be viewed with caution, but some meaningful observations can be made from looking at the overall trend.

The difference in elevation recorded at each manhole is depicted on Figure 8.5.1[8]. This shows the average change in elevation recorded for each of the pipe inverts at the manholes[9], including both the sewer and stormwater systems. The information is separated to show those manholes that are in areas roughly at-grade, in cut or where fill has been placed. It can be seen that virtually all of the manholes located in areas of fill show some decrease in elevation (settlement) between the surveys, whilst many of the manholes in cut areas have risen. The greatest change in elevation is a rise in areas of cut (of around -50 to -140mm). This relates to sewer and stormwater manholes located along the northern part of Road 2 in the Stage Two area, where the thickness of the compressible silt horizon is quite large (4 to 8m). The manholes showing the greatest reduction in elevation (>50mm) are generally located in areas where fill has been placed and a significant thickness of compressible silts is present. There are however some notable exceptions. Both the sewer and stormwater manholes located at the far northern part of Road 1 in Stage Three (SWMH C2 and SSMH Y4), show a reduction in elevation of around 80mm. Approximately 0.5 to 1.0m of fill has been placed but adjacent exploratory holes indicate little or no compressible silts present in this area. Some manholes located in areas where fill has been placed over thick compressible materials, show little or no apparent settlement.

It should be borne in mind when reviewing this information that the earthworks and installation of the services were undertaken at different times for the three stages and therefore the progress of any ongoing settlement/swelling is likely to vary significantly. Also, the time period between the as-built and recent surveys varies and therefore the

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[7] Rotorua Civil Engineering Industry Standard

[8] This presents the average change of the pipe invert levels recorded at each manhole. Manhole lid levels have been excluded due to the apparent inaccuracy between the surveys.

[9] A schematic showing the general layout of the subdivision stormwater system is shown on Figure 8.5.2, included in Appendix G.

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total amount of settlement/swelling would also vary, even for identical ground conditions.

These complications make it difficult to provide any reliable interpretation of the rate and magnitude of post-construction settlement/swelling other than in very general terms. For this and other reasons, we recommend that the manholes continue to be monitored and inspected periodically s to determine the extent of any ongoing movements. As a result of the seasonal variation in groundwater levels and the response of the compressible silt horizon to this change in effective stress, as discussed in Section 7, it will be difficult to separate out movements resulting from the placement of fill or cut and those controlled by the seasonal variation in groundwater levels. Ongoing monitoring of groundwater levels across the site should assist in this evaluation.

Whilst the manhole settlement data provides some indication of ongoing differential movements in areas of cut and fill during the period between the surveys, it does not highlight any deformation which may have occurred to the pipelines between the manholes. In some instances the manholes located at either end of a pipe run are positioned in areas where little or no fill has been placed or are in cut, whilst the alignment of the intervening section of pipe is through filled areas. In order to assess whether significant differential movements along the pipe lengths have occurred, a large part of the sewer and stormwater reticulation systems in Stages Two and Three was lamped and, where possible, pressure tested in December 2008. This work was undertaken by an inspector from RDC and the main contractor, GCL. The inspections did not identify any sections adversely affected by differential movements.

8.5.2.1 Sanitary Sewer

The main sewer line servicing Stage One (Line Z) runs along the front edge of the properties where the fill depths are relatively limited (typically <0.5m). The difference between the as-built levels and recent survey are between -20 and +50mm (+value indicates a reduction in elevation, i.e. settlement). These suggest relatively limited movements since the as-built survey for this stage was completed in December 2006. As shown on Table 8.5.3, the design of Line Z allowed for falls of 1 in 180 (0.56%), with a 1 in 200 (0.5%) gradient between the last manhole and the connection into the existing sewer on Western Road. The as-built survey indicates that the actual gradients were generally very close to the design except the length between SSMH Z3 to SSMH Z2, which was 0.5% and from the last manhole to the existing network, which was 0.44%. The recent survey shows similar results except that the length between SSMH Z3 and SSMH Z2 is now at 0.47%, but all the remaining sections are at steeper gradients than the as-built survey indicated.

The sewer reticulation servicing Stages Two and Three flows from the north and west to the pump station located on Lot 87 at the far eastern end of Stage Two. From here it is pumped to Line Z (SSMH Z2) in Stage One. The majority of this system is designed with minimum falls of 1 in 133 (0.75%), except for Line U which is located beneath Road 2 in Stage Two, which has a design gradient of 1 in 180 (0.55%). As indicated on Table 8.5.2, the as-built gradients were close to the design falls in most cases. The biggest departure relating to the section located along the northern part of Road 2 in Stage Two. The design gradients between manholes SSMH U3 to U2, U2 to U1 and U1 to V1, were all at 0.56%. The as-built records indicate slacker gradients than the design between U3 and U2 and U1 to V1 (0.52 to 0.53%), with a steeper fall between U2 and U1 (0.70%). The recent survey indicates that this has shifted with the greater gradient present between U1 and V1 (0.78%), with slacker gradients further up the line. This can be explained by the apparent

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increase in elevation (swelling) of SSMH U1 of around 130mm. No gradients have reduced to less than the lowest initial gradient.

The only other section that appears to have been affected by differential movements between manholes is located along Line Z (Stage Three) and its connection into Line V (Stage Two). These were both designed with falls of 0.75% and the as-built records indicate that this was achieved. However, the recent survey suggests the falls between Z3 to Z2, Z2 to V4 and V3 to V2 have fallen below 0.75%. This section of sewer passes from an area at-grade or shallow cut in Stage Three and the western side of Stage Two into an area of fill on the western half of Stage Two (between SSMH V4 and V3).

A relatively large reduction in elevation i.e. settlement (of around 80mm) at SSMH W1 which connects into SSMH Z3 (located on Road 1 in Stage Three), has resulted in a reduction in gradient from the design and as-built falls of 0.75 and 0.73%, respectively, to 0.68%. SSMH W1 is located in an area of shallow fill and SSMH Z3 roughly at-grade.

The possible implications of the movements observed on the sewer (and stormwater) system, and possible future movements, are discussed in Section 8.5.4.

8.5.2.2 Stormwater Reticulation

A few sections of the stormwater system appear to have gradients significantly different from the design falls, and there are relatively large discrepancies between the as-built and recent surveys. In the case of the as-built records being notably different from the design, this may simply be due to a revised design that we are not aware of or it could be related to movements taken place prior to the as-built survey.

A significant increase in the level of SWMH B3 (~80mm), located in an area of cut underlain by thick compressible silts at the head of Road 2 in Stage Two, has resulted in much shallower gradients (from 0.77% (as built) to 0.35% (recent)) back to SWMH B4, which is located on shallow fill in the reserve area. Note however that the design gradient for this section of Line B is 0.45%, therefore the pipe was laid at a steeper gradient than the design required. Smaller changes in gradient have occurred elsewhere on this section which has resulted in some sections becoming steeper than the as-built and/or design gradients and other lengths where changes have resulted in the falls reducing below the as-built and/or design gradients.

We consider that the most significant of these changes occur at the bottom end of Line B and the whole of Line A. Virtually the entire subdivision drainage flows along the 1050mm diameter pipe located between manholes SWMH B1 to SWMH A4 and along the remainder of Line A (1200mm diameter pipe) to the surface water outlet located on the southern side of Western Road, discharging into the Ngongotaha Stream. The design gradients for these lengths are between 0.42 and 0.46%. The as-built records show these reducing to between 0.13 and 0.40% and the recent survey suggests even flatter falls of between 0.13% and 0.31%, the flattest lengths being located towards the bottom end. This section of Line B and Line A is located on the reserve lot in Stage Two (Lot 87) and immediately beyond the eastern boundary on the adjacent property (Lot 16 DP 377169) respectively.

8.5.2.3 Water Supply

In order to determine whether any differential ground movements had resulted fracturing of the water supply pipes, a pressure test of the main supply pipe in Stage Three was

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undertaken in December 2008 by an inspector from RDC and the main earthworks contractor, GCL. The pressure was maintained and no significant leaks were detected.

We understand that the main water reticulation comprises 100 and 150mm uPVC and 63mm MDPE pipes.

8.5.3 Recommendations Regarding Future Monitoring, Inspection and Testing

As indicated in Section 8.5.1, we recommend further testing of the roads within Stage Three in approximately 12 months or following 5,000 ESA to assess whether the road pavement has 'settled down'. This should provide some indication as to the likely requirements for future maintenance of the roads. The results of any such testing are unlikely to indicate the cause of any poor performance, but we think this is unlikely to be the result of the soft compressible horizon. The current installation of subsoil drainage will provide some improvement to the subgrade. At the time of the recent survey, monitoring points were established on each of the sewer and stormwater manholes. These have been resurveyed on a monthly basis and up until 19 January 2009 (i.e. three months), movements of between -7 and +3mm have been recorded. It is not possible to determine whether these are related purely to ongoing creep settlements or settlement/swelling resulting from a varying groundwater level, or the relative contribution of each to the observed movements.

To assist in assessing the condition of the sewer and stormwater systems, we recommend monthly monitoring of the manholes and all other survey points, as detailed in Section 4.2.1, is continued until June 2009 to provide a full annual set of readings and then at six monthly intervals (late-summer and late-winter) for the period of the required bond. The need to continue this monitoring should be reviewed on a regular basis as it may become apparent early on that further movements are unlikely to occur.

The survey data obtained from discrete locations may not provide sufficient information to assess the condition of the pipes between the sewer and stormwater manholes (and the water reticulation system). We therefore recommend regular inspections and testing of these systems are carried out if any further significant movement is evident from the survey results. These should include lamping and where possible, pressure testing.

8.5.4 Implications of Settlement and Bonding of Infrastructure for Stage Three

We do not believe that the compressible silt horizon has a significant impact on the future performance of the road pavement. In addition, the proposed subsoil drainage will reduce the ground water level and length of time that the subgrade will be seasonally saturated. However, a number of failed results were recorded in the recent Geobeam testing. It is recommended that RDC should make its own assessment of the implications of these failed results, as this is outside the scope of this report.

It is also beyond the scope of this report to assess or comment on the adequacy or otherwise of the gradients recorded between manholes for the sewer and stormwater systems, as revealed by the recent survey. We should point out however that the design and as-built gradients are low and whilst some future settlement may cause some sections to have an increased gradient, other gradients may be reduced. Flattening of the stormwater or sewer gradients may result in increased siltation requiring more regular maintenance and a minor localised loss in hydraulic capacity.

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The sections considered to be at greatest risk from the effects of future settlement within Stage Three are summarised in Table 8.5.5 below:

Manhole		Distance	Diameter
From	**To**	**(m)**	**(mm)**
Sanitary Sewer			
SSMH Y2	SSMH Y1	83.8	150
SSMH W1	SSMH Z3	68.8	150
SSMH Z4	SSMH Z3	32.5	150
Stormwater			
SWMH B4	SWMH B3	46.0	750
SWMH B3	SWMH D3	36.5	750
SWMH H	SWMH A1	18.3	300
SWMH A2	SWMH A1	51.5	450
SWMH F2	SWMH F1	60.7	300
SWMH F1	SWMH D3	60.5	300
Water Reticulation			
Road 1, Junction with Western Road (west side)	Vicinity of Lot 31	200	63 MDPE
Road 1, Junction with Western Road (east side)	Vicinity of Lot 31	200	150 uPVC

Table 8.5.5: Summary of sewer, stormwater and water reticulation in Stage Three at greatest risk from further movements.

This is based on a number of factors, including the estimated depths of cut/fill along the sections of pipe, the assumed thickness of the compressible silt horizon and current observations of movements in those areas. There is no guarantee that the sections beyond these locations will not suffer from similar differential movements, but the sections included in Table 8.5.5 are presented as a reasonable assessment of those sections which are considered to be 'most likely' to be impacted upon. We therefore recommend that the quantum of the bond required for Stage Three should be set to reflect the potential cost of repairing these lengths.

Repairs, should they be required, be postponed for as long as possible to allow the maximum amount of settlement to occur. Ongoing monitoring of the manholes and other settlement markers should provide a guide as to whether there remains a risk of further differential movements following any initial repairs.

Ongoing movements of the sewer and stormwater lines within Stages One and Two could have an impact on the systems in Stage Three which flow into these areas. Whilst any reduction in elevation of the Stage One and Two manholes could increase the gradients

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from Stage Three, any upward movements, as observed at the western end of Road Two in Stage Two, could reduce the falls between the stages. However, we consider further swelling to be unlikely.

There is a potential risk of further settlement within the fill area in the south east corner of Stage Two. In particular, the section of sewer pipe connecting the pump station and the adjacent manhole (SSMH V1) could be impacted by this settlement, as could the stormwater connection between Lines A and B. Repairs of these systems may therefore be required to ensure the satisfactory long term performance of the Stage Three infrastructure.

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9 Conclusions and Recommendations

9.1 Ground Conditions

The extensive ground investigations undertaken by MTEC and T&T, as detailed in Sections 2.1 and 4.1 of this report, have indicated the presence of a variable thickness of compressible silt materials across most of the subdivision, beneath a 'cover' layer of placed fill and/or natural silty sands. The thickness of the cover materials varies from less than 1m to in excess of 5m. The thickness of the compressible silt horizon varies from non-existent on the slopes in the far northern part of Stage Three to greater than 10m in the south-east corner. In general, the thickness of the silts reduces towards the north and west.

Between 1.5m of cut and up to 2.5m of fill has taken place as part of the subdivision development. The areas which have received a significant depth of fill generally coincide with those parts of the site in which the thickest compressible silt materials are present, particularly in the south-east corner of Stage Two and the eastern half of Stage One.

9.2 Groundwater Conditions

The extensive ground investigations and subsequent monitoring indicate that seasonally high groundwater levels occur across most of the subdivision. Peak winter groundwater levels appear to have risen close to, or reached, the ground surface prior to and subsequent to development of the subdivision, even in areas where fill has been placed.

Subsoil drainage works are required across much of the subdivision to limit the peak winter groundwater levels, and additional waterproofing and drainage of dwelling foundations is required at most lots. A subsoil drainage system has been designed and is currently being installed in Stage Three and a similar system has been designed for Stage Two and the empty lots in Stage One. We recommend that these works be undertaken as soon as possible. These works can be carried out more readily during the summer period when groundwater levels are likely to be depressed below the level of the trenches required to install the drainage pipes than at other times of the year. These works would be very difficult to construct when high groundwater levels exist.

Additional waterproofing of habitable dwellings is also recommended, as detailed in Section 8.3.1 and indicated on Figure 13.

9.3 Foundation Design

This report identifies that the presence of the thick compressible silt horizon, combined with the subdivision earthworks and imposed loads from any future buildings, suggests that there is a potential risk of settlements that could have a detrimental effect on future dwellings. It is advised that all vacant lots, with the exception of a few located at the far northern part of Stage Three where little or no compressible silt materials were encountered, should be subject to specific engineering design by a suitably qualified geotechnical engineer. In some cases a review of the existing ground investigation data, along with the proposed dwelling or structure, may determine that standard shallow foundations constructed in accordance with NZS 3604:1999 may be sufficient, but in the majority of cases, a raft foundation is recommended. Some lots, particularly those located in areas where a significant depth of fill has been placed in areas with thick compressible silt materials, will require a preload and raft foundation. It should be noted that the

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groundwater level at the site during the preload must be taken into account as this will affect the amount and/or time required to achieve the desired result. A preload placed during periods of high groundwater will have less than a similar preload placed when groundwater levels are low. Preloads placed during the winter are therefore likely to require greater amounts of surcharge than preloads undertaken in the summer.

The recommended foundation options are provided in Section 8.2 of this report and summarised on Table 8.2.1.

9.4 Infrastructure Condition

As detailed in Section 8.5 of this report, recent surveys and inspections of the sewer and stormwater systems across the entire subdivision, has not identified any significant damage resulting from post-construction settlements. We consider that some further settlements are likely to occur, particularly in areas where a significant depth of fill has been placed over thick compressible silt materials (ongoing creep settlements), and that these may have a detrimental effect on the gradients of the lines extending from areas of cut. On this basis we have identified those sections within Stage Three that we consider to be at greatest risk of future damage for the purposes of determining the level of bond required to cover the costs of repair. We have also identified those sections within Stages One and Two into which the infrastructure from Stage Three connects, which could have an impact on the satisfactory performance of the Stage Three systems.

Further testing of the road pavements in Stage Three has indicated that these are of marginal performance with respect to the requirements detailed in the RCEIS[10]. We do not believe however that the pavement has deteriorated significantly since it was tested in February/March 2008 and it is likely to be the near-surface subgrade materials and/or the limited thickness of the pavement rather than the presence of the soft compressible silt materials at depth. It is possible that the road may 'settle down' following trafficking and we recommend it is retested in 12 months or 5,000 ESA's.

9.5 Future Monitoring

In order to provide settlement and groundwater data for a full 12 month period which will help to predict the future performance of the subdivision, we recommend monthly monitoring of groundwater levels and settlement markers up until June 2009. After this time the monitoring can be reduced to six monthly intervals for the remaining period of the bonds imposed by RDC, commencing in September 2009. The results should be reviewed periodically to determine whether the full bond needs to be retained.

The proposed groundwater monitoring will also provide an indication of the effectiveness of the subsoil drainage.

9.6 Land Stability

As noted in Section 8.4 of this report, some of the lots located on the sloping ground at the northern end of Stage Three are subject to potential future instability requiring the establishment of Building Restriction Areas, requirements for debris fences and erosion control measures. The lots affected and the requirements for development of these are detailed in the Stage Three Geotechnical Completion Report.

[10] Rotorua Civil Engineering Industry Standard 2000 (Version 2004)

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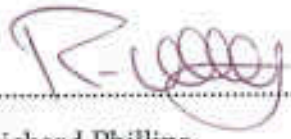
10 Applicability

This report has been prepared for the benefit of Pioneer Property Trust Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

Report prepared by:



Richard Phillips

Senior Engineering Geologist

Authorised for Tonkin & Taylor by:



David A Bouma

Group Manager

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Appendix A: Figures

- **Figure 1: Site Location Plan**
- **Figure 2: Site Layout Plan**
- **Figure 3: Pre-Development Contour Plan**
- **Figure 4: Cut / Fill Plan**
- **Figure 5: Exploratory Hole Location Plan**
- **Figure 6: Groundwater Monitoring Locations**
- **Figure 7: Settlement Monitoring Locations**
- **Figure 8: Cross-Section A**
- **Figure 9: Cross-Section B**
- **Figure 10: Cross-Section C**
- **Figure 11: Layout of Sewer and Stormwater Systems**
- **Figure 12: Subsoil Drainage For Stage Three**
- **Figure 13: Indicative Foundation Detail**

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LOCATION PLAN
SCALE 1:25000



Sourced from Terraview data
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SCALE 1:25,000
0 500 1000 1500 (m)

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DRAFTING CHECKED	WP JT	March	
APPROVED	PAG	5/3/09	
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Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton Tauranga Auckland Christchurch Wanaka

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WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Site Location Plan

DG. No. Figure 1 REV. 0

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NOTES:
1. Site contours are as-built.
2. Stage One contours are at 0.2m intervals. Stage Two and Three contours are at 0.5m intervals.



FUTURE STAGE FOUR

STAGE THREE

STAGE TWO

STAGE ONE

LOOP ROAD

ROAD 1

ROAD 2

ACCESS

WESTERN RD

SCALE 1: 2000
0 20 40 60 80 100 (m)

Tonkin & Taylor
Environmental & Engineering Consultants
Tauranga
Hamilton Auckland Christchurch
Nelson Wellington Whangarei

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PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Site Layout Plan

FIG. No. Figure 2 REV 0

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POSSIBLE FUTURE STAGE
FUTURE STAGE FOUR

LOT 17
DP 336769

STAGE THREE

STAGE TWO

STAGE ONE

LOOP ROAD

ROAD 2

ROAD 92

PIONEER

ACCESS

Local Purpose Reserve (Drainage / Recreation) To Vest In Rotorua District Council

Local Purpose Reserve (Drainage) To Vest In Rotorua District Council

DP5 39879

Ngongotaha Stream

N

SCALE 1:2000
0 20 40 60 80 100 (m)

NOTES:

1. AREAS AND MEASUREMENTS ARE SUBJECT TO TITLE & SURVEY.
2. EXISTING CONTOUR INTERVAL 0.25m

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WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Pre-development Contour Plan

FIG. No. Figure 3 REV. 0

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NOTE:

Cut and fill thickness are approximate.

LEGEND

- >1.0m fill
- 0.5m to 1.0m fill
- 0m to 0.5m fill

WESTERN RD

SCALE 1:2000

0 20 40 60 80 100 (m)

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Environmental & Engineering Consultants
Hamilton, Tauranga, Auckland, Christchurch, Nelson, Wellington, Mt Maunganui

DRAWN	srmb	Mar 09
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SCALES (AT A3 SIZE)	1:2000	
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PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Cut/Fill Plan

FIG No. Figure 4 REV 0

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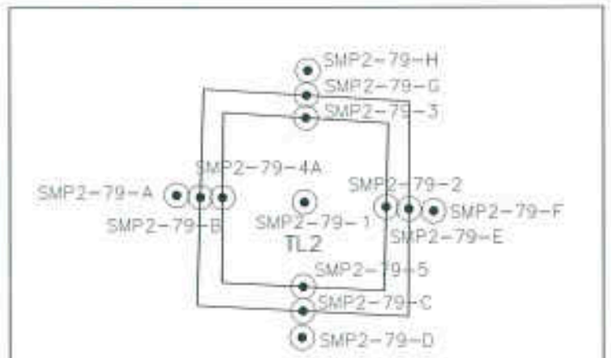


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Version: 2, Version Date: 27/04/2009





TYPICAL TRIAL LOAD LAYOUT
SCALE 1:500

SCALE 1:500
0 5 10 15 20 25 (m)

SCALE 1:2000
0 20 40 60 80 100 (m)

NOTE: Settlement monitoring commenced 17 July 2008.

LEGEND
- SMP2-68 Settlement Markers
- Settlement Markers around constructed dwellings
- TL1 Trial Load Area

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Hamilton, Auckland, Christchurch, Nelson, Wellington, Whangarei

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WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Settlement and Trial Load Monitoring Locations

FIG. No. Figure 7 REV. 0

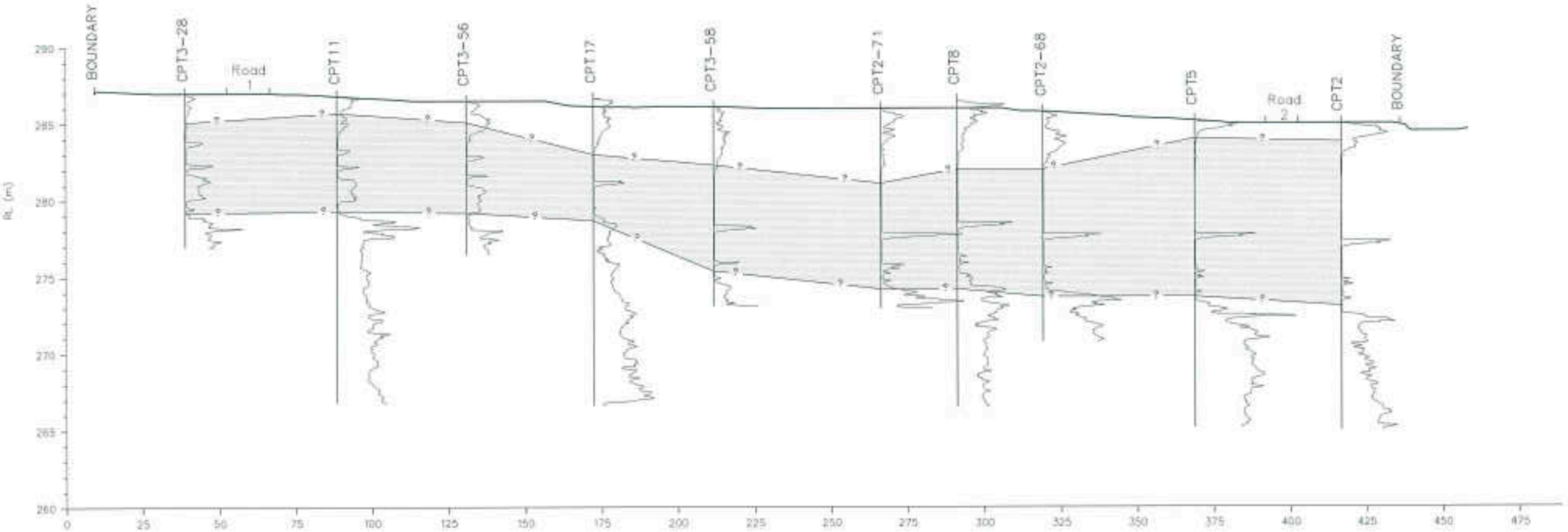
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Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

NOTES:
1. Note x5 vertical exaggeration.
2. Interpreted thickness of compressible silt horizon is based on combination of factors, not purely on cone resistance as shown.
3. Groundwater levels have been omitted.
4. Note cross sections A, B and C drawn to equal scale.

WEST

EAST



SECTION A CROSS SECTION Fig 5

LEGEND

Interpreted thickness of compressible silt horizon with interbedded sand bands

q_c (MPa)
0 10 20 30 CPT plots (see report appendices for details)

VERTICAL SCALE 1:300
0 3 6 9 12 15 (m)

HORIZONTAL SCALE 1:1500
0 15 30 45 60 75 (m)

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(DRAFTING) CHECKED	FB	//
APPROVED	DWG	6/3/09
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PROJECT No.	851126	

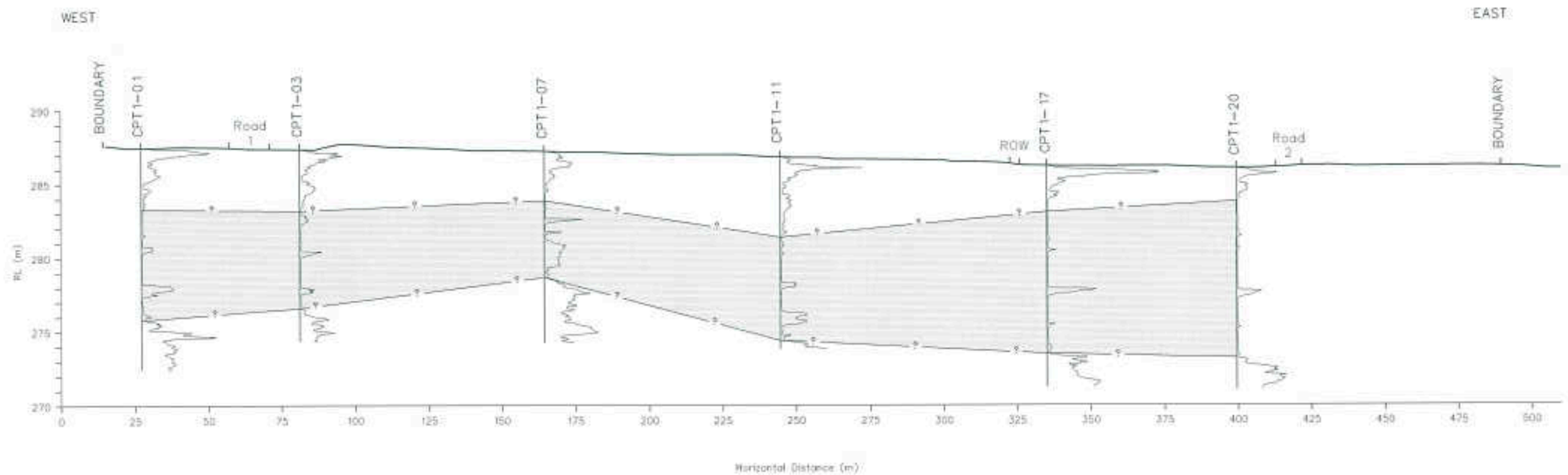
PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Cross Section A

FIG No. Figure 8 REV 0

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Version: 2, Version Date: 27/04/2009

NOTES:
1. Note x5 vertical exaggeration.
2. Interpreted thickness of compressible silt horizon is based on combination of factors, not purely on cone resistance as shown.
3. Groundwater levels have been omitted.
4. Note cross sections A, B and C drawn to equal scale.



SECTION B (Fig 5) CROSS SECTION

LEGEND

Interpreted thickness of compressible silt horizon with interbedded sand bands

q_c (MPa)
0 10 20 30
CPT plots (see report appendices for details)

VERTICAL SCALE 1:300
0 3 6 9 12 15 (m)

HORIZONTAL SCALE 1:1500
0 15 30 45 60 75 (m)

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DRAWN	smb	Mar.09
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PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Cross Section B

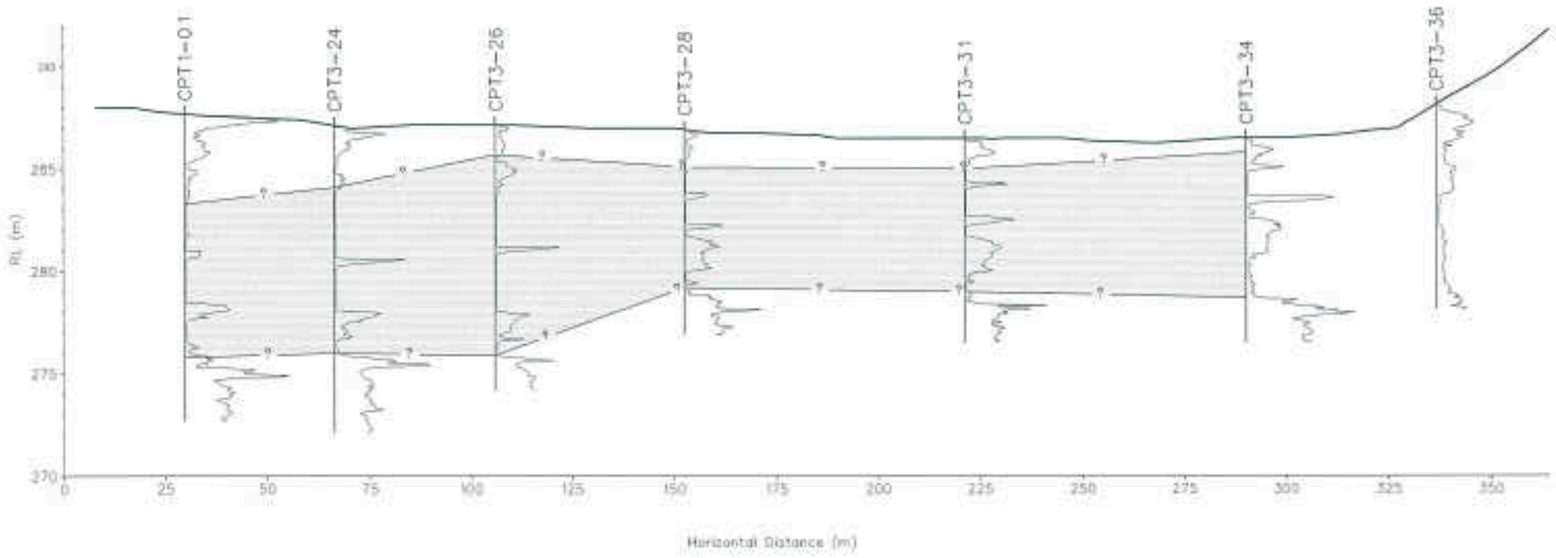
FIG No. Figure 9 REV 0

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Version: 2, Version Date: 27/04/2009

NOTES:
1. Note x5 vertical exaggeration.
2. Interpreted thickness of compressible silt horizon is based on combination of factors, not purely on cone resistance as shown.
3. Groundwater levels have been omitted.
4. Note cross sections A, B and C drawn to equal scale.

SOUTH NORTH



SECTION C Fig 5 CROSS SECTION

LEGEND

Interpreted thickness of compressible silt horizon with interbedded sand bands

q_c (MPa)
0 10 20 30
CPT plots (see report appendices for details)

VERTICAL SCALE 1:300
0 3 6 9 12 15 (m)

HORIZONTAL SCALE 1:1500
0 15 30 45 60 75 (m)

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APPROVED	DMS	17/3/09
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SCALES (AT A3 SIZE)	AS SHOWN	
PROJECT No	851126	

PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Cross Section C

FIG No. Figure 10 REV 0

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Version: 2, Version Date: 27/04/2009

NOTE:
Refer to Figure 4 for cut/fill information. Refer to Table 8.8.2 for detailed information

LEGEND

- >1.0m fill
- 0.5m to 1.0m fill
- 0m to 0.5m fill
- SWMH — Stormwater pipe/manhole
- SSMH — Sewer pipe/manhole

SCALE 1:2000
0 20 40 60 80 100 (m)

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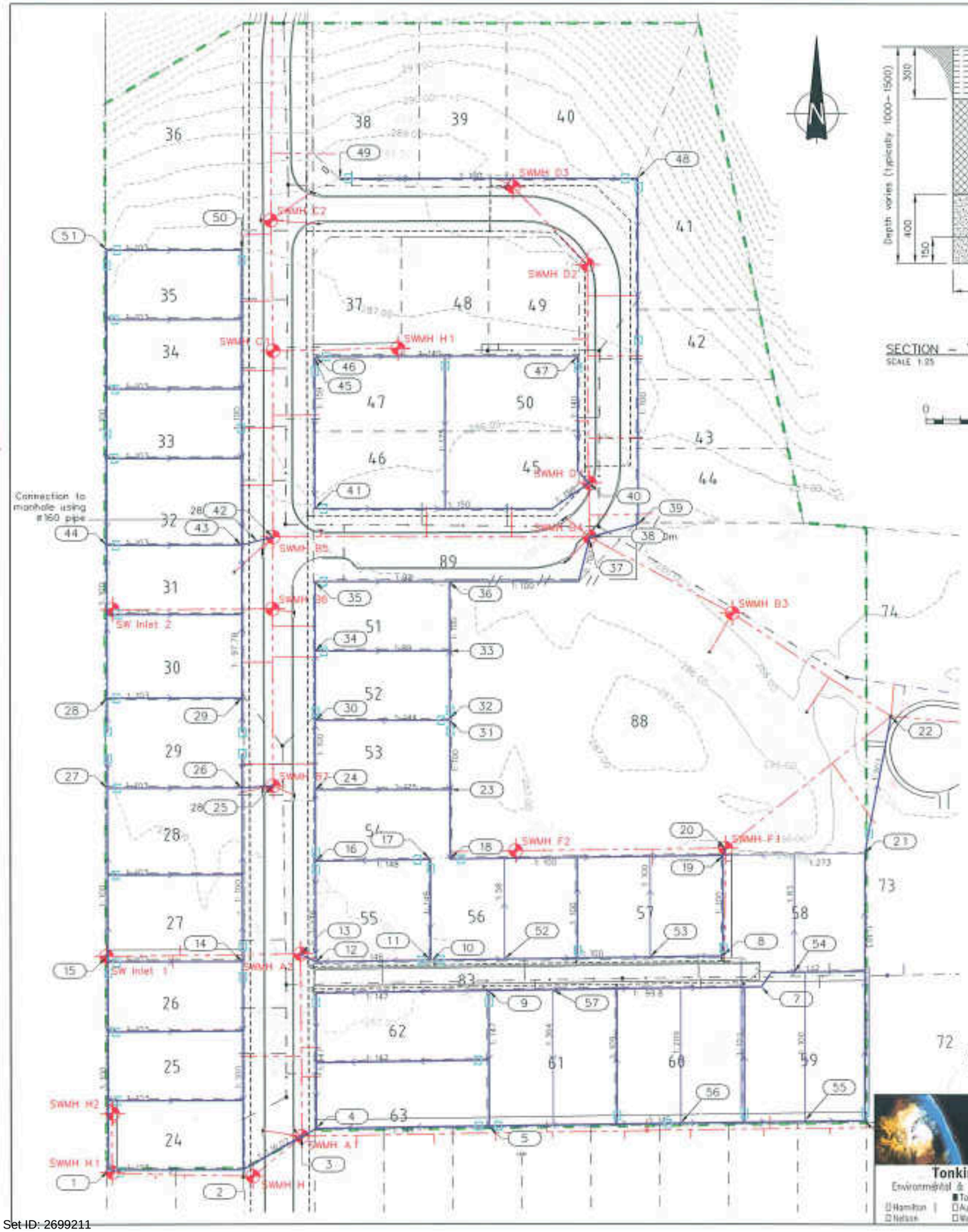
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PROJECT No.	851126	

PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Layout of Sewer and Stormwater Systems

FIG No. Figure 11 REV 0

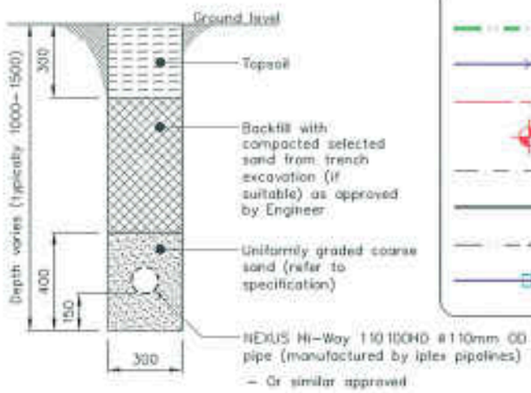
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SCALE 1:1,250

0 10 20 30 40 50 60 70 80 (m)



SECTION – TYPICAL SUBSOIL DRAINAGE DETAIL

SCALE 1:25

SCALE 1:25

0 0.5 1.0 1.5 (m)

LEGEND

- Stage 3 boundary
- Subsoil drainage (pipe grade)
- Stormwater pipe
- Stormwater manhole
- Stage 3 cadastral boundarys
- Stage 3 roading
- Stage 3 sewer
- Subsoil drainage maintenance manhole

NOTES:

1. All dimensions are in millimetres unless noted otherwise.
2. Levels are in termes of Moturiki Datum Origin AAJY (CB1) RL306.68
3. Stockpiling of sand backfill shall be restricted to areas indicated by the Engineer (provisionally lots 88, and 36 to 41 inclusive).

SETOUT TABLE

1	764239.23 mN	376594.54 mE	285.88 m
2	764239.24 mN	376633.54 mE	285.50 m
3	764248.87 mN	376650.40 mE	285.33 m
4	764251.12 mN	376654.48 mE	285.39 m
5	764251.86 mN	376704.47 mE	285.75 m
6	764253.45 mN	376813.53 mE	285.00 m
7	764291.95 mN	376783.43 mE	285.21 m
8	764300.85 mN	376772.35 mE	284.74 m
9	764290.85 mN	376704.54 mE	286.00 m
10	764299.62 mN	376688.29 mE	285.59 m
11	764299.61 mN	376687.76 mE	285.80 m
12	764299.12 mN	376654.62 mE	285.58 m
13	764301.39 mN	376650.15 mE	285.53 m
14	764299.23 mN	376633.60 mE	286.10 m
15	764300.79 mN	376594.17 mE	286.48 m
16	764328.12 mN	376654.61 mE	285.77 m
17	764328.60 mN	376687.91 mE	286.00 m
18	764328.71 mN	376693.61 mE	285.24 m
19	764329.79 mN	376772.32 mE	284.45 m
20	764331.74 mN	376773.16 mE	284.43 m
21	764330.46 mN	376813.52 mE	284.60 m
22	764369.96 mN	376821.15 mE	284.40 m
23	764348.71 mN	376693.46 mE	285.27 m
24	764348.71 mN	376654.61 mE	285.57 m
25	764349.84 mN	376642.31 mE	285.51 m
26	764349.23 mN	376633.52 mE	285.60 m
27	764349.23 mN	376594.60 mE	285.98 m
28	764375.23 mN	376594.59 mE	285.57 m
29	764375.23 mN	376633.51 mE	285.20 m
30	764368.71 mN	376654.60 mE	285.37 m
31	764368.71 mN	376693.60 mE	285.64 m
32	764369.21 mN	376693.53 mE	284.97 m
33	764388.71 mN	376693.60 mE	284.77 m
34	764388.71 mN	376654.45 mE	285.17 m
35	764408.71 mN	376654.44 mE	284.97 m
36	764408.71 mN	376693.59 mE	284.57 m
37	764421.49 mN	376733.93 mE	284.07 m
38	764421.49 mN	376733.93 mE	285.00 m
39	764425.26 mN	376748.09 mE	285.14 m
40	764437.11 mN	376733.86 mE	284.68 m
41	764429.71 mN	376654.59 mE	285.22 m
42	764421.56 mN	376642.44 mE	284.66 m
43	764419.23 mN	376633.43 mE	284.75 m
44	764419.23 mN	376594.44 mE	285.13 m
45	764473.38 mN	376654.52 mE	285.50 m
46	764473.55 mN	376654.69 mE	285.49 m
47	764473.57 mN	376730.43 mE	284.95 m
48	764524.89 mN	376748.07 mE	286.14 m
49	764524.88 mN	376661.99 mE	287.00 m
50	764504.23 mN	376633.42 mE	285.60 m
51	764504.23 mN	376594.57 mE	285.98 m
52	764299.92 mN	376709.06 mE	285.37 m
53	764300.54 mN	376751.25 mE	284.95 m
54	764296.15 mN	376792.96 mE	284.93 m
55	764253.45 mN	376796.15 mE	285.11 m
56	764252.67 mN	376760.12 mE	285.63 m
57	764291.11 mN	376723.04 mE	285.81 m

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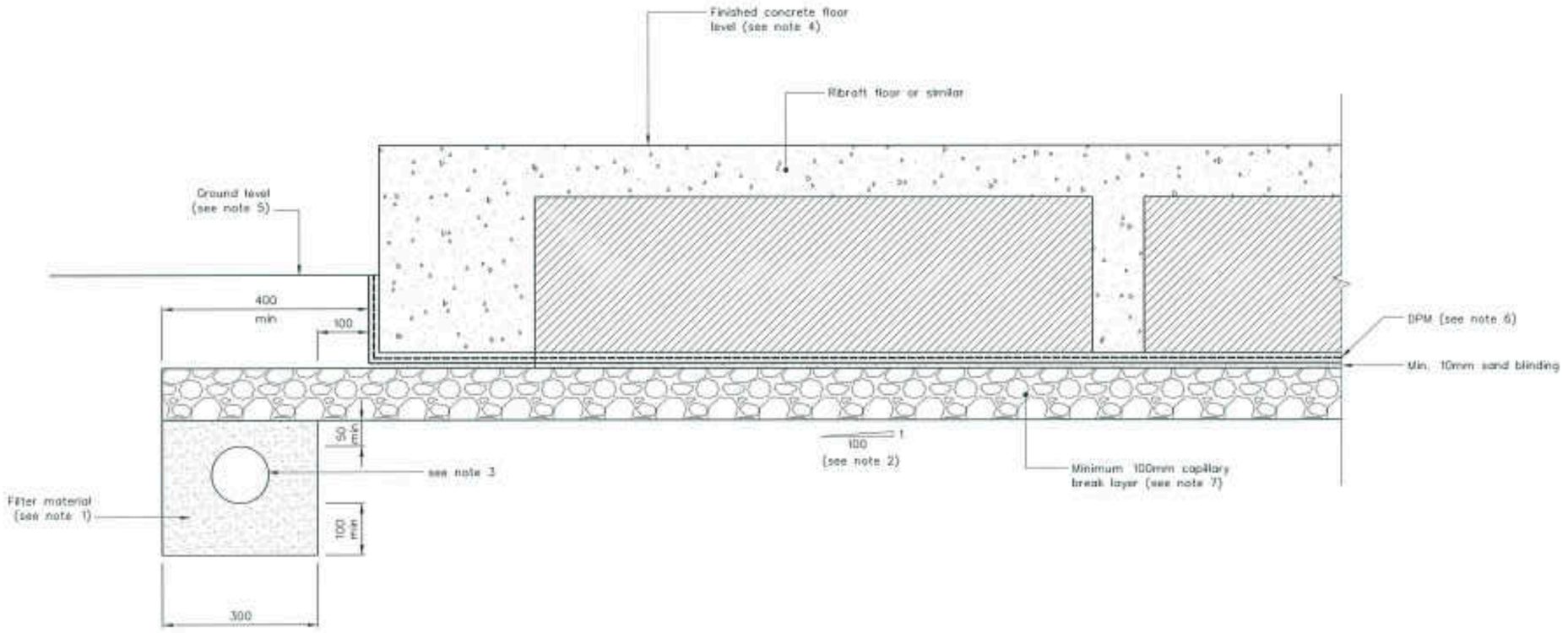
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PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Subsoil Drainage

FIG. No. Figure 12 REV 0

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TYPICAL DETAIL: INDICATIVE FOUNDATION DESIGN

NOTES:

1. Drain filter material grading as indicated in Table 1.
2. Base of capillary-break layer to have a minimum fall of 1:100 towards drain from centre of foundation.
3. Capillary-break drain to extend around perimeter of building with a positive connection to stormwater system.
4. Finished concrete floor level shall be a minimum of 150mm above adjacent ground level or the minimum height given in Clause 7.5.2.1 of NZS3604: 1999 (whichever is greater), dependent upon whether the ground is protected by permanent paving or not and the type of exterior wall covering. Due allowance to be made for anticipated post-construction settlements to ensure compliance with minimum dimensions required by NZS3604, in the long term.
5. A minimum fall of 1:25 to be provided for ground surface adjoining foundation for minimum 1m from the building or permanent paving with minimum 1:150 fall to 100mm wide concrete channel, in accordance with Clause 7.5.2.2 of NZS3604: 1999. Allowance to be made for possible future settlement close to building.
6. DPM to generally comply with Clauses 7.5.4 to 7.5.7 of NZS3604: 1999. Two layers of 0.25mm polythene to be used. Laps for each layer to be staggered. Laps to be taped.
7. Capillary-break material shall be well graded compacted hardfill with not more than 5% passing the 2.2mm sieve and 100% passing the 19mm sieve.
8. Foundation raft details are indicative only and shall be subject to specific engineering design.

TABLE 1	
Test Sieve Aperture (mm)	Percentage passing (%)
26.5	100
13.2	85–100
9.5	80–95
4.75	65–85
2.36	50–70
1.18	35–55
0.6	18–40
0.3	3–25
0.15	8 max
0.075	0

SCALE 1: 100
0 1 2 3 4 5 (m)

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SCALES (AT A3 SIZE)	1: 100	
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PIONEER PROPERTY TRUST
WESTERN ROAD, NGONGOTAHA
GEOTECHNICAL ASSESSMENT REPORT
Indicative Foundation Design

FIG No. Figure 13 REV 0

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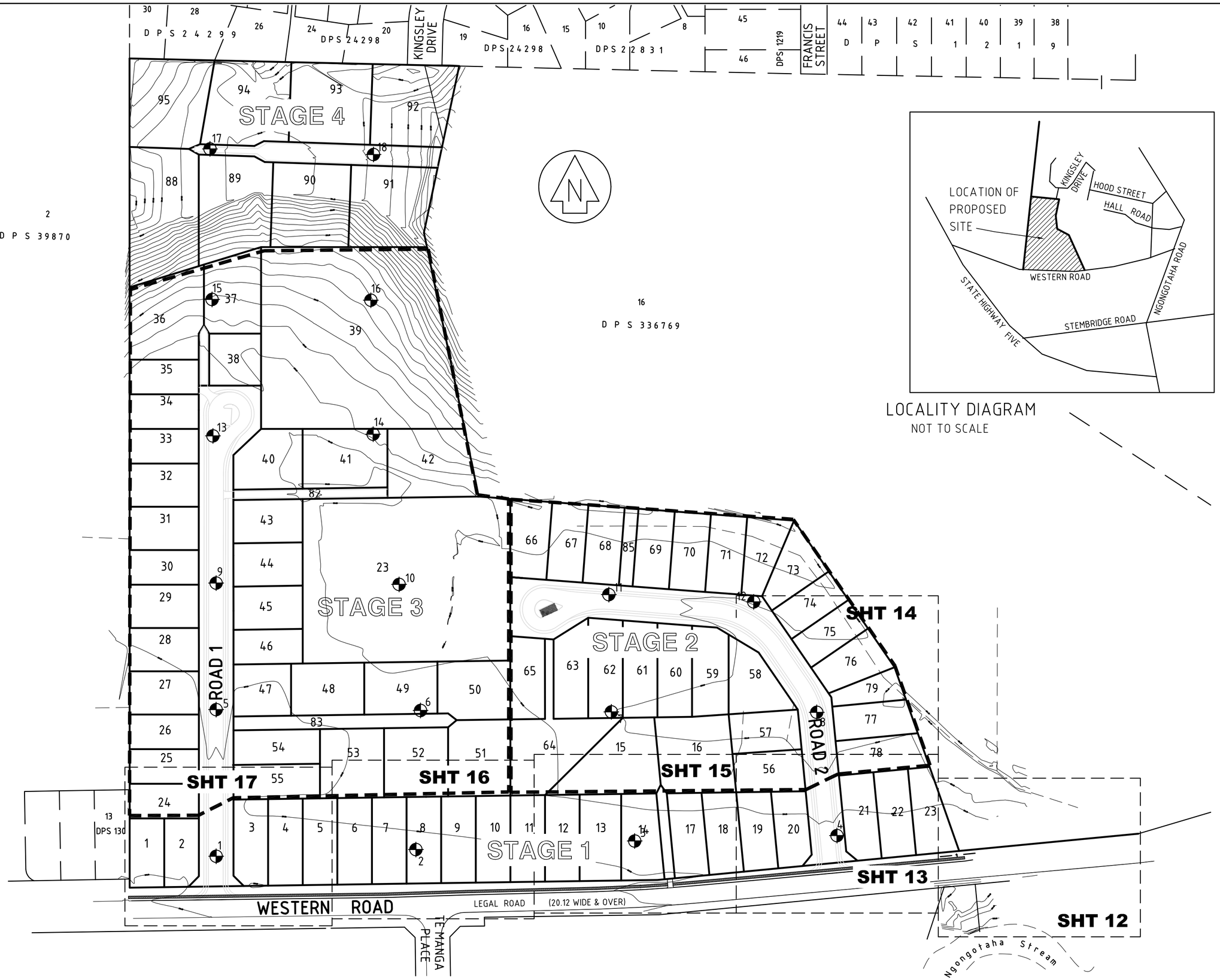
Appendix B: Historic Ground Investigation Data

- **MTEC Consultants Ltd, Western Road, Ngongotaha – Preliminary Site Investigation (October 2004)**
- **MTEC Consultants Ltd, Western Road, Ngongotaha – Recent Site Investigation (February/March 2008)**
- **MTEC Consultants Ltd, Scala Penetration Test Results for Stages One, Two and Three**
- **Coffey Geotechnics (NZ) Ltd, Site Investigation for Proposed Residential Dwelling, Lot 64 Western Road, Ngongotaha (Golden Homes Job No. 8166). 22 August 2007.**
- **Coffey Geotechnics (NZ) Ltd, Site Investigation for Proposed Residential Dwelling, Lot 72 Oaklands Estate, Rotorua (Golden Homes Job No. 8173). 13 September 2007.**

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MTEC Consultants Ltd, Western Road, Ngongotaha – Preliminary Site Investigation (October 2004)

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Version: 2, Version Date: 27/04/2009



LOCALITY DIAGRAM
NOT TO SCALE

NOTES/KEY

1. LEVELS ARE IN TERMS OF MOTURIKI DATUM.

STAGE 1 — STAGE BOUNDARIES

SHT 3 — DETAIL SHEET LAYOUT BOUNDARIES

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THE EXISTING SERVICES SHOWN ON THIS PLAN ARE INDICATIVE ONLY AND MAY NOT INCLUDE ALL EXISTING SERVICES.
IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL EXISTING SERVICES PRIOR TO STARTING WORK.

No.	Date	By	Issue/Revision
A	02/02/05	JM	ISSUED FOR APPROVAL

DRAWN: JM | DESIGNED: JM
CHECKED: _ | SURVEYED BY: _
LOCAL AUTHORITY REF: RDC - EBOP

MTEC CONSULTANTS
SURVEYORS
ENGINEERS
PLANNERS
ROTORUA TE PUKE OPOTIKI
MT MAUNGANUI WHAKATANE

CLIENT
PIONEER PROPERTY TRUST LTD

PROJECT/LOCATION
WESTERN ROAD
NGONGOTAHA

DRAWING DESCRIPTION
PROPOSED SUBDIVISION OF
LOT 1 DP 336769
OVERALL PLAN

SCALE: 1:1500 ORIGINAL DWG. SIZE A2

DRAWING No.	SHEET No.	ISSUE
175781-R-E-D001	01	A

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

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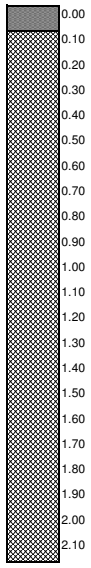
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 1

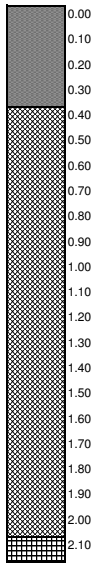


A **TOPSOIL** : black/brown, moist
B **SILT :** slightly sandy, light yellow/brown, moist

water table @550mm

@1700mm silt w/wood fibres, mid brown w/black organic staining

BOREHOLE 2



A **TOPSOIL :** brown, moist

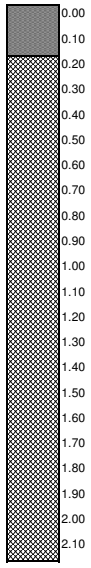
B **SILT :** sandy, freq pumice gravel to 2mm, yellow/brown, moist

silt only no pumice gravel

becomes wet

C **SAND** (fg-mg) : silty, light black/brown, wet

BOREHOLE 3

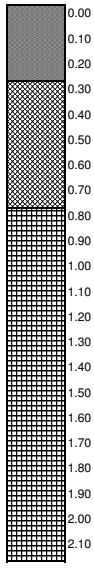


A **TOPSOIL** : black/brown, moist

B **SILT :** sandy, freq pumice gravel to 2mm, yellow/brown, moist
silt only no pumice gravel

water table @800mm

BOREHOLE 4



A **TOPSOIL** : black/brown, damp

B **SILT :** slightly sandy, orangey/brown, damp

silt changes to yellow/brown, moist

C **SAND** (fg-mg) : yellow/brown, moist

100mm band of orangey/brown 5mm pumice gravel

water table @1400mm

100mm band of silty brown w/black organic staining

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Version: 2, Version Date: 27/04/2009

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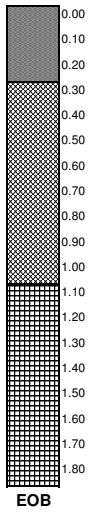
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 5



A **TOPSOIL** : black/brown, moist

B **SILT :** slightly sandy, frequent pumice gravel to 2mm, orangey/brown, moist

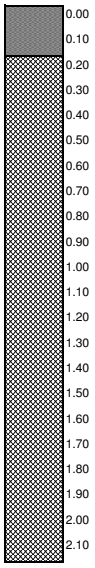
no pumice gravel, yellow/brown
▼ water table @680mm

C **SAND** (fg-mg) : some silt, yellow/brown, wet

mid brown sand w/up to 3mm black gravel

hole would fill back up with gravely sand

BOREHOLE 6



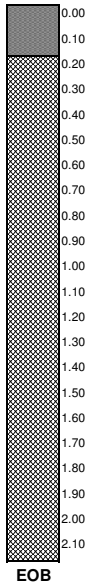
A **TOPSOIL** : black/brown, damp

B **SILT :** slightly sandy, orangey/brown, damp

silt becomes yellow/brown

becomes wet

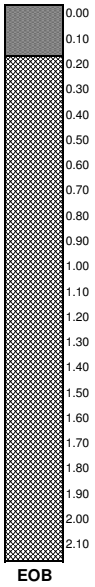
BOREHOLE 7



A **TOPSOIL** : black/brown, moist

B **SILT :** slightly sandy, yellow/brown, moist
▼ water table @250mm

BOREHOLE 8



A **TOPSOIL** : black/brown, damp

B **SILT :** slightly sandy, yellow/brown w/orange staining moist
▼ water table @400mm

silt becomes mid brown

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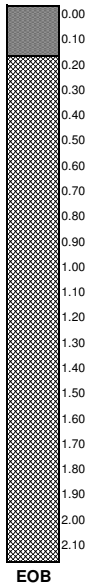
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

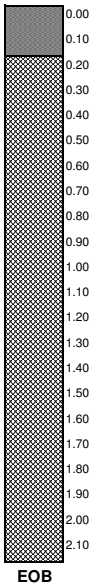
BOREHOLE 9



A **TOPSOIL** : black/brown, moist
water table @180mm
B **SILT :** slightly sandy, yellow/brown, moist

silt becomes white/grey

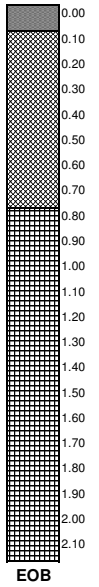
BOREHOLE 10



A **TOPSOIL** : black/brown, moist
water table @200mm
B **SILT :** sandy, frequent pumice gravel to 2mm, orangey/brown, wet
silt becomes grey
silt becomes yellow/brown, no pumice gravel

silt yellow/brown with green/black staining

BOREHOLE 11



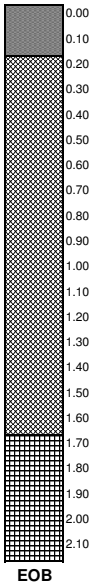
A **TOPSOIL** : black/brown, damp
B **SILT :** orangey/brown, damp

silt becomes slightly sandy and yellow/brown

C **SAND** (fg) : some silt, yellow/brown, moist

water table @1050mm

BOREHOLE 12



A **TOPSOIL** : black/brown, damp

B **SILT :** orangey/brown, damp

silt becomes yellow/brown

water table @1400mm
silt w/100mm band of black staining w/veg particules

C **SAND** (fg-mg) : some silt, occational gravel to 2mm, brown, wet

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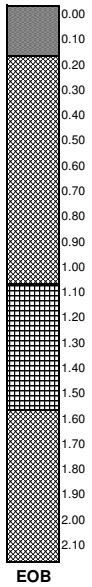
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 13



A **TOPSOIL** : black/brown, damp

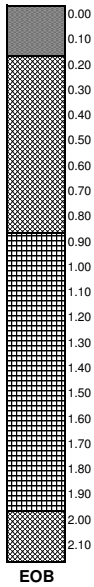
B **SILT :** slightly sandy, yellow/brown with orange staining, moist

water table @640mm

C **SAND** (fg-mg) : hard, grey, wet

B **SILT :** slightly sandy, yellow/brown, wet

BOREHOLE 14



A **TOPSOIL** : black/brown, damp

B **SILT :** sandy, orangey/brown, occasional pumice gravel to 2mm, damp

no pumice gravel

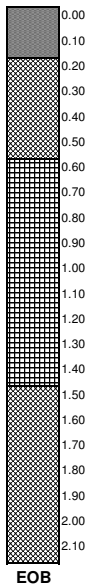
C **SAND** (fg-mg) : yellow/brown, damp

100mm band of pumice gravel to 3mm

sand changes to fg, grey w/orange staining, wet

B **SILT :** sandy, grey w/orange staining, wet

BOREHOLE 15



A **TOPSOIL** : black/brown, damp

B **SILT :** slightly sandy, orangey/brown, damp

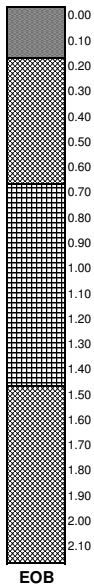
C **SAND** (fg-mg) : yellow/brown, damp

sand changes to orangey/brown, silty

sand changes to yellow/brown, no silt

B **SILT :** sandy, orangey/brown, wet

BOREHOLE 16



A **TOPSOIL** : black/brown, damp

B **SILT :** slightly sandy, orangey/brown, damp

silt changes to yellow/brown

C **SAND** (fg-mg) : silty, yellow/brown, damp

B **SILT :** sandy, orangey/brown, moist

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Version: 2, Version Date: 27/04/2009

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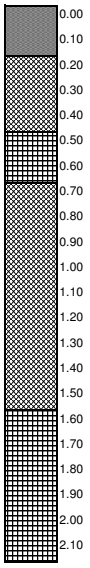
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

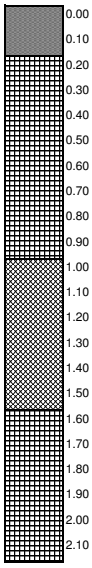
NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 17



A	**TOPSOIL** : brown, damp
B	**SILT :** sandy, orangey/brown, damp
C	**SAND** (fg) : silty, orangey/brown, moist
B	**SILT :** orangey/brown, moist
C	**SAND** (fg-cg) : yellow/brown, damp
	sand changes fg-cg w/frequent pumice gravel to 5mm

BOREHOLE 18



A	**TOPSOIL** : BLACK/brown, damp
C	**SAND** (fg-cg) : silty, w/frequent pumice gravel to 2mm, orangey/brown, damp
B	**SILT :** sandy, orangey/brown, moist
C	**SAND** (fg-mg) : yellow/brown, wet
	sand changes fg-cg w/frequent pumice gravel to 5mm

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BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 4



TOPSOIL : black brown, damp

SILT : slightly sandy, orangey brown, damp

silt changes to yellow brown, moist

SAND (fg-mg) : yellow brown, moist

100mm band of orangey brown 5mm pumice gravel

100mm band of silty brown w black organic staining

sand changes to mg-cg and orangey yellow brown in colour

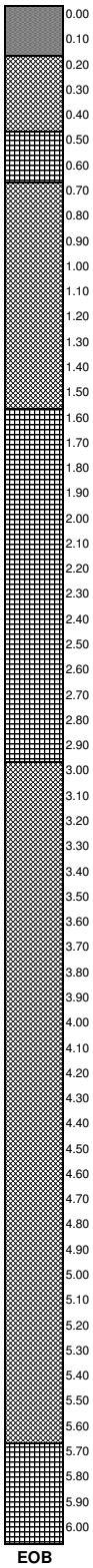
sand changes to mid brown in colour w/orange pumice gravel to 2mm, becomes wet

becomes wet

sand changes to fg-cg and mid grey in colour

SILT : trace of sand, dark brown with dark grey staining, wet

BOREHOLE 17



TOPSOIL : brown, damp

SILT : sandy, orangey brown, damp

SAND (fg) : silty, orangey brown, moist

SILT : orangey brown, moist

SAND (fg-cg) : yellow brown, damp
trace of silt

sand changes fg-cg w/frequent pumice gravel to 7mm and occasional pumice gravel to 15mm colour changes to orangey brown

SILT : trace of sand, yellow brown, moist

silt changes to dark grey in colour, becomes wet

silt changes to light grey in colour, becomes wetter

silt changes to yellow brown in colour

SAND (mg-cg) : yellow orangey brown, wet
frequent pumice gravel to 3mm and occasional pumice gravel to 5mm

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colour changes to orangey brown

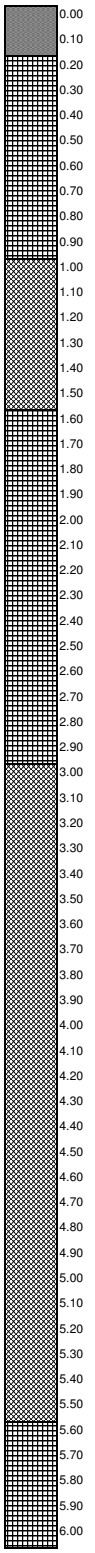
BOREHOLE LOGS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

BOREHOLE 18



TOPSOIL : black brown, damp

SAND (fg-cg) : silty, w/frequent pumice gravel to 2mm, orangey brown, damp

SILT : sandy, orangey brown, moist

SAND (fg-mg) : yellow brown, wet

sand changes fg-cg w/frequent pumice gravel to 5mm and occasional pumice gravel to 10mm
colour changes to orangey yellow brown

SILT : trace of sand, mid brown, moist

silt changes to yellow brown in colour

silt changes to dark grey in colour, becomes wet

SAND (mg-cg) : orangey brown intermixed with grey silt, wet
frequent pumice gravel to 10mm and
occasional pumice gravel to 20mm

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	SP 1			SP 2			SP 3		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		350	310		390	350		530	490
10		720	370		580	190		815	285
15		1175	455		790	210		1250	435
20		1325	150		950	160		1700	450
25		1510	185		1350	400		1950(3)	
30		1700	190		1590	240			
35		1910	210		1830	240			
40		1950(1)			1940	110			
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	SP 4			SP 5			SP 6		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		50			60			40	
5		400	350		410	350		345	305
10		1000	600		700	290		590	245
15		1180	180		910	210		895	305
20		1280	100		1100	190		1260	365
25		1350	70		1200	100		1560	300
30		1400	50		1290	90		2005	445
35		1460	60		1385	95			
40		1550	90		1480	95			
45		1700	150		1600	120			
50		1860	160		1700	100			
55		2000	140		1800	100			
60					1860	60			
65					1945	85			
70									
75									
80									
85									
90									
95									
100									

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	SP 7			SP 8			SP 9		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		70			60			70	
5		545	475		500	440		575	505
10		810	265		990	490		920	345
15		1150	340		1510	520		1660	740
20		1450	300		1910	400		1990	330
25		1700	250						
30		1880	180						
35		1990(4)							
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	SP 10			SP 11			SP 12		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		70			50			40	
5		510	440		495	445		375	335
10		880	370		675	180		555	180
15		1700	820		860	185		715	160
20		1980(4)			1175	315		845	130
25					1375	200		990	145
30					1580	205		1375	385
35					1780	200		1600	225
40					1990(4)			1700	100
45								1800	100
50								1920	120
55								1970(2)	
60									
65									
70									
75									
80									
85									
90									
95									
100									

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA
JOB NUMBER: 175781/E

DATE: 13/10/2004
BY: GFB

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

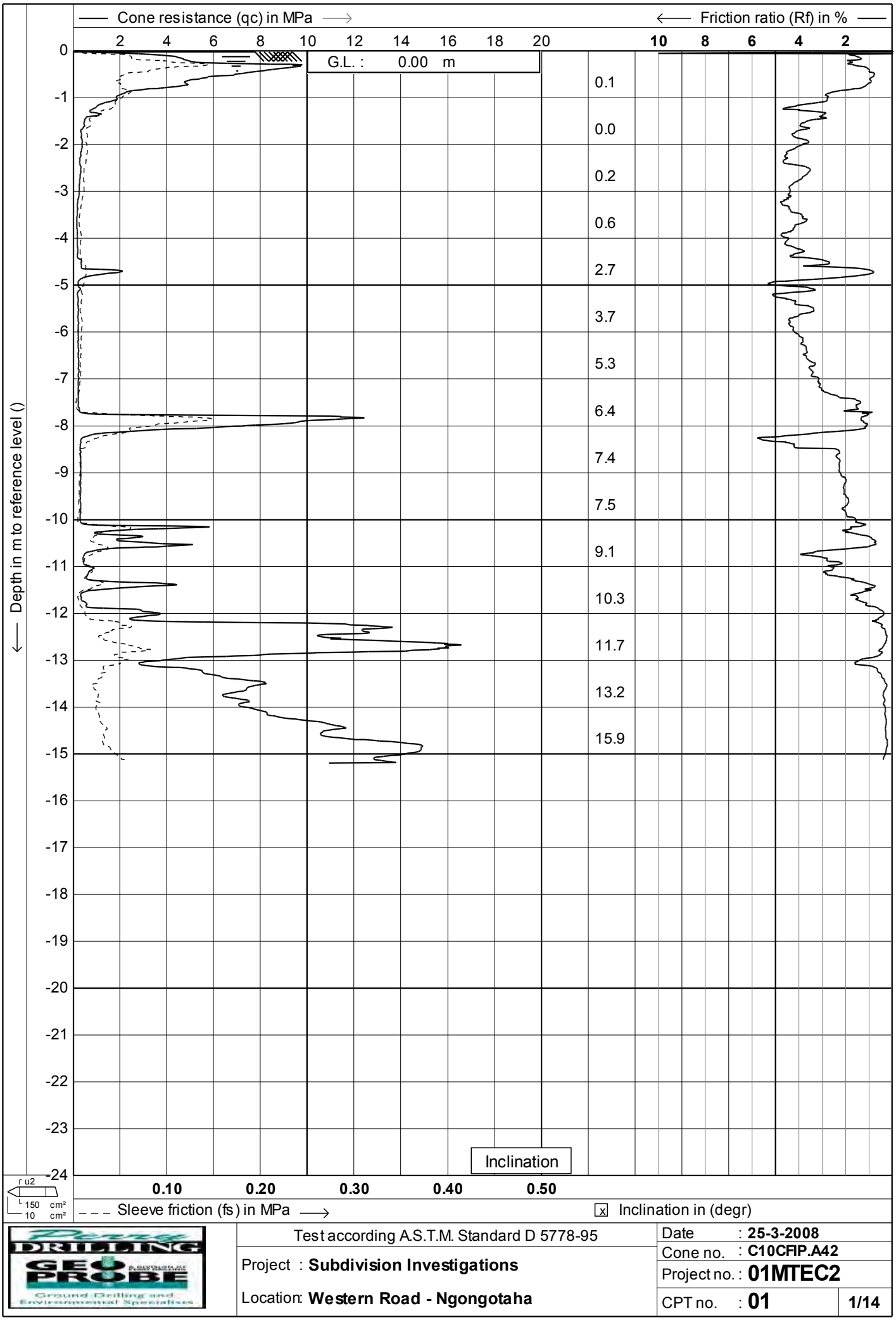
NUMBER	SP 13			SP 14			SP 15		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		60			40			50	
5		580	520		580	540		430	380
10		945	365		990	410		720	290
15		1270	325		1110	120		950	230
20		1305	35		1200	90		1125	175
25		1330	25		1330	130		1240	115
30		1350	20		1580	250		1350	110
35		1380	30		1660	80		1460	110
40					1710	50		1640	180
45					1780	70		1810	170
50					1850	70		1920	110
55					2000	150		2000	80
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	SP 16			SP 17			SP 18		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		50			40			40	
5		525	475		380	340		450	410
10		820	295		600	220		795	345
15		940	120		850	250		1095	300
20		1130	190		1080	230		1250	155
25		1250	120		1240	160		1380	130
30		1490	240		1420	180		1495	115
35		1630	140		1545	125		1605	110
40		1750	120		1650	105		1745	140
45		1860	110		1740	90		1870	125
50		1970	110		1820	80		1990	120
55					1890	70			
60					1960	70			
65									
70									
75									
80									
85									
90									
95									
100									

Document Set ID: 2699211
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MTEC Consultants Ltd, Western Road, Ngongotaha – Recent Site Investigation (February/March 2008)

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

Cone no. : **C10CFIP.A42**

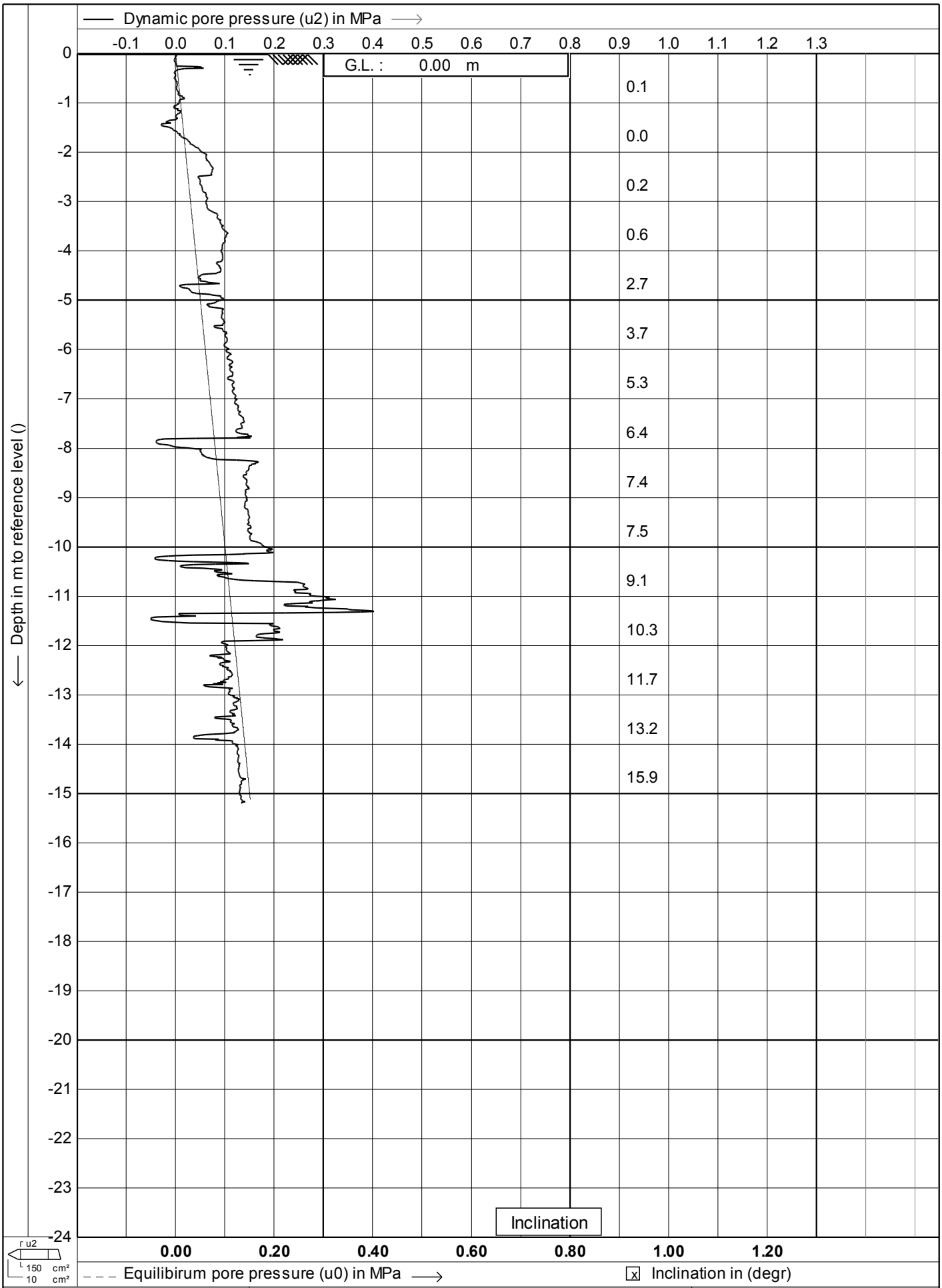
Project no. : **01MTEC2**

CPT no. : **01**

1/14

CPTask V1.14a

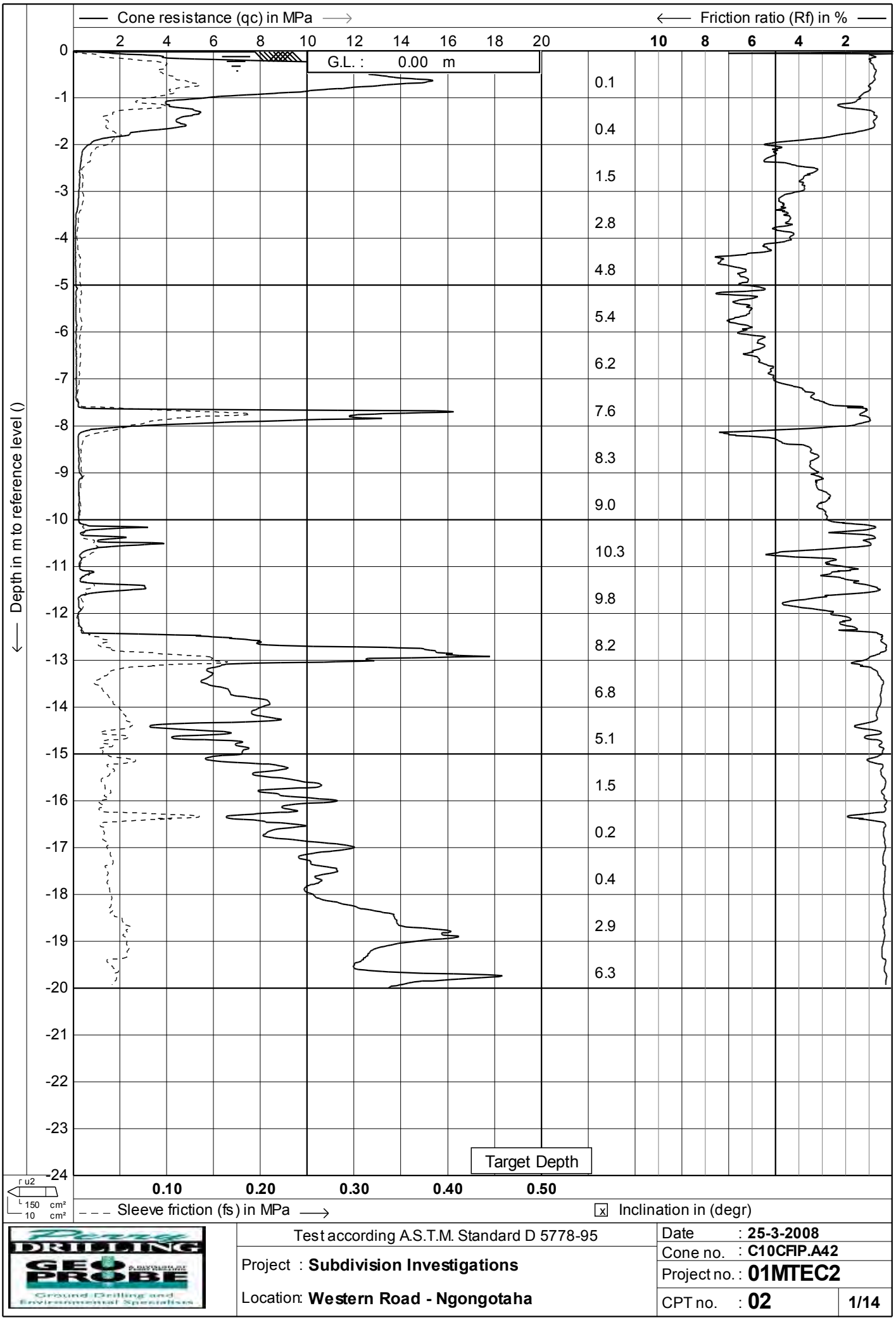
Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95		Date	: **25-3-2008**
		Cone no.	: **C10CFIP.A42**
Project : **Subdivision Investigations**		Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**		CPT no.	: **01** **2/14**

CPTask V1.14a

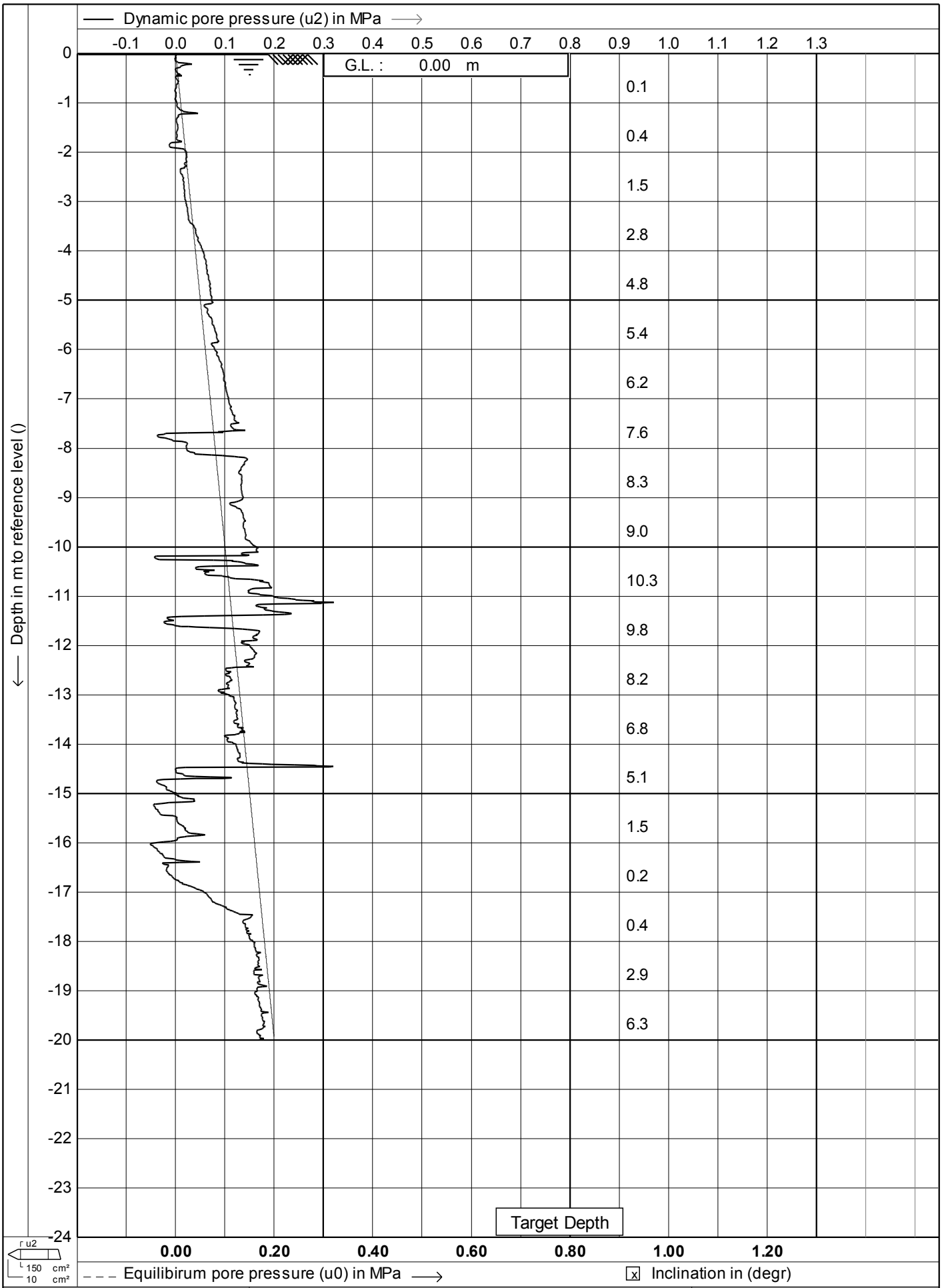
Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
	Cone no.	: **C10CFIP.A42**
Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **02** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



CPTask V1.14a

Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

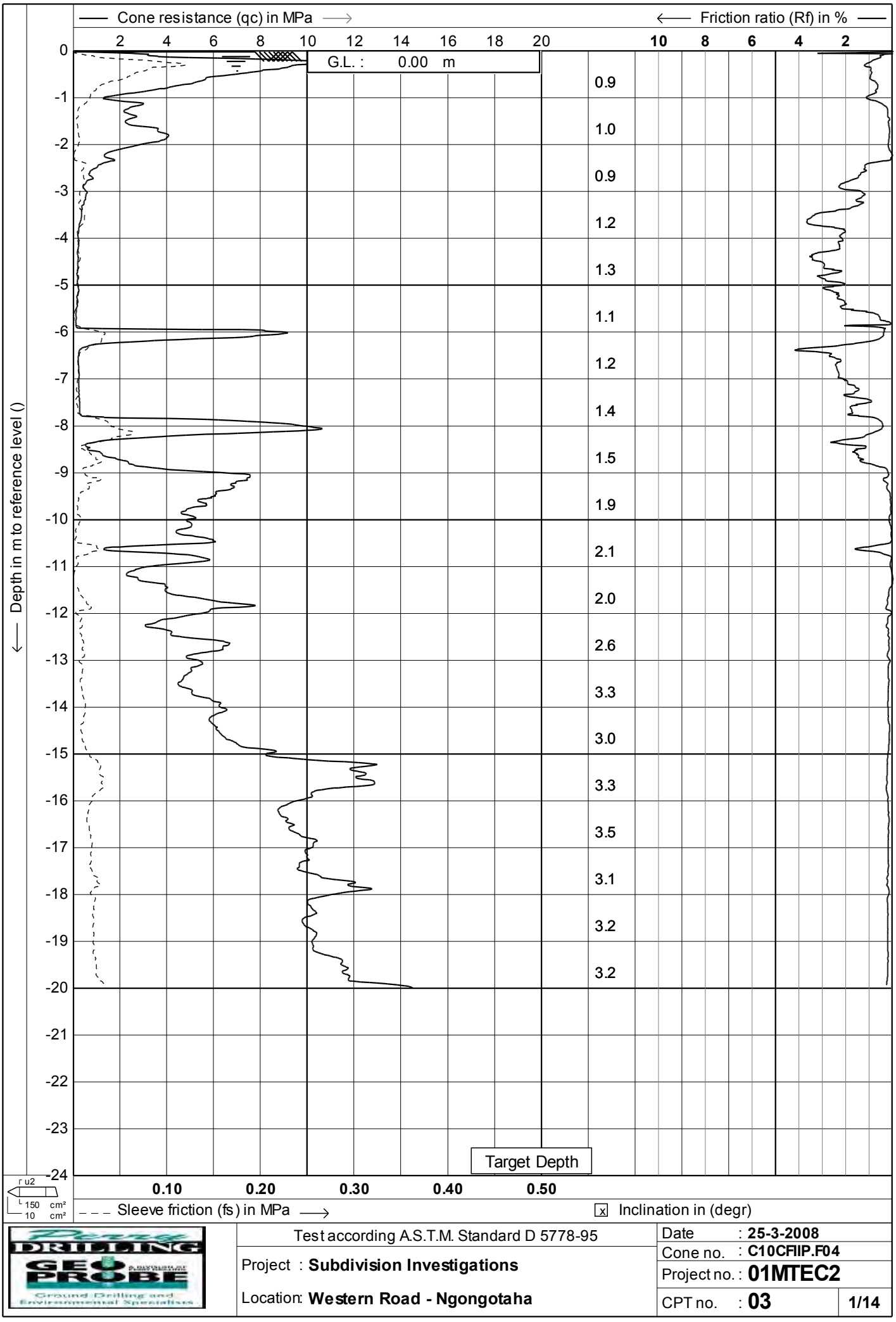
Cone no. : **C10CFIP.A42**

Project no. : **01MTEC2**

CPT no. : **02**

2/14

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

Cone no. : **C10CFIIP.F04**

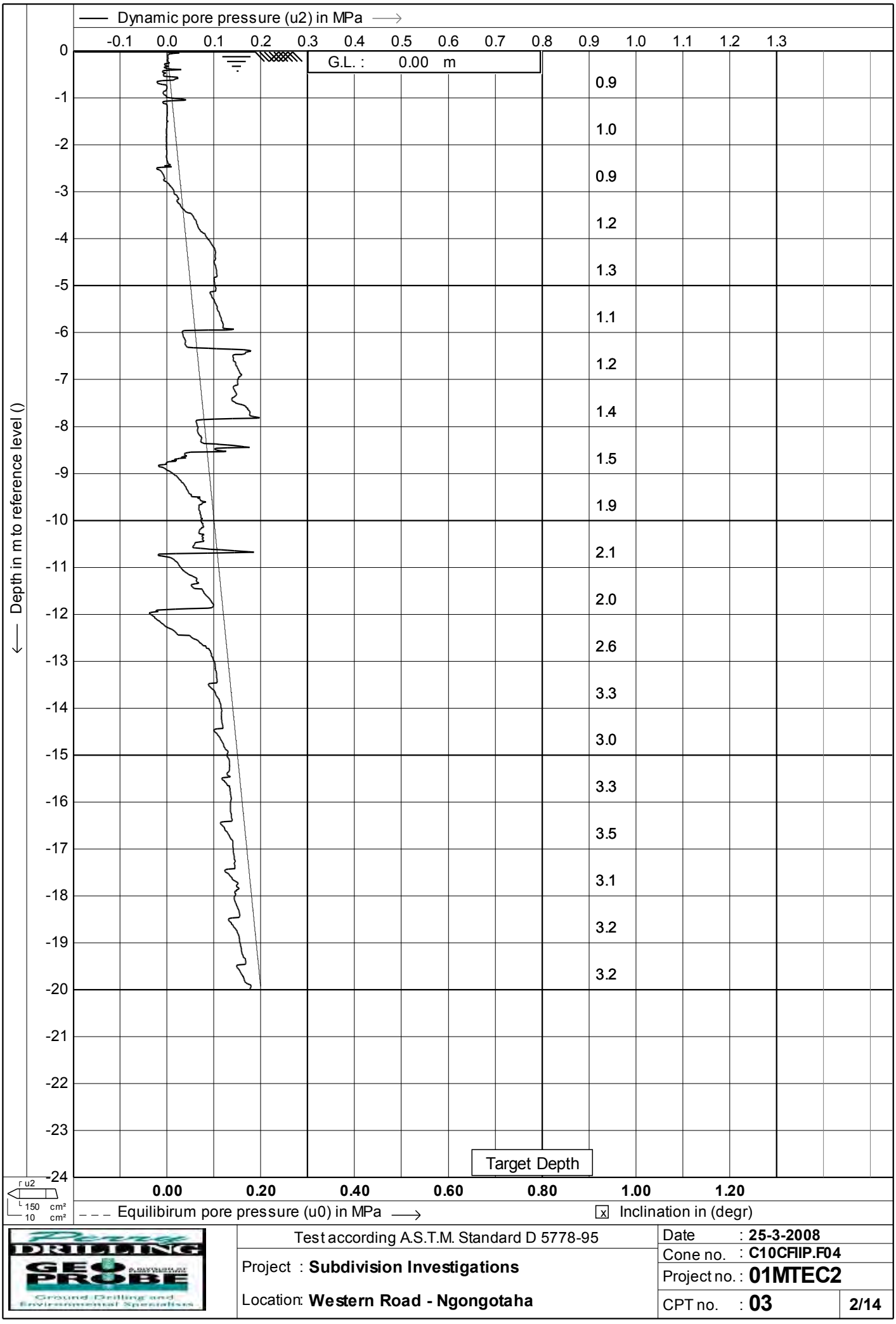
Project no. : **01MTEC2**

CPT no. : **03**

1/14

CPTask V1.14a

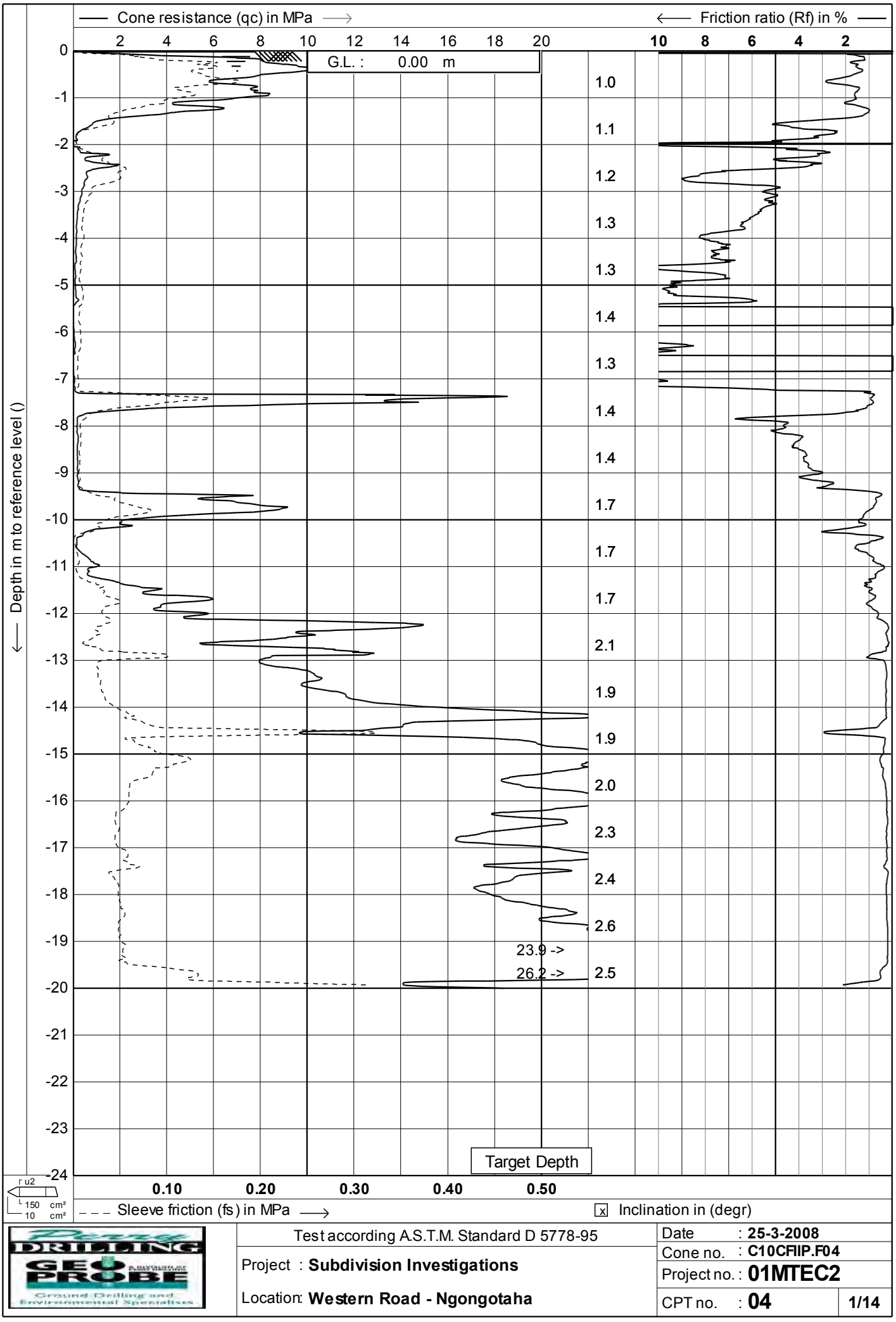
Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
	Cone no.	: **C10CFIIP.F04**
Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **03** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

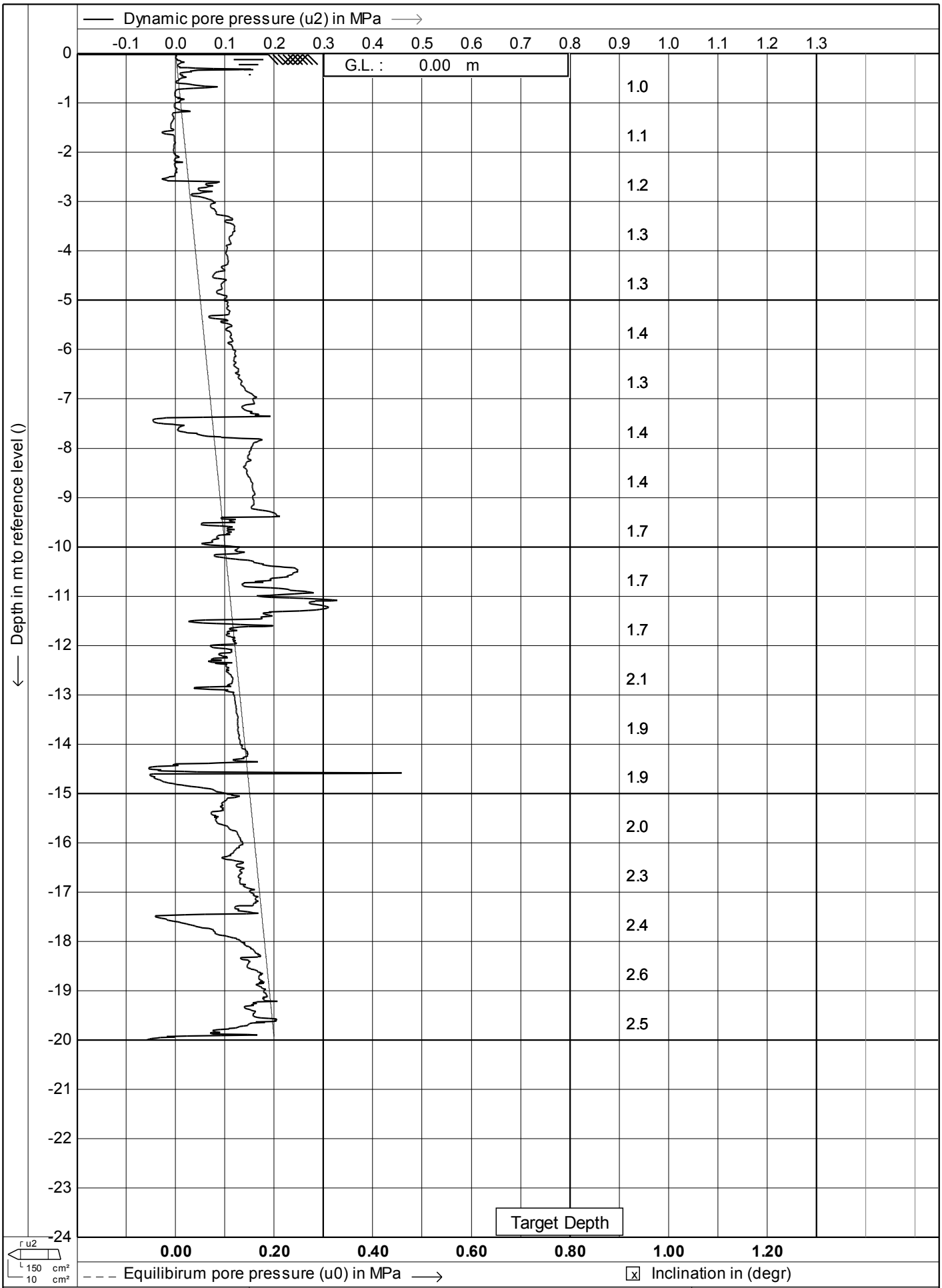


Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
	Cone no.	: **C10CFIIP.F04**
Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **04** 1/14

Ground Drilling and Environmental Specialists

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



CPTask V1.14a

Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

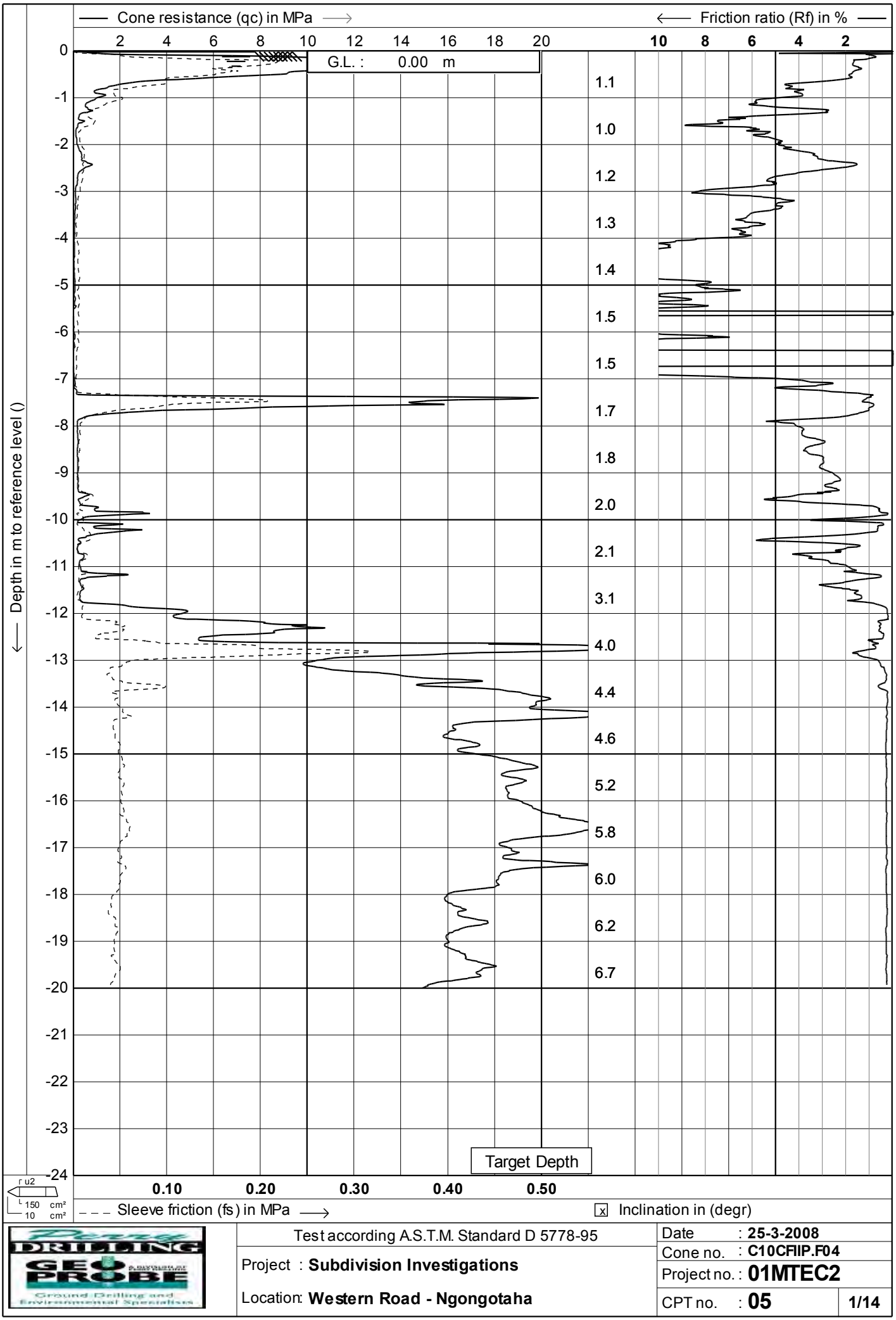
Date : **25-3-2008**

Cone no. : **C10CFIIP.F04**

Project no. : **01MTEC2**

CPT no. : **04**

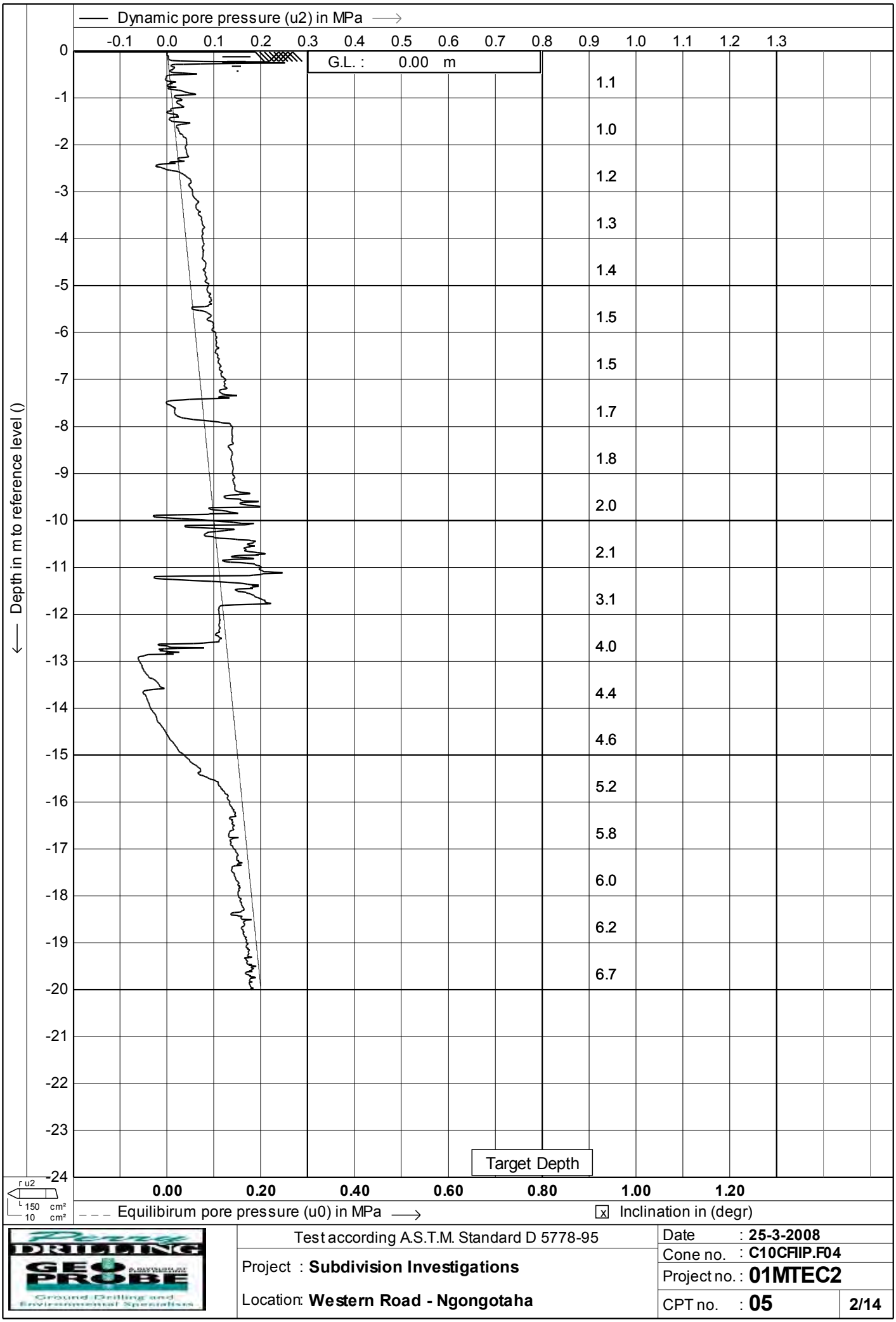
Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
	Cone no.	: **C10CFIIP.F04**
Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **05** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

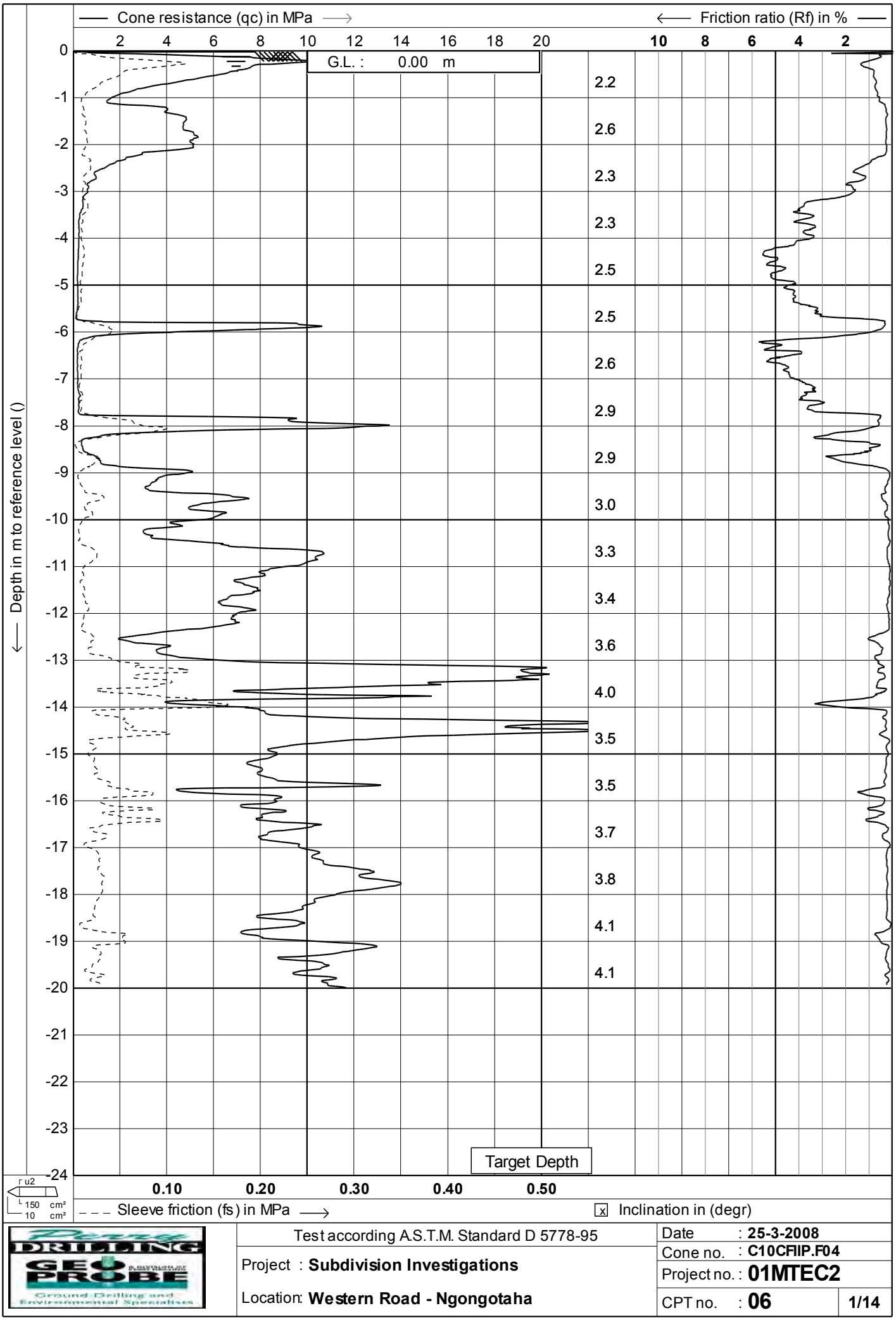
Cone no. : **C10CFIIP.F04**

Project no. : **01MTEC2**

CPT no. : **05** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

Cone no. : **C10CFIIP.F04**

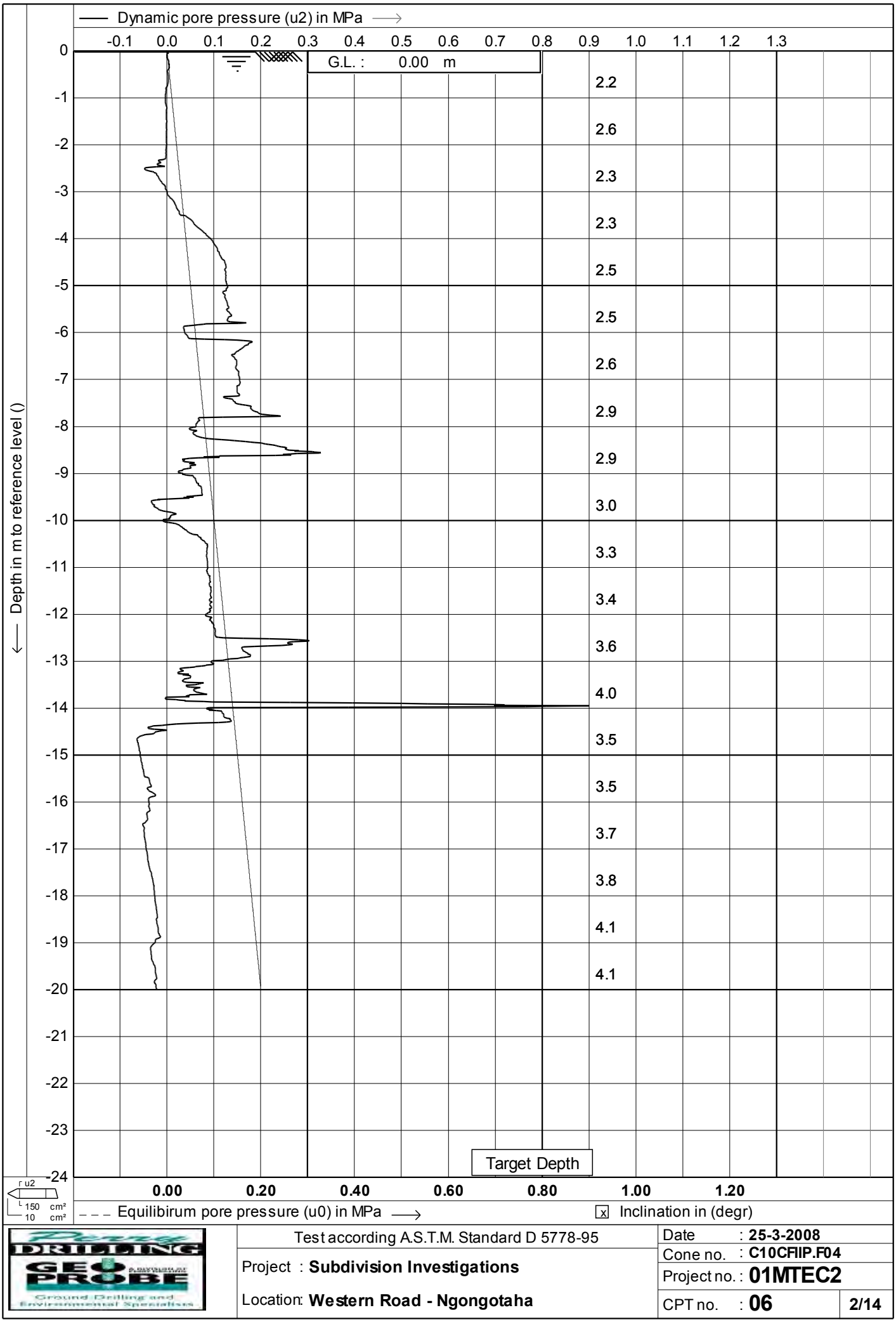
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CPT no. : **06**

1/14

CPTask V1.14a

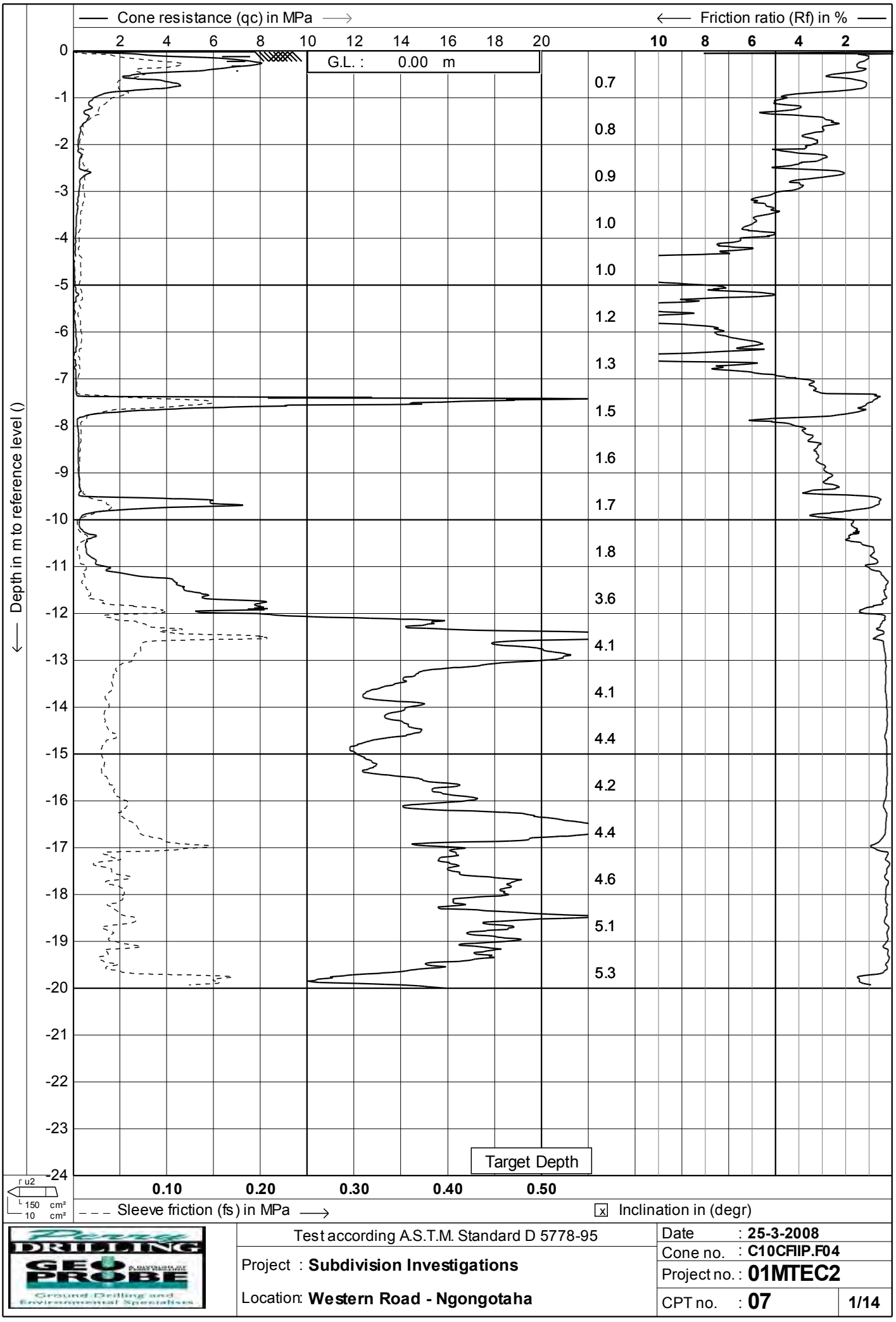
Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **06** **2/14**

CPTask V1.14a

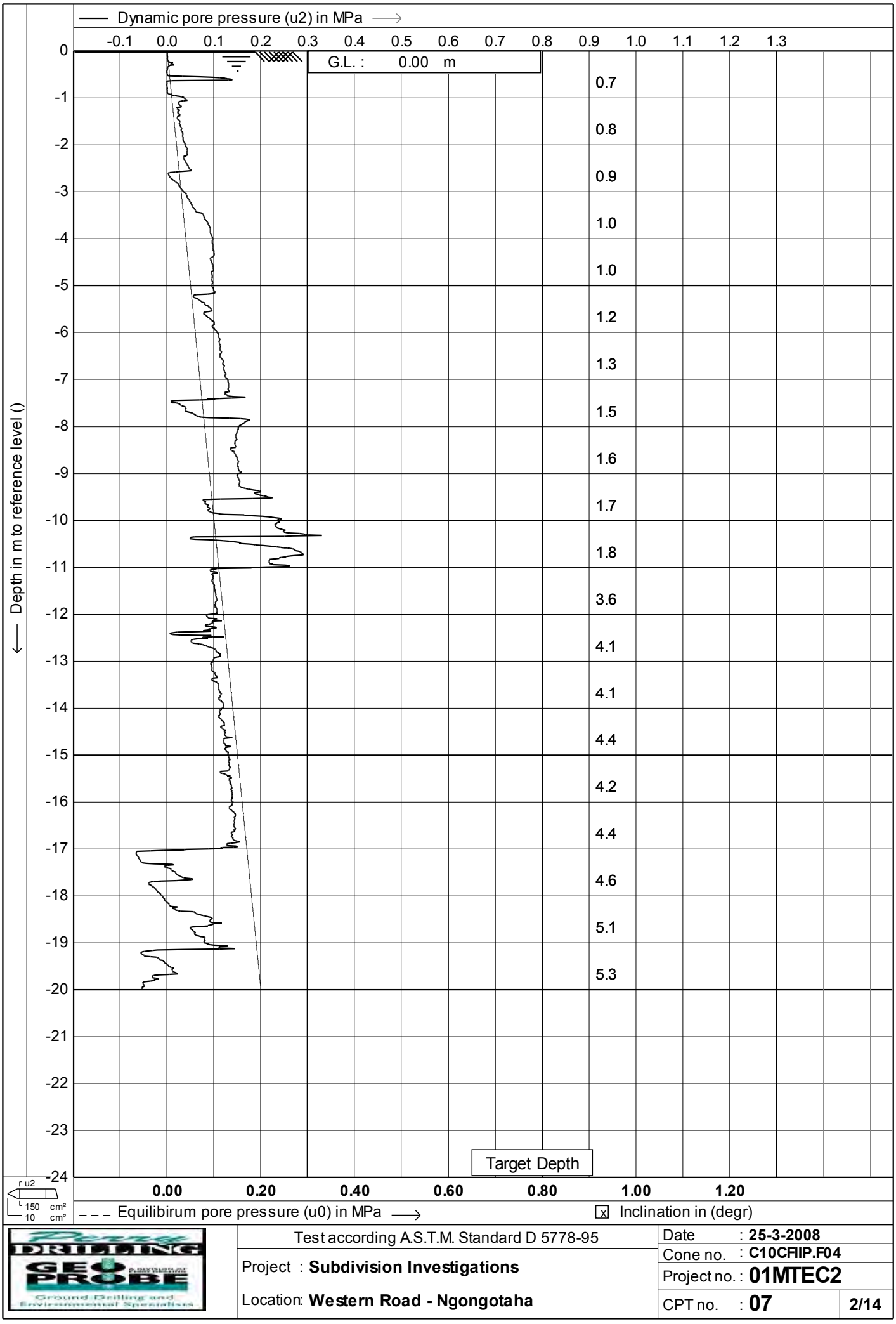
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Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **07** 1/14

CPTask V1.14a

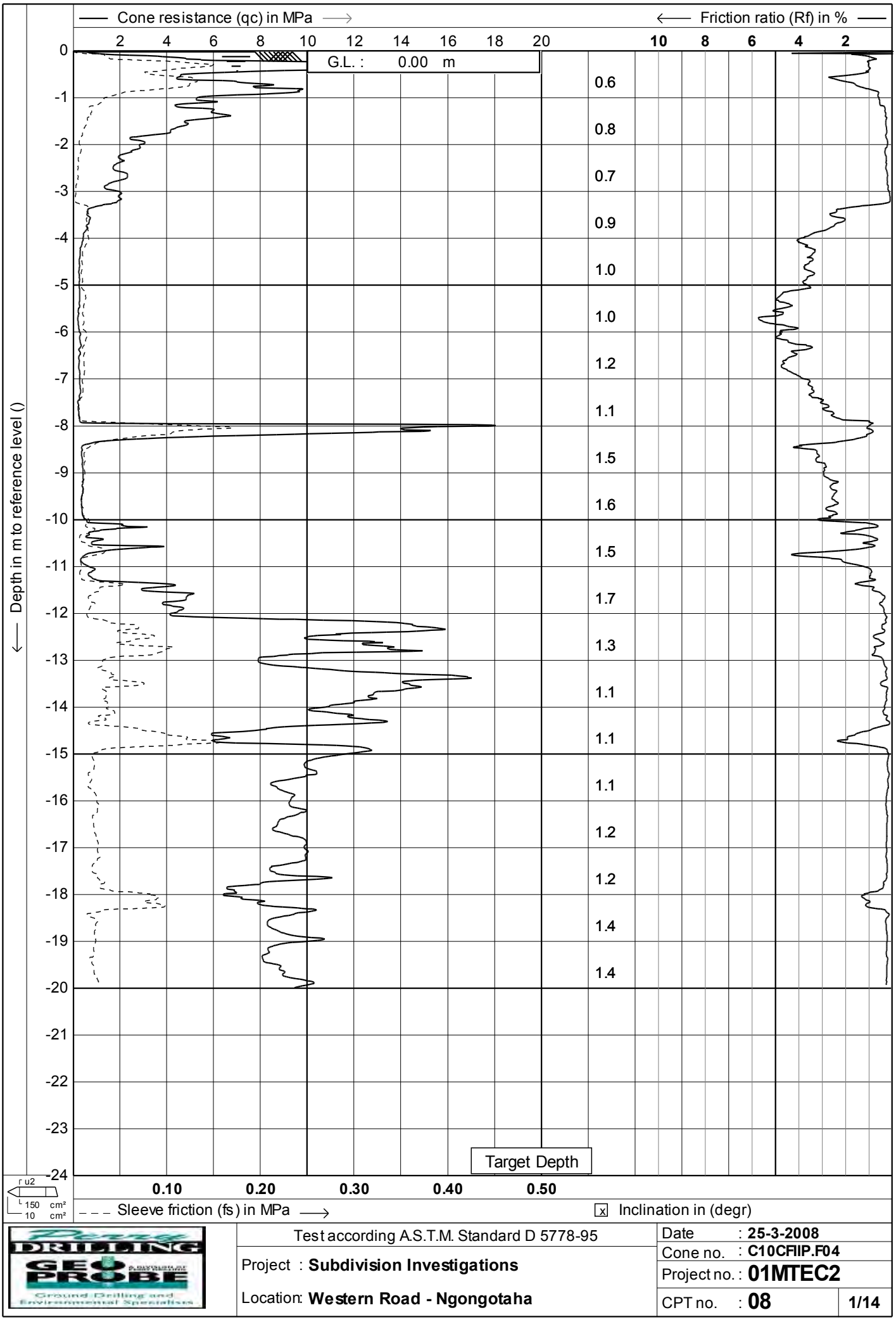
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Version: 2, Version Date: 27/04/2009



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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **07** **2/14**

CPTask V1.14a

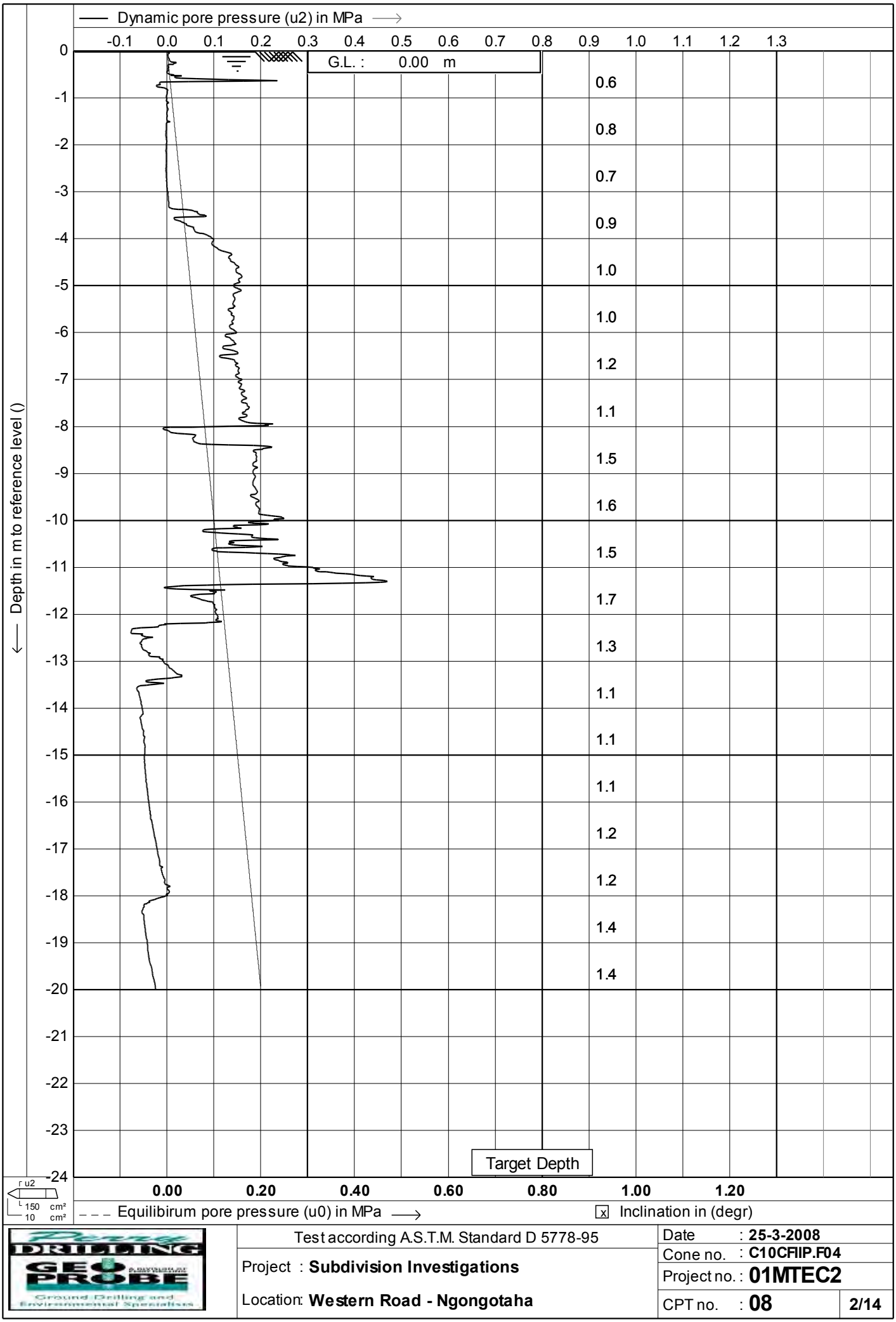
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **08** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

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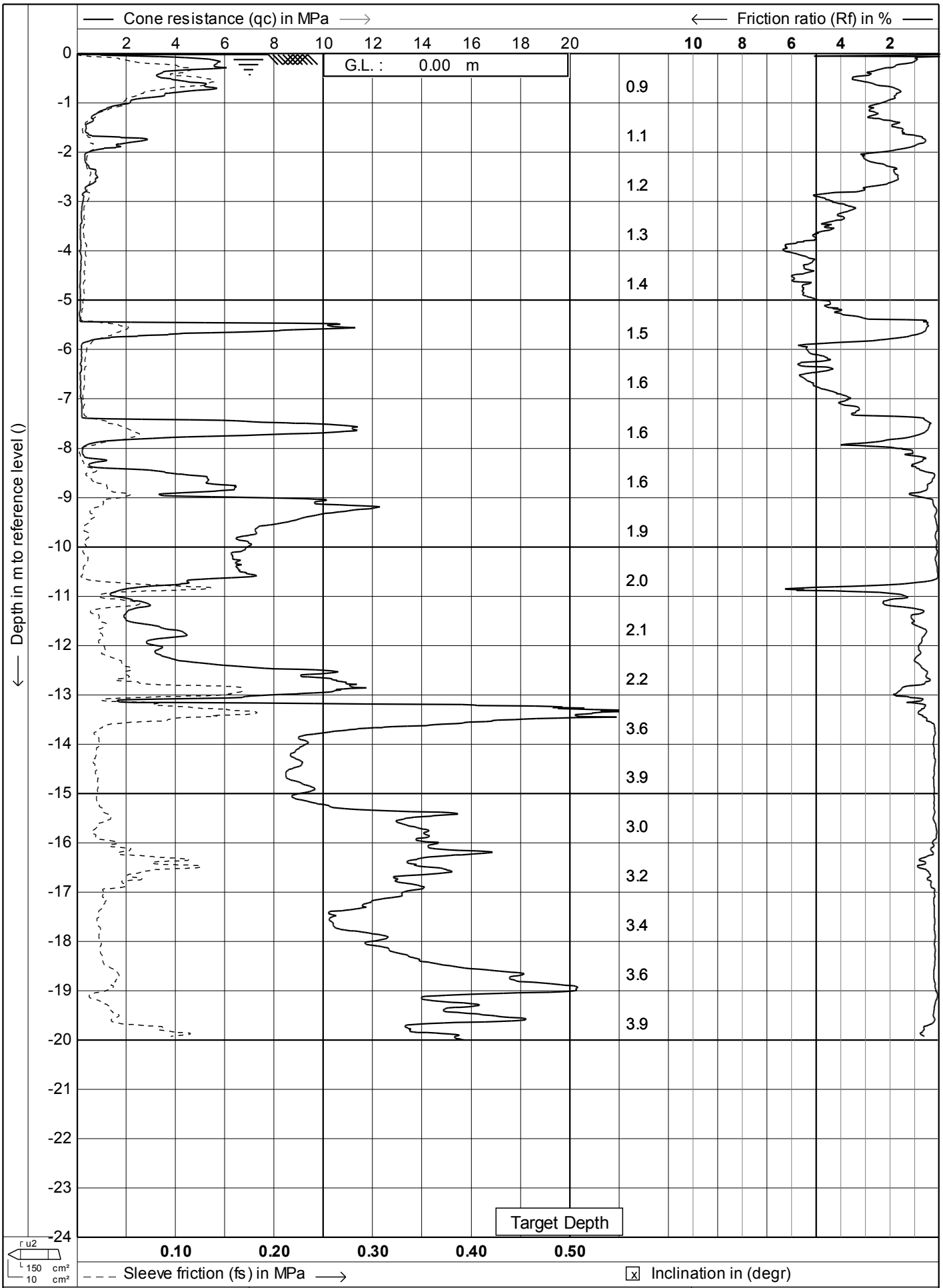
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CPT no. : **08**

2/14

CPTask V1.14a

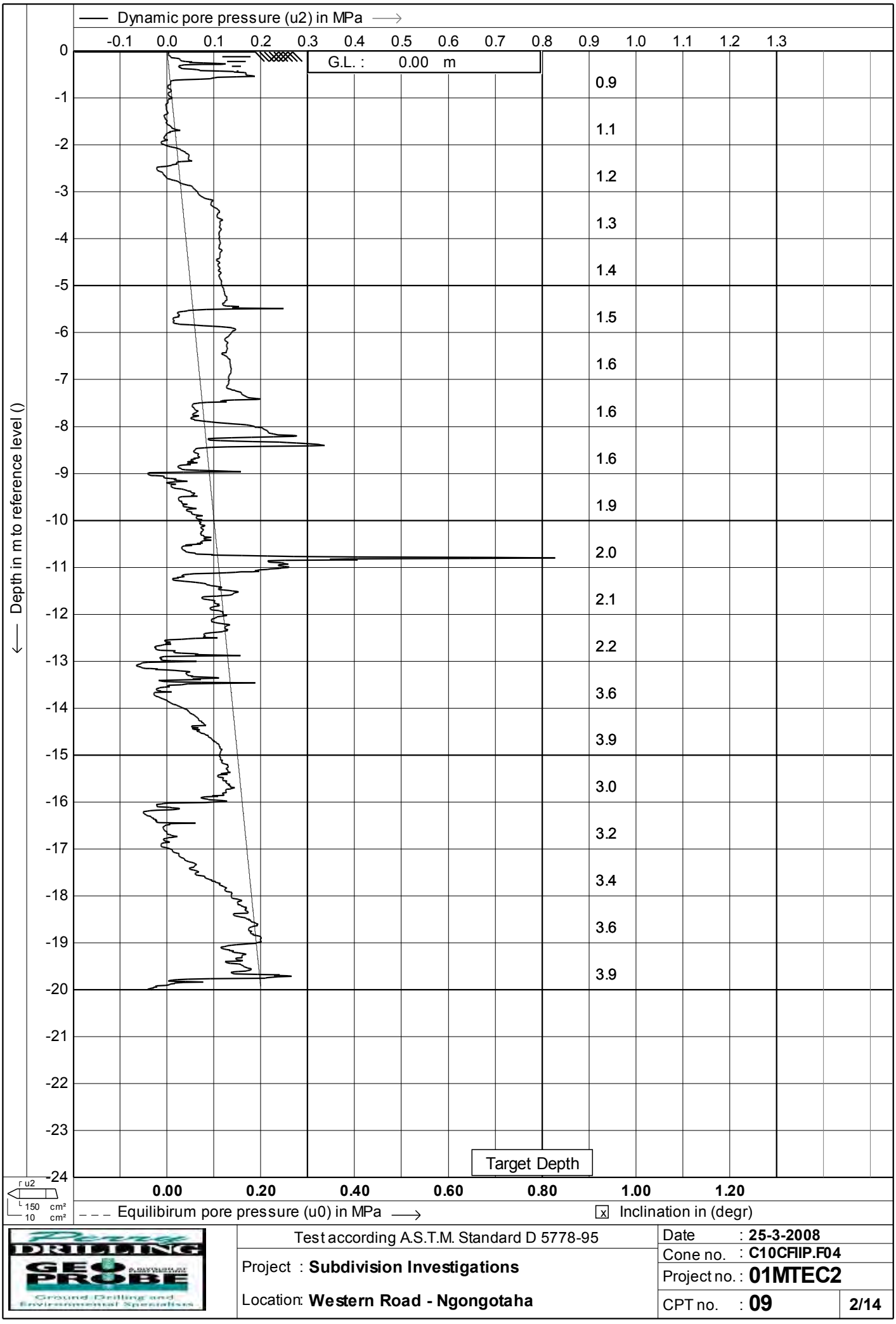
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Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **09** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



CPTask V1.14a

Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

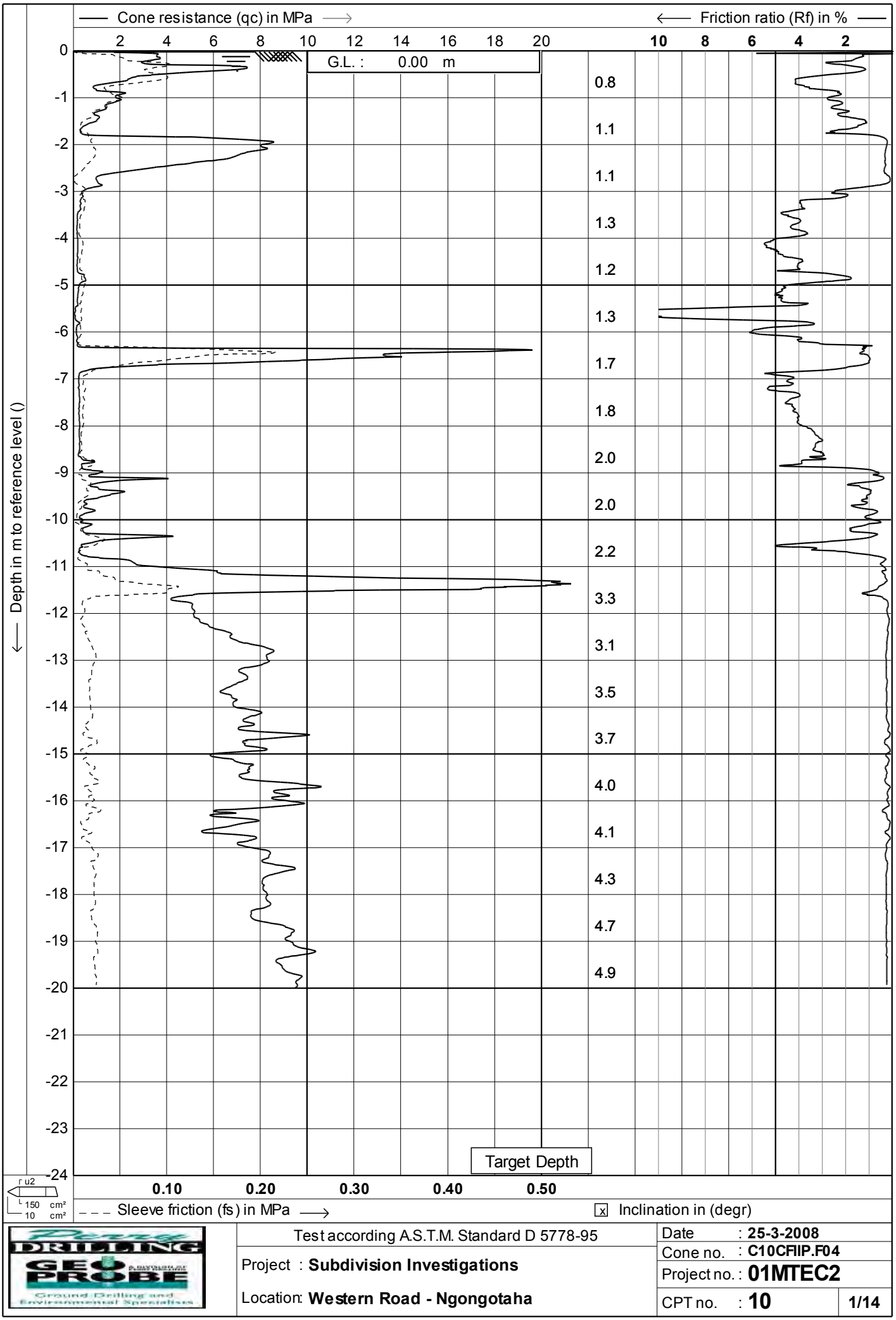
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Project no. : **01MTEC2**

CPT no. : **09**

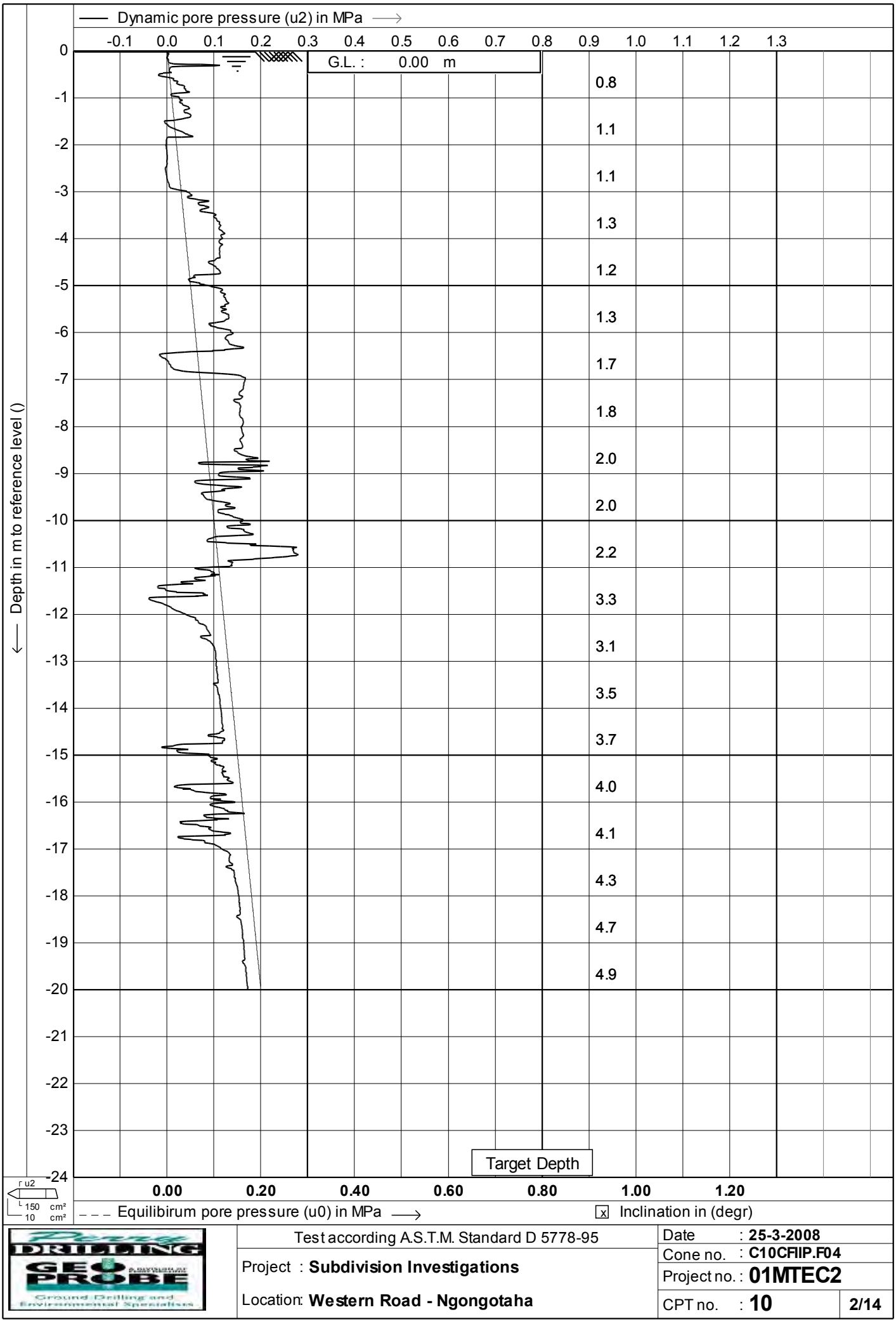
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Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **10** 1/14

CPTask V1.14a

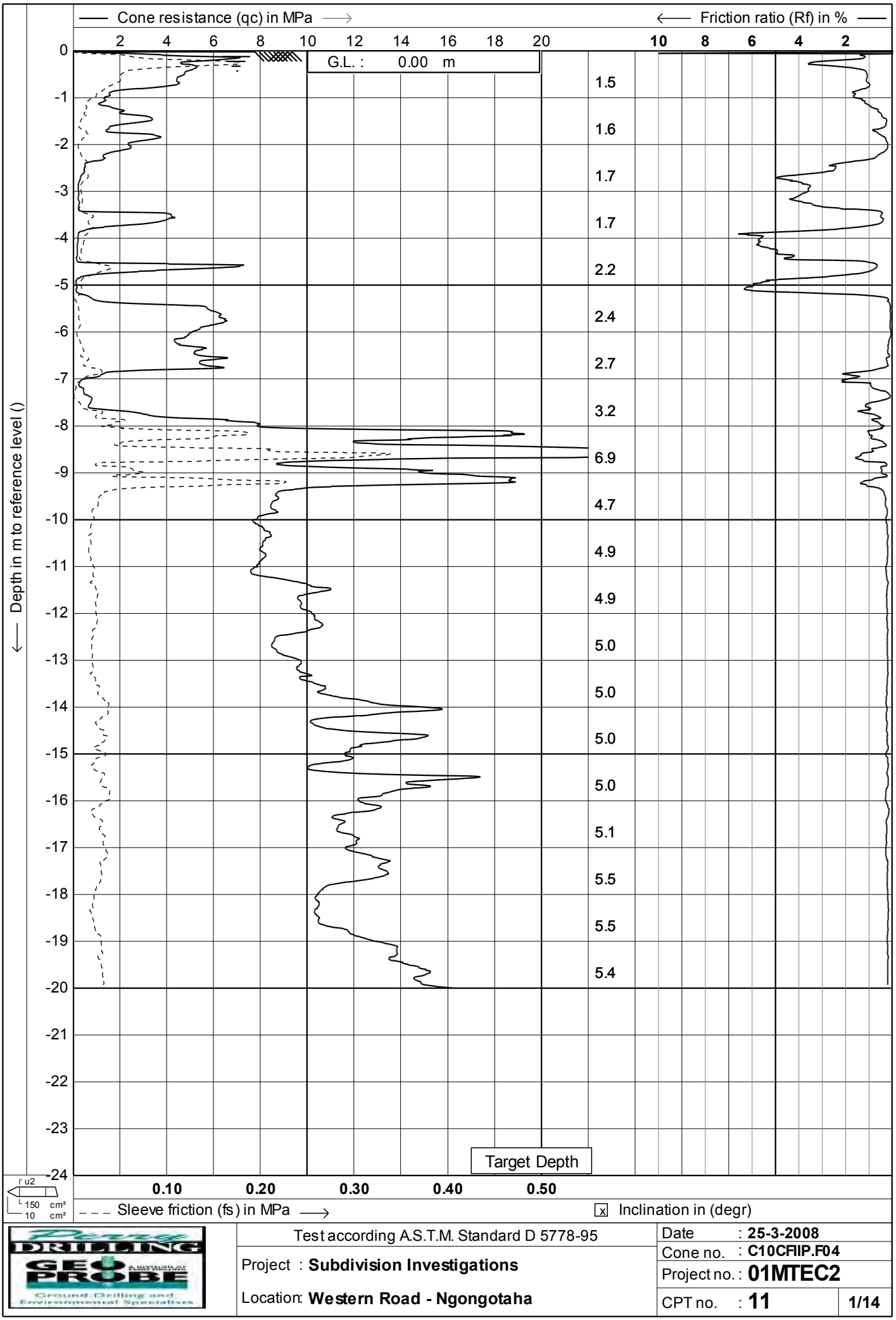
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Project : **Subdivision Investigations**		Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**		CPT no.	: **10** **2/14**

CPTask V1.14a

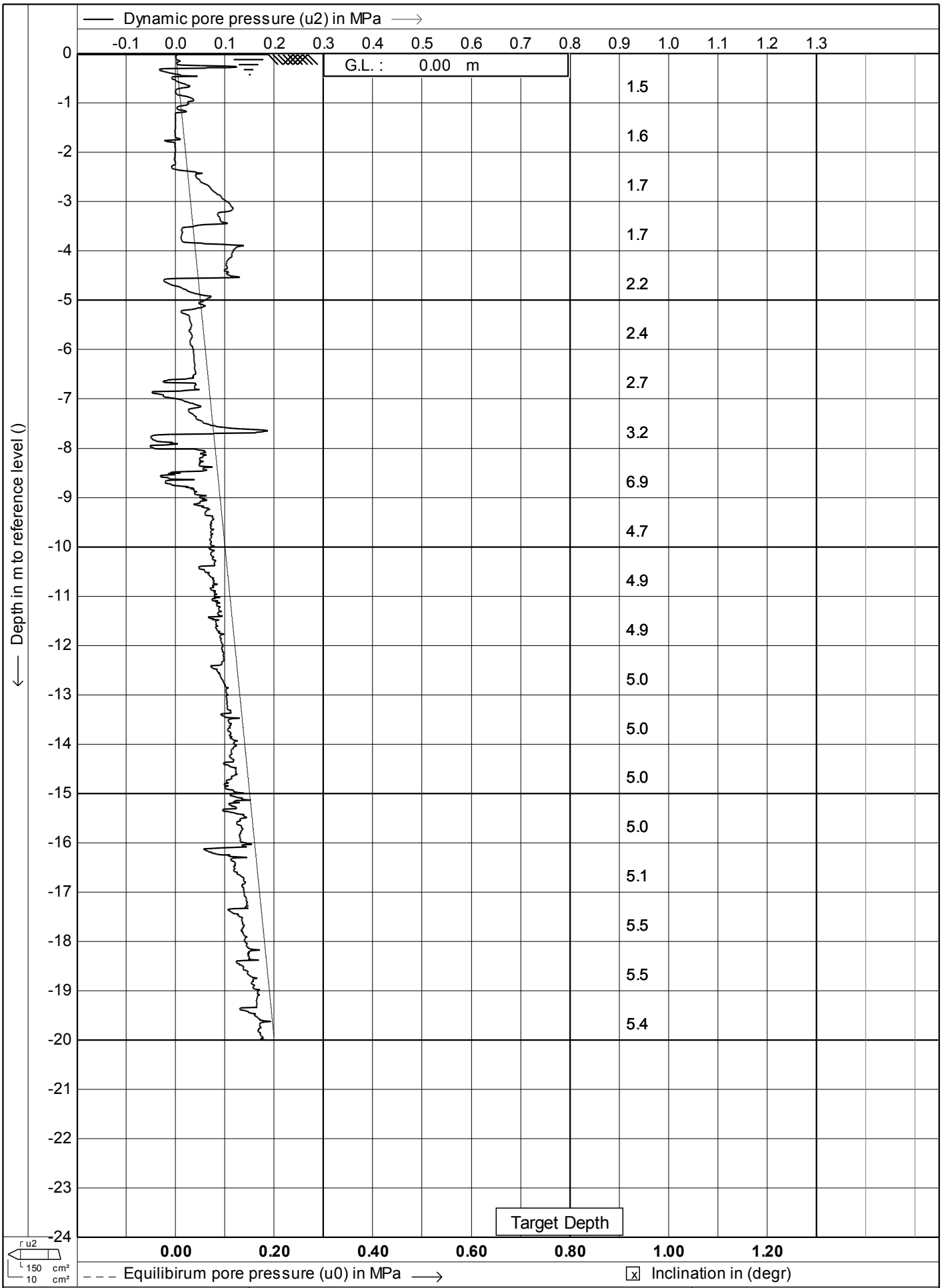
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Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **11** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



CPTask V1.14a

Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

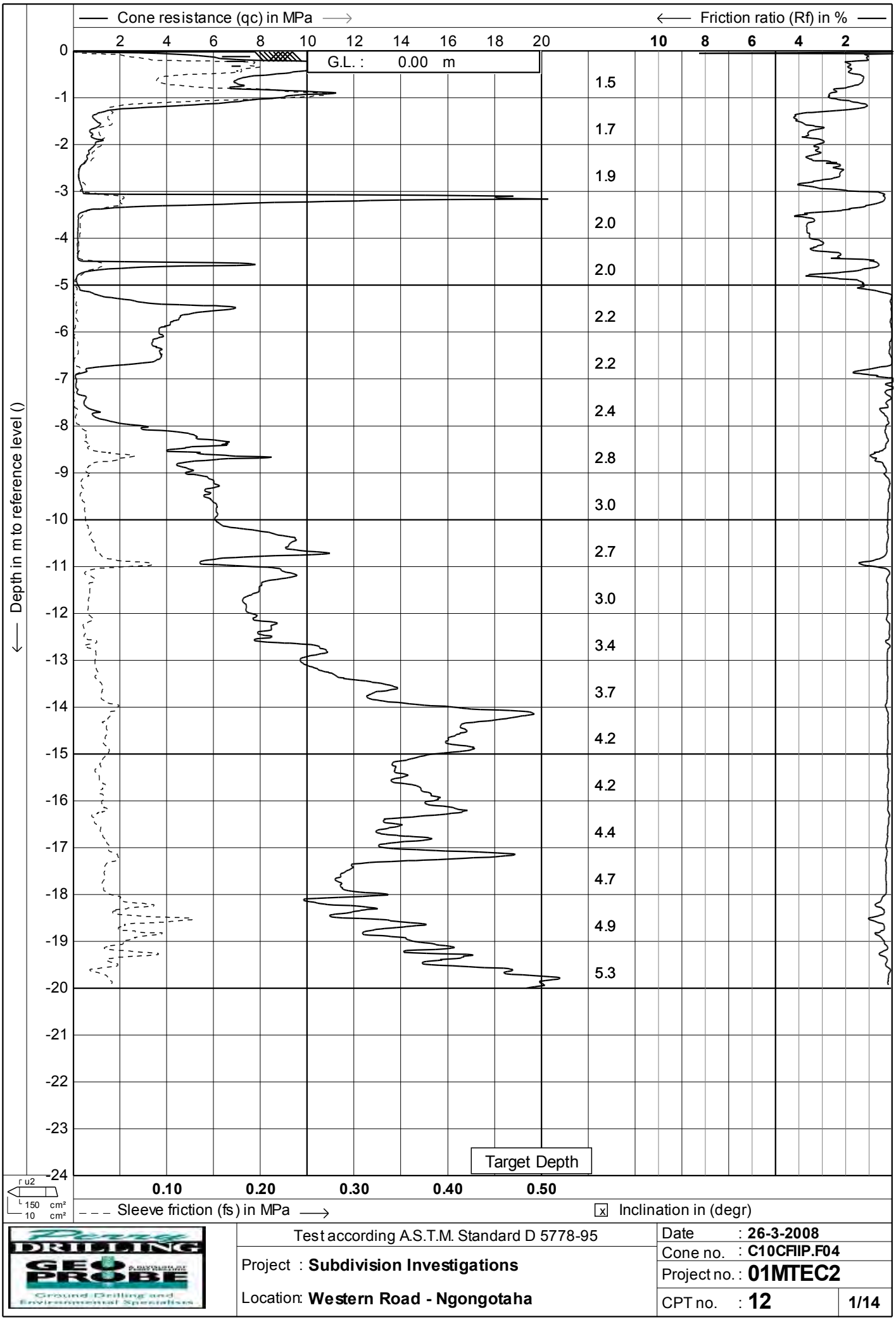
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Project no. : **01MTEC2**

CPT no. : **11** **2/14**

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **26-3-2008**

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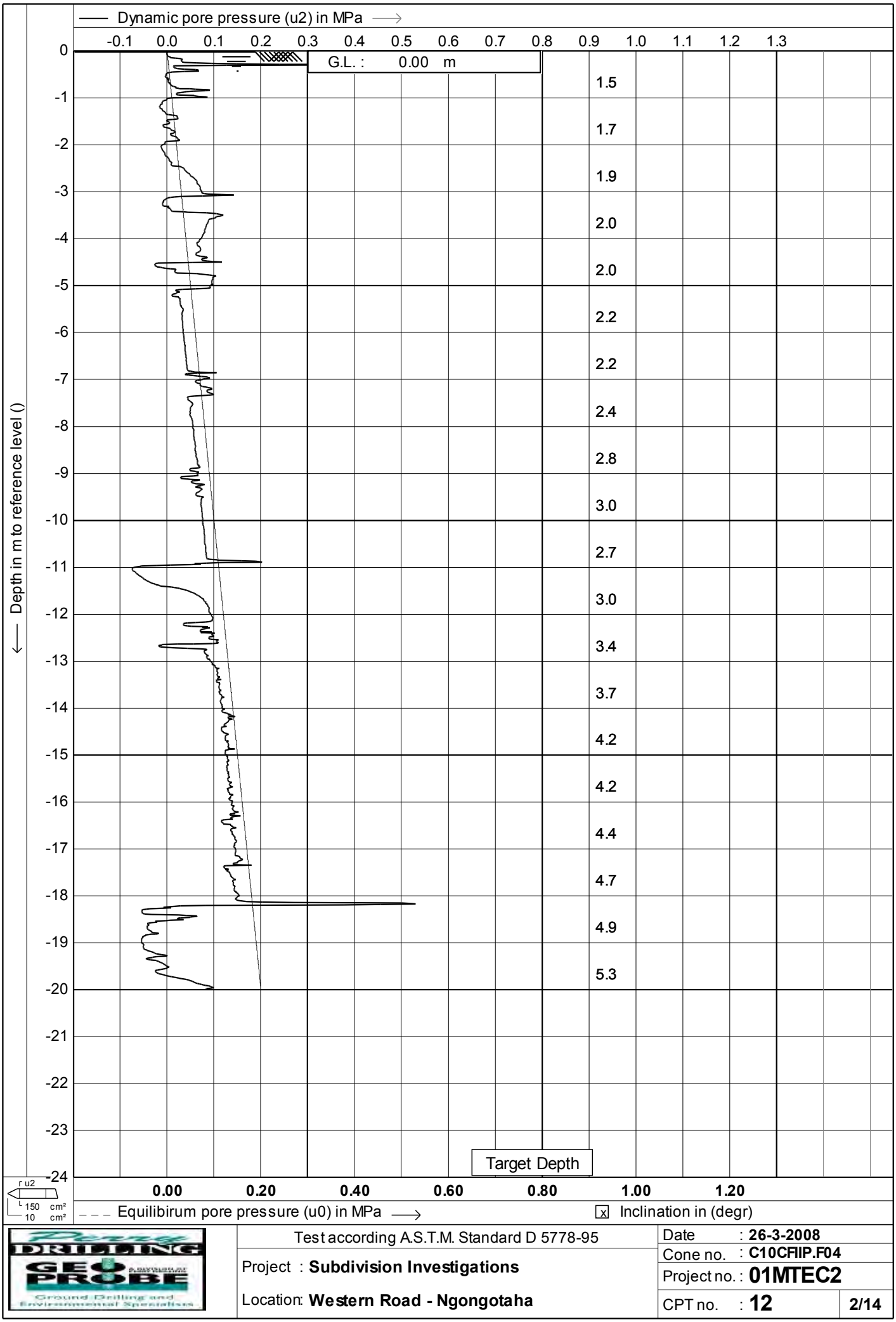
Project no. : **01MTEC2**

CPT no. : **12**

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CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **26-3-2008**

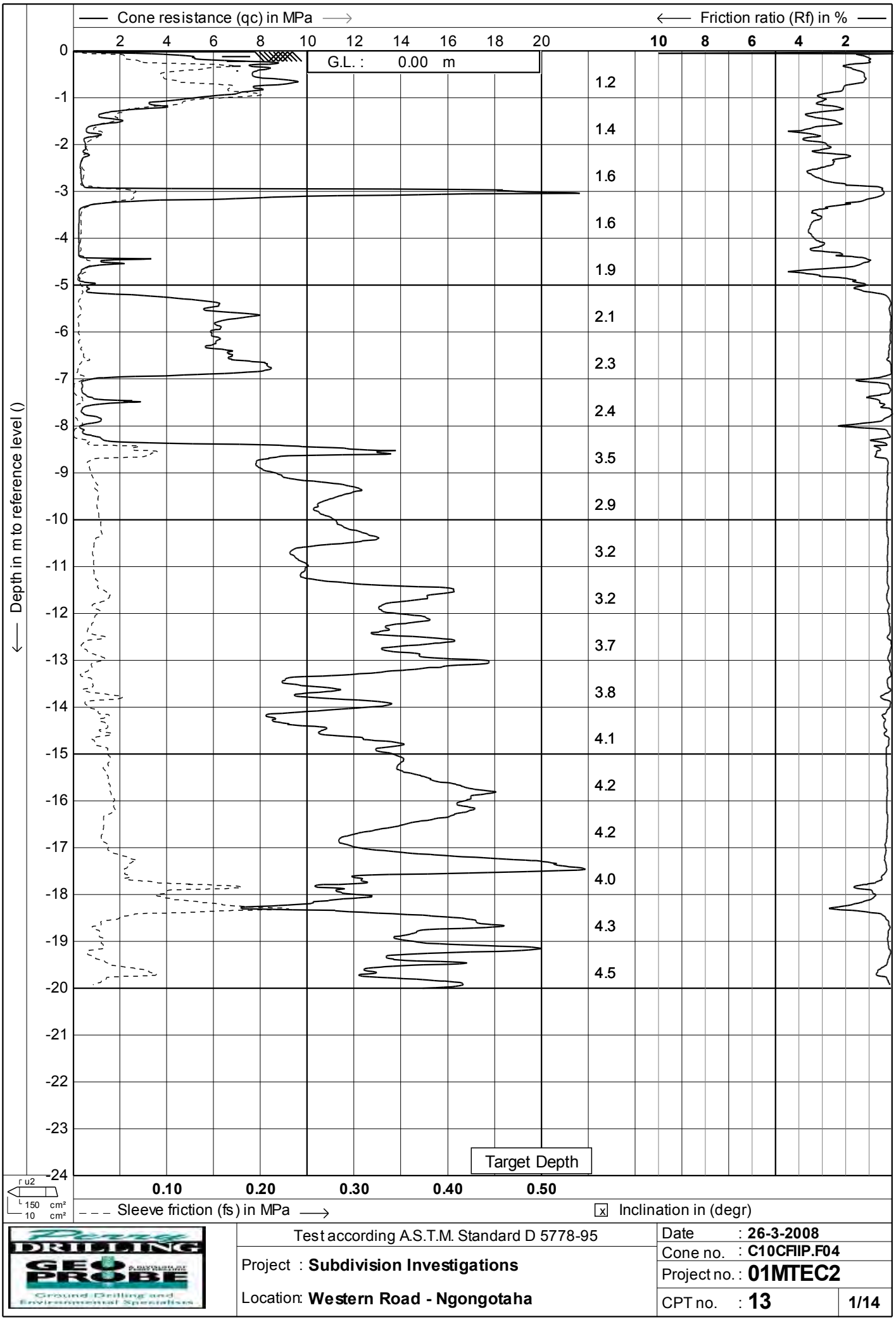
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CPT no. : **12** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **26-3-2008**

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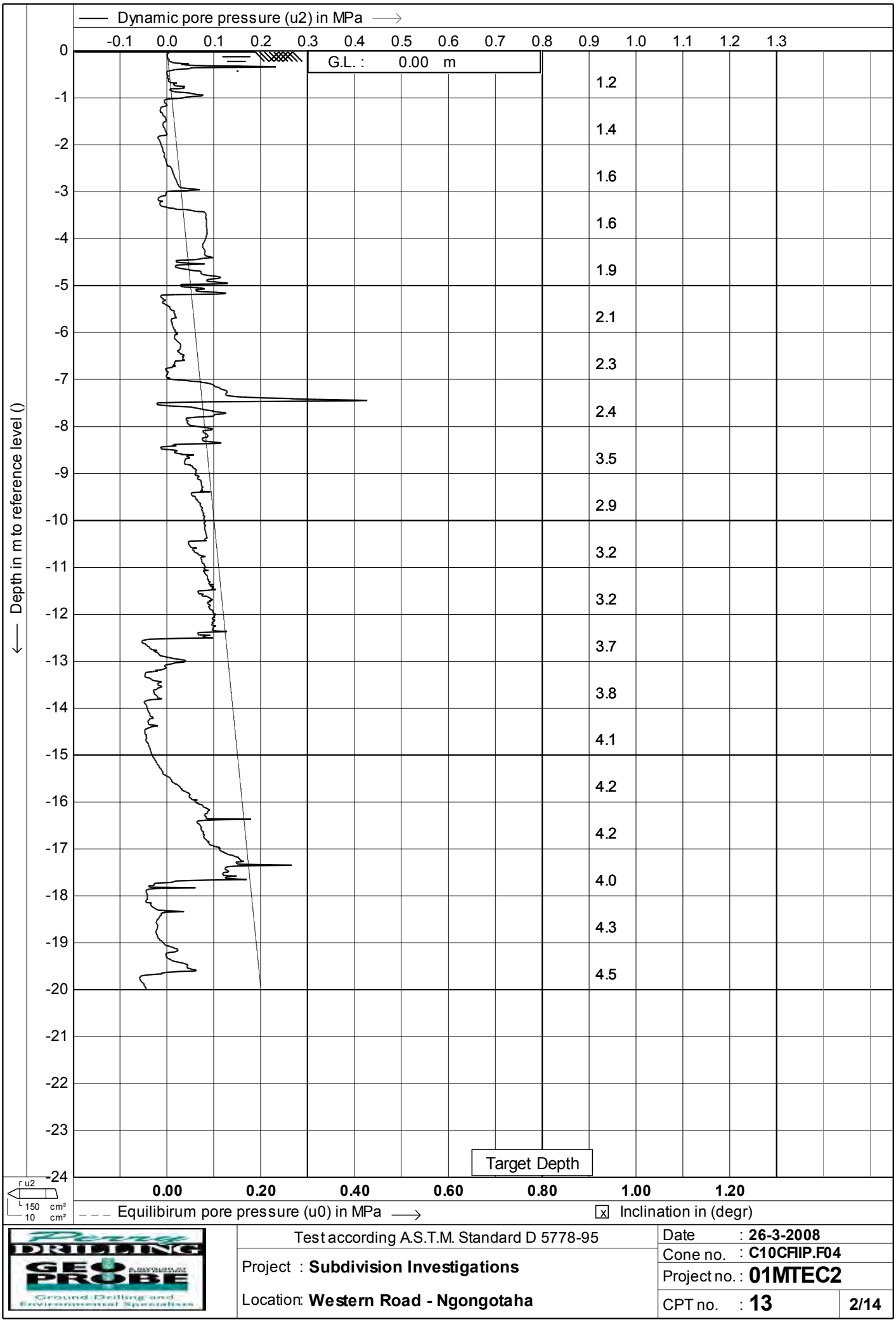
Project no. : **01MTEC2**

CPT no. : **13**

1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

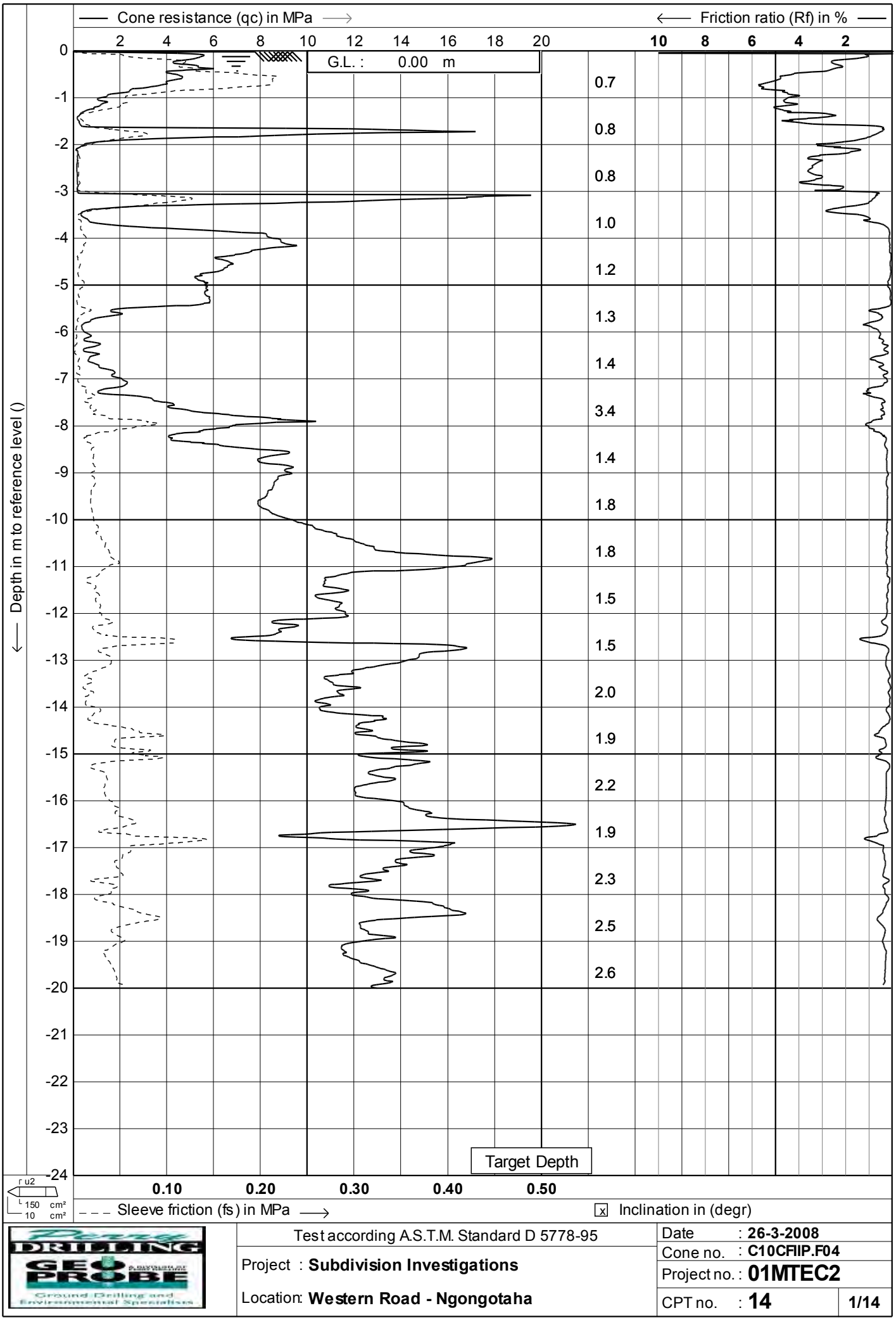
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Location: **Western Road - Ngongotaha**

Date	: **26-3-2008**
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Project no.	: **01MTEC2**
CPT no.	: **13**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **26-3-2008**

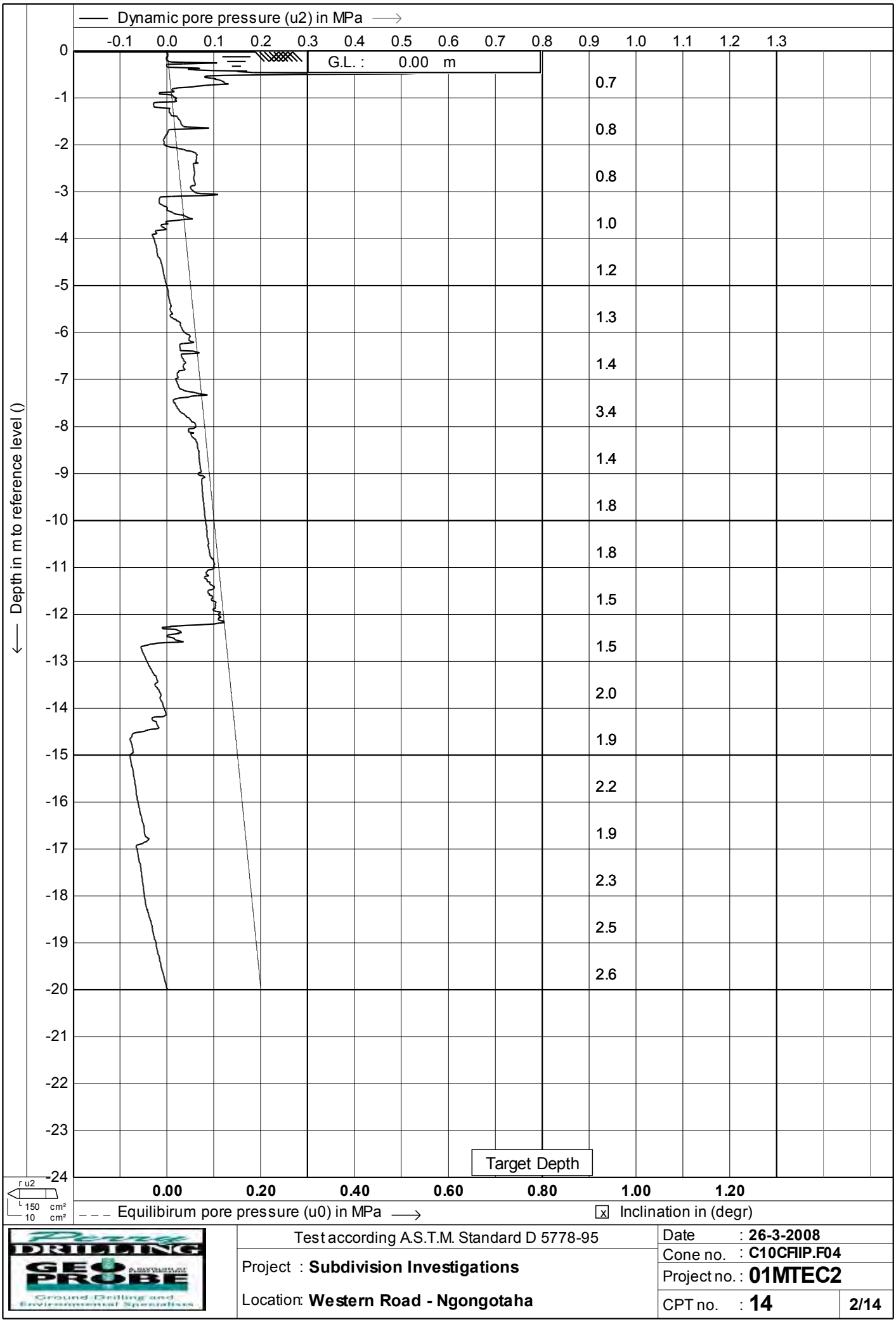
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Project no. : **01MTEC2**

CPT no. : **14** **1/14**

CPTask V1.14a

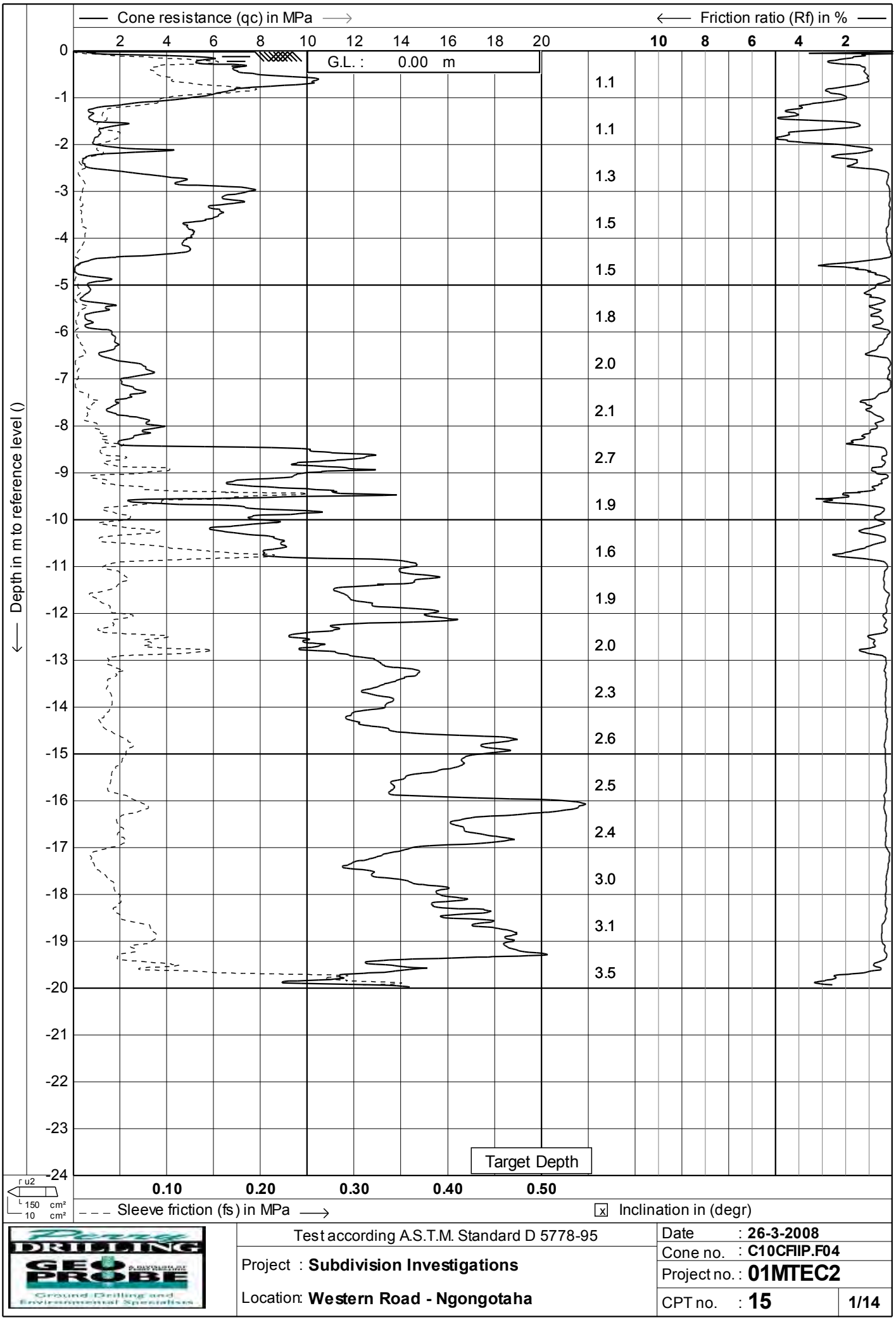
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Test according A.S.T.M. Standard D 5778-95	Date	: **26-3-2008**
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Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **14** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **26-3-2008**

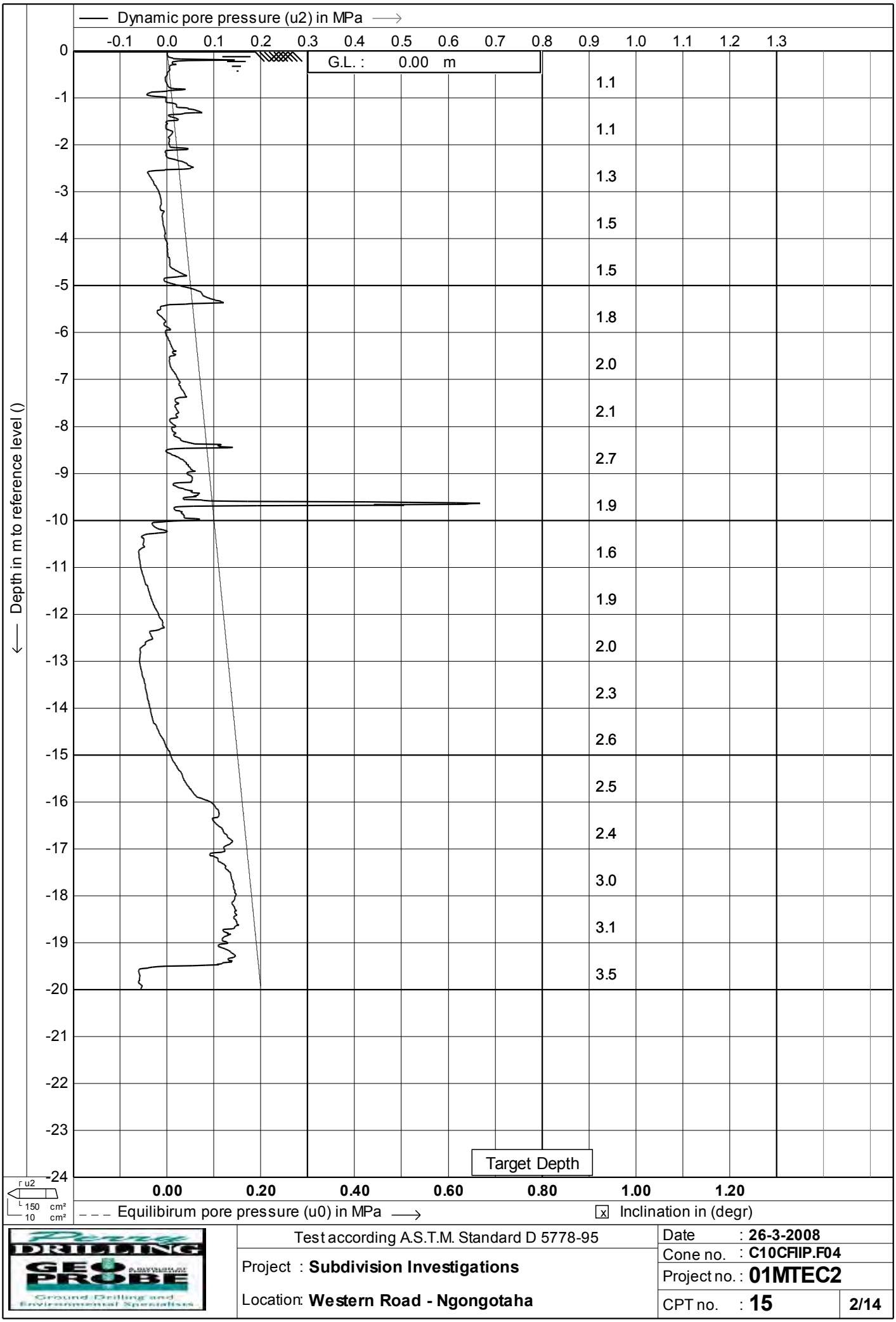
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Project no. : **01MTEC2**

CPT no. : **15** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



CPTask V1.14a

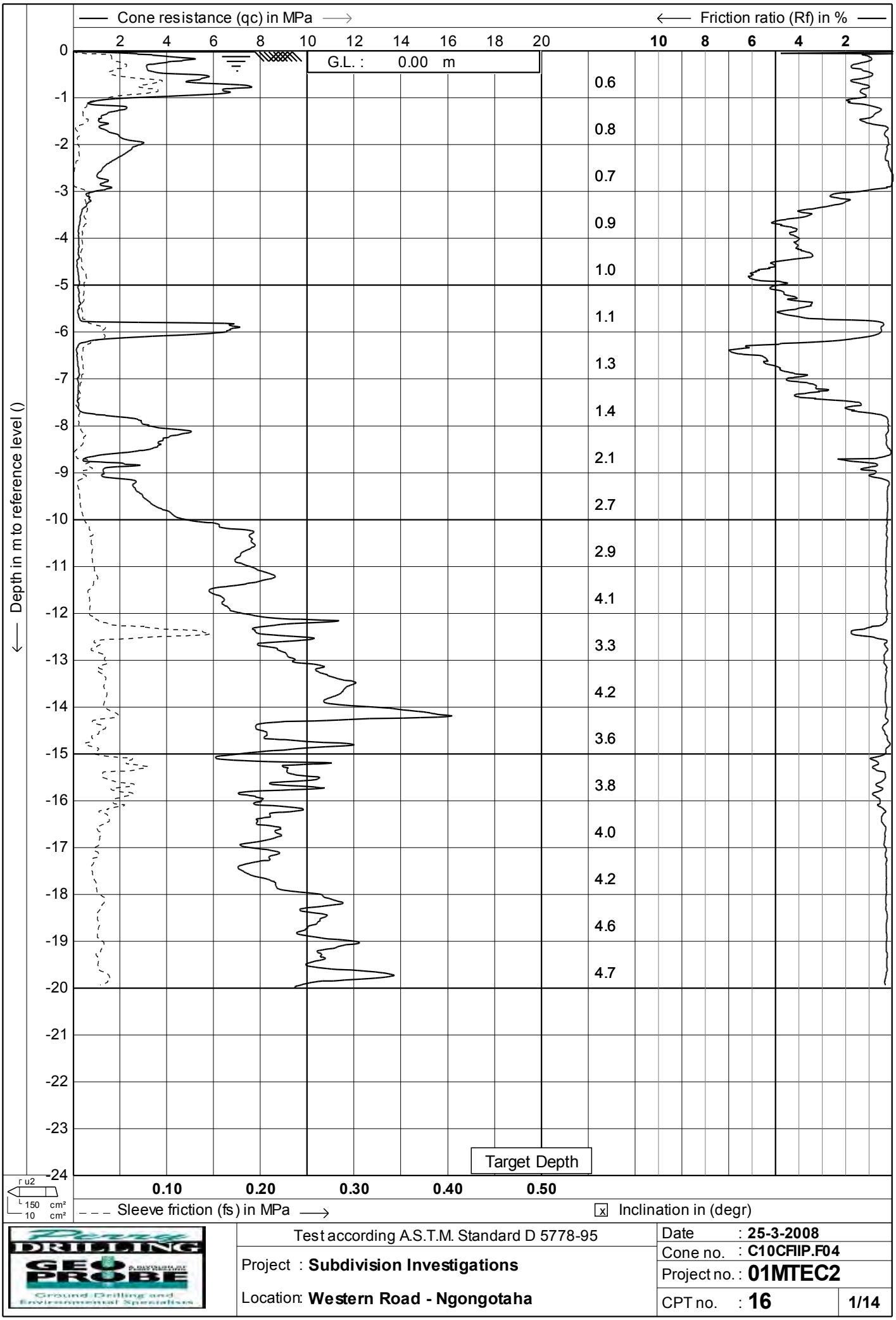
Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date	: **26-3-2008**
Cone no.	: **C10CFIIP.F04**
Project no.	: **01MTEC2**
CPT no.	: **15**

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

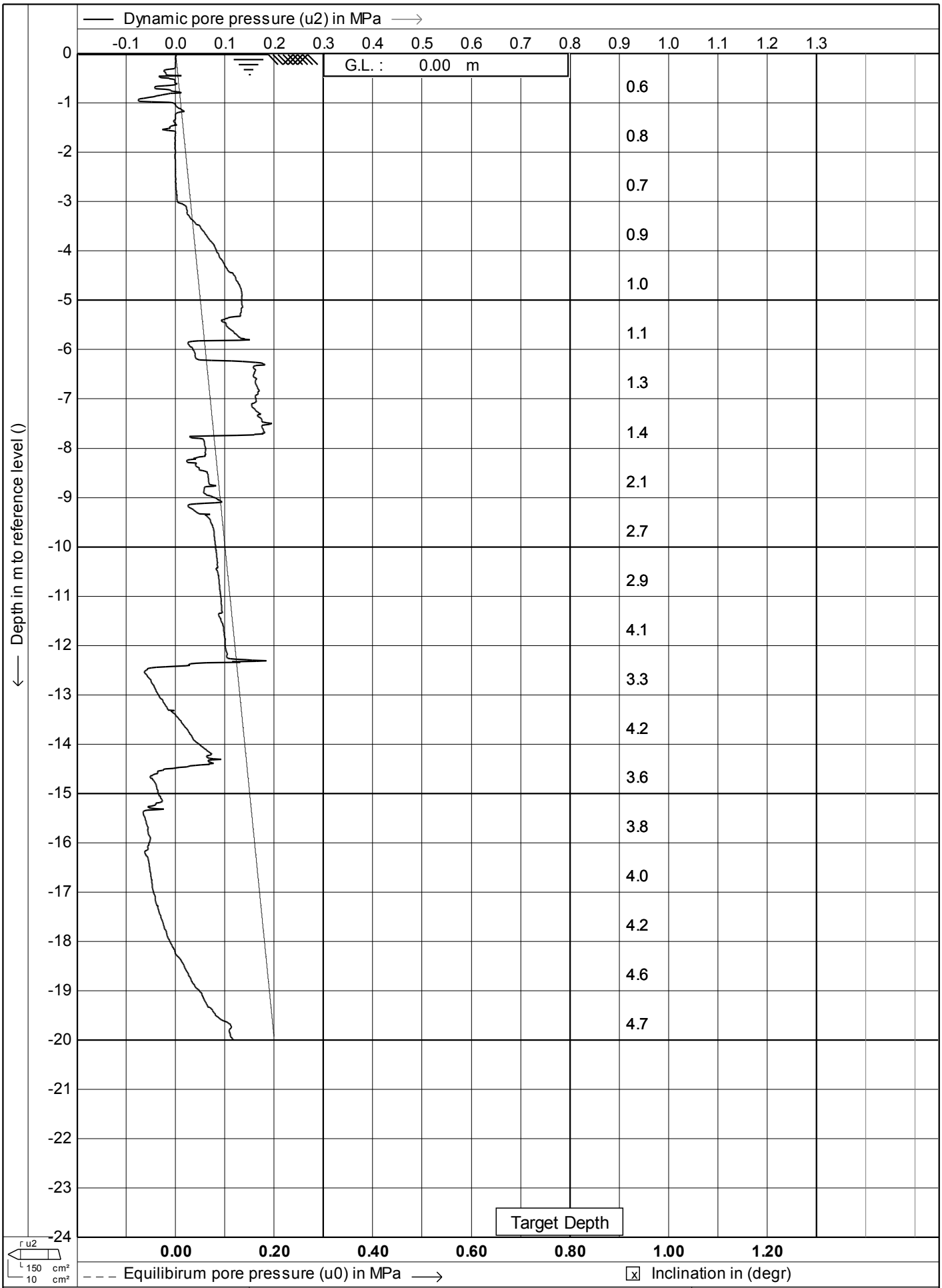
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Project no. : **01MTEC2**

CPT no. : **16** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

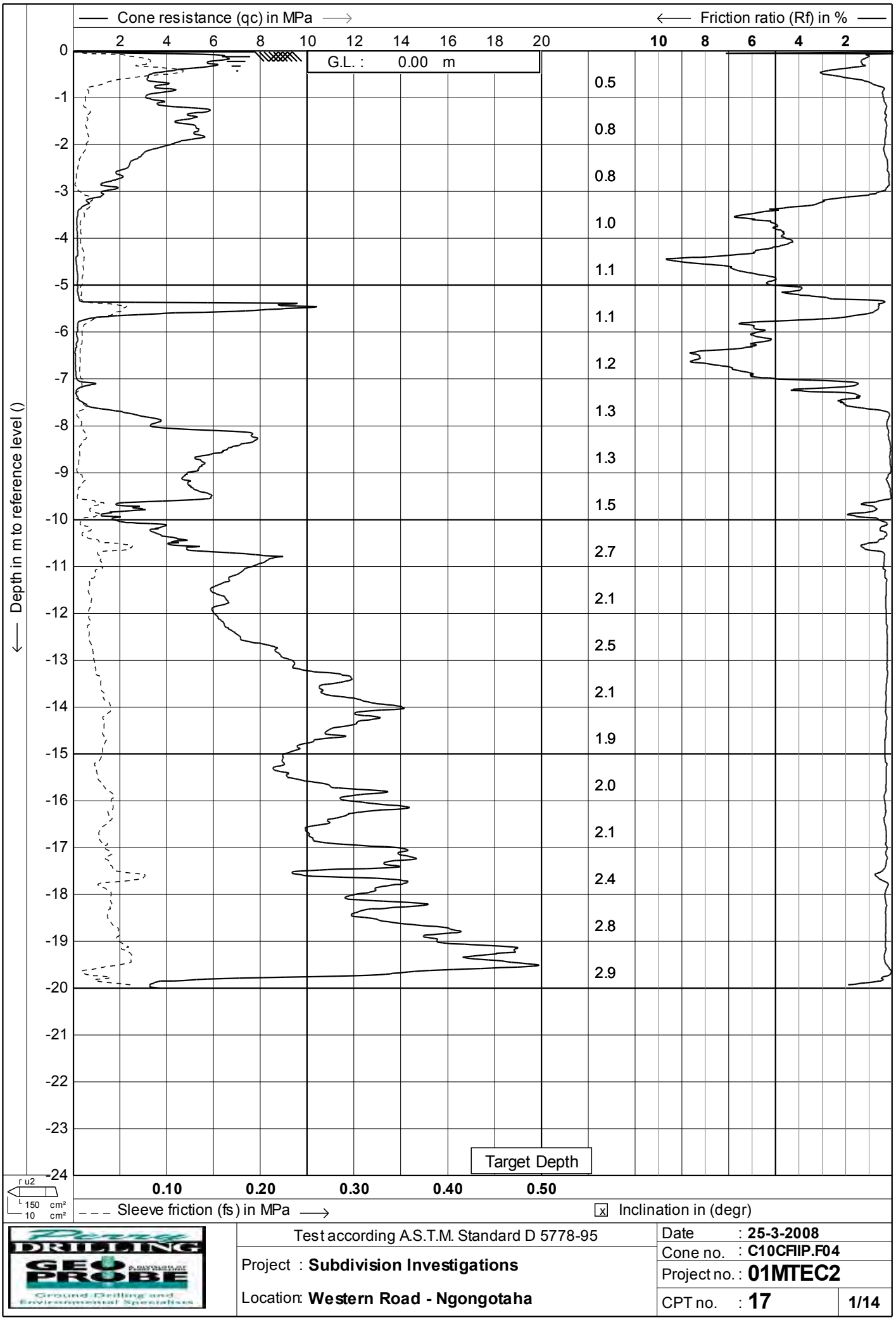
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Project no. : **01MTEC2**

CPT no. : **16**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **25-3-2008**

Cone no. : **C10CFIIP.F04**

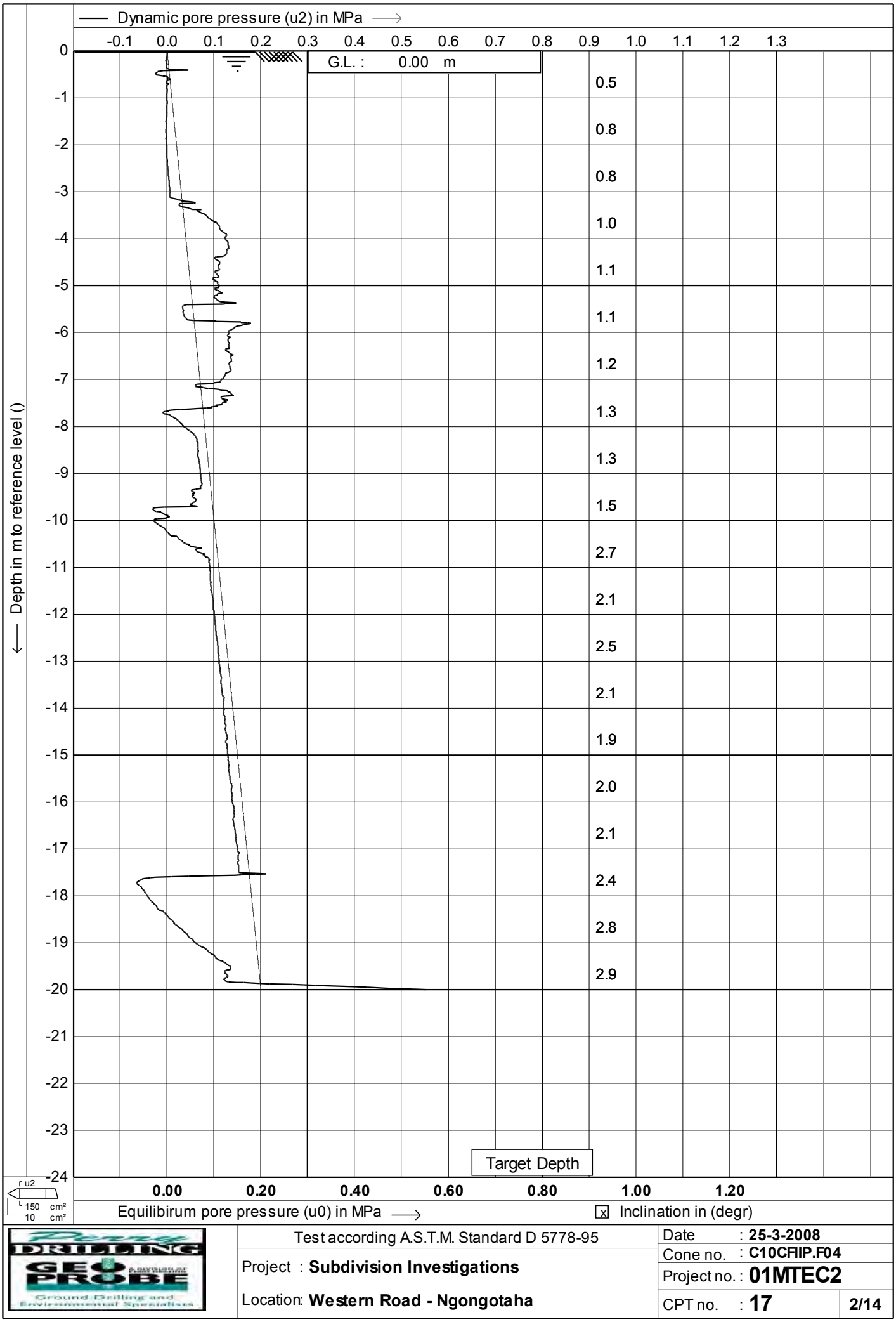
Project no. : **01MTEC2**

CPT no. : **17**

1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95	Date	: **25-3-2008**
	Cone no.	: **C10CFIIP.F04**
Project : **Subdivision Investigations**	Project no.	: **01MTEC2**
Location: **Western Road - Ngongotaha**	CPT no.	: **17** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

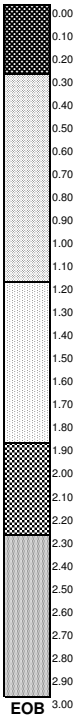
MTEC CONSULTANTS LTD

BOREHOLE LOGS

JOB NAME: **PIONEER PROPERTIES** ***DATE:*** **27.02.08**
SITE ADDRESS: **WESTERN RAOD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 15(1)



A **TOPSOIL :** black, occasional PG to 10mm, damp

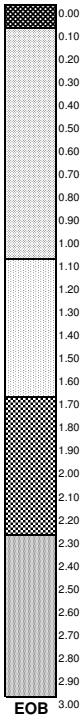
B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) sand, light brown, moist

E **SILT :** very soft, dark/brown, wet

LOT 15(2)



A **TOPSOIL :** black, occasional PG to 10mm, dry

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

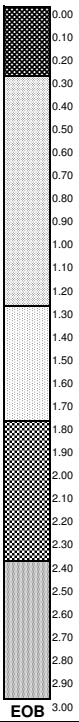
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) sand, light brown, moist

E **SILT :** very soft, dark/brown, wet

#WATER TABLE @ 2800mm

LOT 16(1)



A **TOPSOIL :** black, occasional PG to 10mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

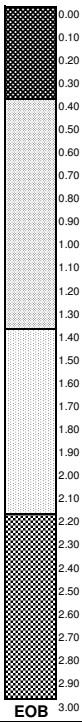
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) sand, light brown, moist

E **SILT :** very soft, dark/brown, wet

#WATER TABLE @ 2800mm

LOT 16(2)



A **TOPSOIL :** black, occasional PG to 15mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) sand, light brown, moist

#moisture increases with depth

Document Set ID: 2699211
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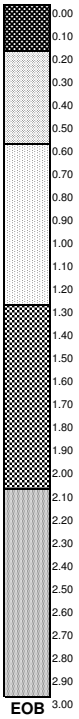
MTEC CONSULTANTS LTD

BOREHOLE LOGS

JOB NAME: **PIONEER PROPERTIES** ***DATE:*** **27.02.08**
SITE ADDRESS: **WESTERN RAOD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 64(1)



A **TOPSOIL :** black, dry

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

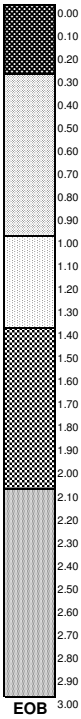
C **SAND :** (mg) sand, light brown, some silt, damp occasional PG to 10mm

D **SILT :** some (fg) sand, light brown, moist very firm

E **SILT :** very soft, dark/brown, wet

#moisture increases with depth

LOT 64(2)



A **TOPSOIL :** black, dry

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

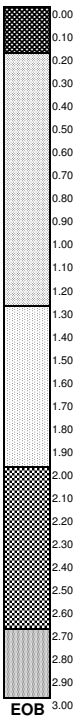
C **SAND :** (mg) sand, light brown, some silt, moist

D **SILT :** some (fg) sand, light brown, moist very firm

E **SILT :** very soft, dark/brown, wet

#moisture increases with depth

LOT 65(1)



A **TOPSOIL :** black, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

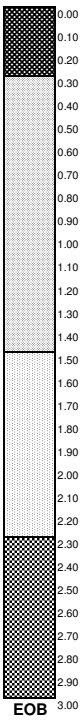
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) gravel, light brown, moist

E **SILT :** very soft, dark/brown, some (fg) gravel, wet

#moisture increases with depth

LOT 65(2)



A **TOPSOIL :** black, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) gravel, light brown, moist

#moisture increases with depth

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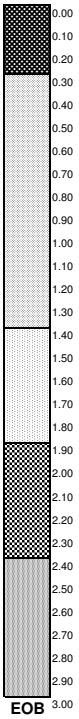
MTEC CONSULTANTS LTD

BOREHOLE LOGS

JOB NAME: **PIONEER PROPERTIES** ***DATE:*** **27.02.08**
SITE ADDRESS: **WESTERN RAOD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 66(1)



A **TOPSOIL :** black, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

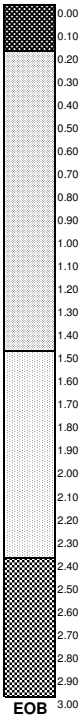
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (fg) sand, light brown, moist occasional PG to 2mm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

#moisture increases with depth

LOT 66(2)



A **TOPSOIL :** black, occasional PG to 10mm, damp

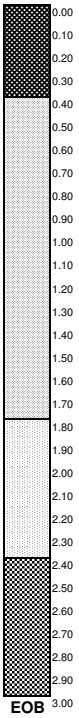
B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) sand, light brown, moist

#moisture increases with depth

LOT67(1)



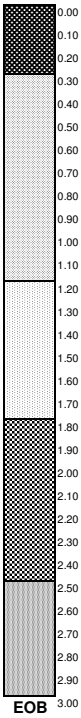
A **TOPSOIL :** black, occasional PG to 20mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) sand, light brown, moist occasional PG to 5mm

LOT 67(2)



A **TOPSOIL :** black, occasional PG to 20mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist occasional PG to 10mm

D **SILT :** some (fg) sand, light brown, moist

E **SILT :** very soft, some (vfg) sand, dark brown, wet

#moisture increases with depth

Document Set ID: 2699211
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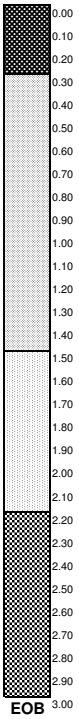
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BOREHOLE LOGS

JOB NAME: **PIONEER PROPERTIES** ***DATE:*** **27.02.08**
SITE ADDRESS: **WESTERN RAOD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 82(1)



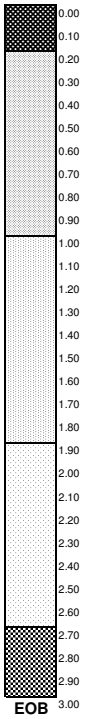
A **TOPSOIL :** black, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) sand, light brown, moist

LOT 82(2)



A **TOPSOIL :** black, damp

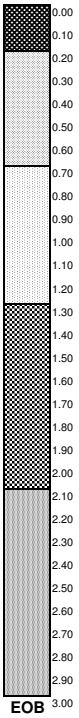
B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist occasional PG to 2mm

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand moist

D **SILT :** some (vfg) sand, light brown, moist

LOT 83(1)



A **TOPSOIL :** black, occasional PG to 20mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

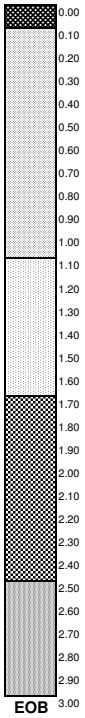
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) gravel, light brown, moist
very firm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

#moisture increases with depth

LOT 83(2)



A **TOPSOIL :** black, occasional PG to 10mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) gravel, light brown, moist
very firm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

#moisture increases with depth

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

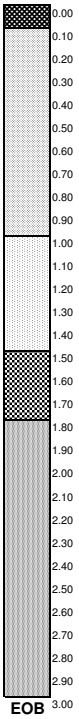
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BOREHOLE LOGS

JOB NAME: **PIONEER PROPERTIES** ***DATE:*** **27.02.08**
SITE ADDRESS: **WESTERN RAOD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 84(1)



A **TOPSOIL :** black, occasional PG to 20mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

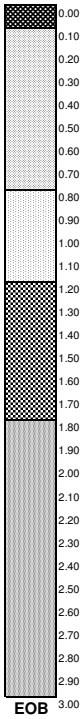
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) gravel, light brown, moist very firm

E **SILT :** very soft, some (vfg) sand, dark brown, wet trace of organic material

#moisture increases with depth

LOT 84(2)



A **TOPSOIL :** black, occasional PG to 10mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

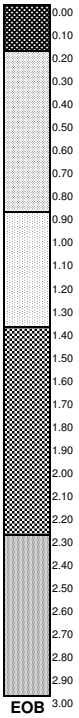
C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) gravel, light brown, moist very firm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

#moisture increases with depth

LOT 85(1)



A **TOPSOIL :** black, occasional PG to 20mm, damp

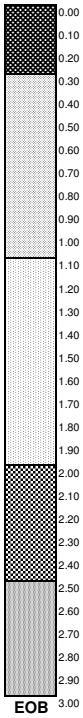
B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) sand, light brown, moist occasional PG to 3mm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

LOT 85(2)



A **TOPSOIL :** black, occasional PG to 10mm, damp

B **FILL, SAND :** (fg) sand, some silt, orangey/brown, damp, occasional PG to 3mm

C **SAND :** (mg) sand, light brown, trace of silt, moist

D **SILT :** some (vfg) sand, light brown, moist occasional PG to 3mm

E **SILT :** very soft, some (vfg) sand, dark brown, wet

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

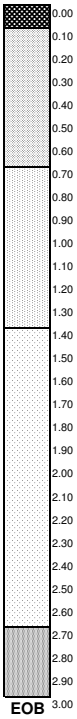
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BOREHOLE LOGS

JOB NAME:	**PIONEER PROPERTIES**	***DATE:***	**12.03.08**
SITE ADDRESS:	**WESTERN RAOD, NGONGOTAHA**	***BY:***	**CBW**
JOB NUMBER:	**175781/E**		

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 69



A **TOPSOIL :** black, damp

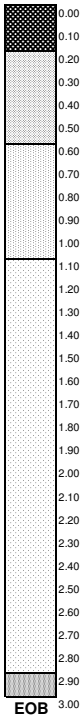
B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

C **SAND :** (mg) sand, light brown, moist

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand moist

E **SILT :** very soft, some (vfg) sand, dark brown, wet

LOT 71



A **TOPSOIL :** black, damp

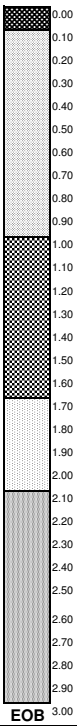
B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

C **SAND :** (mg) sand, light brown, moist

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand moist

E **SILT :** very soft, some (vfg) sand, dark brown, wet

LOT 75



A **TOPSOIL :** black, damp

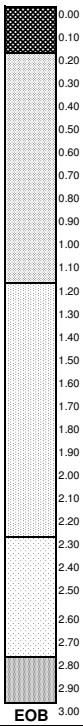
B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

D **SILT :** very firm, light brown, trace of (vfg) sand moist

C **SAND :** (mg) sand, light brown, some silt, wet

E **SILT :** very soft, some (vfg) sand, dark brown, wet

LOT 77



A **TOPSOIL :** black, damp

B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

C **SAND :** (mg) sand, light brown, moist

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand wet

E **SILT :** very soft, some (vfg) sand, dark brown, wet

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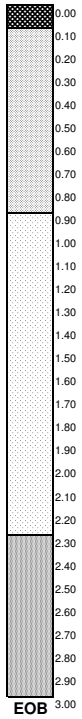
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BOREHOLE LOGS

JOB NAME:	**PIONEER PROPERTIES**	***DATE:***	**12.03.08**
SITE ADDRESS:	**WESTERN RAOD, NGONGOTAHA**	***BY:***	**CBW**
JOB NUMBER:	**175781/E**		

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL

LOT 79



A **TOPSOIL :** black, damp

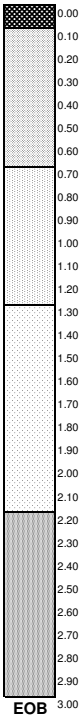
B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand moist

#WATER TABLE @ 2200mm

E **SILT :** very soft, some (vfg) sand, dark brown saturated

LOT 81



A **TOPSOIL :** black, damp

B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

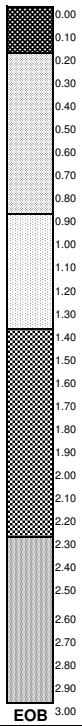
C **SAND :** (mg) sand, light brown, moist

F **GRAVEL :** (fg) gravel, light brown, some (fg) sand wet

#WATER TABLE @ 2200mm

E **SILT :** very soft, some (vfg) sand, dark brown saturated

LOT 86(1)



A **TOPSOIL :** black, damp

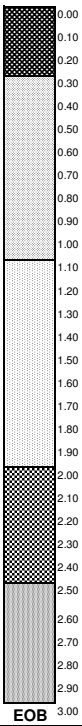
B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

C **SAND :** (mg) sand, light brown, moist

SILT : very firm, light brown, trace of (vfg) sand moist

SILT : very soft, some (vfg) sand, dark brown wet

LOT 86(2)



A **TOPSOIL :** black, damp

B **SAND :** (fg) sand, some silt, orangey/brown, moist occasional PG to 3mm

C **SAND :** (mg) sand, light brown, moist

SILT : very firm, light brown, trace of (vfg) sand moist

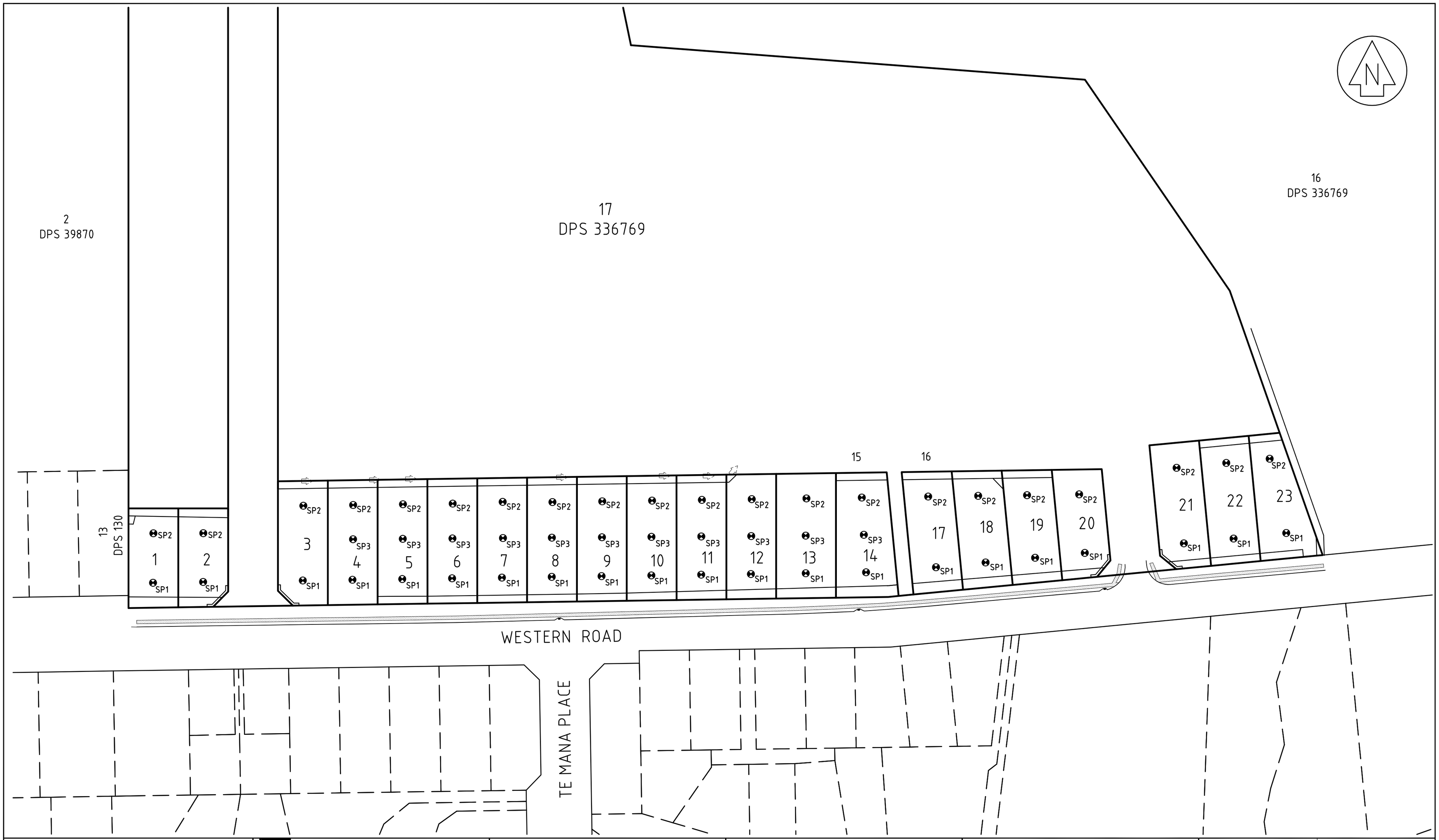
SILT : very soft, some (vfg) sand, dark brown wet

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MTEC Consultants Ltd, Scala Penetration Test Results for Stages One, Two and Three

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Version: 2, Version Date: 27/04/2009

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Version: 2, Version Date: 27/04/2009



NOTES/KEY:

SP1 = SCALA PENETROMETER TEST SITE

TEC CONSULTANTS
SURVEYORS
ENGINEERS
PLANNERS
ROTORUA TE PUKE OPOTIKI
MT MAUNGANUI WHAKATANE

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IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL EXISTING SERVICES PRIOR TO STARTING WORK.

CLIENT
PIONEER PROPERTY TRUST LTD

No.	Date	By	Issue/Revision
A	08/12/06	GD	ISSUED FOR APPROVAL

PROJECT/LOCATION
WESTERN ROAD
NGONGOTAHA

DRAWING DESCRIPTION
AS BUILT
SCALAPENETROMETER
TEST SITE PLAN

DRAWN: GD	DESIGNED: JM
CHECKED: JM	SURVEYED BY: -
LOCAL AUTHORITY REF: -	
SCALE: 1 : 1000	ORIGINAL DWG. SIZE A2
DRAWING No. 175781-R-E-D003	SHEET No. 12 / ISSUE A

I:\175781_KENNY (The Pioneer Property Trust Ltd)\dwg\175781-R-E-D003-asbuilt.dwg, 6/03/2009 8:47:38 a.m.

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 1 (1)			LOT 1 (2)			LOT 2 (1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		80	40		200	160		160	120
10		110	30		300	100		210	50
15		130	20		370	70		240	30
20		180	50		420	50		270	30
25		200	20		450	30		340	70
30		230	30		470	20		410	70
35		250	20		490	20		460	50
40		270	20		520	30		550	90
45		290	20		560	40		610	60
50		310	20		600	40		670	60
55		340	30		630	30		760	90
60		350	10		670	40		860	100
65		370	20		710	40		950 (2)	90
70		400	30		770	60			
75		420	20		880	110			
80		450	30		1000	120			
85		470	20						
90		530	60						
95		600	70						
100		670	70						

NUMBER	LOT 2 (2)			LOT 3 (1)			LOT 3 (2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		140	100		130	90		270	230
10		200	60		160	30		390	120
15		240	40		190	30		510	120
20		260	20		220	30		650	140
25		280	20		260	40		800	150
30		300	20		300	40		900	100
35		310	10		350	50		1000	100
40		330	20		400	50			
45		350	20		460	60			
50		370	20		540	80			
55		400	30		630	90			
60		420	20		720	90			
65		450	30		880	160			
70		480	30		1000	120			
75		510	30						
80		540	30						
85		560	20						
90		590	30						
95		610	20						
100		660	50						

Document Set ID: 2699211
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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 4 (1)			LOT 4 (2)			LOT 4 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		170	130		290	250		200	160
10		280	110		360	70		390	190
15		300	20		420	60		510	120
20		330	30		490	70		670	160
25		360	30		600	110		720	50
30		400	40		770	170		760	40
35		440	40		940 (2)	170		810	50
40		480	40					860	50
45		520	40					940	80
50		620	100					1000	60
55		720	100						
60		820	100						
65		940 (1)	120						
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 5 (1)			LOT 5 (2)			LOT 5 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		200	160		220	180		220	180
10		330	130		360	140		460	240
15		400	70		450	90		720	260
20		450	50		570	120		910	190
25		500	50		690	120		1000	90
30		550	50		820	130			
35		600	50		900	80			
40		650	50		1000	100			
45		690	40						
50		740	50						
55		800	60						
60		890	90						
65		1000	110						
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 6 (1)			LOT 6 (2)			LOT 6 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		90	50		230	190		270	230
10		190	100		290	60		430	160
15		290	100		350	60		580	150
20		360	70		370	20		640	60
25		410	50		380	10		680	40
30		460	50		390	10		730	50
35		520	60		400	10		790	60
40		590	70		410	10		840	50
45		650	60		420	10		920	80
50		720	70		430	10		1000	80
55		790	70		450	20			
60		870	80		460	10			
65		1000	130		470	10			
70					490	20			
75					510	20			
80					520	10			
85					540	20			
90					570	30			
95					610	40			
100					650	40			

NUMBER	LOT 7 (1)			LOT 7 (2)			LOT 7 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		150	110		290	250		250	210
10		240	90		390	100		420	170
15		270	30		510	120		520	100
20		300	30		740	230		620	100
25		350	50		900	160		680	60
30		370	20		1000	100		710	30
35		390	20					760	50
40		400	10					810	50
45		430	30					900	90
50		460	30					1000	100
55		520	60						
60		620	100						
65		680	60						
70		730	50						
75		790	60						
80		860	70						
85		920	60						
90		1000	80						
95									
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 8 (1)			LOT 8 (2)			LOT 8 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		120	80		240	200		190	150
10		250	130		300	60		350	160
15		310	60		370	70		420	70
20		340	30		450	80		450	30
25		370	30		510	60		480	30
30		400	30		620	110		520	40
35		430	30		720	100		560	40
40		470	40		880	160		590	30
45		560	90		1000	120		640	50
50		620	60					690	50
55		700	80					740	50
60		800	100					790	50
65		890	90					840	50
70		1000	110					900	60
75								940	40
80								1000	60
85									
90									
95									
100									

NUMBER	LOT 9 (1)			LOT 9 (2)			LOT 9 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		180	140		260	220		200	160
10		330	150		340	80		310	110
15		500	170		370	30		370	60
20		560	60		400	30		400	30
25		720	160		450	50		430	30
30		950 (1)	230		500	50		460	30
35					570	70		500	40
40					740	170		540	40
45					880	140		600	60
50					1000	120		680	80
55								710	30
60								730	20
65								750	20
70								770	20
75								810	40
80								850	40
85								900	50
90								960	60
95								1000	40
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 10 (1)			LOT 10 (2)			LOT 10 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		230	190		170	130		260	220
10		310	80		400	230		400	140
15		390	80		510	110		430	30
20		500	110		600	90		450	20
25		580	80		700	100		490	40
30		660	80		750	50		520	30
35		740	80		810	60		560	40
40		950 (1)	210		900	90		580	20
45					1000	100		610	30
50								630	20
55								660	30
60								700	40
65								740	40
70								770	30
75								800	30
80								840	40
85								900	60
90								950	50
95								1000	50
100									

NUMBER	LOT 11 (1)			LOT 11 (2)			LOT 11 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		140	100		160	120		240	200
10		300	160		350	190		340	100
15		360	60		580	230		490	150
20		410	50		920 (1)	340		610	120
25		480	70					690	80
30		580	100					720	30
35		680	100					750	30
40		770	90					790	40
45		910	140					810	20
50		1000	90					840	30
55								870	30
60								910	40
65								950	40
70								1000	50
75									
80									
85									
90									
95									
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 12 (1)			LOT 12 (2)			LOT 12 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		180	140		220	180		220	180
10		340	160		360	140		340	120
15		410	70		530	170		420	80
20		470	60		660	130		520	100
25		550	80		760	100		600	80
30		660	110		870	110		650	50
35		740	80		1000	130		690	40
40		830	90					720	30
45		920	90					750	30
50		1000	80					790	40
55								830	40
60								860	30
65								890	30
70								910	20
75								950	40
80								1000	50
85									
90									
95									
100									

NUMBER	LOT 13 (1)			LOT 13 (2)			LOT 13 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		80	40		200	160		410	370
10		120	40		370	170		470	60
15		140	20		500	130		530	60
20		150	10		560	60		570	40
25		160	10		610	50		630	60
30		170	10		640	30		680	50
35		190	20		660	20		730	50
40		220	30		700	40		770	40
45		260	40		760	60		800	30
50		300	40		870	110		830	30
55		340	40		1000	130		870	40
60		400	60					910	40
65		480	80					940	30
70		600	120					1000	60
75		690	90						
80		800	110						
85		900	100						
90		1000	100						
95									
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 14 (1)			LOT 14 (2)			LOT 14 (3)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		140	100		250	210		200	160
10		170	30		350	100		320	120
15		200	30		390	40		380	60
20		220	20		420	30		410	30
25		240	20		460	40		450	40
30		250	10		520	60		480	30
35		270	20		590	70		500	20
40		290	20		640	50		530	30
45		320	30		670	30		560	30
50		350	30		760	90		600	40
55		370	20		1000	240		630	30
60		400	30					660	30
65		430	30					700	40
70		450	20					740	40
75		480	30					800	60
80		500	20					870	70
85		520	20					930	60
90		550	30					1000	70
95		590	40						
100		620	30						

NUMBER	LOT 17 (1)			LOT 17 (2)			LOT 18 (1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		110	70		200	160		130	90
10		160	50		340	140		230	100
15		210	50		460	120		250	20
20		250	40		470	10		280	30
25		280	30		480	10		300	20
30		300	20		490	10		320	20
35		320	20		510	20		340	20
40		340	20		530	20		350	10
45		360	20		540	10		380	30
50		380	20		560	20		410	30
55		400	20		590	30		440	30
60		410	10		630	40		470	30
65		430	20		670	40		510	40
70		450	20		730	60		540	30
75		470	20		810	80		560	20
80		500	30		910	100		590	30
85		540	40		1000	90		620	30
90		580	40					650	30
95		610	30					670	20
100		630	20					700	30

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SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER TRUST - STAGE 1 - FINAL EARTHWORKS ***DATE:*** 24/11/2006
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 18 (2)			LOT 19 (1)			LOT 19 (2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		250	210		200	160		150	110
10		300	50		300	100		250	100
15		340	40		350	50		290	40
20		370	30		370	20		320	30
25		420	50		400	30		370	50
30		500	80		430	30		450	80
35		580	80		460	30		570	120
40		670	90		500	40		850	280
45		780	110		550	50		1000	150
50		900	120		630	80			
55		1000	100		760	130			
60					1000	240			
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 20 (1)			LOT 20 (2)			LOT 21 (1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		110	70		150	110		110	70
10		120	10		320	170		180	70
15		130	10		430	110		250	70
20		150	20		650	220		330	80
25		180	30		900	250		400	70
30		290	110		1000	100		470	70
35		340	50					530	60
40		380	40					600	70
45		410	30					670	70
50		490	80					740	70
55		570	80					810	70
60		660	90					900	90
65		760	100					1000	100
70		890	130						
75		1000	110						
80									
85									
90									
95									
100									

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SCALA PENETROMETER TEST RESULTS

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SITE ADDRESS: WESTERN ROAD, NGONGOTAHA ***BY:*** CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 21 (2)			LOT 22 (1)			LOT 22 (2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0		40			40			40	
5		180	140		90	50		170	130
10		280	100		180	90		270	100
15		340	60		240	60		370	100
20		400	60		290	50		450	80
25		450	50		330	40		550	100
30		510	60		390	60		660	110
35		550	40		430	40		770	110
40		610	60		500	70		850	80
45		650	40		550	50		1000	150
50		700	50		590	40			
55		740	40		630	40			
60		770	30		660	30			
65		800	30		710	50			
70		840	40		770	60			
75		1000	160		870	100			
80					1000	130			
85									
90									
95									
100									

NUMBER	LOT 23 (1)			LOT 23 (2)					
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.			
RL START									
0		40			40				
5		150	110		240	200			
10		210	60		360	120			
15		300	90		430	70			
20		360	60		510	80			
25		410	50		610	100			
30		520	110		700	90			
35		600	80		790	90			
40		670	70		860	70			
45		740	70		920	60			
50		810	70		1000	80			
55		900	90						
60		1000	100						
65									
70									
75									
80									
85									
90									
95									
100									

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NOTES/KEY:

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IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL EXISTING SERVICES PRIOR TO STARTING WORK.

CLIENT
PIONEER PROPERTY TRUST LTD

No.	Date	By	Issue/Revision
A		GD	ISSUED FOR APPROVAL

PROJECT/LOCATION
WESTERN ROAD
NGONGOTAHA

DRAWING DESCRIPTION
AS BUILT STAGE 2
OVERALL PLAN
SOIL TEST LOCATIONS

DRAWN: GD	DESIGNED: JM
CHECKED: JM	SURVEYED BY: -
LOCAL AUTHORITY REF: -	
SCALE: 1 : 750	ORIGINAL DWG. SIZE A2
DRAWING No. 175781-R-E-D007	SHEET No. 01 / ISSUE A

MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	**LOT 15(1)**			**LOT 15(2)**			**LOT 16(1)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		200	160		210	170
10		270	100		300	100		320	110
15		380	110		440	140		400	80
20		500	120		570	130		480	80
25		610	110		680	110		540	60
30		700	90		780	100		610	70
35		800	100		850	70		670	60
40		900	100		980(1)	130		740	70
45		1000	100					850	110
50								970(1)	120
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	**LOT 16(2)**			**LOT 64(1)**			**LOT 64(2)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		380	340		240	200		220	180
10		470	90		310	70		310	90
15		640	170		400	90		390	80
20		680	40		460	60		470	80
25		740	60		510	50		520	50
30		800	60		600	90		600	80
35		860	60		700	100		830	230
40		930	70		840	140		960(2)	130
45		1000	70		960(2)	120			
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 65(1)			LOT 65(2)			LOT 66(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		200	160		230	190		140	100
10		260	60		310	80		230	90
15		320	60		420	110		310	80
20		380	60		510	90		400	90
25		440	60		570	60		480	80
30		500	60		630	60		580	100
35		580	80		690	60		680	100
40		650	70		740	50		790	110
45		720	70		790	50		900	110
50		820	100		840	50		1000	100
55		950(2)	130		890	50			
60					950	60			
65					1000	50			
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 66(2)			LOT 67(1)			LOT 67(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		120	80		90	50		110	70
10		200	80		130	40		190	80
15		270	70		200	70		270	80
20		350	80		270	70		360	90
25		450	100		350	80		450	90
30		560	110		420	70		550	100
35		660	100		500	80		640	90
40		740	80		560	60		730	90
45		820	80		630	70		820	90
50		900	80		700	70		910	90
55		1000	100		800	100		1000	90
60					900	100			
65					1000	100			
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	**LOT 68(1)**			**LOT 68(2)**			**LOT 69(1)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		350	310		340	300		290	250
10		470	120		430	90		400	110
15		570	100		520	90		510	110
20		740	170		670	150		660	150
25		940(2)	200		780	110		780	120
30					900	120		870	90
35					1000	100		1000	130
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	**LOT 69(2)**			**LOT 70(1)**			**LOT 70(2)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		230	190		380	340		280	240
10		340	110		470	90		350	70
15		440	100		640	170		400	50
20		580	140		680	40		480	80
25		700	120		740	60		550	70
30		880	180		800	60		620	70
35		1000	120		860	60		710	90
40					930	70		790	80
45					1000	70		860	70
50								940(3)	80
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 71(1)			LOT 71(2)			LOT 72(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		320	280		280	240		220	180
10		400	80		410	130		300	80
15		460	60		530	120		380	80
20		540	80		670	140		460	80
25		600	60		790	120		510	50
30		670	70		880	90		590	80
35		720	50		1000	120		690	100
40		790	70					830	140
45		890	100					940(2)	110
50		1000	110						
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 72(2)			LOT 73(1)			LOT 73(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		230	190		190	150
10		270	100		300	70		260	70
15		370	100		430	130		320	60
20		490	120		510	80		370	50
25		600	110		570	60		440	70
30		710	110		630	60		500	60
35		810	100		690	60		580	80
40		900	90		740	50		640	60
45		1000	100		790	50		720	80
50					850	60		830	110
55					900	50		960(2)	130
60					960	60			
65					1000	40			
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 74(1)			LOT 74(2)			LOT 75(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		270	230		340	300		280	240
10		360	90		480	140		340	60
15		490	130		590	110		380	40
20		680	190		740	150		420	40
25		1000	320		1000	260		480	60
30								550	70
35		**SV**			**SV**			620	70
40		72			78			670	50
45		68			71			710	40
50		80			64			770	60
55	**AV**	73.33333		**AV**	71			840	70
60								900	60
65	**=**	**114 kPa**		**=**	**111 kPa**			950	50
70								1000	50
75									
80									
85									
90									
95									
100									

NUMBER	LOT 75(2)			LOT 76(1)			LOT 76(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		200	160		180	140		150	110
10		310	110		300	120		240	90
15		410	100		410	110		330	90
20		490	80		510	100		420	90
25		540	50		620	110		520	100
30		610	70		730	110		610	90
35		670	60		840	110		710	100
40		740	70		960(2)	120		820	110
45		850	110					910	90
50		970(1)	120					1000	90
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 77(1)			LOT 77(2)			LOT 78(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		240	200		230	190		230	190
10		380	140		310	80		340	110
15		570	190		400	90		440	100
20		690	120		460	60		570	130
25		750	60		510	50		690	120
30		810	60		600	90		780	90
35		870	60		690	90		890	110
40		970(1)	100		820	130		1000	110
45					910	90			
50					1000	90			
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 78(2)			LOT 79(1)			LOT 79(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		270	230		180	140		240	200
10		360	90		260	80		380	140
15		480	120		350	90		570	190
20		670	190		450	100		690	120
25		970(1)	300		590	140		750	60
30					750	160		810	60
35		**SV**			940(3)	190		870	60
40		72						970(1)	100
45		68							
50		84							
55	**AV**	74.66667							
60									
65	**=**	**117 kPa**							
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **29.05.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **CBW**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 80(1)			LOT 80(2)			LOT 81(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		120	80		200	160
10		300	130		210	90		300	100
15		420	120		310	100		440	140
20		510	90		400	90		570	130
25		610	100		480	80		680	110
30		700	90		560	80		770	90
35		790	90		620	60		840	70
40		880	90		710	90		970(1)	130
45		1000	120		810	100			
50					900	90			
55					1000	100			
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 81(2)			LOT 82(1)			LOT 82(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		280	240		110	70		130	90
10		400	120		200	90		210	80
15		490	90		290	90		300	90
20		590	100		400	110		380	80
25		700	110		500	100		460	80
30		800	100		590	90		540	80
35		900	100		670	80		620	80
40		1000	100		750	80		710	90
45					830	80		810	100
50					910	80		900	90
55					1000	90		980(1)	80
60									
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **27.07.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **JM**
JOB NUMBER: **175781/E**

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	**LOT 83(1)**			**LOT 83(2)**			**LOT 84(1)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.25	250	0	-0.10	100	0	-0.28	280	0
5		450	200		340	240		470	190
10		590	140		480	140		680	210
15		750	160		680	200		880	200
20		900	180		810	130		1050	170
25					1000	190			
30									
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	**LOT 84(2)**			**LOT 85(1)**			**LOT 85(2)**		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.10	100	0	-0.05	50	0	-0.15	150	0
5		330	230		320	270		280	130
10		490	160		490	170		400	120
15		650	160		600	110		550	150
20		870	220		710	110		700	150
25		1000	130		870	160		850	150
30					1000	130		930	80
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: **PIONEER PROPERTY TRUST LTD** ***DATE:*** **27.07.07**
SITE ADDRESS: **WESTERN ROAD, NGONGOTAHA** ***BY:*** **JM**
JOB NUMBER: **175781/E**

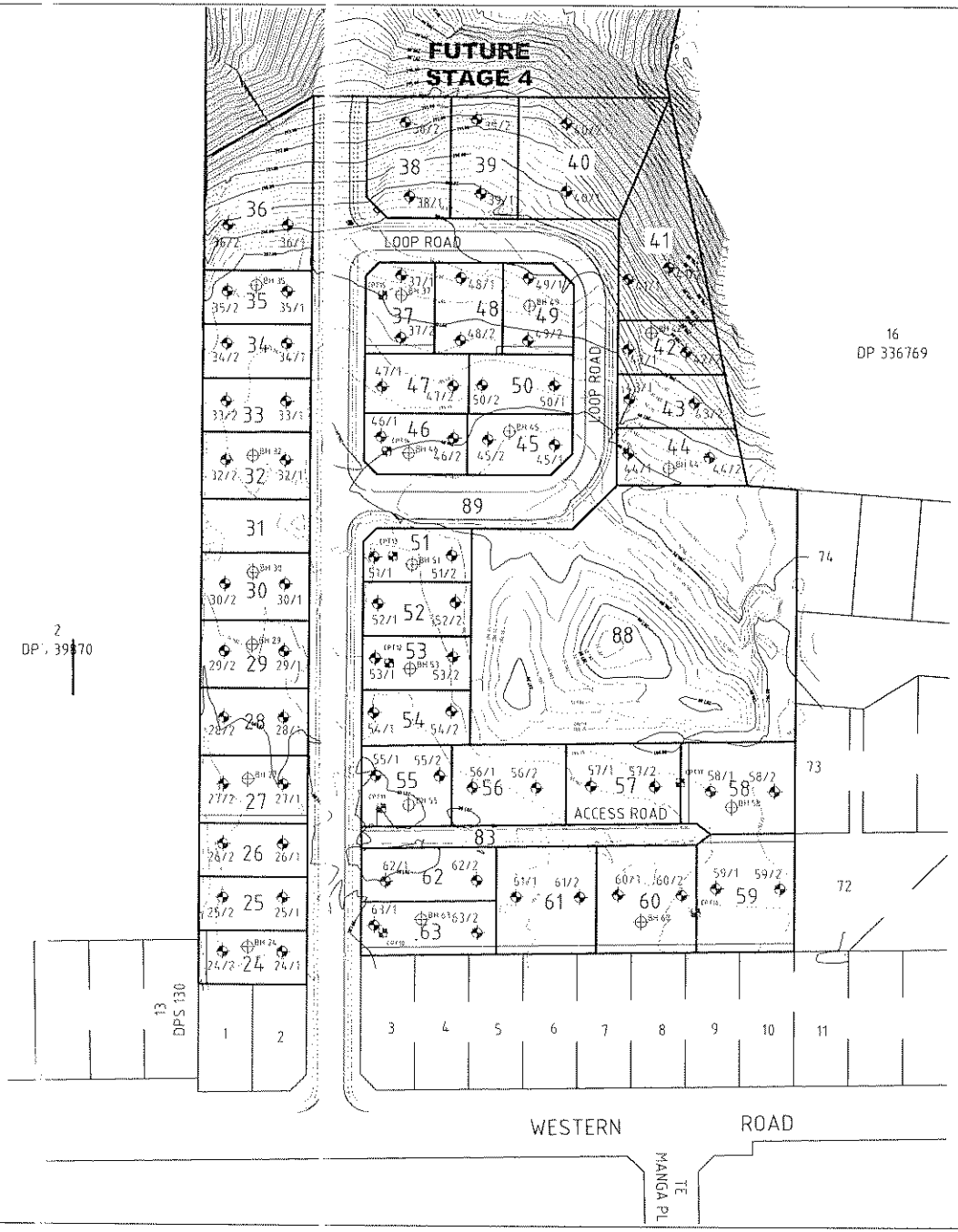
NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	**LOT 86(1)**			**LOT 86(2)**					
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.10	100	0	-0.30	300	0	0.00		0
5		450	350		480	180			0
10		570	120		580	100			
15		650	80		680	100			
20		720	70		810	130			
25		800	80		1050	240			
30		880	80						
35		1000	120						
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER			
OF BLOWS	RL	READING	PENETR.
RL START			
0	0.00		0
5			0
10			
15			
20			
25			
30			
35			
40			
45			
50			
55			
60			
65			
70			
75			
80			
85			
90			
95			
100			

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NOTES/KEY:

- CPT TEST SITES
- SCALA PENETROMETER TEST SITES
- 2.0m BORE HOLES
- ASBUILT CONTOUR INTERVAL AT 0.25m

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SERVICES:

A	21/01/08	PK	ISSUED FOR APPROVAL
No.	Date	By	Description

DRAWN: PK | DESIGNED: JM
CHECKED: JM | SURVEYED BY:
LOCAL AUTHORITY REF:

MTEC CONSULTANTS
SURVEYORS
ENGINEERS
PLANNERS

CLIENT:
PIONEER PROPERTY TRUST LTD

PROJECT/LOCATION:
WESTERN ROAD
NGONGOTAHA

DRAWING DESCRIPTION:
AS BUILT - EARTHWORKS
OVER ALL PLAN
AS BUILT CONTOURS

SCALE: 1 : 1200 ORIGINAL DWG SIZE A2

DRAWING No.	SHEET No.	ISSUE
175781-R-E-D010	28	A

MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER PROPERTY TRUST LTD
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA , ROTORUA
JOB NUMBER: 175781/E-STAGE 3 E/W TESTING

DATE: 27.09.07
BY: CBW

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 24(1)			LOT 24(2)			LOT 25(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		210	170		170	130		210	170
10		330	120		280	110		310	100
15		390	60		360	80		400	90
20		460	70		430	70		500	100
25		540	80		510	80		570	70
30		630	90		600	90		640	70
35		740	110		690	90		720	80
40		840	100		790	100		800	80
45		940(2)	100		890	100		870	70
50					1000	110		960(3)	90
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 25(2)			LOT 26(1)			LOT 26(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		160	120		240	200		220	180
10		290	130		400	160		320	100
15		380	90		540	140		400	80
20		490	110		700	160		460	60
25		600	110		830	130		510	50
30		720	120		920	90		570	60
35		840	120		1000	80		630	60
40		1000	160					690	60
45								770	80
50								850	80
55								920	70
60								1000	80
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER PROPERTY TRUST LTD
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA , ROTORUA
JOB NUMBER: 175781/E

DATE: 27.09.07
BY: CBW

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 27(1)			LOT 27(2)			LOT 28(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		140	100		290	250		230	190
10		200	60		490	200		300	70
15		270	70		570	80		380	80
20		370	100		710	140		470	90
25		480	110		830	120		560	90
30		600	120		1000	170		660	100
35		710	110					750	90
40		790	80					850	100
45		870	80					940(2)	90
50		960(3)	90						
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 28(2)			LOT 29(1)			LOT 29(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		310	270		110	70		240	200
10		520	210		190	80		380	140
15		700	180		250	60		520	140
20		830	130		310	60		650	130
25		950(2)	120		380	70		780	130
30					430	50		900	120
35					500	70		1000	100
40					570	70			
45					640	70			
50					720	80			
55					800	80			
60					1000	200			
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER PROPERTY TRUST LTD *DATE:* 27.09.07
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA, ROTORUA *BY:* CBW
JOB NUMBER: 175781/E

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 30(1)			LOT 30(2)			LOT 32(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		190	150		210	170		230	190
10		300	110		320	110		400	170
15		430	130		440	120		560	160
20		560	130		580	140		760	200
25		680	120		720	140		890	130
30		800	120		880	160		1000	110
35		910	110		1000	120			
40		1000	90						
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 32(2)			LOT 33(1)			LOT 33(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		200	160		250	210
10		300	130		350	150		340	90
15		420	120		500	150		430	90
20		500	80		640	140		520	90
25		570	70		780	140		610	90
30		640	70		900	120		700	90
35		720	80		1000	100		800	100
40		790	70					910	110
45		870	80					1000	90
50		960(2)	90						
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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MTEC CONSULTANTS LTD

SCALA PENETROMETER TEST RESULTS

JOB NAME: PIONEER PROPERTY TRUST LTD
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA , ROTORUA
JOB NUMBER: 175781/E

DATE: 27.09.07
BY: CBW

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 34(1)			LOT 34(2)			LOT 35(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		330	290		290	250		120	80
10		380	50		390	100		230	110
15		410	30		490	100		340	110
20		460	50		540	50		430	90
25		510	50		570	30		500	70
30		560	50		640	70		570	70
35		630	70		700	60		630	60
40		740(4)	110		760	60		710	80
45					800	40		800	90
50					840	40		880	80
55					910	70		960(2)	80
60					1000	90			
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 35(2)			LOT 36(1)			LOT 36(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		90	50		160	120		130	90
10		140	50		260	100		210	80
15		210	70		370	110		290	80
20		270	60		470	100		400	110
25		340	70		560	90		530	130
30		500	160		650	90		660	130
35		630	130		740	90		770	110
40		730	100		820	80		890	120
45		830	100		900	80		1000	110
50		900	70		1000	100			
55		980(1)	80						
60									
65									
70									
75									
80									
85									
90									
95									
100									

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JOB NAME: PIONEER PROPERTY TRUST LTD
SITE ADDRESS: WESTERN ROAD, NGONGOTAHA , ROTORUA
JOB NUMBER: 175781/E

DATE: 27.09.07
BY: CBW

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 37(1)			LOT 37(2)			LOT 38(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		130	90		100	60		180	140
10		160	30		150	50		300	120
15		200	40		220	70		410	110
20		250	50		300	80		500	90
25		300	50		370	70		580	80
30		340	40		440	70		670	90
35		380	40		510	70		770	100
40		440	60		590	80		830	60
45		510	70		670	80		890	60
50		620	110		800	130		950	60
55		740	120		910	110		1000	50
60		850	110		1000	90			
65		960(2)	110						
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 38(2)			LOT 39(1)			LOT 39(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		380	340		250	210
10		230	60		490	110		390	140
15		310	80		600	110		520	130
20		400	90		700	100		610	90
25		480	80		790	90		710	100
30		590	110		870	80		760	50
35		720	130		940	70		810	50
40		810	90		1000	60		880	70
45		900	90					960(2)	80
50		1000	100						
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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SITE ADDRESS: WESTERN ROAD, NGONGOTAHA , ROTORUA
JOB NUMBER: 175781/E

DATE: 27.09.07
BY: CBW

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 40(1)			LOT 40(2)			LOT 41(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		160	120		200	160		130	90
10		250	90		330	130		210	80
15		390	140		420	90		280	70
20		600	210		520	100		360	80
25		790	190		590	70		500	140
30		1000	210		660	70		630	130
35					770	110		770	140
40					900(3)	130		900(4)	130
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 41(2)			LOT 42(1)			LOT 42(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		360	320		300	260		210	170
10		560	200		480	180		370	160
15		780	220		620	140		500	130
20		1000	220		800	180		630	130
25					980(1)	180		770	140
30								910(3)	140
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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JOB NUMBER: 175781/E

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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 43(1)			LOT 43(2)			LOT 44(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		110	70		120	80		130	90
10		150	40		180	60		300	170
15		190	40		260	80		450	150
20		260	70		310	50		580	130
25		340	80		370	60		700	120
30		420	80		450	80		800	100
35		500	80		530	80		890	90
40		590	90		630	100		1000	110
45		690	100		740	110			
50		770	80		840	100			
55		850	80		940(3)	100			
60		920	70						
65		1000	80						
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 44(2)			LOT 45(1)			LOT 45(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		150	110		140	100		190	150
10		240	90		240	100		300	110
15		330	90		340	100		420	120
20		430	100		450	110		560	140
25		500	70		510	60		690	130
30		560	60		600	90		800	110
35		630	70		690	90		910(4)	110
40		700	70		770	80			
45		780	80		850	80			
50		900	120		920	70			
55		1000	100		1000	80			
60									
65									
70									
75									
80									
85									
90									
95									
100									

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JOB NUMBER: 175781/E

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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 46(1)			LOT 46(2)			LOT 47(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		130	90		210	170
10		250	80		180	50		330	120
15		340	90		270	90		470	140
20		440	100		330	60		600	130
25		520	80		390	60		710	110
30		600	80		450	60		820	110
35		710	110		520	70		910	90
40		820	110		590	70		1000	90
45		920	100		660	70			
50		980(2)	60		780	120			
55					900	120			
60					1000	100			
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 47(2)			LOT 48(1)			LOT 48(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		230	190		170	130		200	160
10		300	70		340	170		350	150
15		380	80		500	160		500	150
20		460	80		630	130		610	110
25		520	60		730	100		730	120
30		590	70		830	100		850	120
35		650	60		940	110		970(2)	120
40		700	50		1000	60			
45		750	50						
50		810	60						
55		870	60						
60		930	60						
65		1000	70						
70									
75									
80									
85									
90									
95									
100									

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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 49(1)			LOT 49(2)			LOT 50(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		140	100		160	120		170	130
10		240	100		270	110		250	80
15		280	40		380	110		320	70
20		300	20		490	110		390	70
25		330	30		600	110		470	80
30		370	40		700	100		550	80
35		410	40		790	90		630	80
40		450	40		880	90		710	80
45		530	80		970(2)	90		800	90
50		600	70					890	90
55		670	70					1000	110
60		740	70						
65		810	70						
70		870	60						
75		940	70						
80		1000	60						
85									
90									
95									
100									

NUMBER	LOT 50(2)			LOT 51(1)			LOT 51(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		230	190		170	130		210	170
10		310	80		260	90		350	140
15		400	90		380	120		460	110
20		490	90		700	320		600	140
25		580	90		930(3)	230		980(1)	380
30		660	80						
35		740	80						
40		800	60						
45		870	70						
50		930	60						
55		1000	70						
60									
65									
70									
75									
80									
85									
90									
95									
100									

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JOB NUMBER: 175781/E

DATE: 27.09.07
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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER OF BLOWS	LOT 52(1)			LOT 52(2)			LOT 53(1)		
	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		200	160		210	170		240	200
10		320	120		330	120		620	380
15		480	160		410	80		760	140
20		660	180		490	80		830	70
25		1000	340		860(4)	370		920	90
30								1000	80
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER OF BLOWS	LOT 53(2)			LOT 54(1)			LOT 54(2)		
	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		150	110		180	140		210	170
10		270	120		280	100		320	110
15		370	100		390	110		430	110
20		460	90		480	90		740(4)	310
25		540	80		550	70			
30		630	90		640	90			
35		800	170		850	210			
40		980(1)	180		1000	150			
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 55(1)			LOT 55(2)			LOT 56(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		180	140		220	180		210	170
10		280	100		350	130		350	140
15		390	110		640(4)	290		460	110
20		550	160					600	140
25		670	120					970(1)	370
30		810	140						
35		950(2)	140						
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 56(2)			LOT 57(1)			LOT 57(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		180	140		220	180		190	150
10		280	100		400	180		300	110
15		350	70		540	140		450	150
20		730(3)	380		680	140		590	140
25					800	120		720	130
30					920(3)	120		840	120
35								960(2)	120
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER OF BLOWS	LOT 58(1)			LOT 58(2)			LOT 59(1)		
	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		240	200		210	170		200	160
10		400	160		330	120		330	130
15		620	220		410	80		450	120
20		770	150		490	80		550	100
25		840	70		610	120		660	110
30		920	80		730	120		770	110
35		1000	80		860(4)	130		1000	230
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER OF BLOWS	LOT 59(2)			LOT 60(1)			LOT 60(2)		
	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		180	140		150	110		250	210
10		280	100		270	120		360	110
15		380	100		370	100		440	80
20		470	90		460	90		520	80
25		540	70		540	80		630	110
30		630	90		630	90		850	220
35		840	210		750	120		1000	150
40		1000	160		890	140			
45					1000	110			
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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SCALA PENETROMETER TEST RESULTS

JOB NAME:	PIONEER PROPERTY TRUST LTD	*DATE:*	27.09.07
SITE ADDRESS:	WESTERN ROAD, NGONGOTAHA , ROTORUA	*BY:*	CBW
JOB NUMBER:	175781/E		

NOTE: DEPTH OF PENETRATION BEGINS AT EXISTING GROUND LEVEL
TABLE OF PENETRATION IN mm PER 5 BLOWS
LINE INDICATES LEVEL OF FIRM GROUND

NUMBER	LOT 61(1)			LOT 61(2)			LOT 62(1)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		210	170		180	140		200	160
10		310	100		280	100		290	90
15		410	100		390	110		400	110
20		520	110		550	160		610	210
25		630	110		800	250		790	180
30		730(4)	100		1000	200		980(1)	190
35									
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

NUMBER	LOT 62(2)			LOT 63(1)			LOT 63(2)		
OF BLOWS	RL	READING	PENETR.	RL	READING	PENETR.	RL	READING	PENETR.
RL START									
0	-0.04	40	0	-0.04	40	0	-0.04	40	0
5		170	130		220	180		240	200
10		290	120		300	80		340	100
15		500	210		430	130		400	60
20		640	140		560	130		470	70
25		710	70		700	140		630	160
30		780	70		800	100		770	140
35		900	120		900	100		970(1)	200
40		1000	100		1000	100			
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									

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Coffey Geotechnics (NZ) Ltd, Site Investigation for Proposed Residential Dwelling, Lot 64 Western Road, Ngongotaha (Golden Homes Job No. 8166). 22 August 2007.

Coffey Geotechnics (NZ) Ltd, Site Investigation for Proposed Residential Dwelling, Lot 72 Oaklands Estate, Rotorua (Golden Homes Job No. 8173). 13 September 2007.

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

COPY

5/2/08

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

22 August 2007

Baywide Construction Limited
PO Box 7052
Rotorua
Email. rotorua@goldenhomes.co.nz

Dear Sir / Madam

RE: Site Investigation for Proposed Residential Dwelling
Lot 64 Western Road, Ngongotaha (Golden Homes Job No. 8166)

1 INTRODUCTION AND SCOPE OF REPORT

Further to instructions from Baywide Construction Limited, we are pleased to advise that we have now completed our investigations into the site conditions at the above property where it is proposed to construct a new single level residential dwelling as shown on the Golden Homes plans.

The scope of this report is specifically limited to the provision of site levels, wind zone assessment and determining the foundation bearing capacity of the subsoils below the site.

2 SITE DESCRIPTION

The subject site is situated within a recently completed residential subdivision development on the northern side of Western Road, Ngongotaha. Presently the site is relatively flat and open to the north, south, east and west.

3 FIELD INVESTIGATIONS

Our fieldwork was undertaken on 21 August 2007 and involved the following:

- Visual inspection to provide sufficient information for determination of the building wind zone in accordance with section 5 of NZS 3604;
- Collection of existing ground levels at a 5 metre square grid pattern across the site in relation to a known benchmark using a tape measure and Topcon RL-H3C Rotating Laser level;
- Drilling of two hand auger boreholes to 2 metres depth to determine soil foundation bearing capacity characteristics.

Results of the site survey are presented on the appended site plan and discussed below.

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4 FOUNDATION BEARING CAPACITY

The subsoils encountered within the boreholes comprised 200-300mm topsoil overlying very stiff gravely and sandy silt FILLING to depths of 0.9 to 1 metre overlying weak organic silt / clay containing decaying to roots.

While the near surface fill is considered suitable for residential building construction, we have concerns regarding the settlement characteristics of the underlying organic soils, particularly with respect to time frames associated with the recently constructed filling and further minor earthfills required to create a level building platform.

Further evaluation of the subdivision fill certification and building suitability is required in this instance.

5 EXPANSIVE SITE CLASS

While no specific laboratory testing has been completed for this site, our preliminary assessment of the site soils is that an AS 2870 expansive site class of A (stable), the equivalent of NZS 3604 'good ground' should be appropriate.

6 BUILDING WIND ZONE

The site is presently located within an open green field area, however it's a new residential development that will be completed within the next 5 years over near-level ground topography.

The following classification according to Section 5 of NZS 3604 is suggested:

Suggested Building Wind Zone in accordance with NZS 3604			
Item	**Reference (NZS 3604)**	**Value**	**Comments**
Wind Region	Figure 5.1	R1	-
Lee Zone	Figure 5.1	No	-
Ground roughness	Clause 5.2.3	Urban	Few wind obstructions presently but many other surrounding properties will be completed within the next 5 years
Site exposure	Clause 5.2.4	Sheltered	Will be surrounded by residential dwellings when project is completed
Topographic class	Table 5.4, Figure 5.2	T1	-
Building Wind Zone	Table 5.1	L	-

7 LIMITATION

This report has been prepared for Baywide Construction Limited to provide an assessment of site conditions relevant to the determination of a suggested building wind zone, ground elevations and foundation soil conditions. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

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For and on behalf of Coffey Geotechnics (NZ) Limited

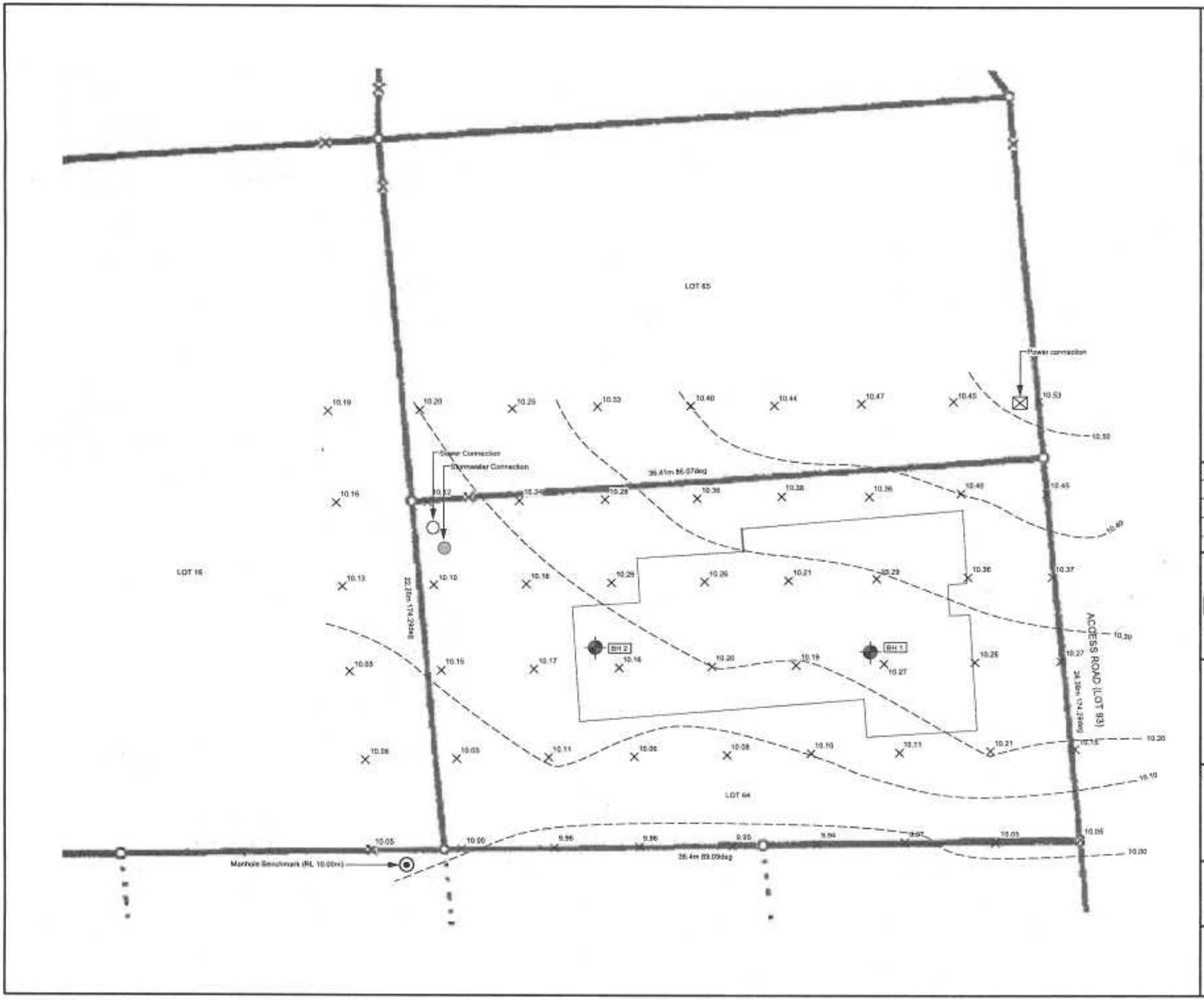
T FRANKS
Graduate Geologist

RW MELVILLE-SMITH
Principal Geotechnical Engineer

cc tauranga@zog.co.nz

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LEGEND AND/OR NOTES:

- Hand Auger Boreholes
- Proposed Dwelling Position
- 10.80 Contour Lines (RL-metres)
- 1.95 Relative Level (RL-metres)

NO.	REVISION	BY	DATE

JOB NUMBER 13597
DRAWN MAP
DATE 23.06.07
CHECKED

CLIENT

BAYWIDE CONSTRUCTION LIMITED

DRAWING TITLE

SITE PLAN

LOT 64 WESTERN ROAD NGONGOTAHA

Coffey Geotechnics
141 Cameron Road
Tauranga
Ph +64 7 571 6081

SCALE (A3) 1 : 200
SHEET No. 1 of 1

coffey geotechnics

Client : BAYWIDE CONSTRUCTION LIMITED

Project Location : Lot 64 Western Road Ngongotaha

Job Number: 13597

Auger Borehole No. 1

Sheet 1 of 2

Vane Head:	Logged By:	Processor :	Date:
591	TF	MAP	21.08.07

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear Strength (kPa)	Soil Sensitivity	Scala Penetrometer (blows/100mm) 2 4 6 8 10
TOPSOIL		0.0				
Fill: Sandy Gravelly SILT, light brown with white pink black and orange mottling, low plasticity, friable when reworked, pumiceous gravels up to 20mm long, sub-angular				189+		
Fill: Sandy Gravelly Clayey SILT, very stiff, light brown with orange black and white mottling, big pumiceous gravels, medium plasticity		0.5		189+		
Silty CLAY, firm, insensitive, light brown, with orange mottling, roots evident and other organic braces, high plasticity, soft, moist		1.0		43	1.9	
at 1.6m becoming moderately sensitive		1.5		47	2.2	
E.O.B at 2.0 metres		2.0		55	1.9	
		2.5				
		3.0				
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

coffey geotechnics

Comments: Groundwater not encountered.

Borehole Diameter: 50mm

Checked:

Topsoil		Sand		Sandstone		Plutonic	
Fill		Gravel		Siltstone		No Core	
Clay		Organic		Limestone			
Silt		Pumice		Volcanic			

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Version: 2, Version Date: 27/04/2009

Client : BAYWIDE CONSTRUCTION LIMITED

Project Location : Lot 64 Western Road Ngongotaha

Job Number: 13597

Auger Borehole No. 2

Sheet 2 of 2

Vane Head:	Logged By:	Processor :	Date:
591	TF	MAP	21.08.07

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear Strength (kPa)	Soil Sensitivity
TOPSOIL		0.0			
Fill: SILT, very stiff, with minor sand and gravel, light brown with white and orange inclusions, friable				189+	
Fill: Sandy Gravelly SILT, light brown with white grey and black mottling, pumiceous gravels can be up to 20mm long		0.5			
Fill: Silty Gravelly SAND, very stiff, sensitive, orange with black mottling, friable				163	4.7
Silty CLAY, very stiff, sensitive, with minor sand and gravel, brown black and orange inclusions, soft, moist, high plasticity, some organics		1.0		106	5.0
		1.5			
E.O.B at 2.0 metres		2.0		117	7.3
		2.5			
		3.0			
		3.5			
		4.0			
		4.5			
		5.0			
		5.5			
		6.0			

Scala Penetrometer (blows/100mm): 2 4 6 8 10

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Comments: Groundwater not encountered.

Borehole Diameter: 50mm

Checked:

Topsoil, Fill, Clay, Silt, Sand, Gravel, Organi, Pumice, Sandstor, Siltstone, Limestor, Volcanic, Plutonic, No Core

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SPECIALISTS MANAGING THE EARTH

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P - 01336

13 September 2007

Baywide Construction Limited
PO Box 7052
Rotorua

Email: rotorua@goldenhomes.co.nz

Dear Sir / Madam

RE: Site Investigation for Proposed Residential Dwelling
Lot 72, Oaklands Estate, Rotorua (Golden Homes Job Number 8173)

1 INTRODUCTION AND SCOPE OF REPORT

Further to instructions from Baywide Construction Limited, we are pleased to advise that we have now completed our investigations into the site conditions at the above property where it is proposed to construct a new single level residential dwelling as shown on the Golden Homes plans.

The scope of this report is specifically limited to the provision of site levels, wind zone assessment and determining the foundation bearing capacity of the subsoils below the site.

2 SITE DESCRIPTION

The subject site is situated within the Oaklands Subdivision, positioned over generally level ground topography and surrounded by similar residential lots.

3 FIELD INVESTIGATIONS

Our fieldwork was undertaken on 29 August 2007 and involved the following:

- Visual inspection to provide sufficient information for determination of the building wind zone in accordance with section 5 of NZS 3604;
- Collection of existing ground levels at a 5 metre square grid pattern across the site in relation to a known benchmark using a tape measure and Topcon RL-H3C Rotating Laser level;
- Drilling of two hand auger boreholes to 2 metres depth to determine soil foundation bearing capacity characteristics.

Results of the site survey are presented on the appended site plan and discussed below.

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4 FOUNDATION BEARING CAPACITY

The subsoils encountered within the boreholes comprised 300mm of topsoil overlying very stiff alluvial silts to depths of 0.9 to 1.1 metres followed by medium dense gravely sands to below the base of the 2 metre deep boreholes.

The site is essentially level and the foundation soils exposed directly below the existing topsoil layer sre sufficiently stiff such that a Geotechnical Ultimate Bearing Capacity of 300 kPa should be available for shallow foundations designed in accordance with NZS 3604 or for proprietary or engineer designed raft foundation systems.

5 EXPANSIVE SITE CLASS

While no specific laboratory testing has been completed for this site, our preliminary assessment of the site soils is that an AS 2870 expansive site class of A (stable), the equivalent of NZS 3604 'good ground' should be appropriate.

6 BUILDING WIND ZONE

The site is located within a large open site over near-level ground topography with surrounding residential dwellings expected to be completed within the next 5 years.

The following classification according to Section 5 of NZS 3604 is suggested:

Suggested Building Wind Zone in accordance with NZS 3604			
Item	**Reference (NZS 3604)**	**Value**	**Comments**
Wind Region	Figure 5.1	R1	-
Lee Zone	Figure 5.1	No	-
Ground roughness	Clause 5.2.3	Urban	Presently open but other surrounding dwellings will be built within 5 years
Site exposure	Clause 5.2.4	Sheltered	Level site
Topographic class	Table 5.4, Figure 5.2	T1	-
Building Wind Zone	Table 5.1	L	-

7 LIMITATION

This report has been prepared for Baywide Construction Limited to provide an assessment of site conditions relevant to the determination of a suggested building wind zone, ground elevations and foundation soil conditions. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

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For and on behalf of Coffey Geotechnics (NZ) Limited

T FRANKS
Graduate Geologist

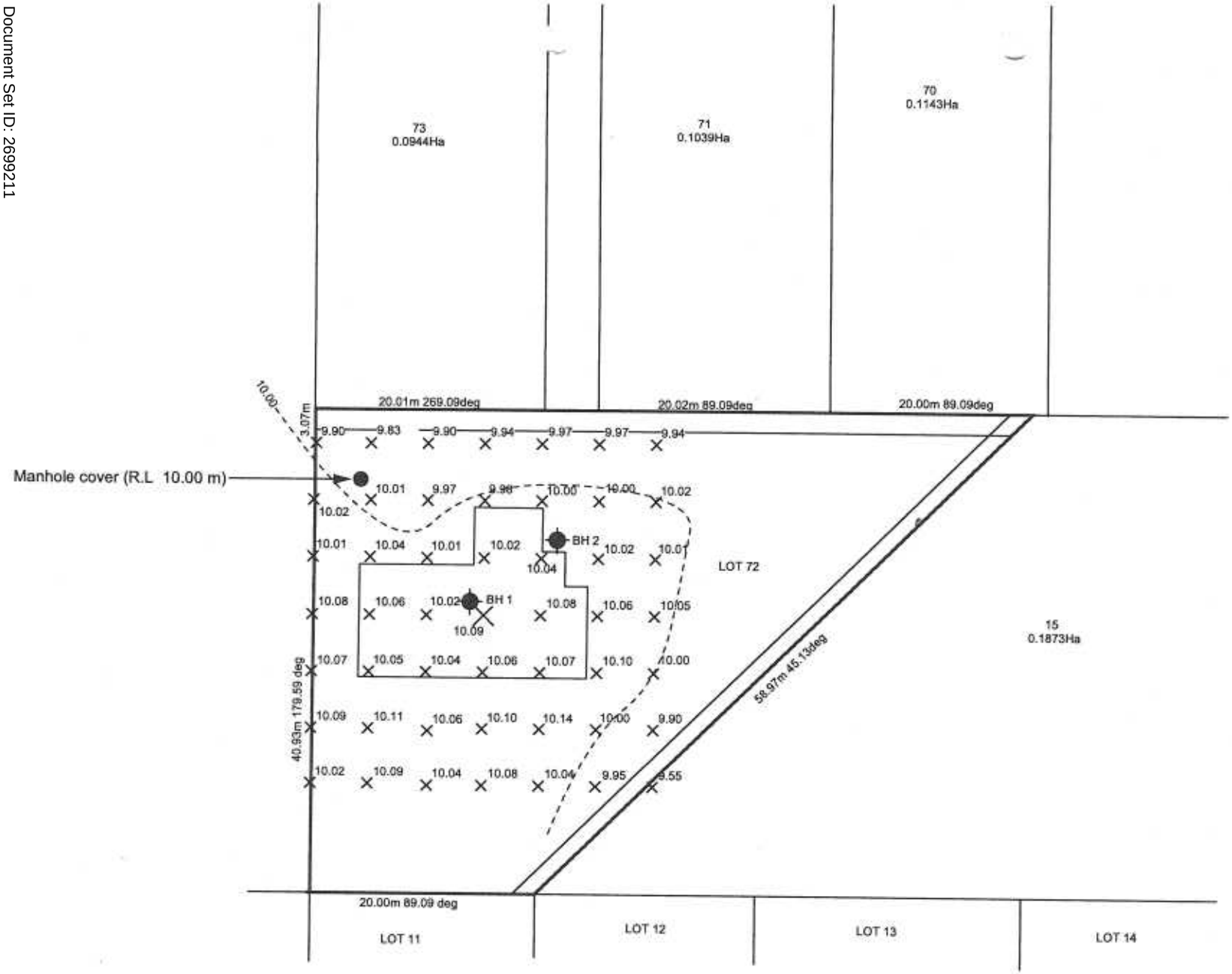
RW MELVILLE-SMITH
Principal Geotechnical Engineer

cc tauranga@zog.co.nz

cc tim@cupolex.co.nz

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BAYWIDE CONSTRUCTION

ct Location : LOT 72 OAKLANDS ESTATE ROTORUA

b Number: 13596

Auger Borehole No. 1

Sheet 1 of 1

Vane Head:	Logged By:	Processor:	Date:
591	TF	MAP	29.08.07

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear Strength (kPa)	Soil Sensitivity
TOPSOIL			
Fill: SILT with gravel, brown with orange inclusions, low plasticity, friable when reworked			
SILT with gravel, light grey/brown, low plasticity, friable when reworked	0.5	189+	
		189+	
SILT with sand, light grey/brown, low plasticty , friable when reworked.	1.0		
SAND with silt, orange with brown inclusions, some pumice gravels & friable			
SAND, cream with black speckling, friable.		189+	
SAND with small sub-angular gravels, light brown with black & orange speckling, friable, moist. Moderatly sensitive.	1.5	189+	
E.O.B at 2.0 metres	2.0	75	3.2

Scala Penetrometer (blows/100mm): 2 4 6 8 10

2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0

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Comments: Groundwater not encountered.

Borehole Diameter: 50mm

Checked:

Topsoil | Fill | Clay | Silt | Sand | Gravel | Organi | Pumice | Sandsto | Siltstone | Limeston | Volcanic | Plutonic | No Core

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BAYWIDE CONSTRUCTION LIMITED

ect Location : LOT 72 OAKLANDS ESTATE ROTORUA

b Number: 13596

Auger Borehole No. 2

Sheet 1 of 1

Vane Head:	Logged By:	Processor :	Date:
591	TF	MAP	29.08.07

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear Strength (kPa)	Soil Sensitivity	Scala Penetrometer (blows/100mm)
TOPSOIL		0.0				
SILT, with sand & gravel. Orange with brown incluisions, medium plasticity, moist.				189+		
SILT, light brown, low plasticity, friable when reworked.		0.5				
SAND, slightly silty/gravelly. Light brown & orange, moist.		1.0		189+		
SAND, light brown with orange, black & cream mottling, gravel of mixed lithology, friable, moist.		1.5				
E.O.B at 2.0 metres		2.0				
		2.5				
		3.0				
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

coffey geotechnics

Comments: Groundwater encountered at base of borehole.

Borehole Diameter: 50mm

Checked:

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

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REPORT

PIONEER PROPERTY TRUST LIMITED

WESTERN ROAD, NGONGOTAHA

GEOTECHNICAL ASSESSMENT REPORT

Volume 2 of 2

Report prepared for:

PIONEER PROPERTY TRUST LIMITED

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

PIONEER PROPERTY TRUST LIMITED	3 copies
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March 2009

T&T Ref: 851126/ Version1.0

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Appendix C: Recent Ground Investigation Fieldwork Data

- **Table 5.1.2: Exploratory Hole Summary Table**
- **Figure 5.1.1: Cone Penetration Test CPT5 (Lot 66, Stage Two)**
- **Figure 6.1.1: Cone Penetration Test Results (Filled Areas)**
- **Figure 6.1.2: Cone Penetration Test Results (Areas At-Grade/Cut)**
- **CPT Results (including Dissipation Tests)**
- **Borehole Logs**
- **Annotated Core Photographs**
- **Standpipe Installation Details**

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Western Road, Ngongotaha
Geotechnical Assessment Report
Table 5.1.2: Exploratory Hole Summary Table

March 2008 Cone Penetration Tests

Exploratory Hole	Length	Stage	Location	Ground Level (estimated from As-Built Contours)	Depth of Cut/Fill (estimated from As-Built Contour Plan)	Depth of Cover	Elevation at Top of Silt Horizon	Elevation at Bottom of Silt Horizon	Thickness of Silt Horizon (including sand bands)	Thickness of Silts (excluding sand bands)	Elevation at Base of Hole	Sand Horizons within Silts									Total Thickness of Sand Bands
												Upper			Middle			Lower			
												Top	Bottom	Thickness	Top	Bottom	Thickness	Top	Bottom	Thickness	
	(m)			(m AMD)	(m)	(m bgl)	(m AMD)	(m AMD)	(m)	(m)	(m AMD)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m)
CPT1	15.00	2	Lot 86	285.40	0.50	1.70	283.70	273.50	10.20	9.20	270.40	280.70	280.50	0.20	277.60	277.20	0.40	275.20	274.80	0.40	1.00
CPT2	20.00	2	Lot 84	285.50	0.80	1.70	283.80	273.10	10.70	10.00	265.50	277.80	277.30	0.50	274.10	273.90	0.20				0.70
CPT3	20.00	2	Lot 81	285.50	-0.60	3.30	282.20	276.90	5.30	4.40	265.50	279.50	279.20	0.30	277.70	277.10	0.60				0.90
CPT4	20.00	2	Lot 64	285.40	0.75	2.60	282.80	273.90	8.90	7.60	265.40	278.10	277.60	0.50	276.00	275.20	0.80				1.30
CPT5	20.00	2	Lot 66	285.50	0.45	1.50	284.00	273.70	10.30	9.90	265.50	278.10	277.70	0.40							0.40
CPT6	20.00	2	Lot 79	286.00	-0.75	3.60	282.40	277.40	5.00	4.10	266.00	280.20	279.80	0.40	278.20	277.70	0.50				0.90
CPT7	20.00	2	Lot 15	285.50	0.60	0.90	284.60	274.50	10.10	9.50	265.50	278.00	277.70	0.30	275.90	275.60	0.30				0.60
CPT8	20.00	2	Lot 69/79	285.50	-0.65	3.50	282.00	274.20	7.80	7.50	265.50	277.50	277.20	0.30							0.30
CPT9	20.00	2	Lot 76	286.00	0.25	2.80	283.20	277.60	5.60	5.00	266.00	280.40	280.10	0.30	278.40	278.10	0.30				0.60
CPT10	20.00	3	Lot 63	287.00	0.00	3.00	284.00	276.00	8.00	7.60	267.00	280.60	280.20	0.40							0.40
CPT11	20.00	3	Lot 55	287.00	0.00	2.30	284.70	279.30	5.40	2.50	267.00	283.40	283.10	0.30	282.40	282.10	0.30	281.80	279.50	2.30	2.90
CPT12	20.00	3	Lot 53	286.50	0.75	2.50	284.00	279.20	4.80	2.50	266.50	283.40	283.10	0.30	281.90	281.70	0.20	281.40	279.60	1.80	2.30
CPT13	20.00	3	Lot 51	286.50	0.50	3.40	283.10	278.20	4.90	2.90	266.50	282.00	281.80	0.20	281.30	279.50	1.80				2.00
CPT14	20.00	3	Lot 46	286.00	0.25	0.90	285.10	282.40	2.70	1.70	266.00	284.90	284.70	0.20	284.40	283.90	0.50	282.90	282.60	0.30	1.00
CPT15	20.00	3	Lot 37	287.00	0.60	1.10	285.90	281.60	4.30	0.80	267.00	285.60	284.70	0.90	284.50	281.90	2.60				3.50
CPT16	20.00	3	Lot 59/60	286.50	-0.75	3.30	283.20	278.70	4.50	4.10	266.50	280.70	280.30	0.40							0.40
CPT17	20.00	3	Lot 57/58	286.30	-0.25	3.30	283.00	278.70	4.30	4.00	266.30	280.90	280.60	0.30							0.30
Count	17			17	17	17	17	17	17	17	17	17	17	17	12	12	12	4	4	4	17
Maximum	20.00			287.00	0.80	3.60	285.90	282.40	10.70	10.00	270.40	285.60	284.70	0.90	284.50	283.90	2.60	282.90	282.60	2.30	3.50
Minimum	15.00			285.40	-0.75	0.90	282.00	273.10	2.70	0.80	265.40	277.50	277.20	0.20	274.10	273.90	0.20	275.20	274.80	0.30	0.30
Average	19.71			286.06	0.14	2.44	283.63	276.99	6.64	5.49	266.36	280.69	280.33	0.36	279.37	278.66	0.71	280.33	279.13	1.20	1.15
Total	335.00																				

June 2008 Cone Penetration Tests

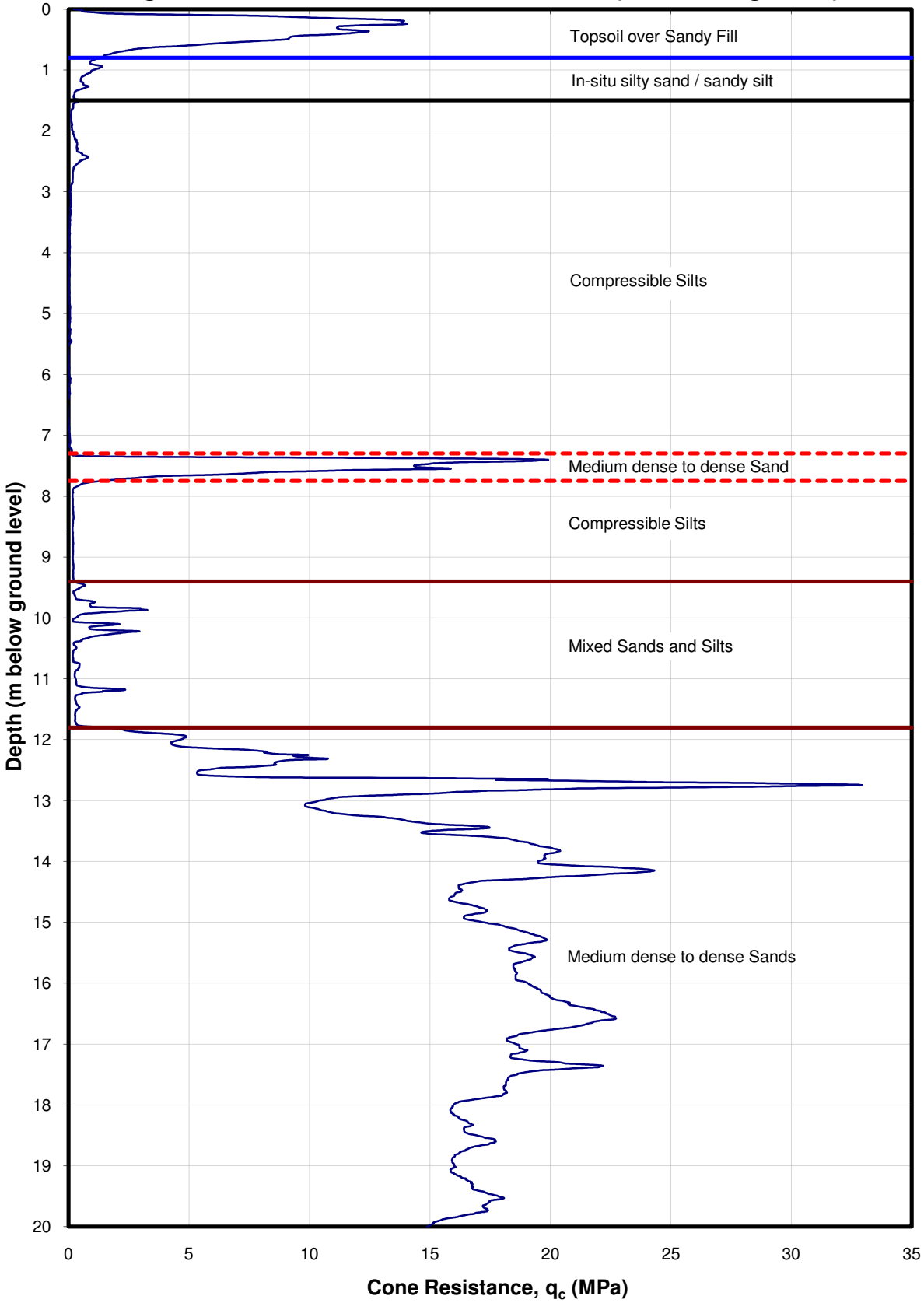
Exploratory Hole	Length	Stage	Location	Ground Level (estimated from As-Built Contours)	Depth of Cut/Fill (estimated from As-Built Contour Plan)	Depth of Cover	Elevation at Top of Silt Horizon	Elevation at Bottom of Silt Horizon	Thickness of Silt Horizon (including sand bands)	Thickness of Silts (excluding sand bands)	Elevation at Base of Hole	Sand Horizons within Silts									Total Thickness of Sand Bands
												Upper			Middle			Lower			
												Top	Bottom	Thickness	Top	Bottom	Thickness	Top	Bottom	Thickness	
	(m)			(m AMD)	(m)	(m bgl)	(m AMD)	(m AMD)	(m)	(m)	(m AMD)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m)
CPT1-01	15.00	1	Lot 1	287.50	0.60	4.20	283.30	275.80	7.50	6.30	272.50	280.80	280.50	0.30	278.30	277.40	0.90				1.20
CPT1-03	13.00	1	Lot 3	287.40	1.20	4.20	283.20	276.60	6.60	5.30	274.40	282.90	282.30	0.60	280.50	280.10	0.40	277.90	277.60	0.30	1.30
CPT1-07	13.00	1	Lot 7	287.20	1.20	3.30	283.90	278.70	5.20	2.60	274.20	282.60	282.30	0.30	281.10	278.80	2.30				2.60
CPT1-11	13.00	1	Lot 11	286.60	1.50	5.20	281.40	274.30	7.10	5.80	273.60	278.00	277.70	0.30	276.10	275.10	1.00				1.30
CPT1-17	15.00	1	Lot 17	286.30	1.40	3.20	283.10	273.50	9.60	9.10	271.30	278.00	277.50	0.50							0.50
CPT1-20	15.00	1	Lot 20	286.00	0.75	2.20	283.80	273.20	10.60	10.20	271.00	277.70	277.30	0.40							0.40
CPT2-16	11.00	2	Lot 16	285.50	0.75	1.30	284.20	274.70	9.50	8.60	274.50	278.20	277.70	0.50	276.10	275.70	0.40				0.90
CPT2-68	15.00	2	Lot 68	285.50	0.00	3.50	282.00	273.70	8.30	7.60	270.50	277.50	277.20	0.30	275.30	274.90	0.40				0.70
CPT2-71	13.00	2	Lot 71	285.50	-0.75	4.40	281.10	274.20	6.90	5.90	272.50	277.30	276.90	0.40	275.10	274.50	0.60				1.00
CPT2-74	11.00	2	Lot 74	286.00	0.60	1.80	284.20	278.70	5.50	5.10	275.00	281.30	281.10	0.20	279.30	279.10	0.20				0.40
CPT3-24	15.00	3	Lot 24	287.30	0.50	3.20	284.10	276.00	8.10	6.90	272.30	280.70	280.40	0.30	278.20	277.50	0.70	277.00	276.80	0.20	1.20
CPT3-26	13.00	3	Lot 26	287.30	0.00	1.60	285.70	275.90	9.80	6.70	274.30	285.50	283.90	1.60	281.40	280.90	0.50	278.10	277.10	1.00	3.10
CPT3-28	10.00	3	Lot 28	287.00	0.00	1.90	285.10	279.20	5.90	3.60	277.00	283.80	283.50	0.30	282.30	282.00	0.30	281.70	280.00	1.70	2.30
CPT3-31	10.00	3	Lot 31	286.50	0.50	2.50	284.00	279.00	5.00	2.10	276.50	282.70	282.20	0.50	281.70	279.30	2.40				2.90
CPT3-34	10.00	3	Lot 34	286.50	0.25	1.70	284.80	278.70	6.10	3.10	276.50	283.70	283.30	0.40	282.90	280.70	2.20	279.40	279.00	0.40	3.00
CPT3-36	10.00	3	Lot 36	283.30	0.40					0.00	273.30										0.00
CPT3-39	10.00	3	Lot 39	289.70	-0.50					0.00	279.70										0.00
CPT3-41	7.00	3	Lot 41	292.00	-0.75					0.00	285.00										0.00
CPT3-44	10.00	3	Lot 44	286.50	0.25	1.40	285.10	278.30	6.80	3.00	276.50	284.60	284.20	0.40	282.90	282.60	0.30	282.10	279.00	3.10	3.80
CPT3-45	10.00	3	Lot 45	285.80	0.00	1.80	284.00	282.90	1.10	1.10	275.80										0.00
CPT3-49	10.00	3	Lot 49	287.50	-0.25	1.60	285.90	285.80	0.10	0.10	277.50										0.00
CPT3-56	10.00	3	Lot 56	286.80	-0.25	2.70	284.10	279.20	4.90	2.60	276.80	283.20	282.90	0.30	281.90	281.80	0.10	281.40	279.50	1.90	2.30
CPT3-58	13.00	3	Lot 58	286.50	-0.50	4.20	282.30	275.40	6.90	5.90	273.50	278.80	278.30	0.50	276.30	276.00	0.30	275.30	275.10	0.20	1.00
CPT3-61	13.00	3	Lot 61	286.50	-0.50	3.20	283.30	276.80	6.50	5.20	273.50	280.30	279.70	0.60	277.70	277.00	0.70				1.30
Count	24			24	24	21	21	21	21	24	24	19	19	19	17	17	17	8	8	8	24
Maximum	15.00			292.00	1.50	5.20	285.90	285.80	10.60	10.20	285.00	285.50	284.20	1.60	282.90	282.60	2.40	282.10	280.00	3.10	3.80
Minimum	7.00			283.30	-0.75	1.30	281.10	273.20	0.10	0.00	270.50	277.30	276.90	0.20	275.10	274.50	0.10	275.30	275.10	0.20	0.00
Average	11.88			286.78	0.27	2.81	283.74	277.17	6.57	4.45	274.90	280.93	280.47	0.46	279.24	278.44	0.81	279.11	278.01	1.10	1.30
Total	285.00																				

June 2008 Boreholes

Exploratory Hole	Length	Stage	Location	Ground Level (estimated from As-Built Contours)	Depth of Cut/Fill (estimated from As-Built Contour Plan)	Depth of Cover	Elevation at Top of Silt Horizon	Elevation at Bottom of Silt Horizon	Thickness of Silt Horizon (including sand bands)	Thickness of Silts (excluding sand bands)	Elevation at Base of Hole	Sand Horizons within Silts									Total Thickness of Sand Bands
												Upper			Middle			Lower			
												Top	Bottom	Thickness	Top	Bottom	Thickness	Top	Bottom	Thickness	
	(m)			(m AMD)	(m)	(m bgl)	(m AMD)	(m AMD)	(m)	(m)	(m AMD)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m AMD)	(m AMD)	(m)	(m)
BH2-64	15.00	2	Lot 64	285.45	-0.75	1.70	283.75	275.75	8.00	6.90	270.45	278.15	277.05	1.10							1.10
BH2-79	15.00	2	Lot 79	285.73	0.60	2.80	283.13	277.23	5.90	5.60	270.73	278.33	278.03	0.30							0.30
BH3-58	15.00	3	Lot 58	286.32	-0.50	3.00	281.82	275.02	6.80	4.50	271.32	278.62	277.32	1.30	276.42	275.42	1.00				2.30
Count	3			3	3	3	3	3	3	3	3	3	3	3	1	1	1	0	0	0	3
Maximum	15.00			286.32	0.60	3.00	283.75	277.23	8.00	6.90	271.32	278.62	278.03	1.30	276.42	275.42	1.00				2.30
Minimum	15.00			285.45	-0.75	1.70	281.82	275.02	5.90	4.50	270.45	278.15	277.05	0.30	276.42	275.42	1.00				0.30
Average	15.00			285.83	-0.22	2.50	282.90	276.00	6.90	5.67	270.83	278.37	277.47	0.90	276.42	275.42	1.00				1.23
Total	45.00																				

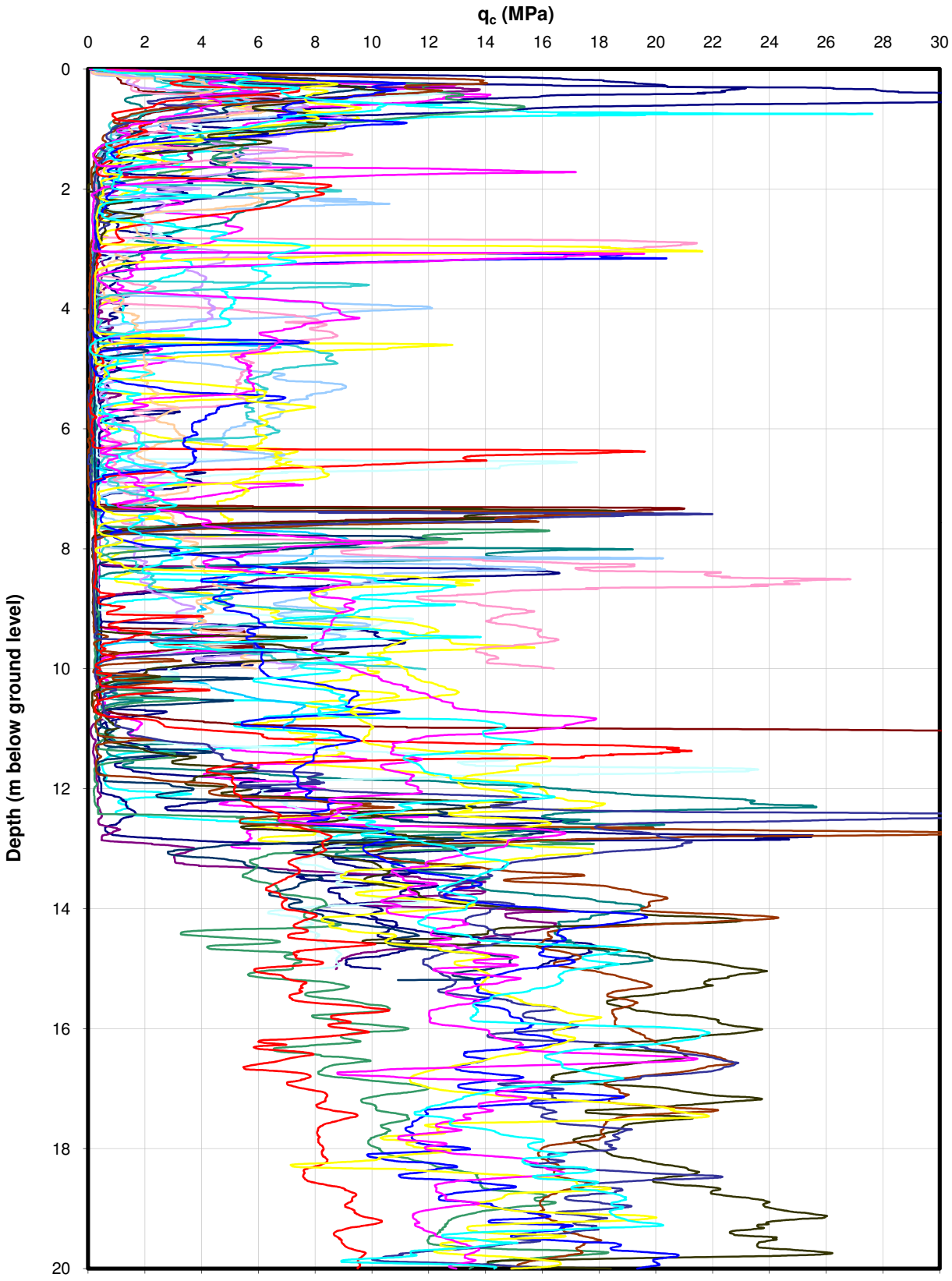
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Version: 2, Version Date: 27/04/2009

Western Road, Ngongotaha
Geotechnical Assessment Report
Figure 5.1.1: Cone Penetration Test CPT5 (Lot 66, Stage Two)



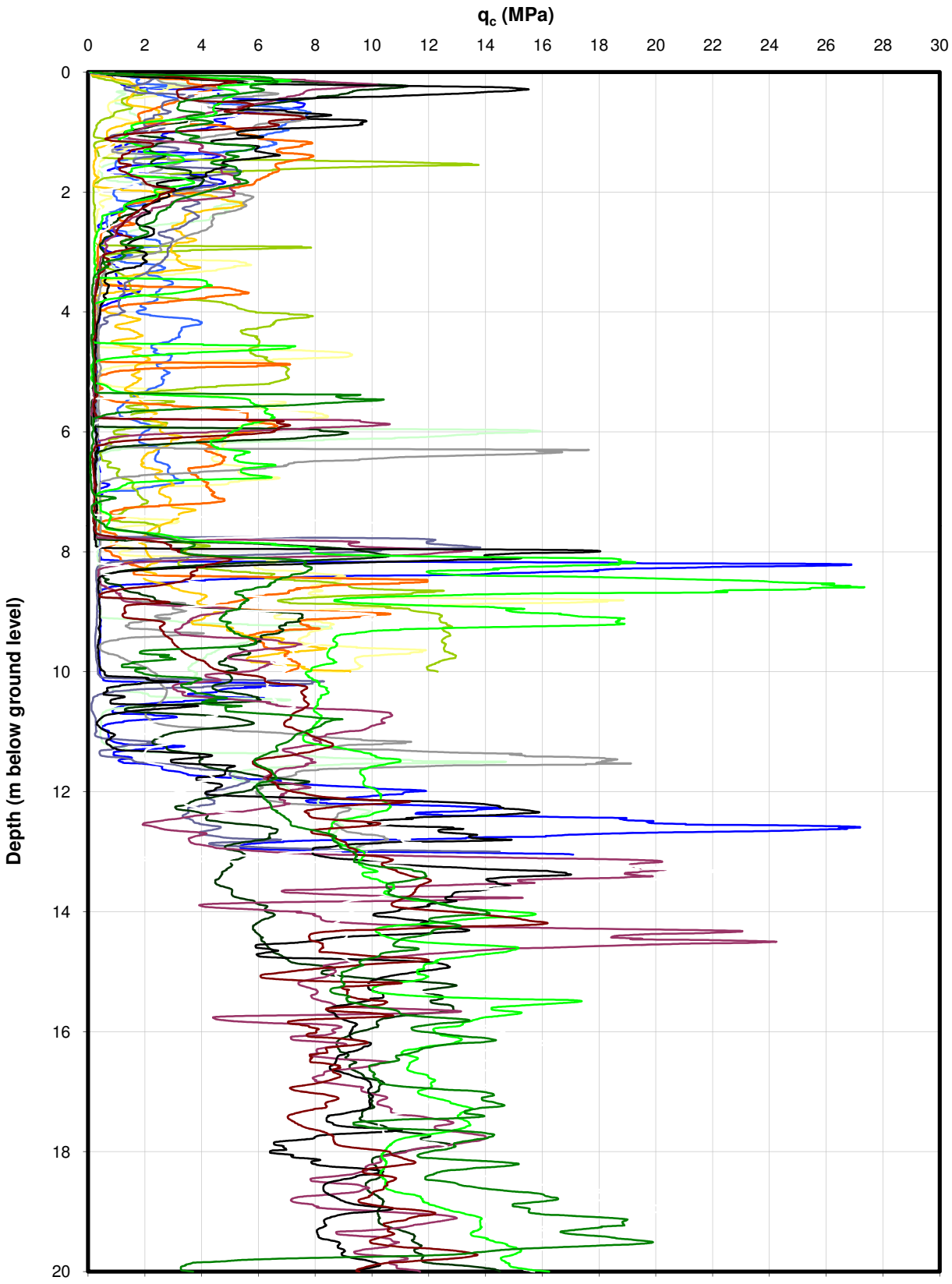
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Version: 2, Version Date: 27/04/2009

Western Road, Ngongotaha
Geotechnical Assessment Report
Figure 6.1.1: Cone Penetration Test Results (Filled Areas)



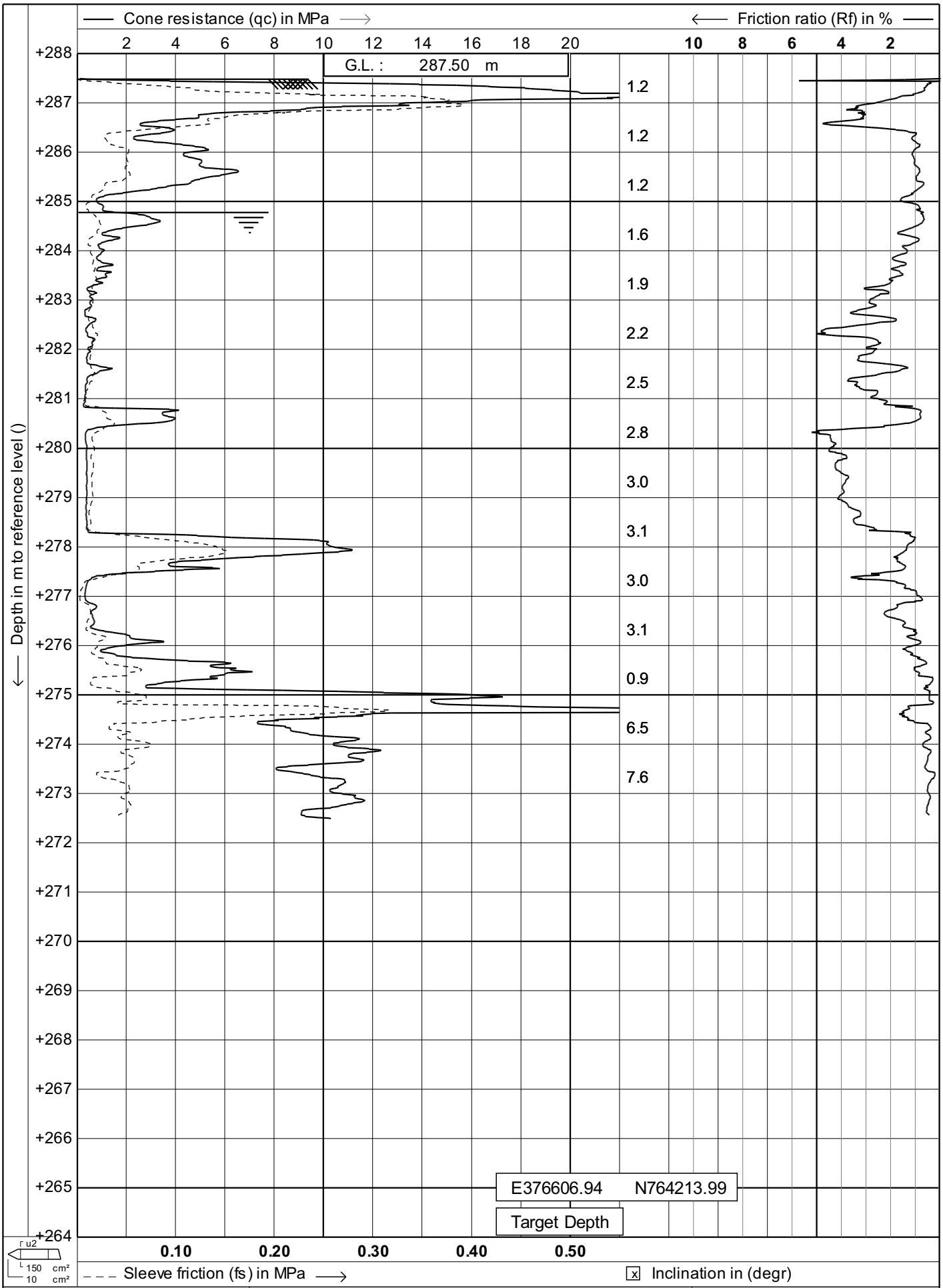
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Version: 2, Version Date: 27/04/2009

Western Road, Ngongotaha
Geotechnical Assessment Report
Figure 6.1.2: Cone Penetration Test Results (Areas At-Grade/Cut)



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- **CPT Results (including Dissipation Tests)**



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

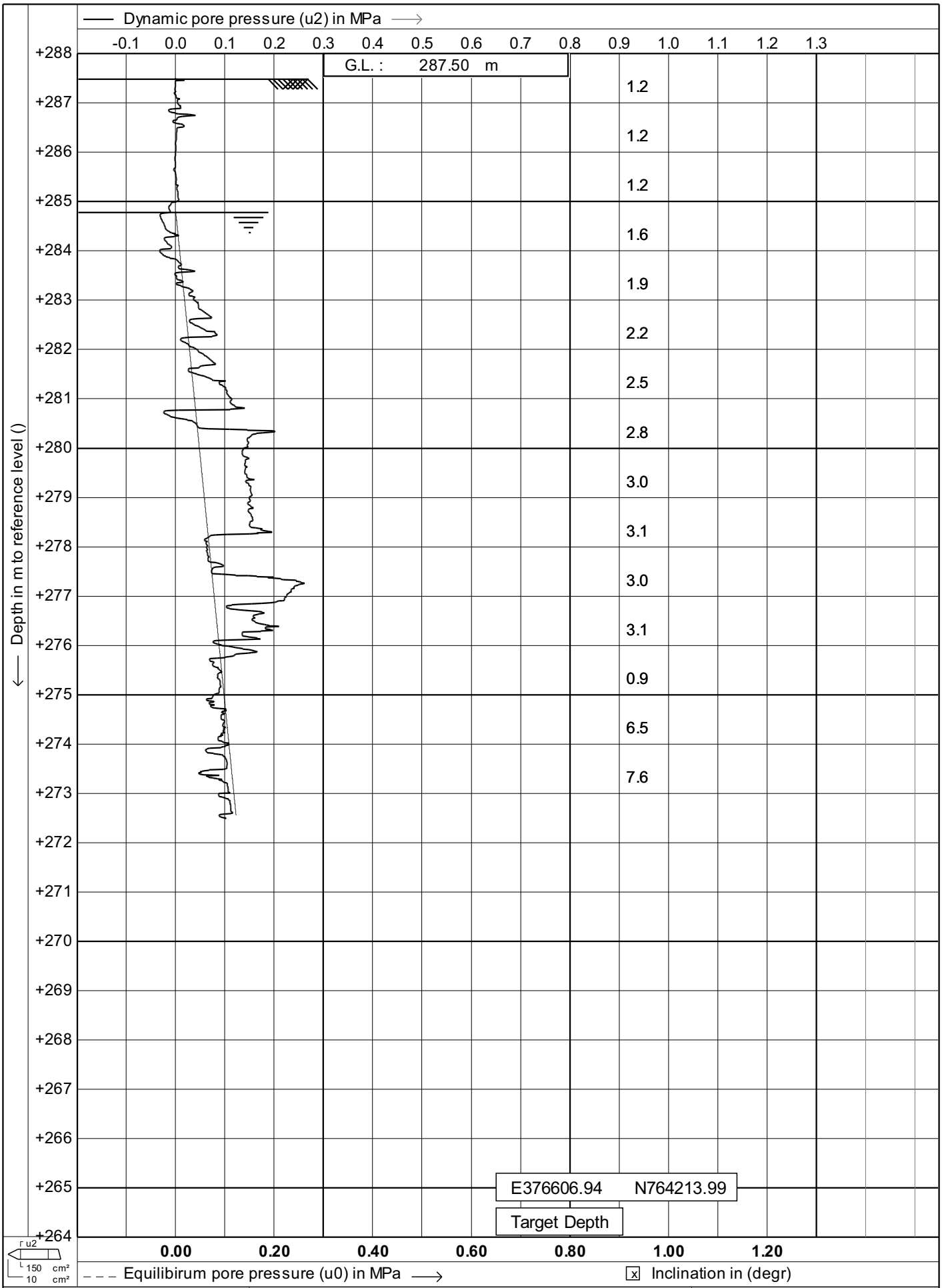
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **1-01** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

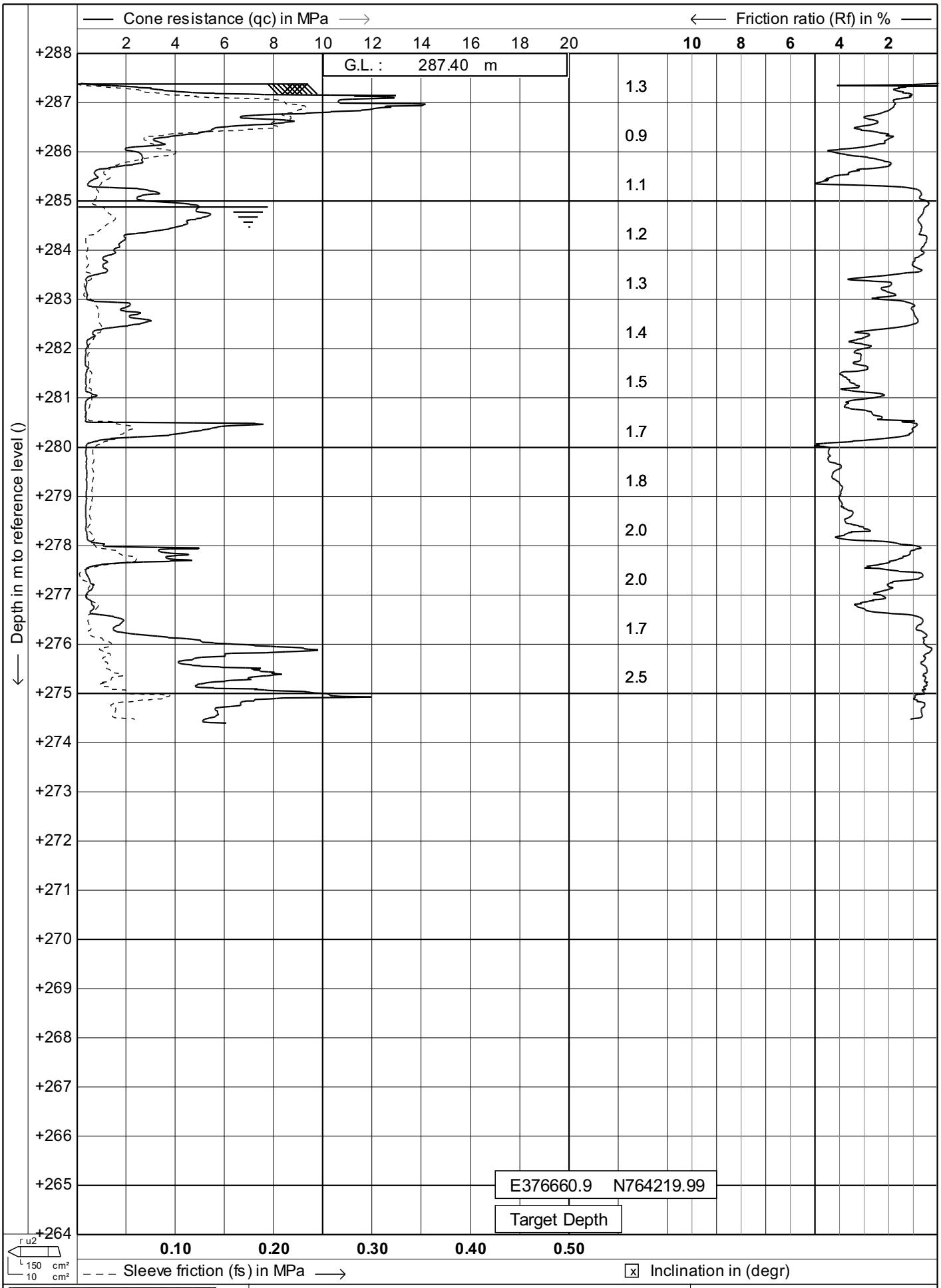
Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date	: **20-6-2008**
Cone no.	: **C10CFIIP.E59**
Project no.	: **02TT8**
CPT no.	: **1-01**

CPTask V1.14a

Document Set ID: 2699211
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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

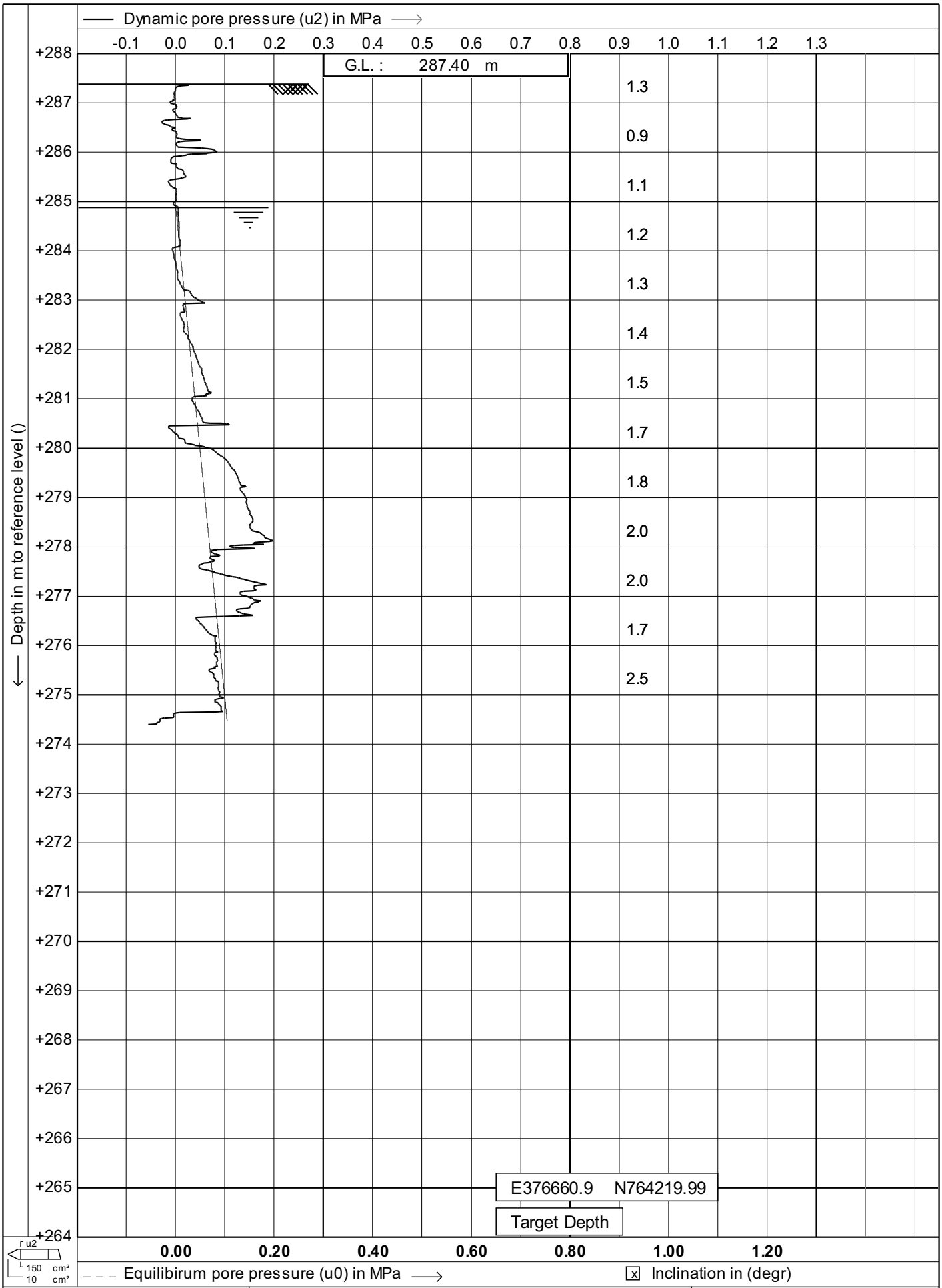
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Project no. : **02TT8**

CPT no. : **1-03** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

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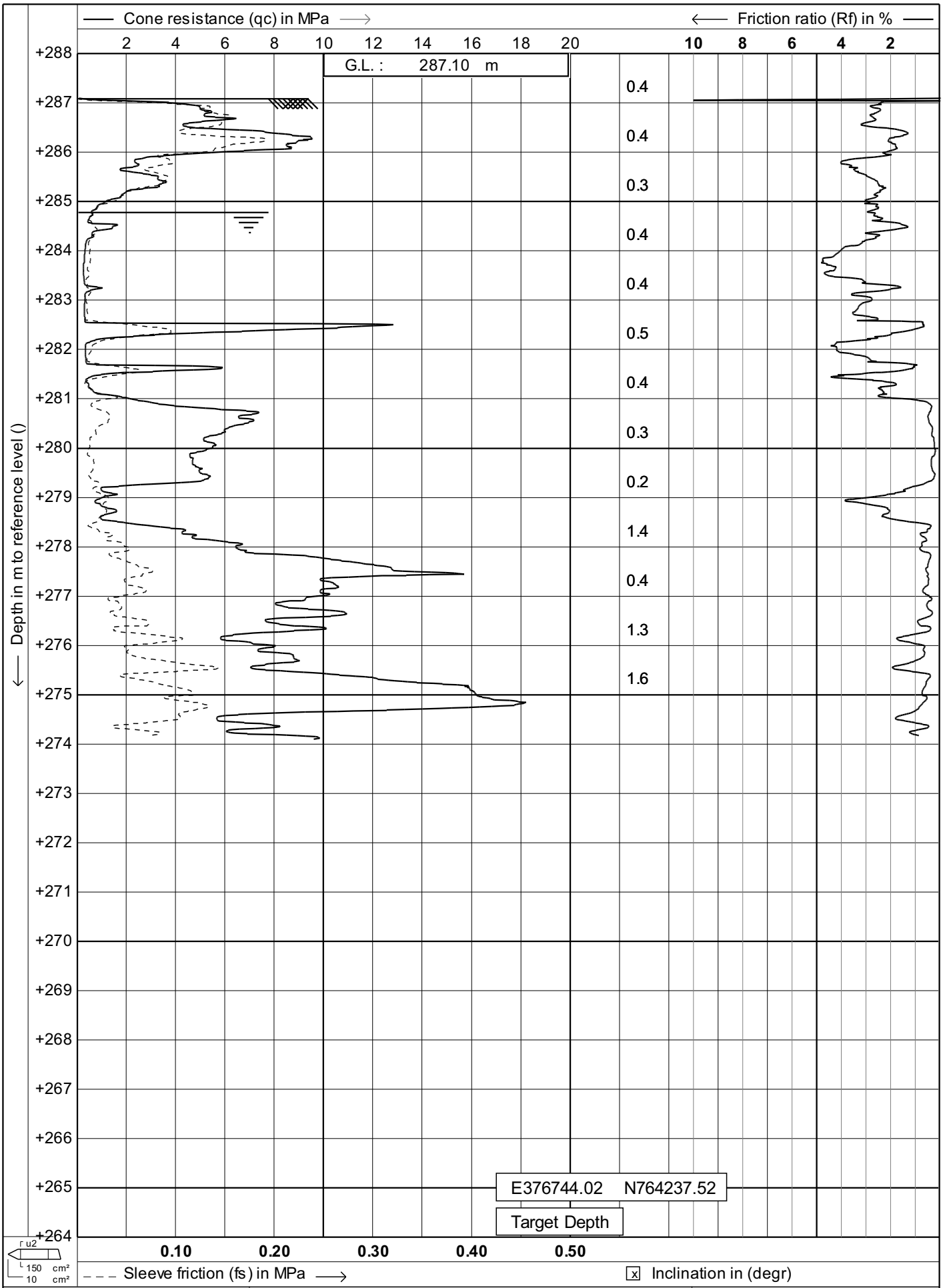
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CPT no. : **1-03**

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CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

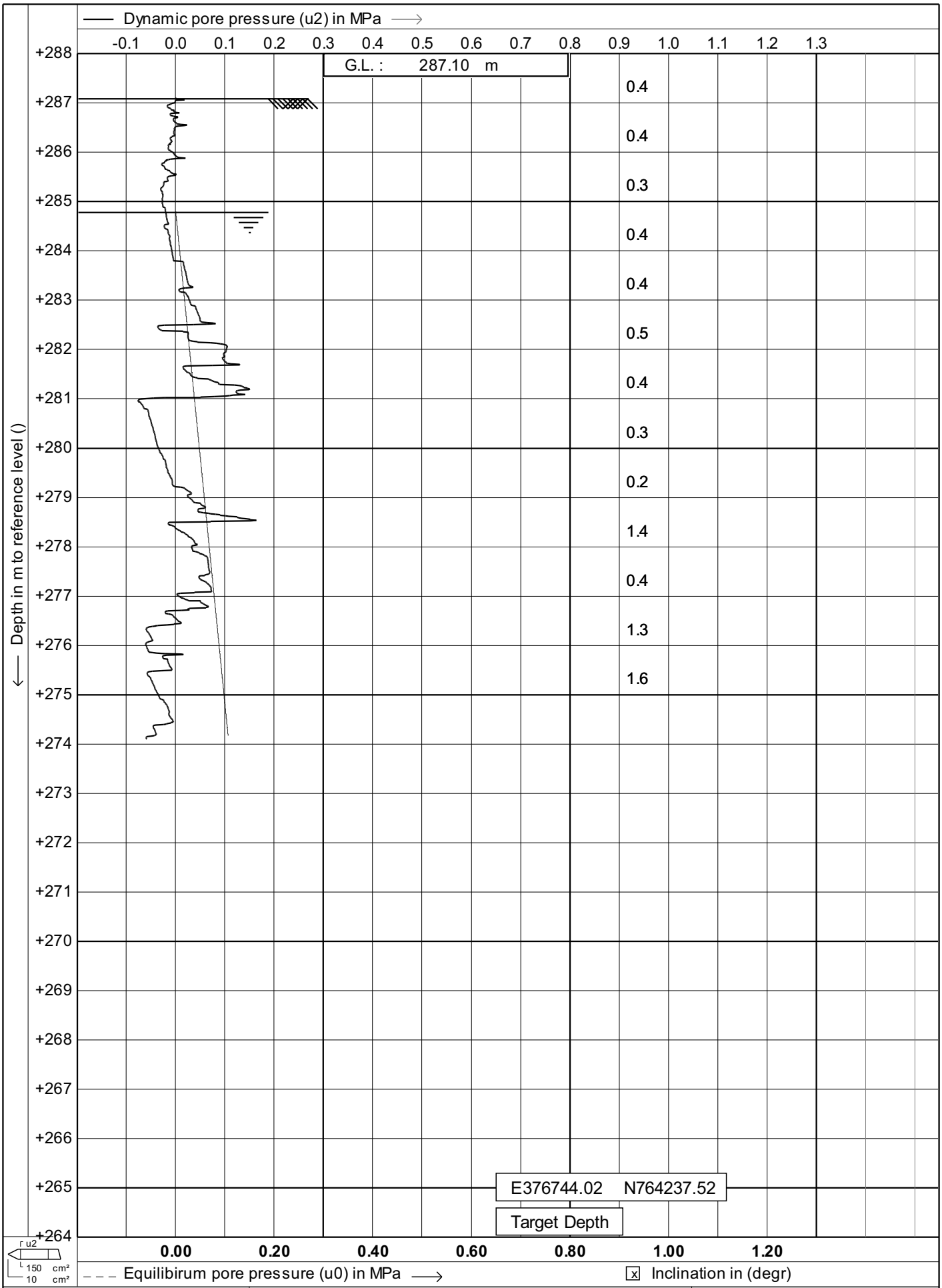
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Project no. : **02TT8**

CPT no. : **1-07** 1/14

CPTask V1.14a

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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

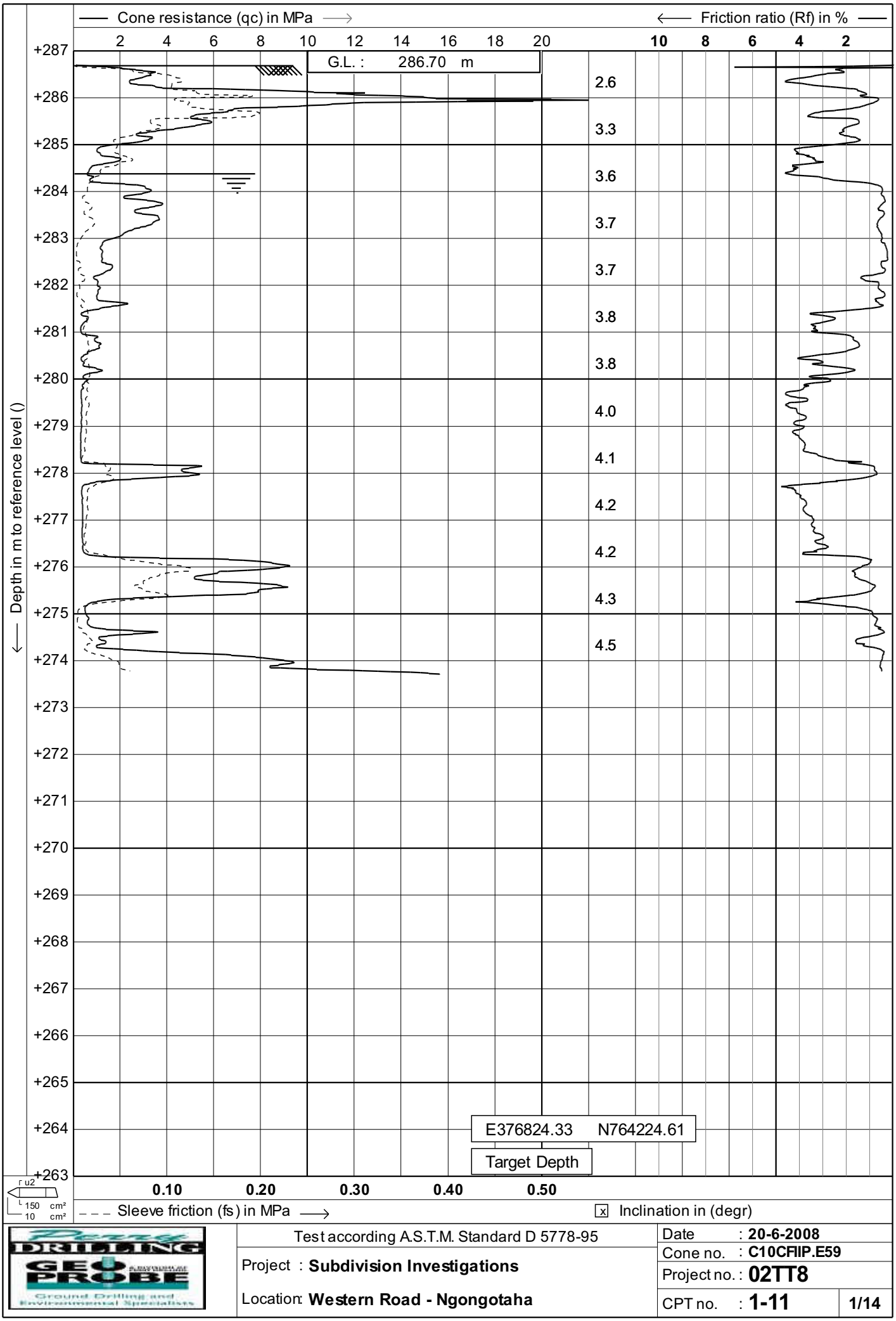
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Project no. : **02TT8**

CPT no. : **1-07** **2/14**

CPTask V1.14a

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Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

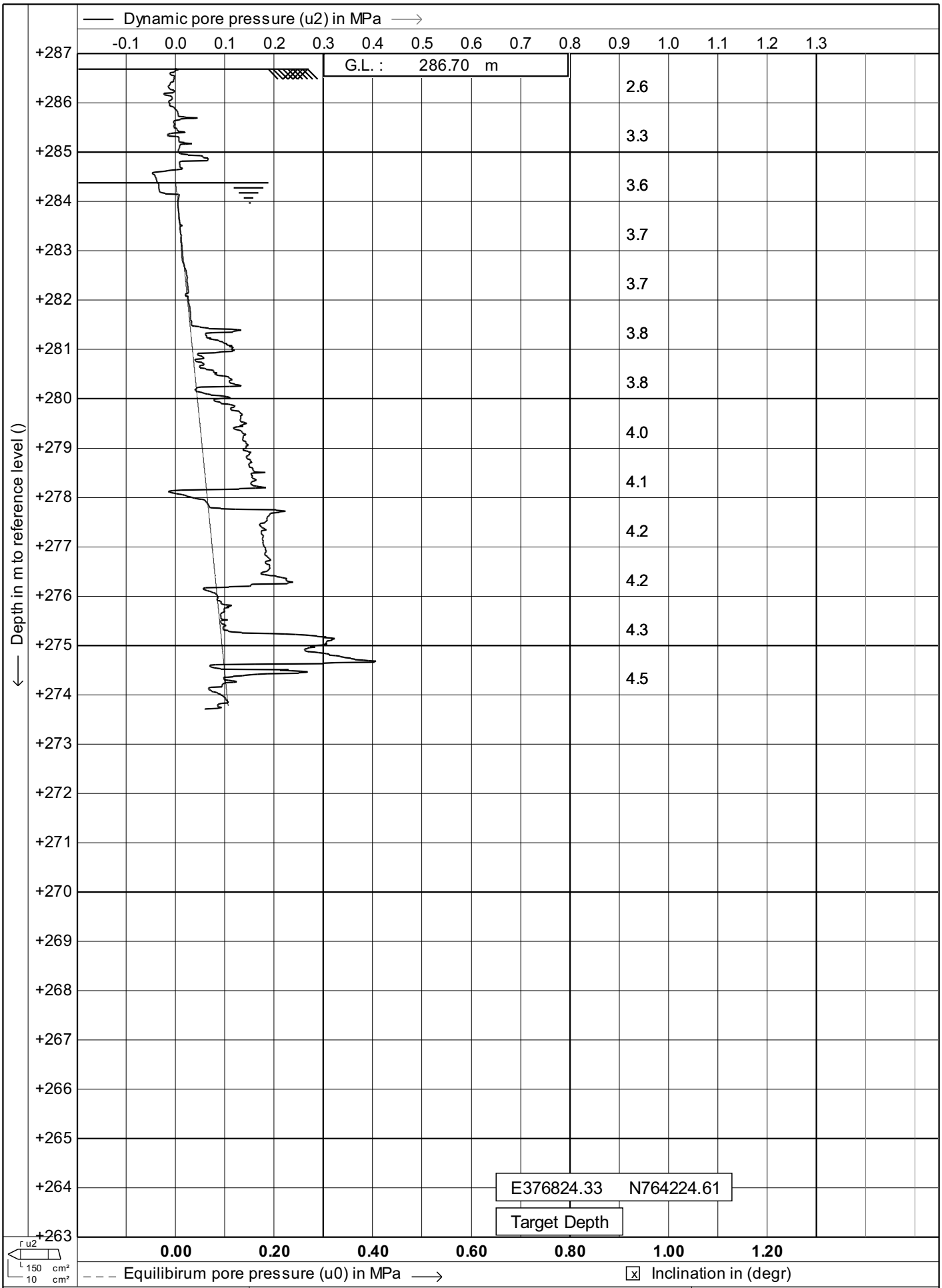
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Project no. : **02TT8**

CPT no. : **1-11** 1/14

CPTask V1.14a

Document Set ID: 2699211
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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

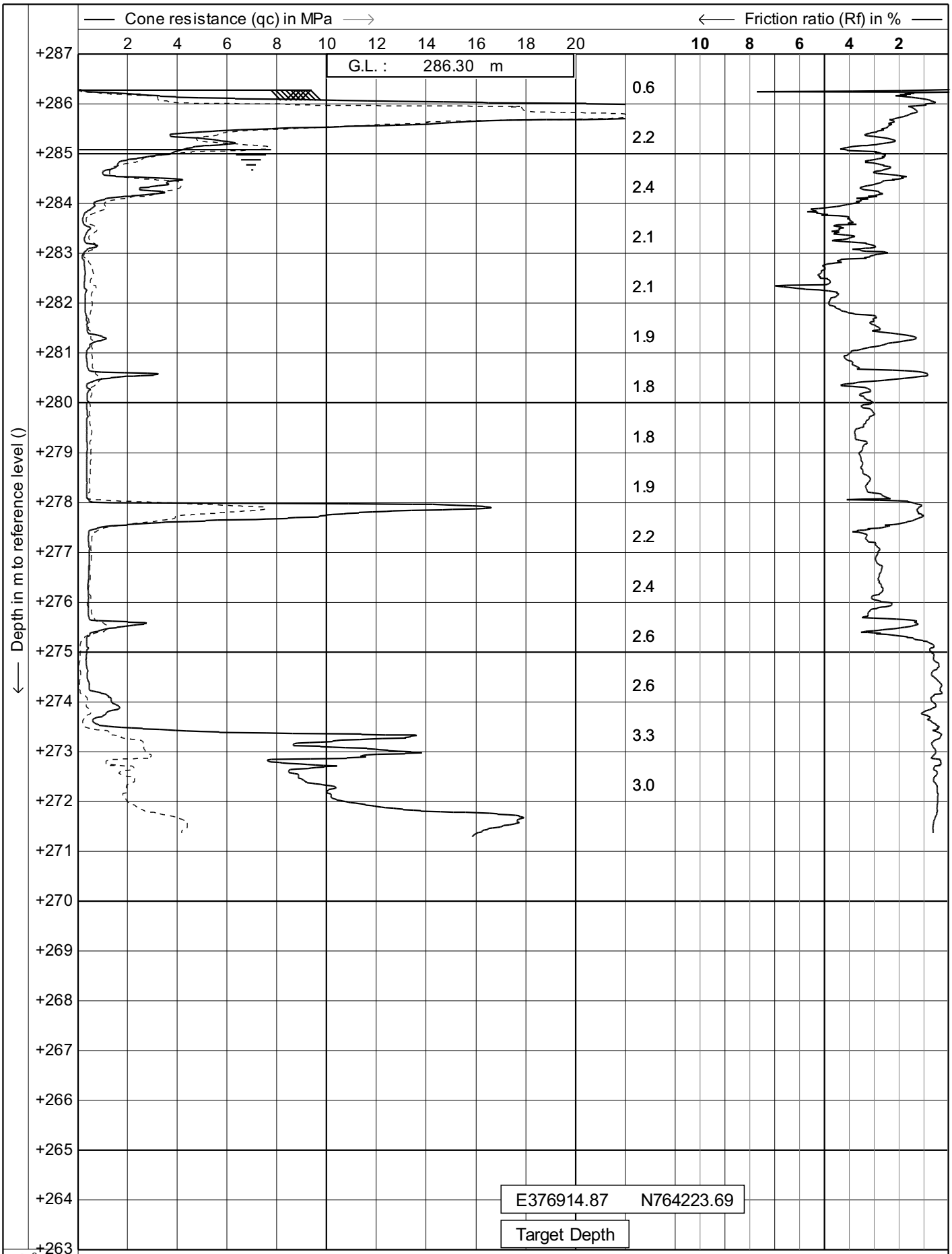
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Project no. : **02TT8**

CPT no. : **1-11** **2/14**

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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

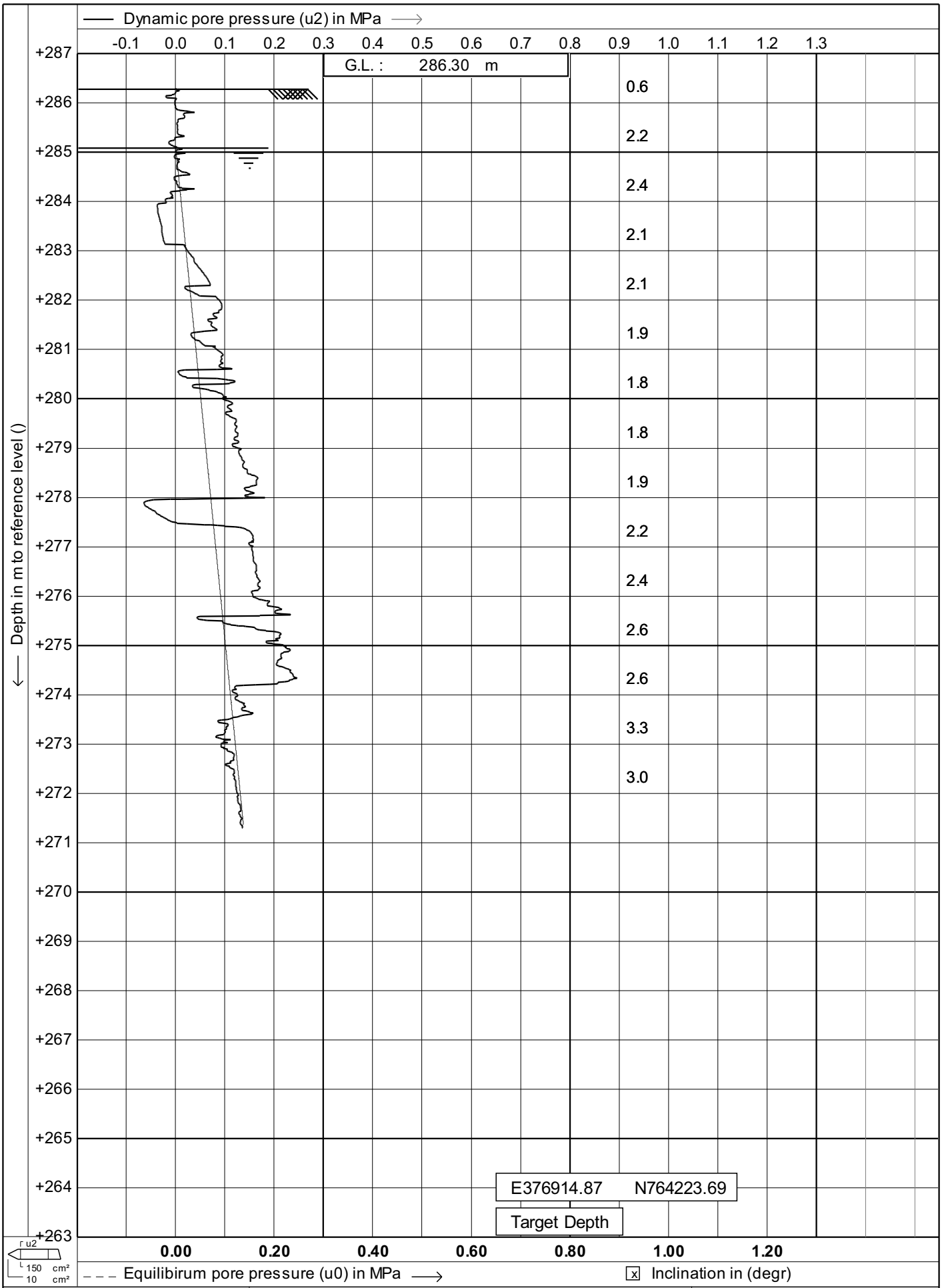
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Project no.	: **02TT8**
CPT no.	: **1-17**

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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

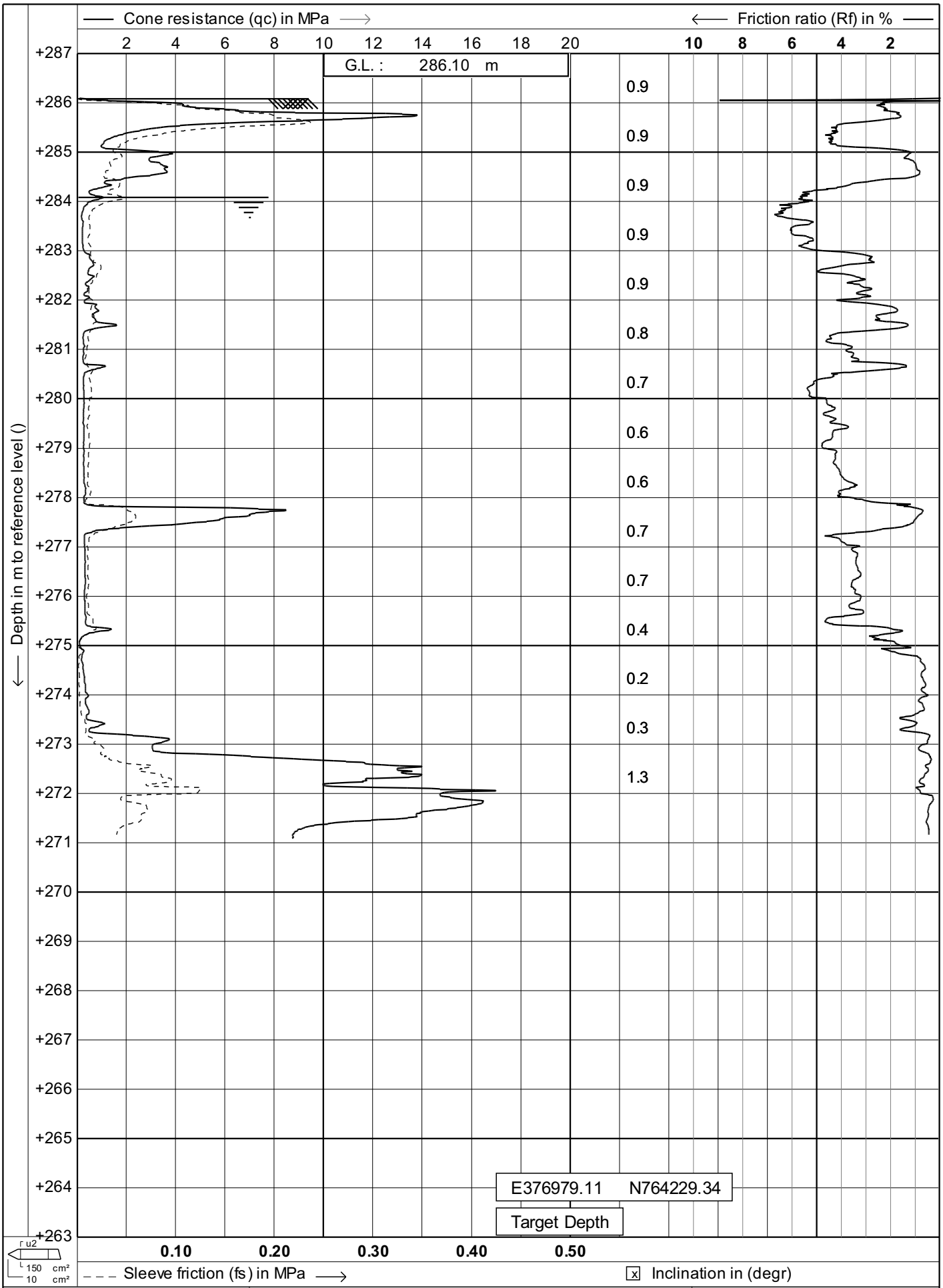
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Project no. : **02TT8**

CPT no. : **1-17** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



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Project : **Subdivision Investigations**

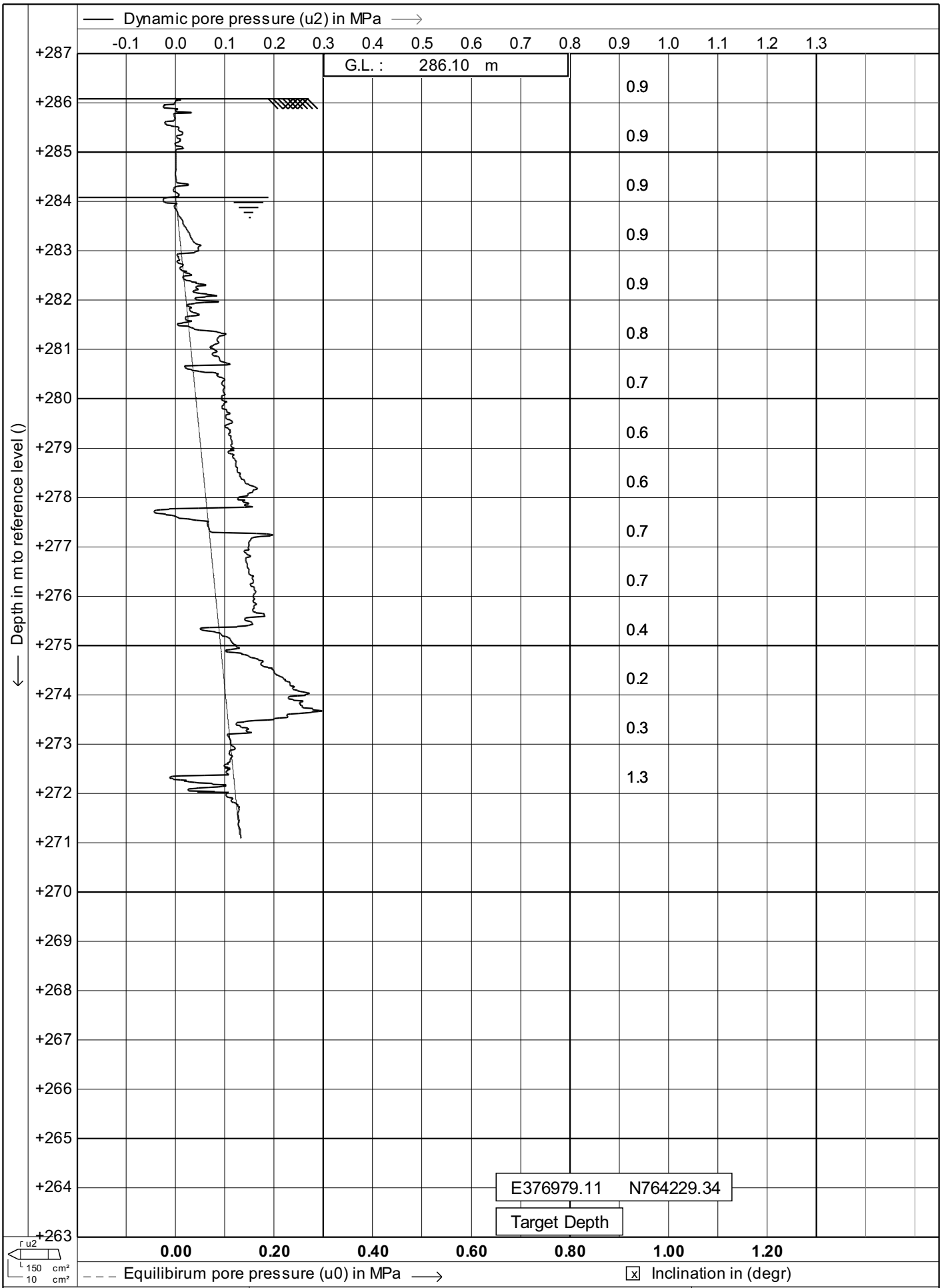
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Project no.	: **02TT8**
CPT no.	: **1-20**

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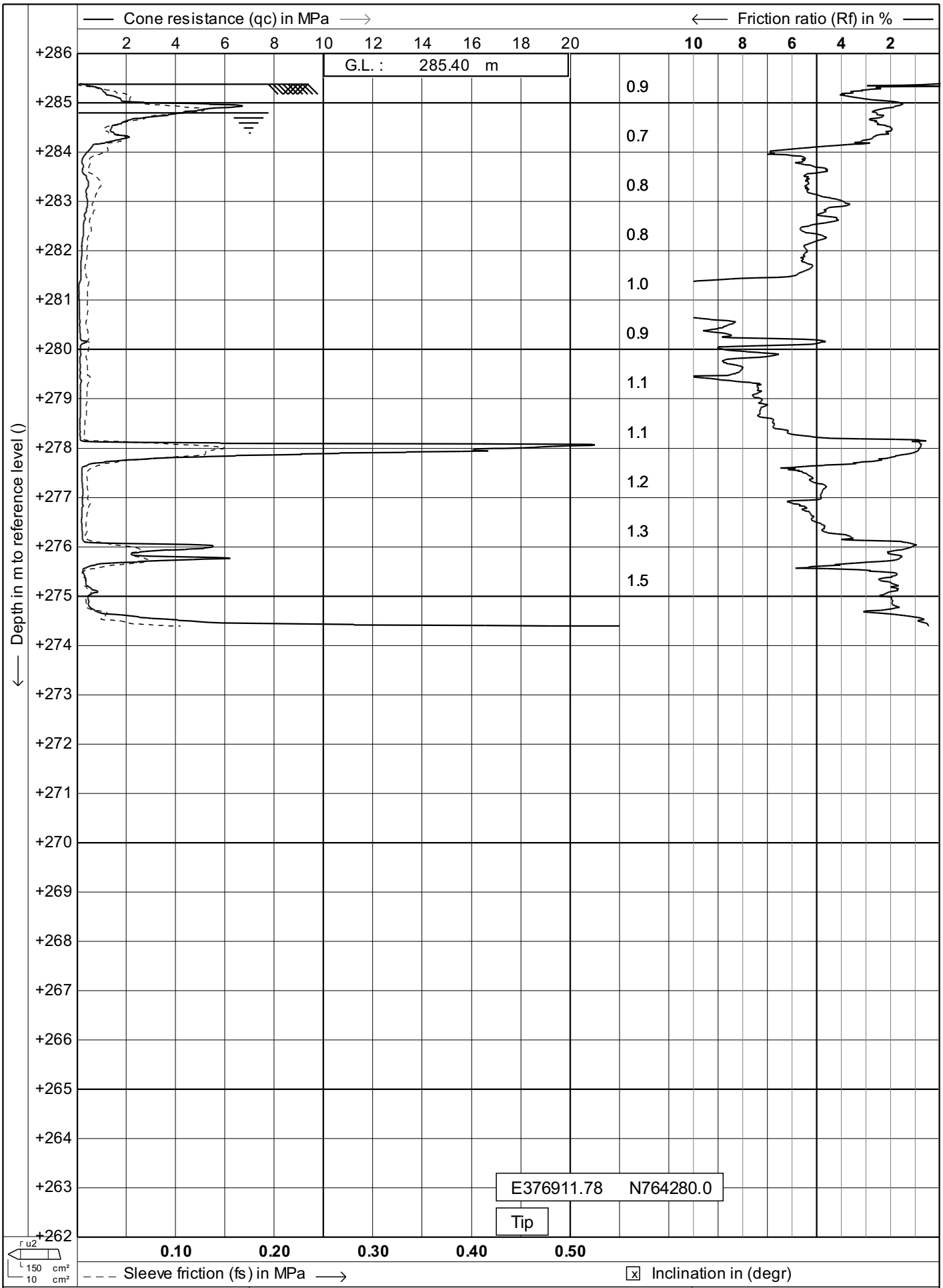
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CPT no.	: **1-20**

CPTask V1.14a

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Project : **Subdivision Investigations**

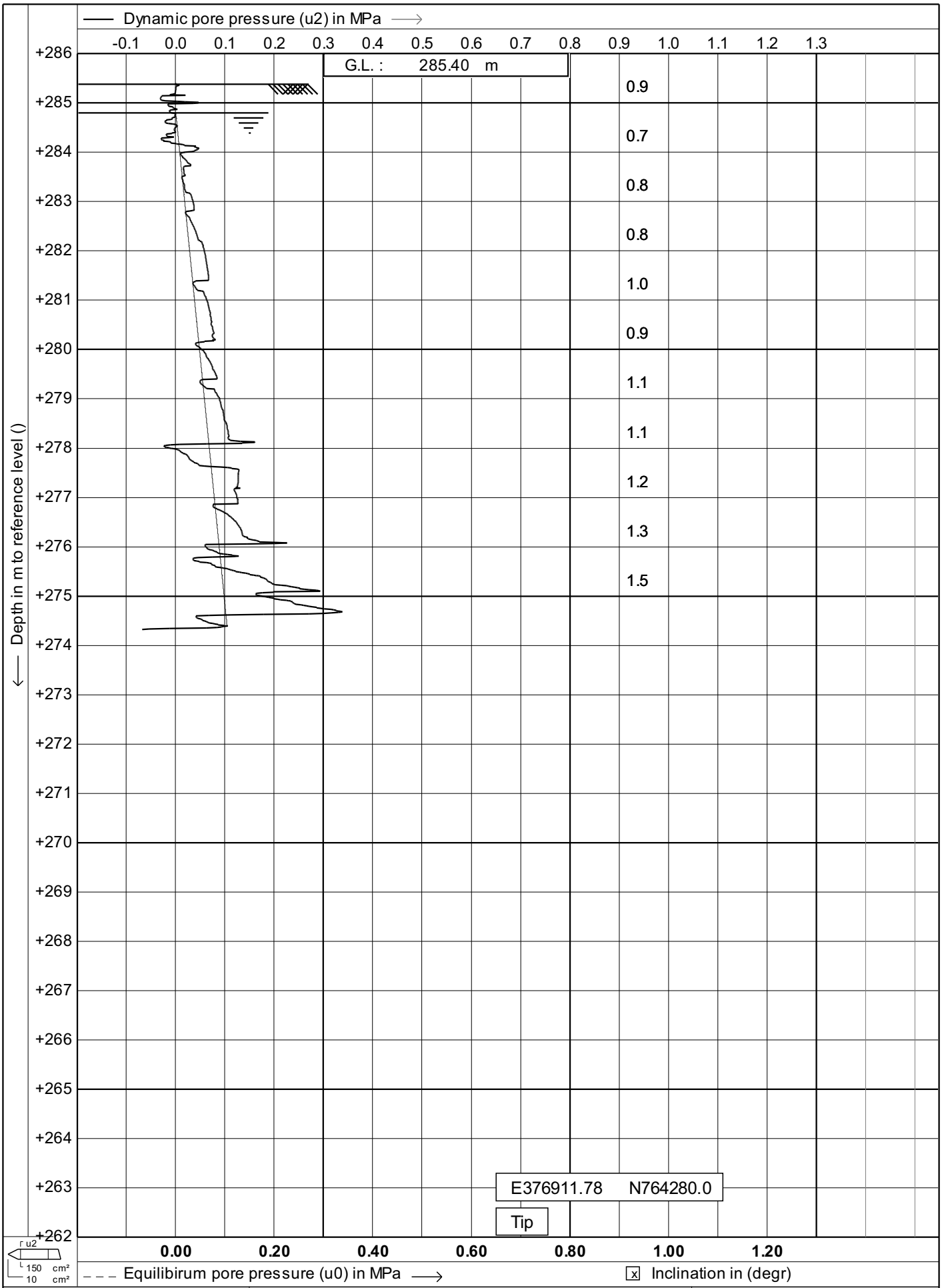
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Date	: **19-6-2008**
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Project no.	: **02TT8**
CPT no.	: **2-16**

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Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

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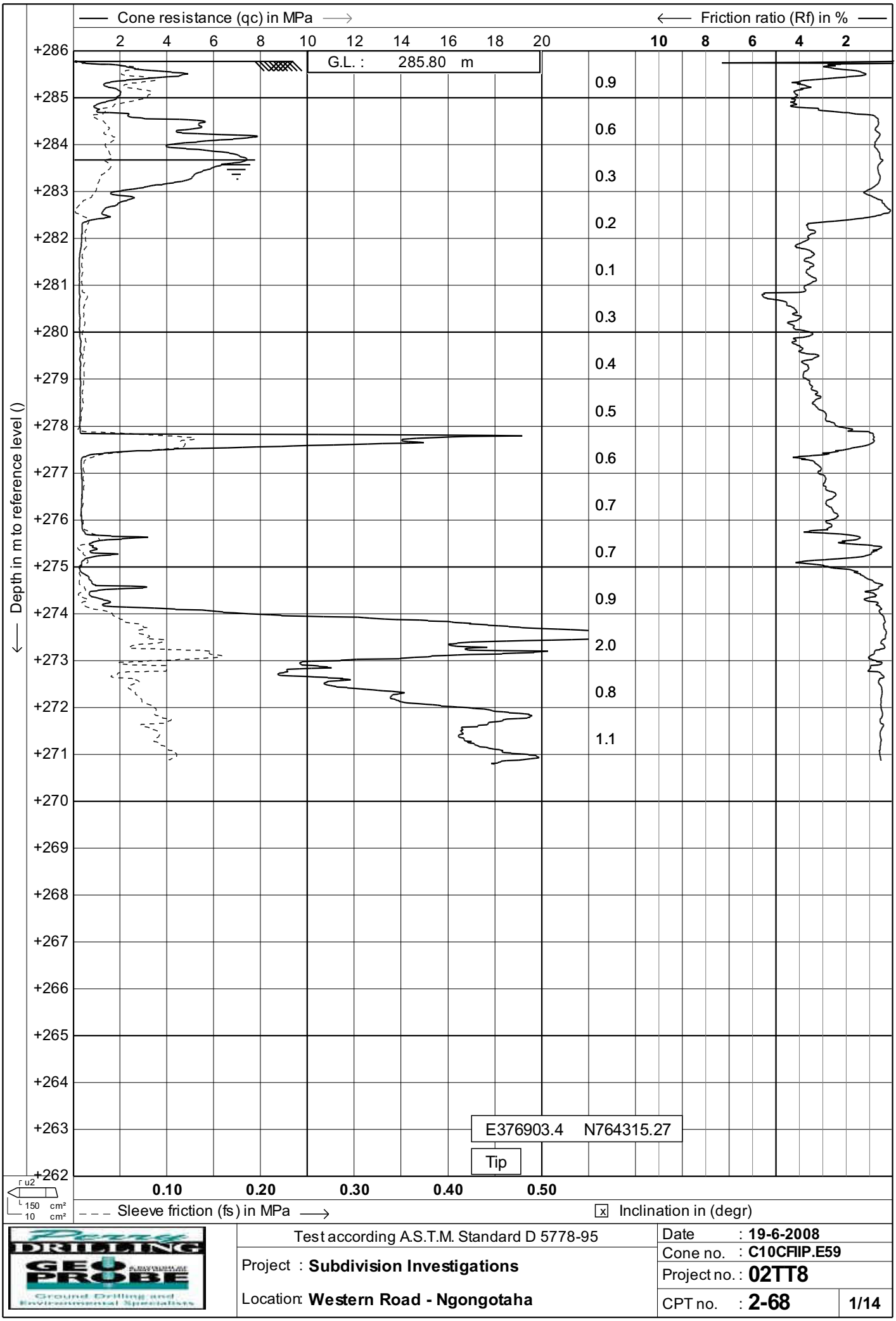
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CPT no. : **2-16**

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CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



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Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

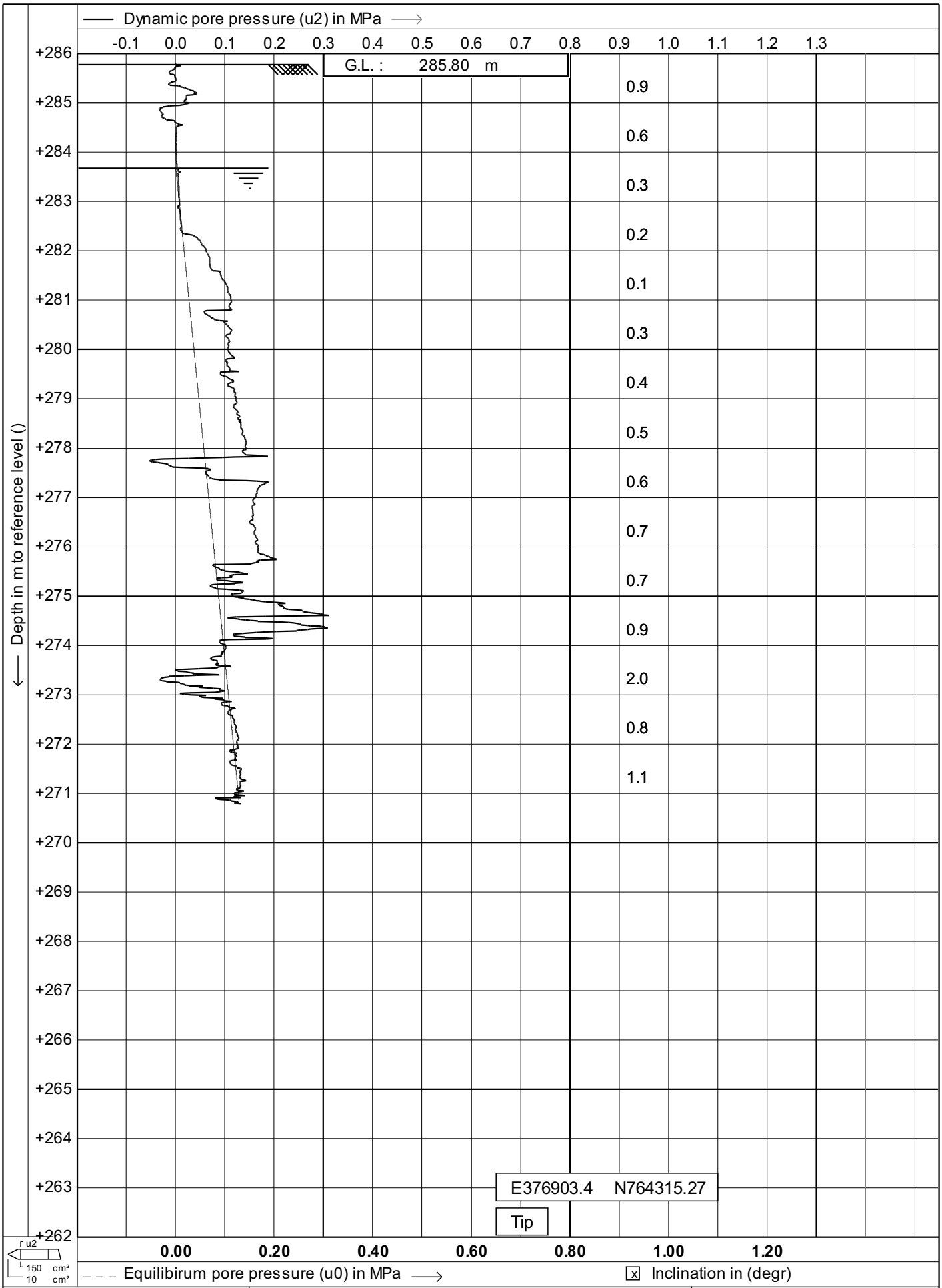
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CPT no. : **2-68** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

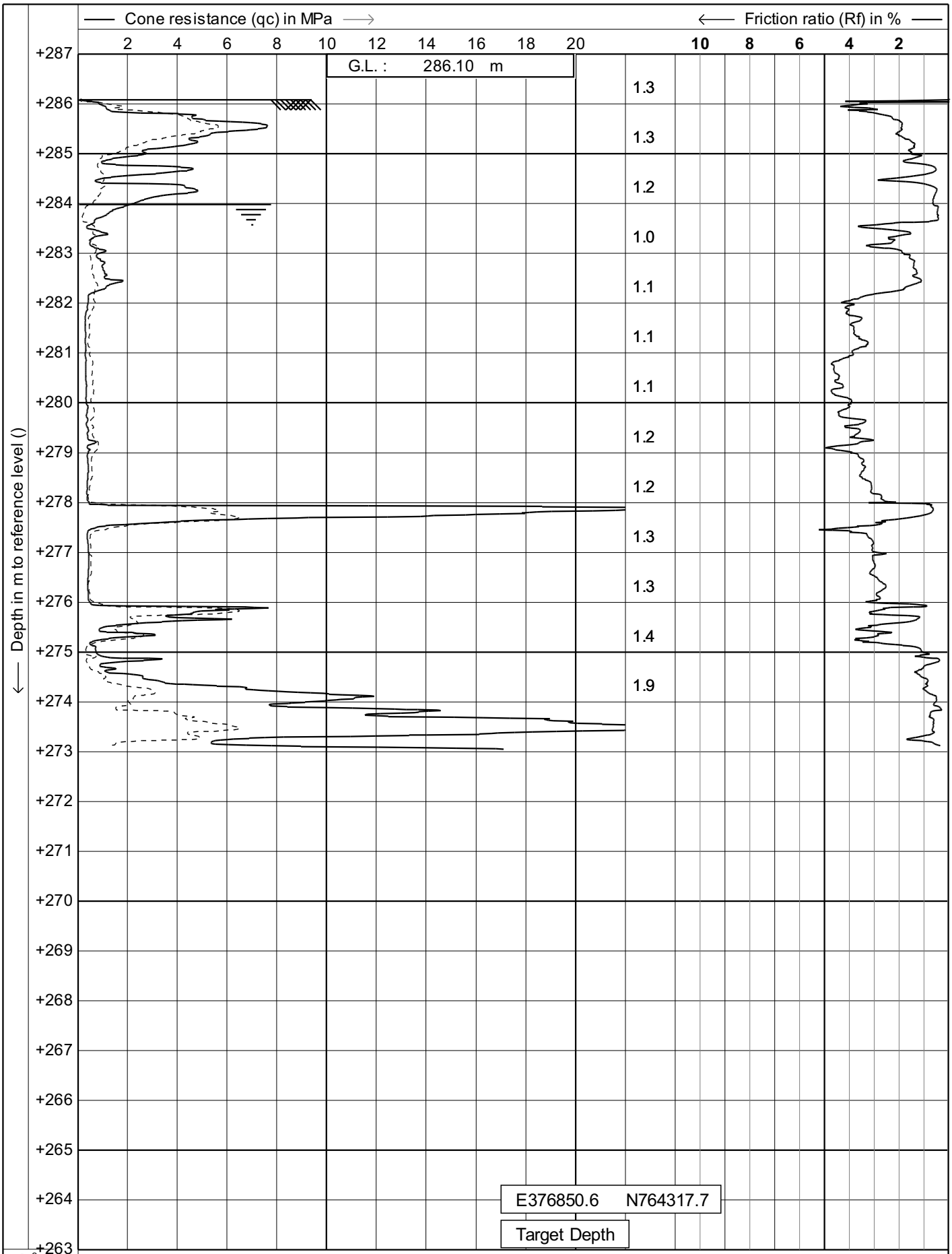
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CPT no. : **2-68** **2/14**

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Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

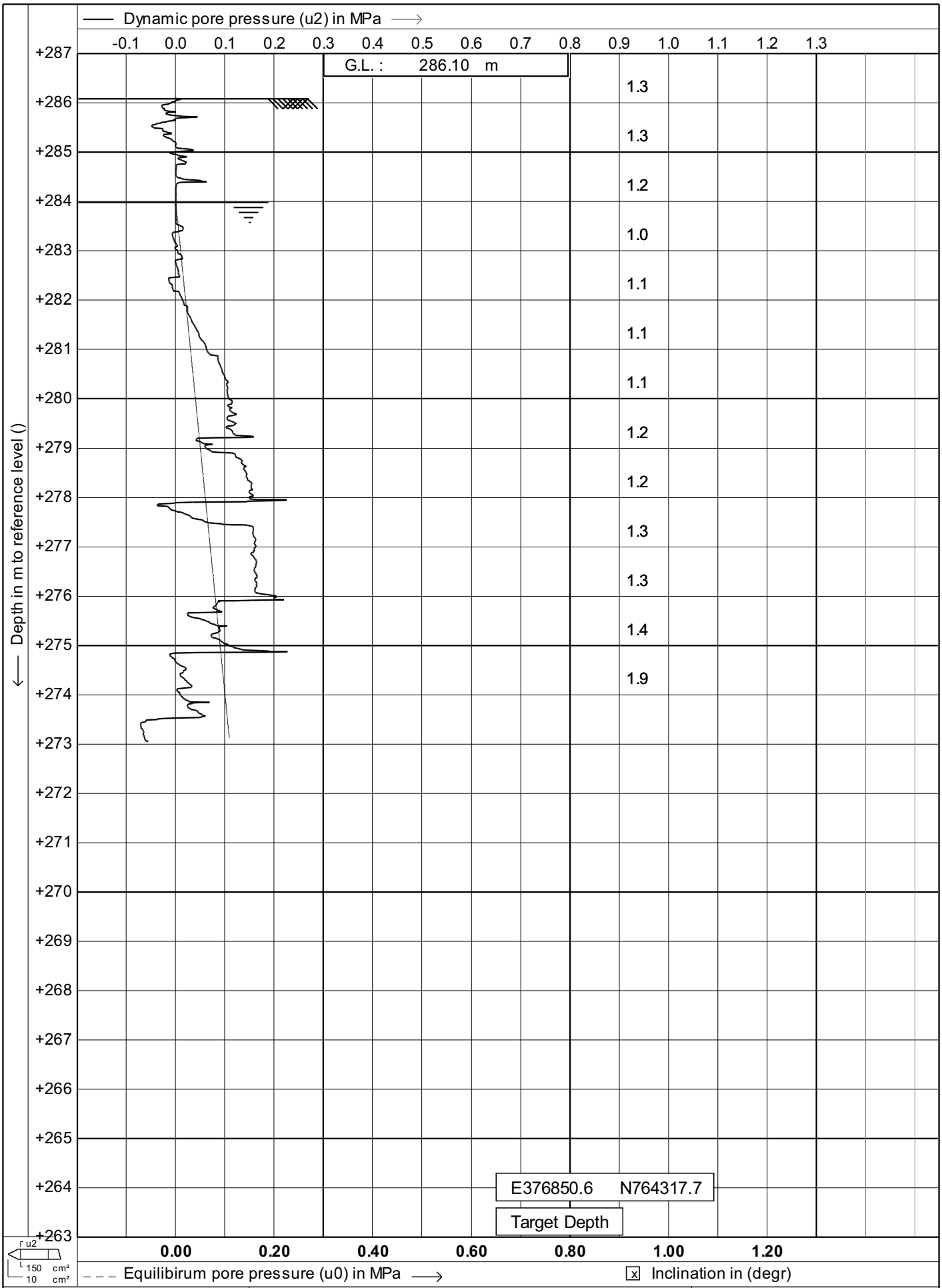
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CPT no. : **2-71** 1/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

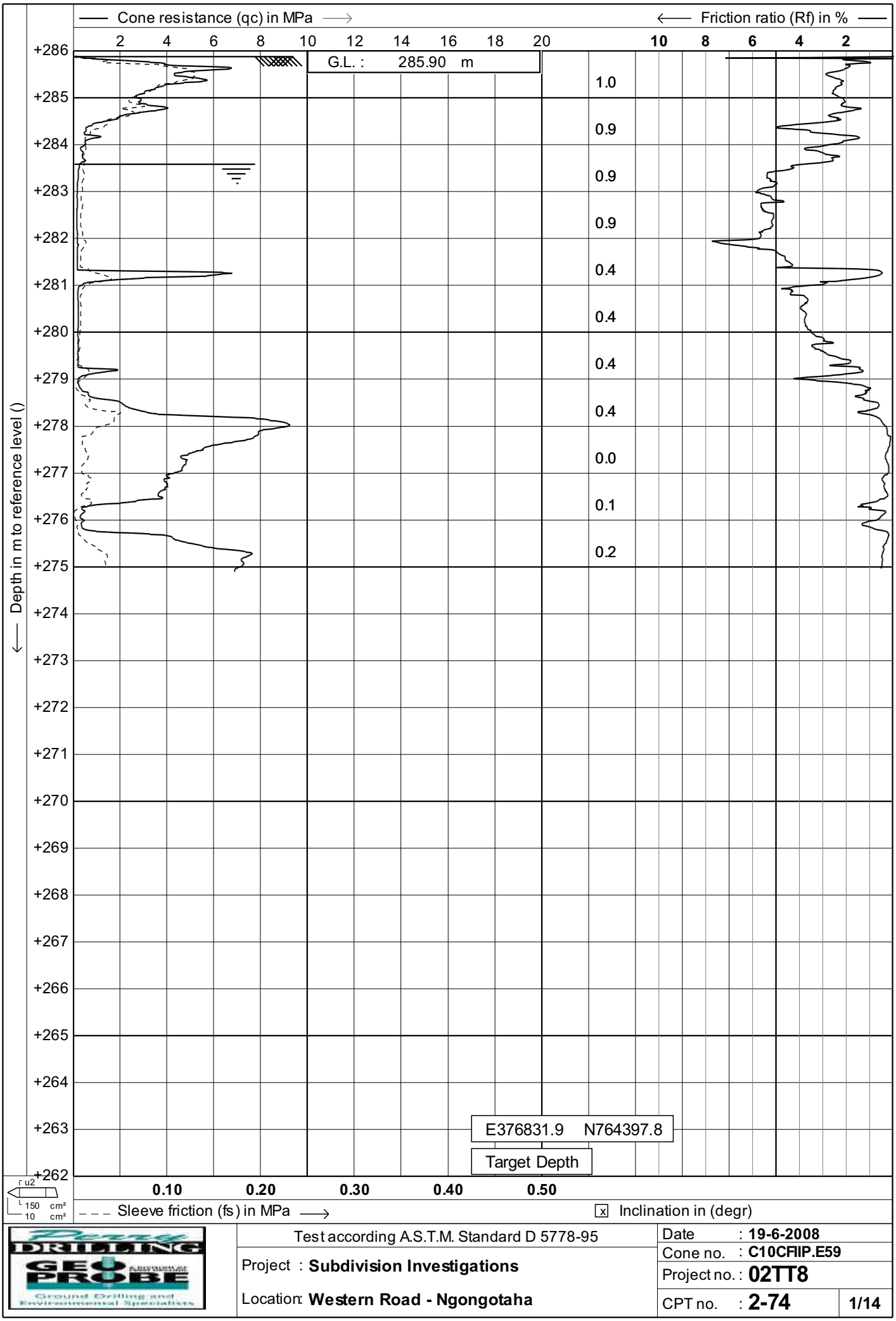
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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

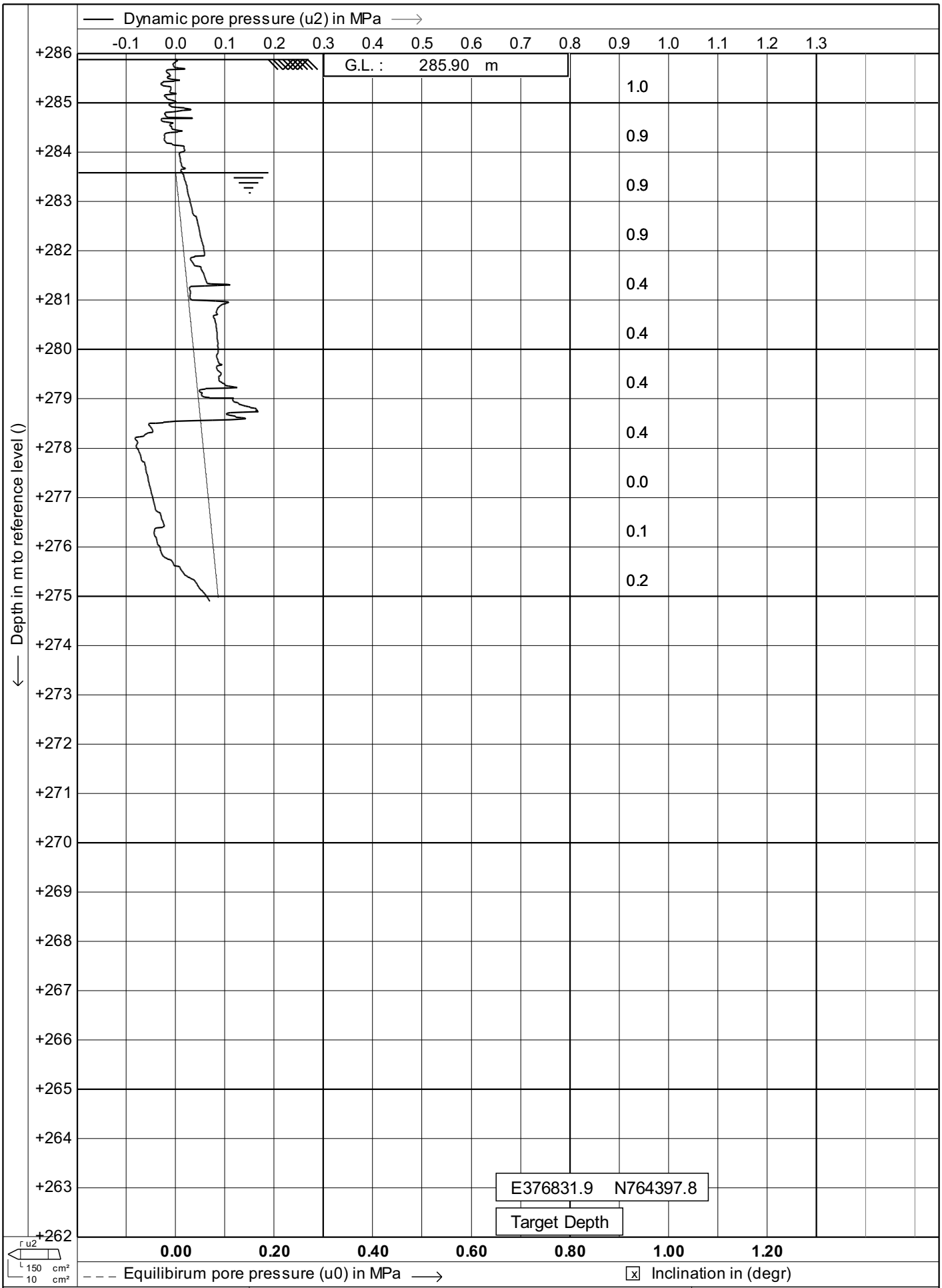
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Project no. : **02TT8**

CPT no. : **2-74** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

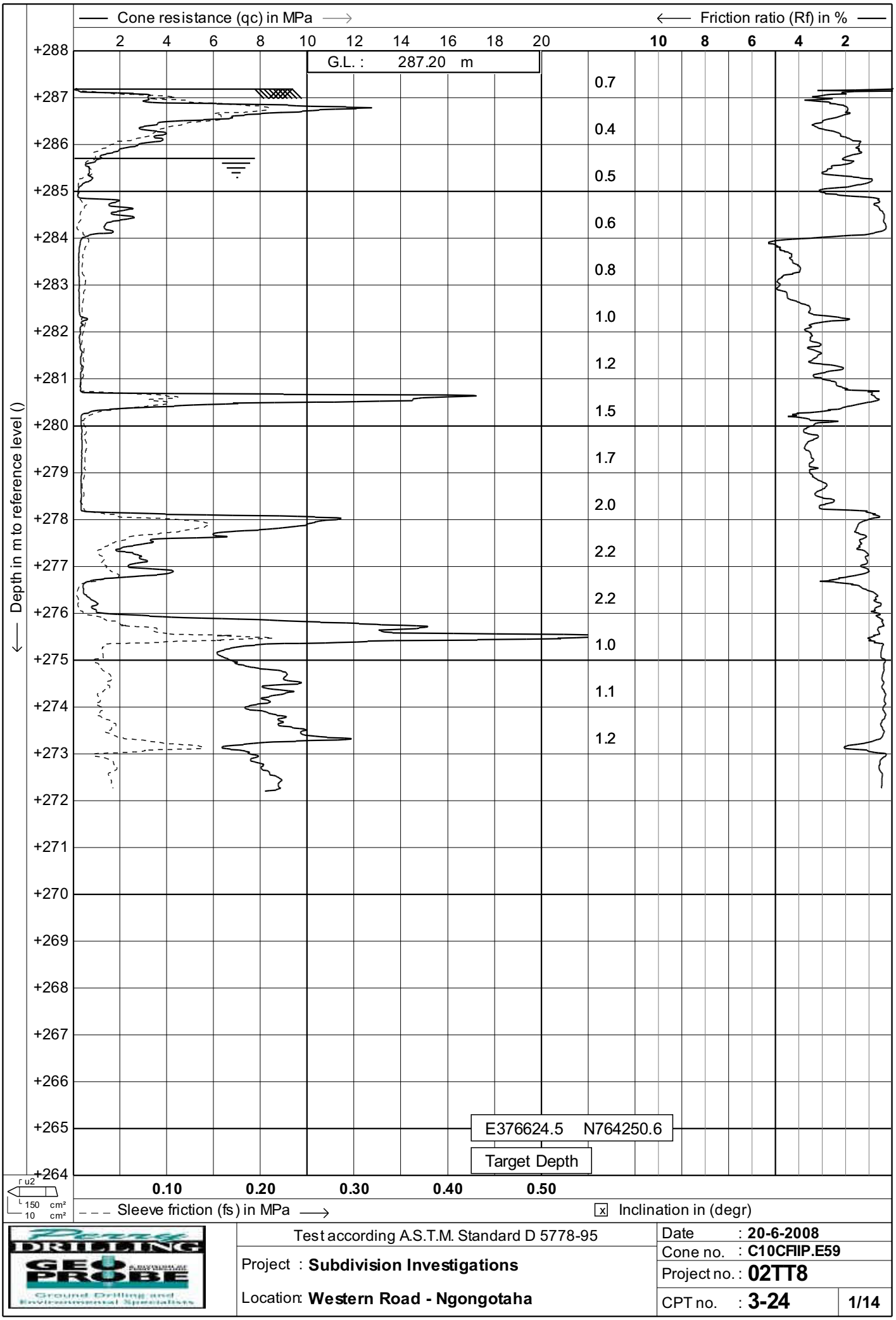
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **2-74** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Penny Drilling GEOPROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-95

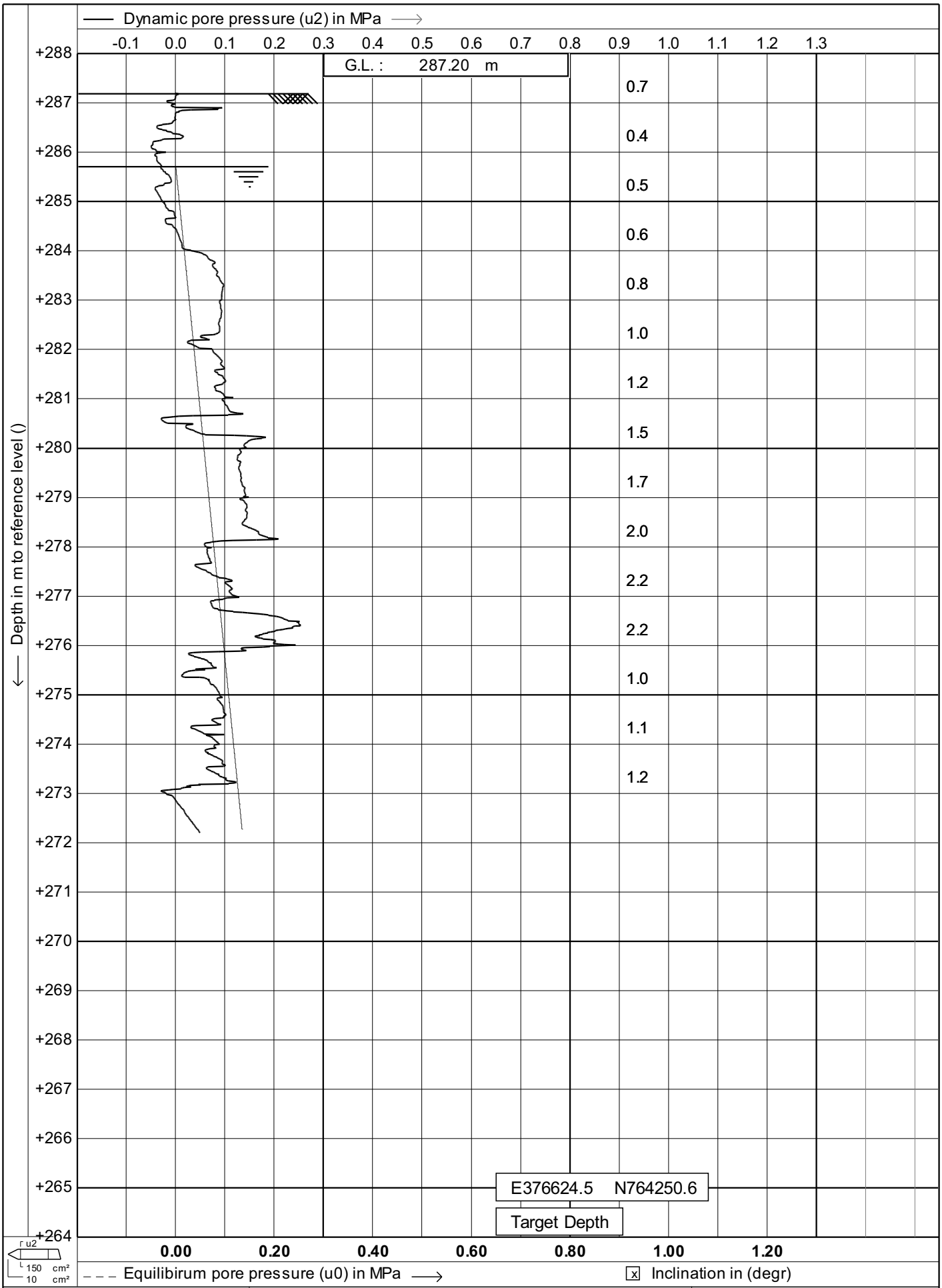
Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date	: **20-6-2008**
Cone no.	: **C10CFIIP.E59**
Project no.	: **02TT8**
CPT no.	: **3-24**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Penny DRILLING GEO PROBE Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-95

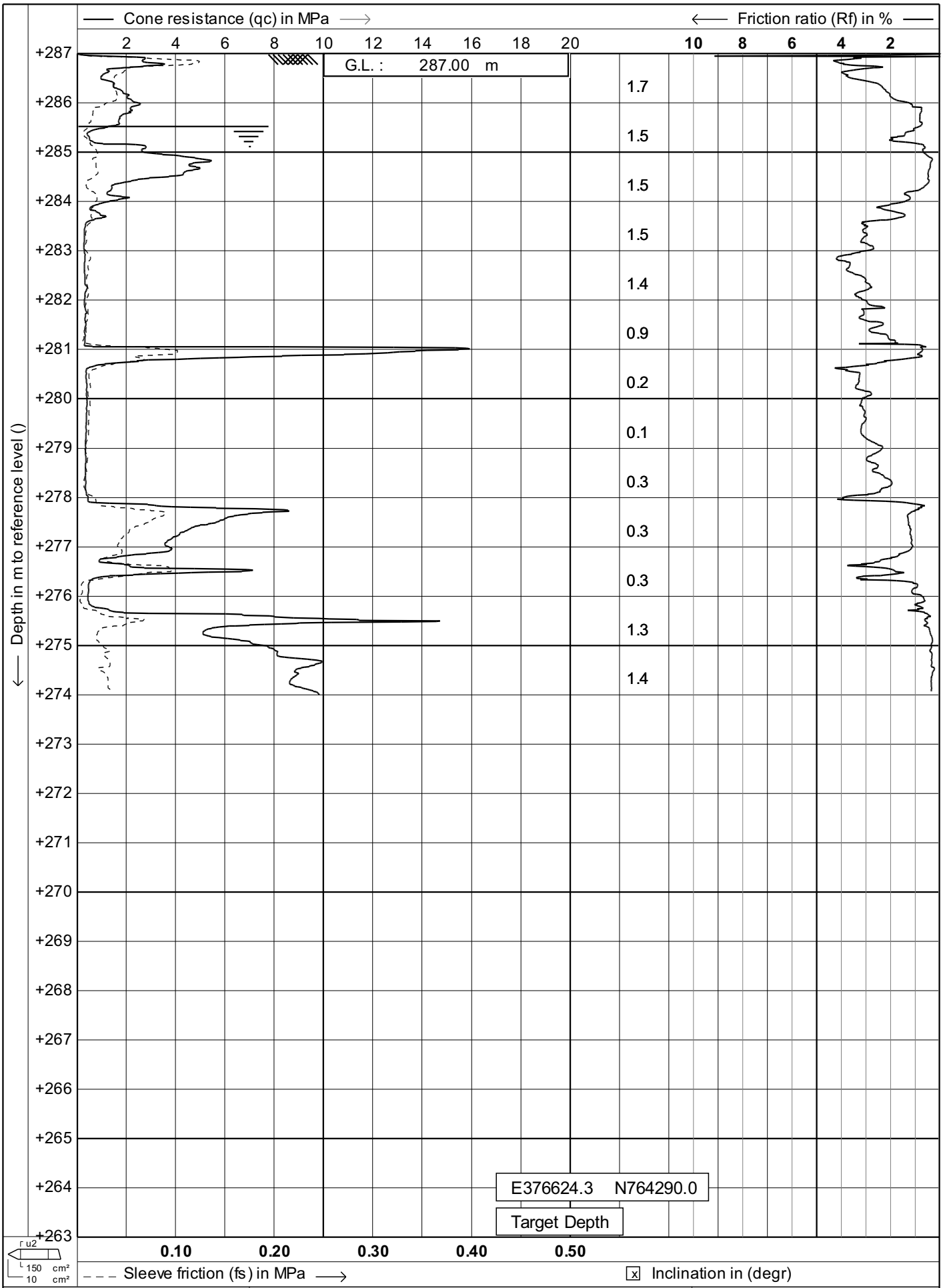
Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date	: **20-6-2008**
Cone no.	: **C10CFIIP.E59**
Project no.	: **02TT8**
CPT no.	: **3-24**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

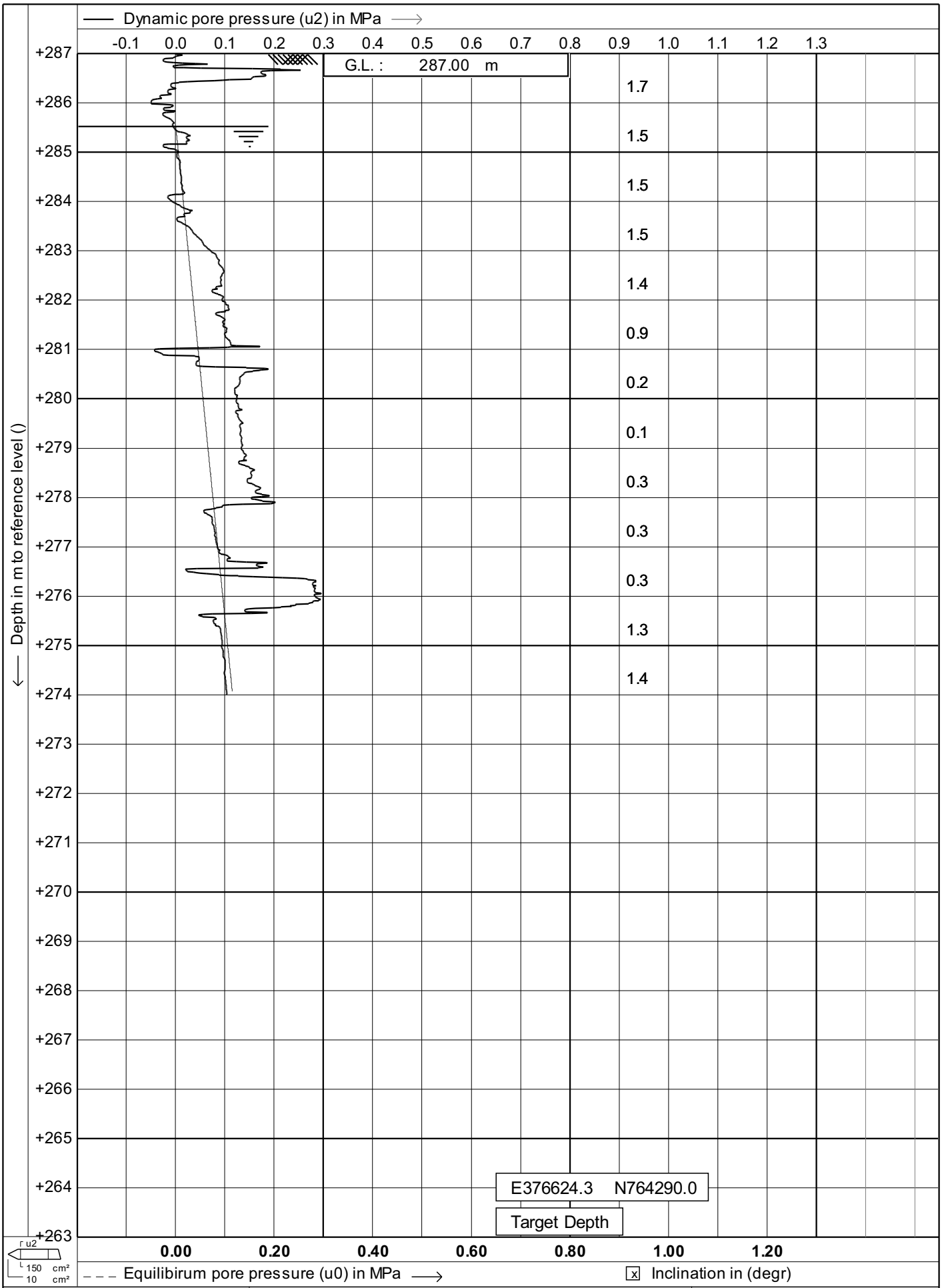
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-26** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

Cone no. : **C10CFIIP.E59**

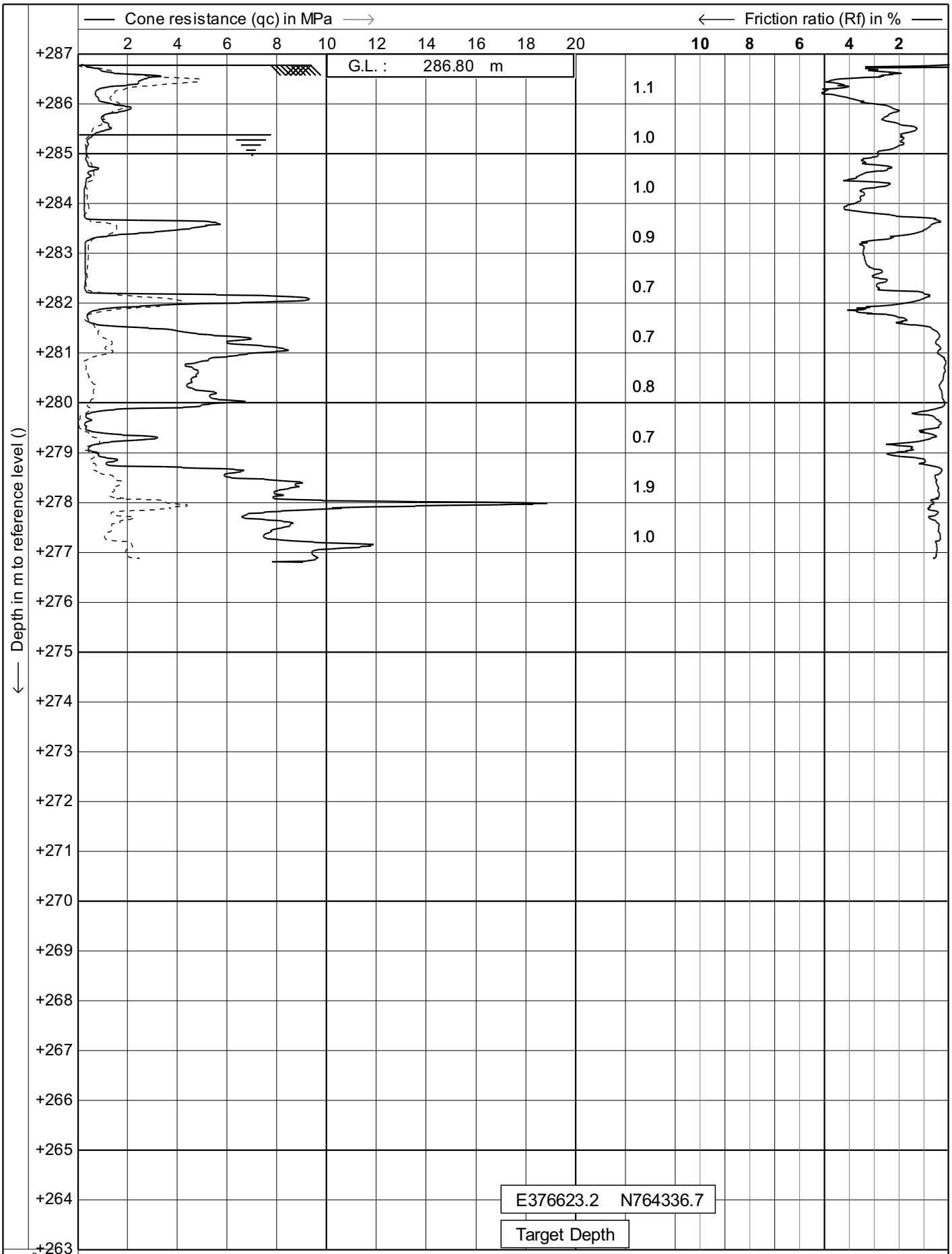
Project no. : **02TT8**

CPT no. : **3-26**

2/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

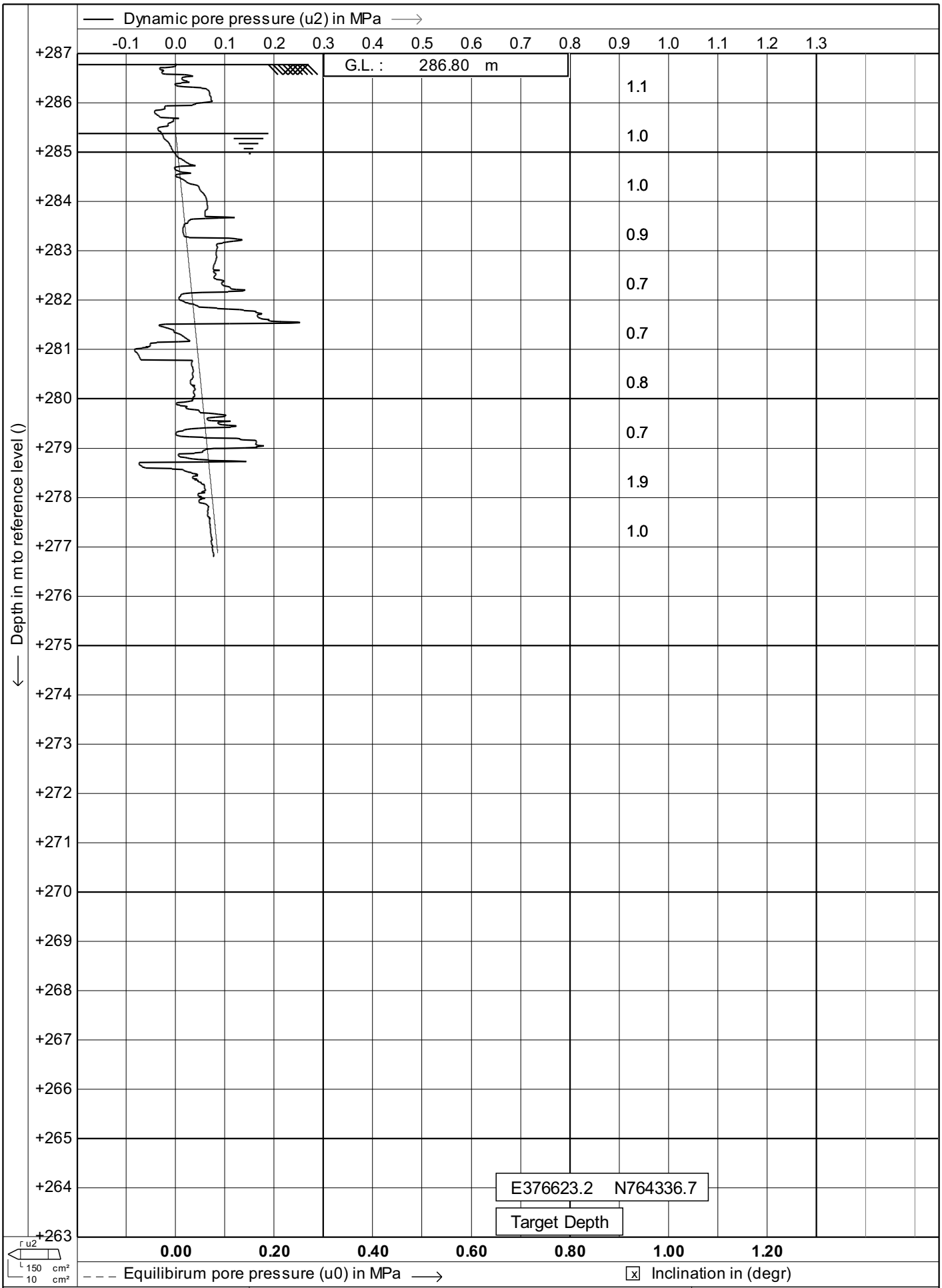
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-28** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

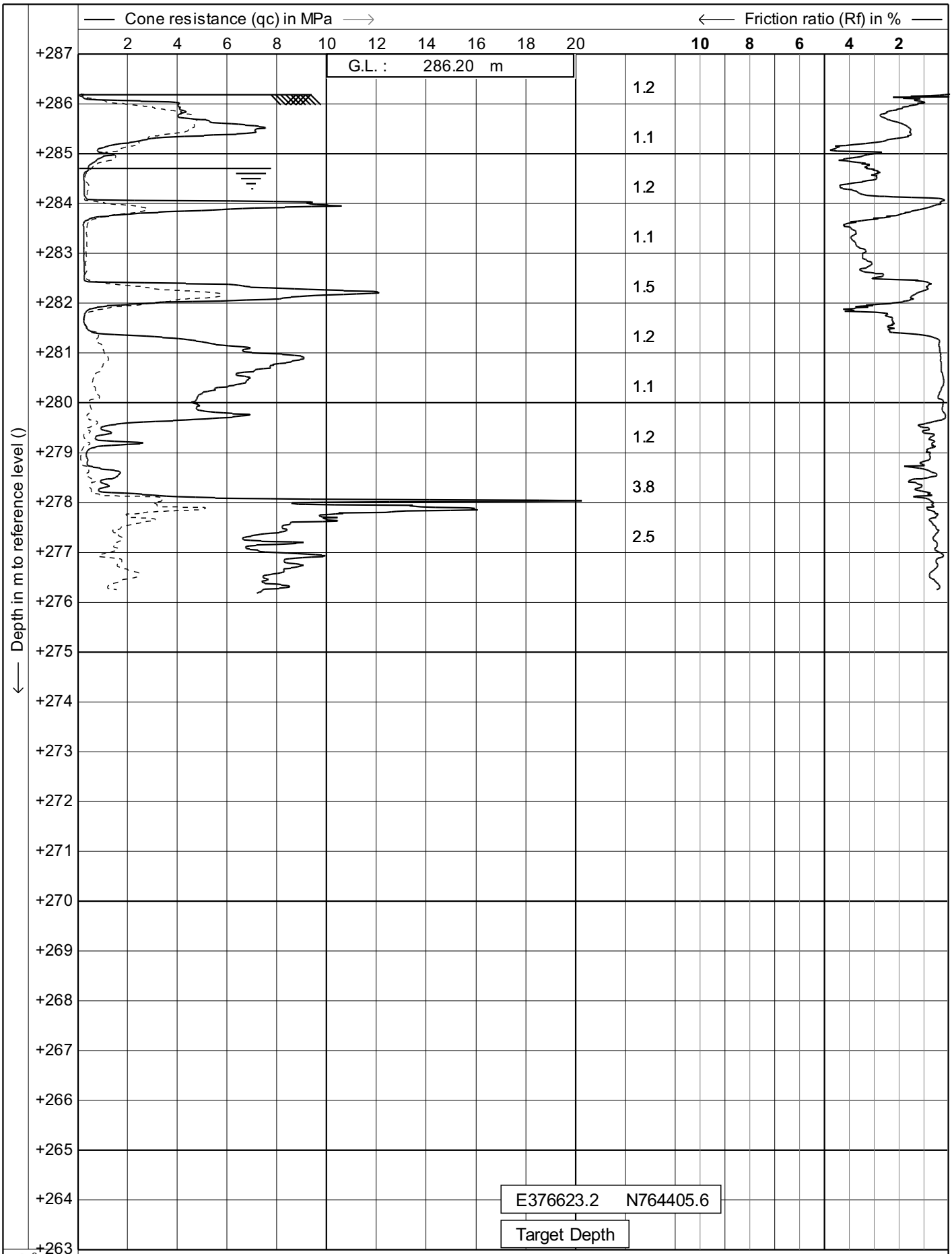
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Project no. : **02TT8**

CPT no. : **3-28** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

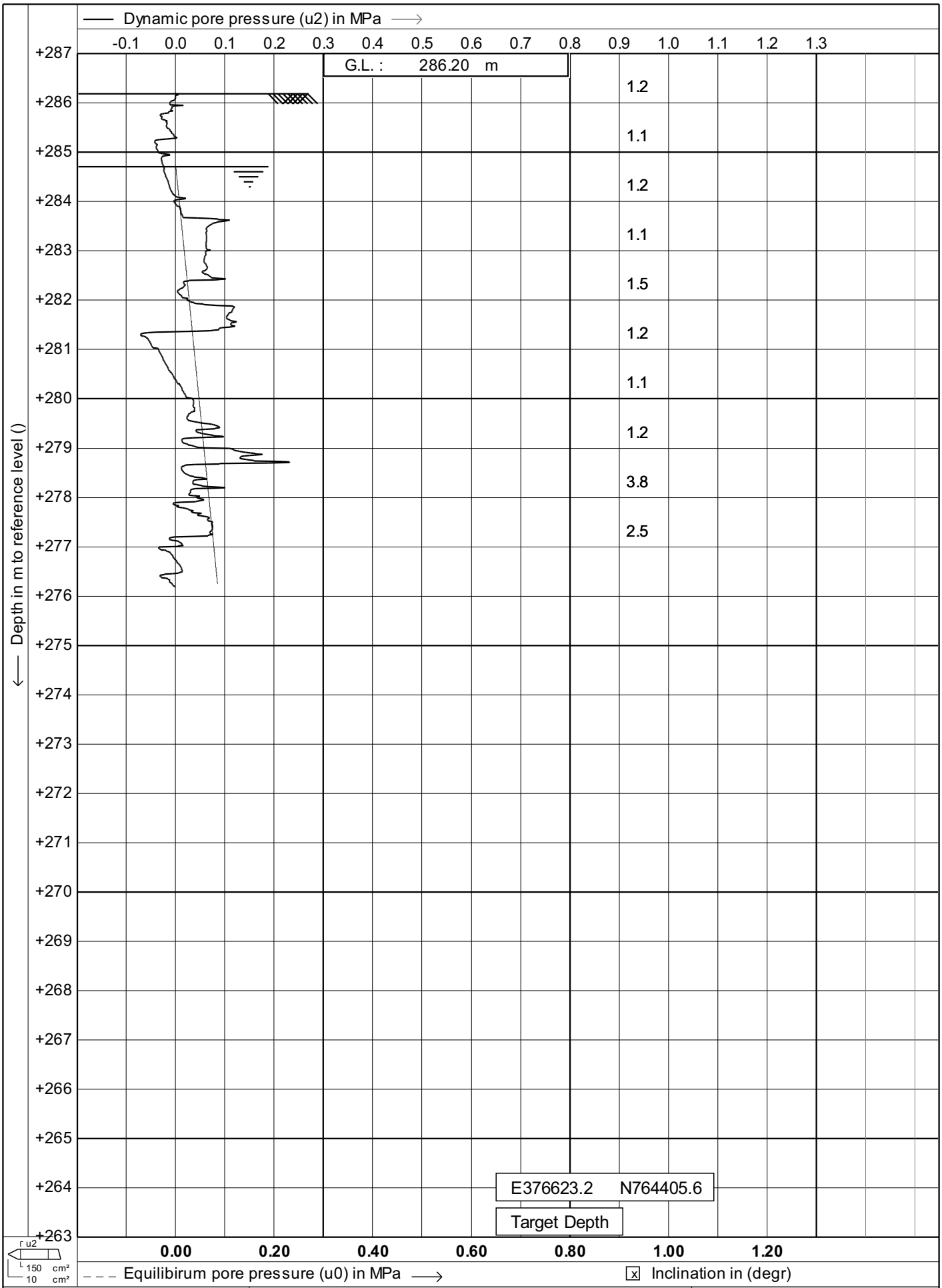
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-31** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

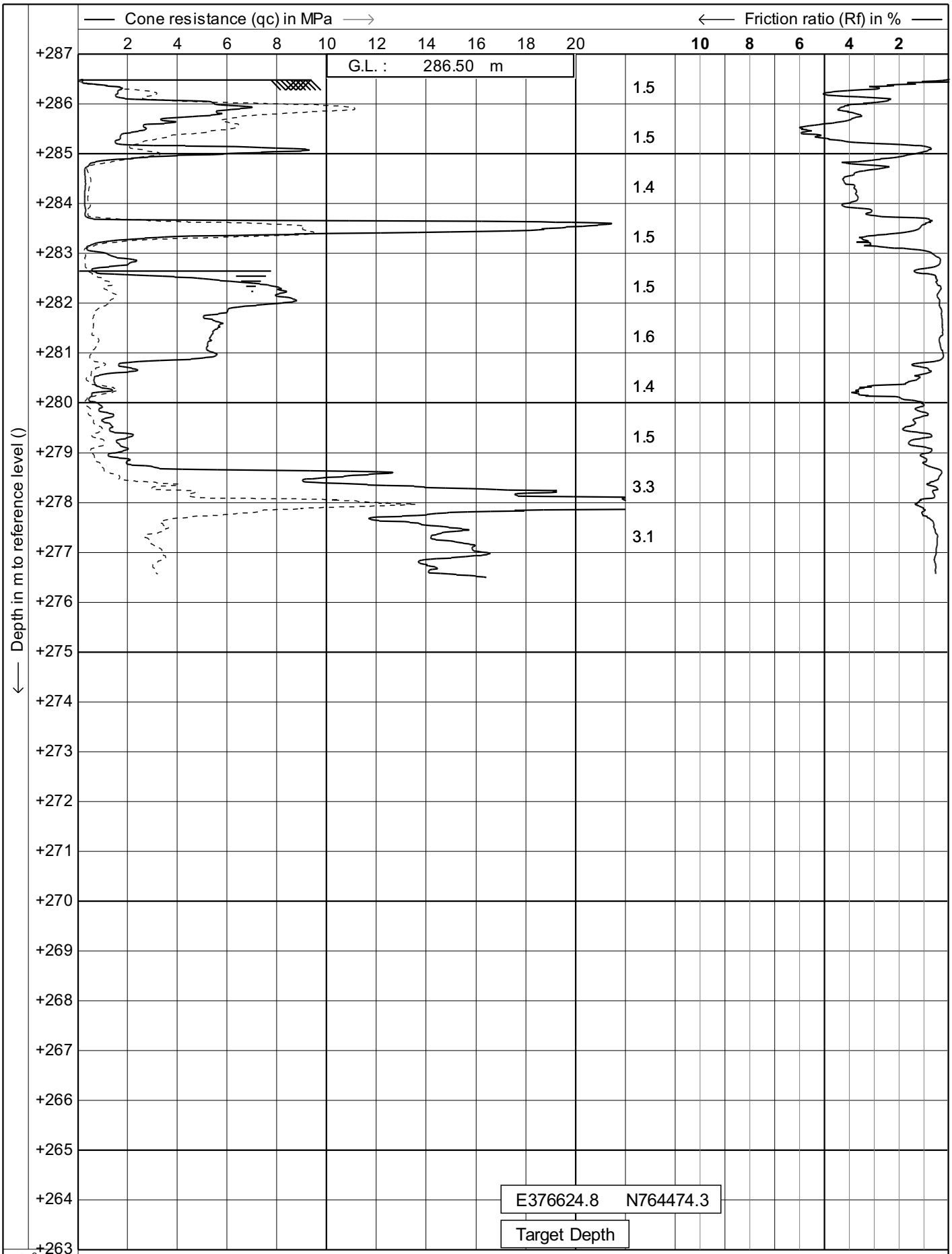
Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

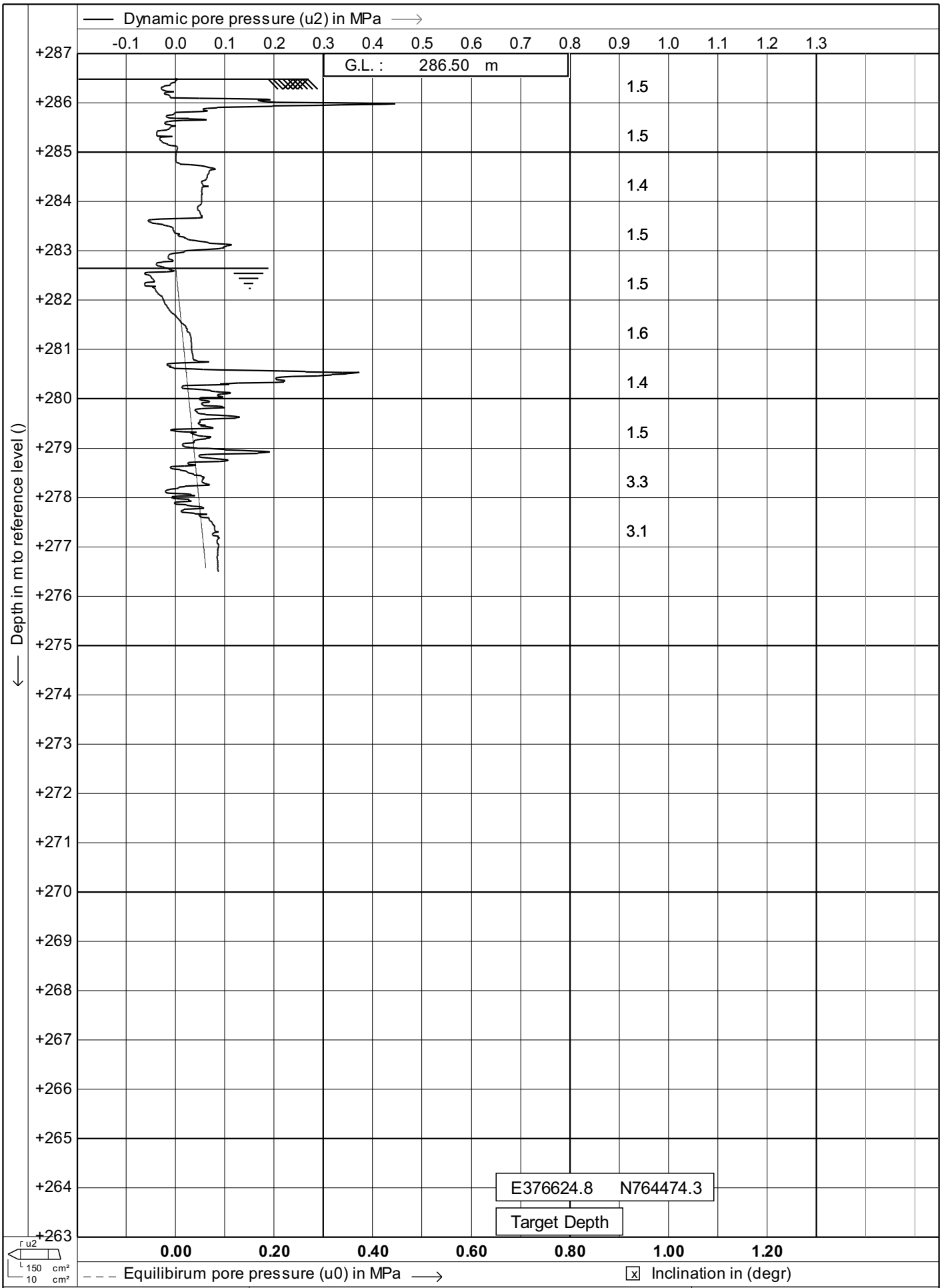
Date	: **20-6-2008**
Cone no.	: **C10CFIIP.E59**
Project no.	: **02TT8**
CPT no.	: **3-31**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

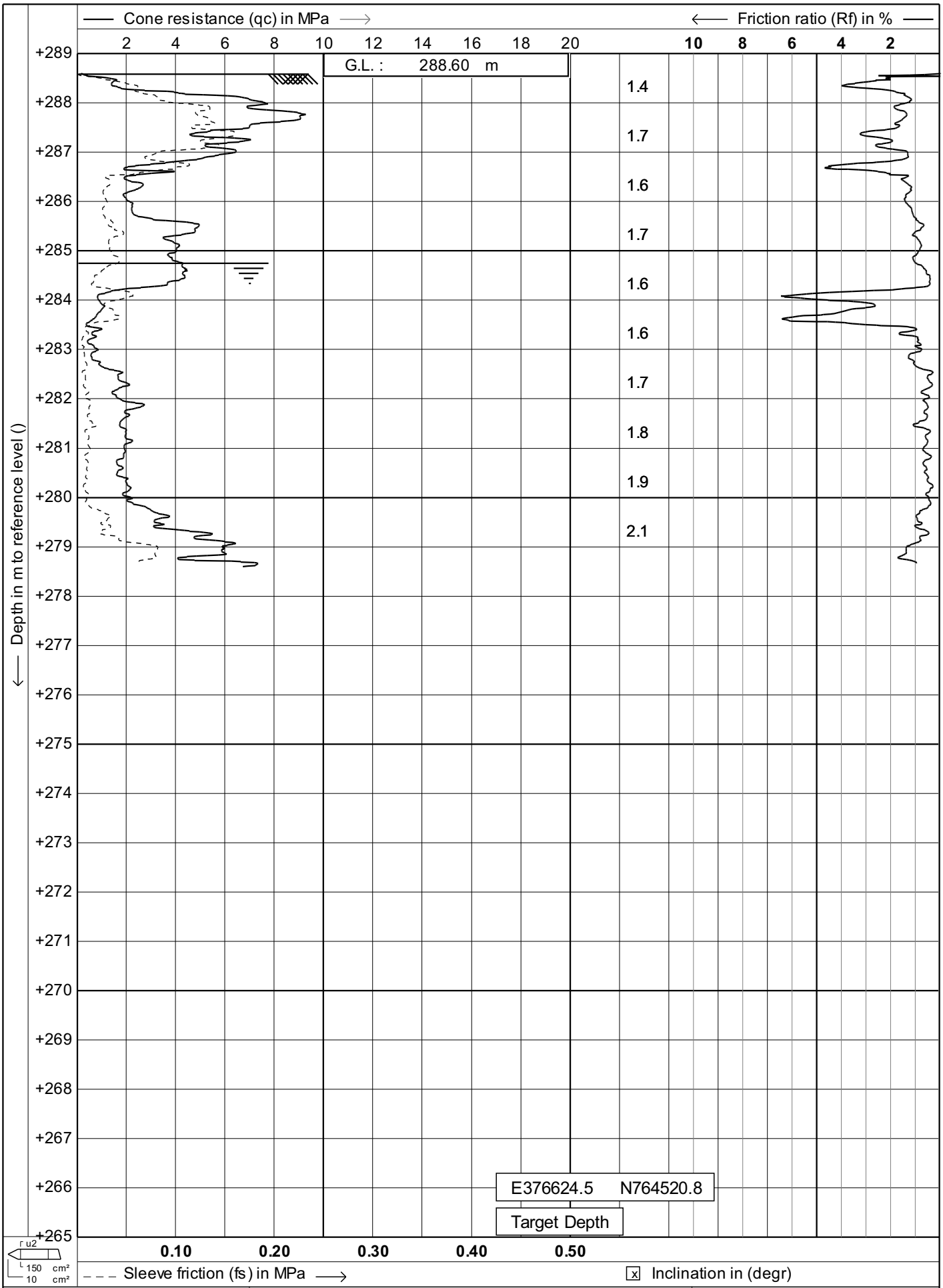
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-34** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

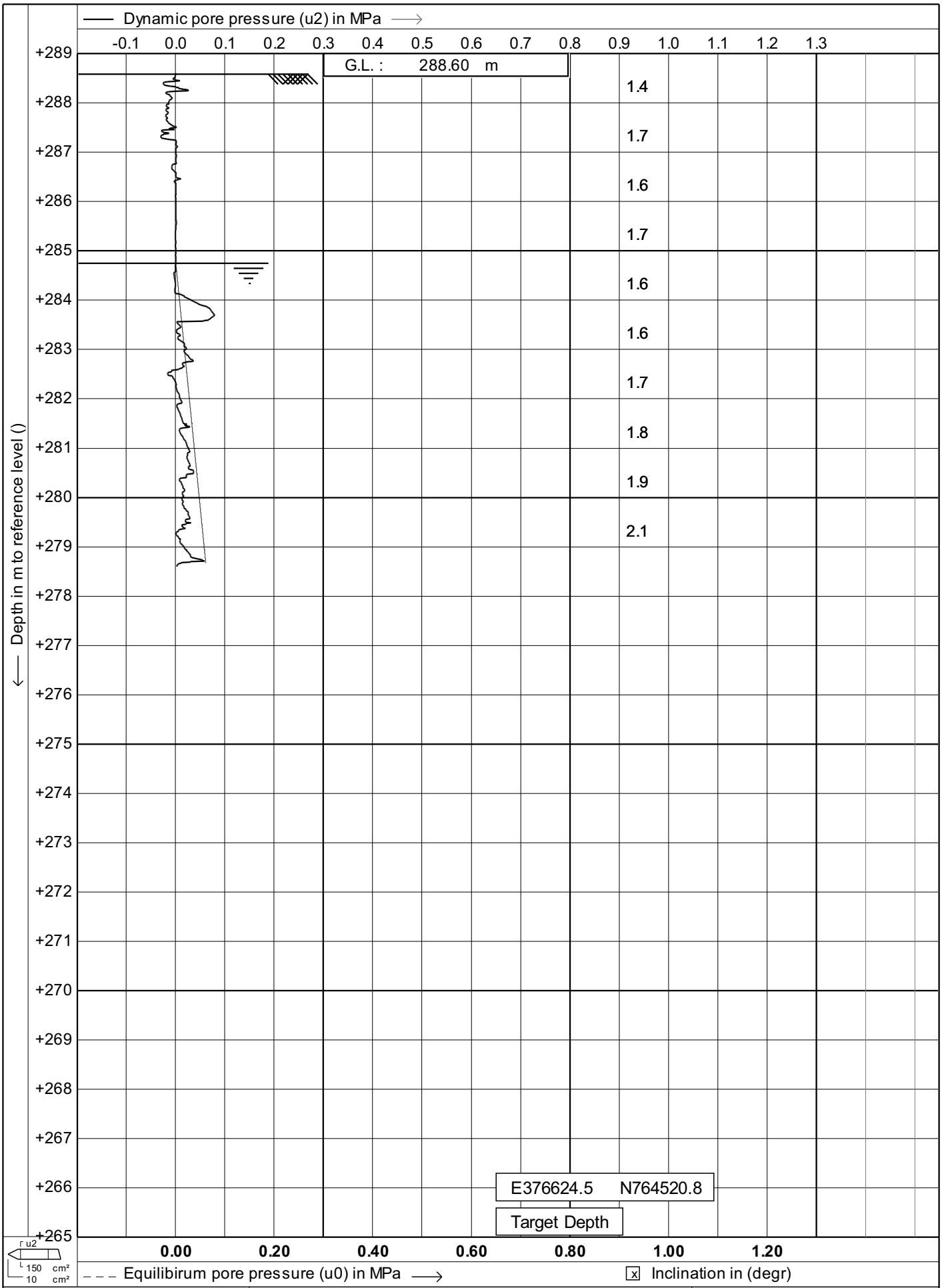
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-36** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



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Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

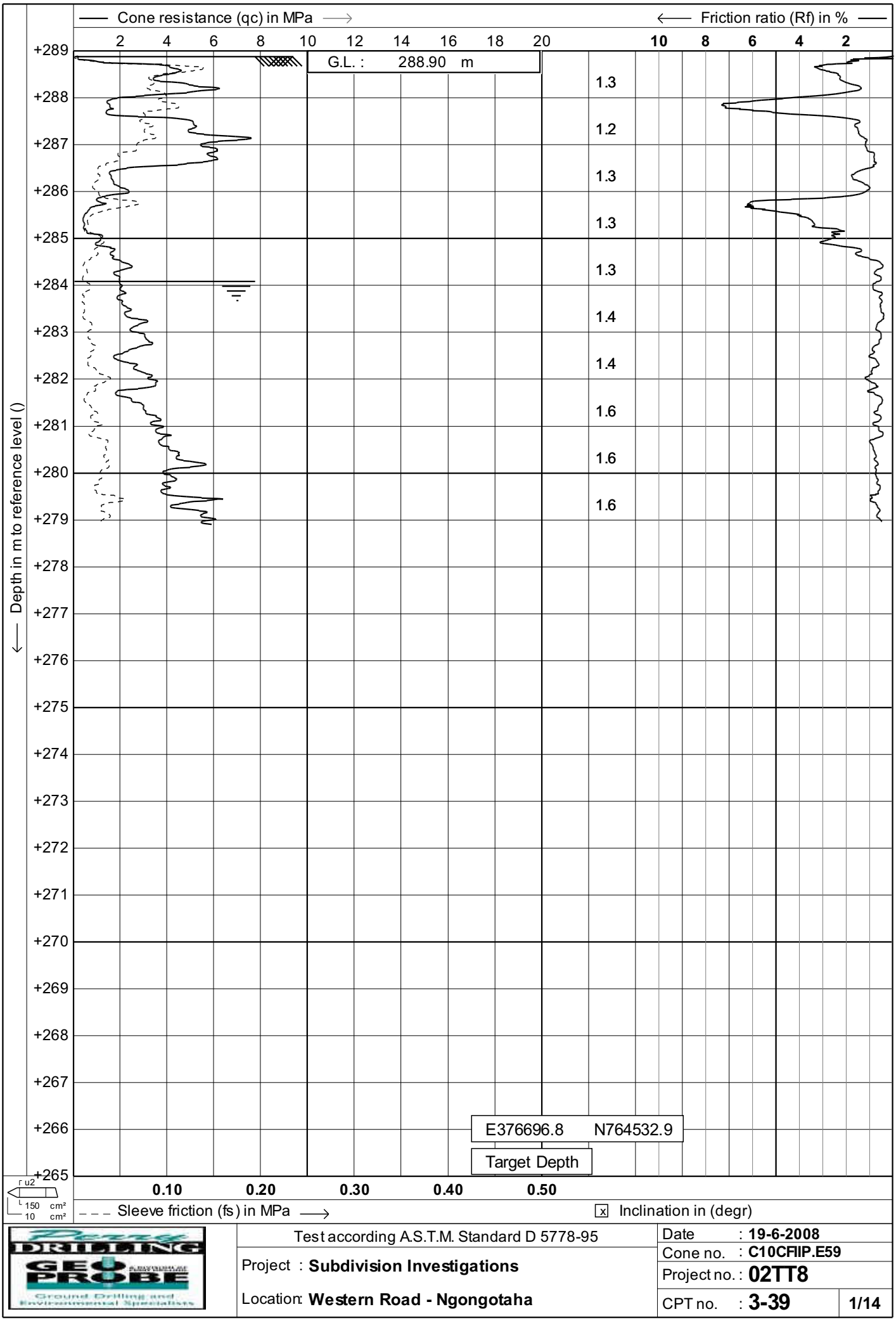
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Project no. : **02TT8**

CPT no. : **3-36** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

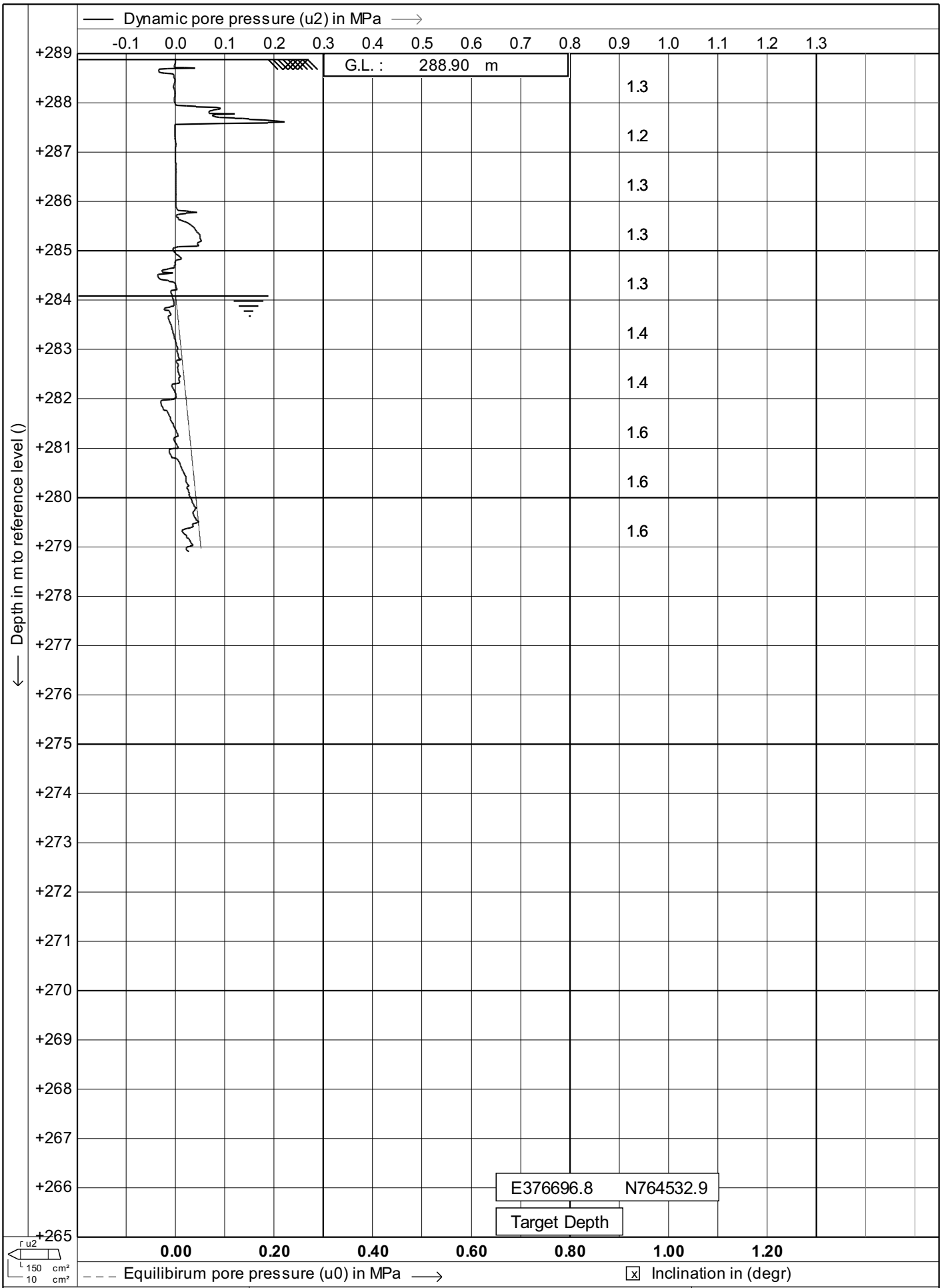
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-39** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

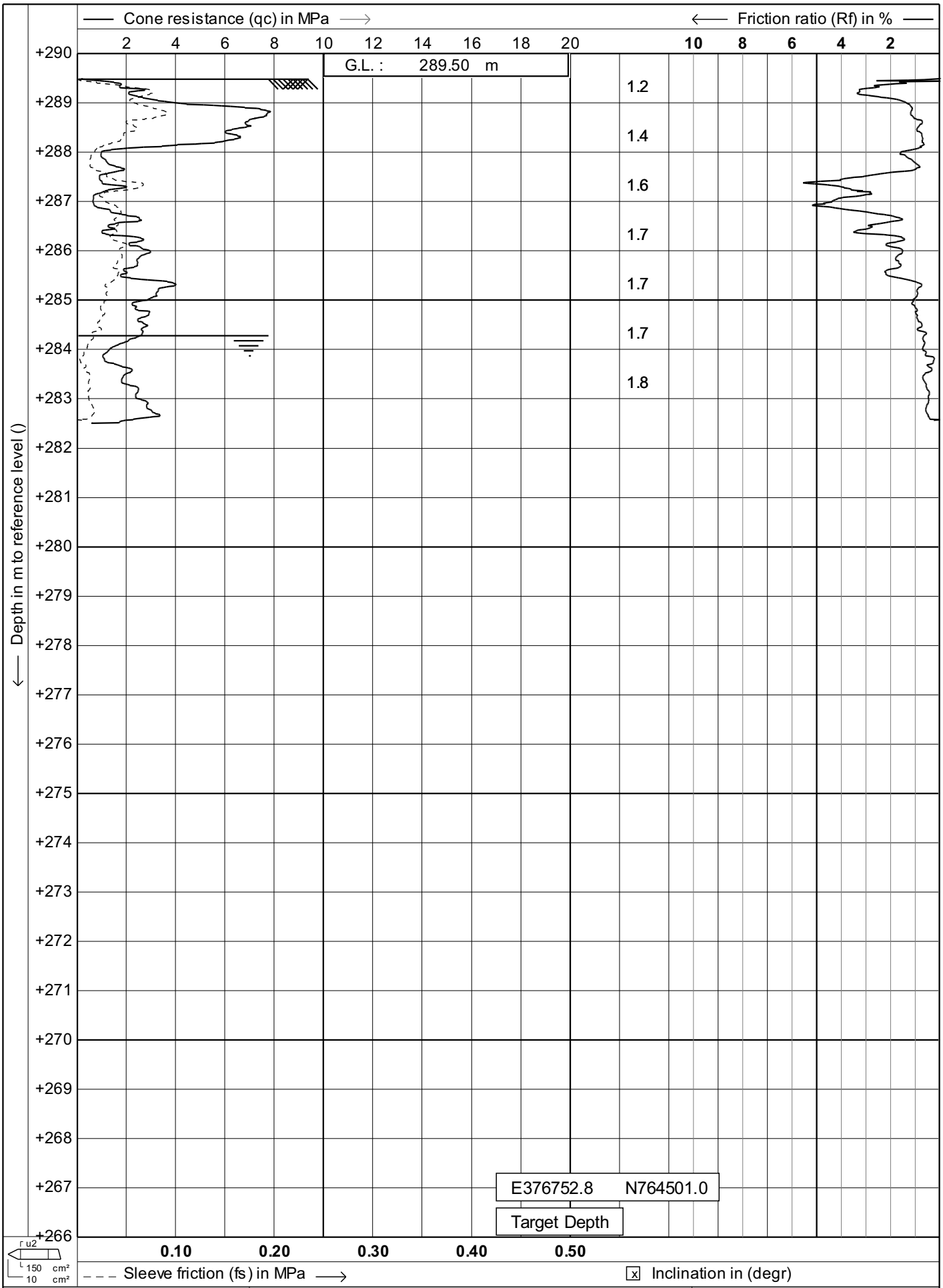
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-39** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

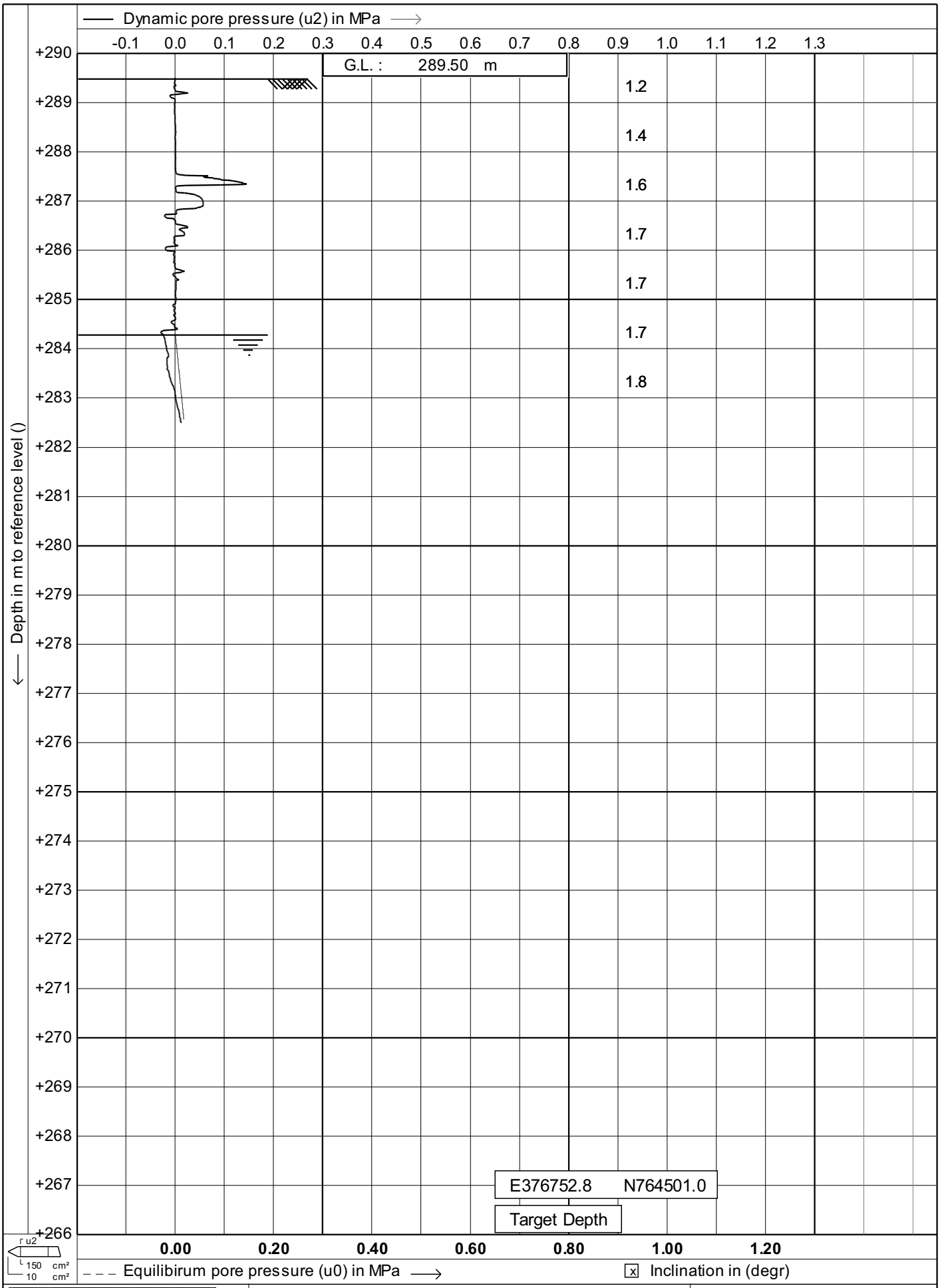
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-41** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

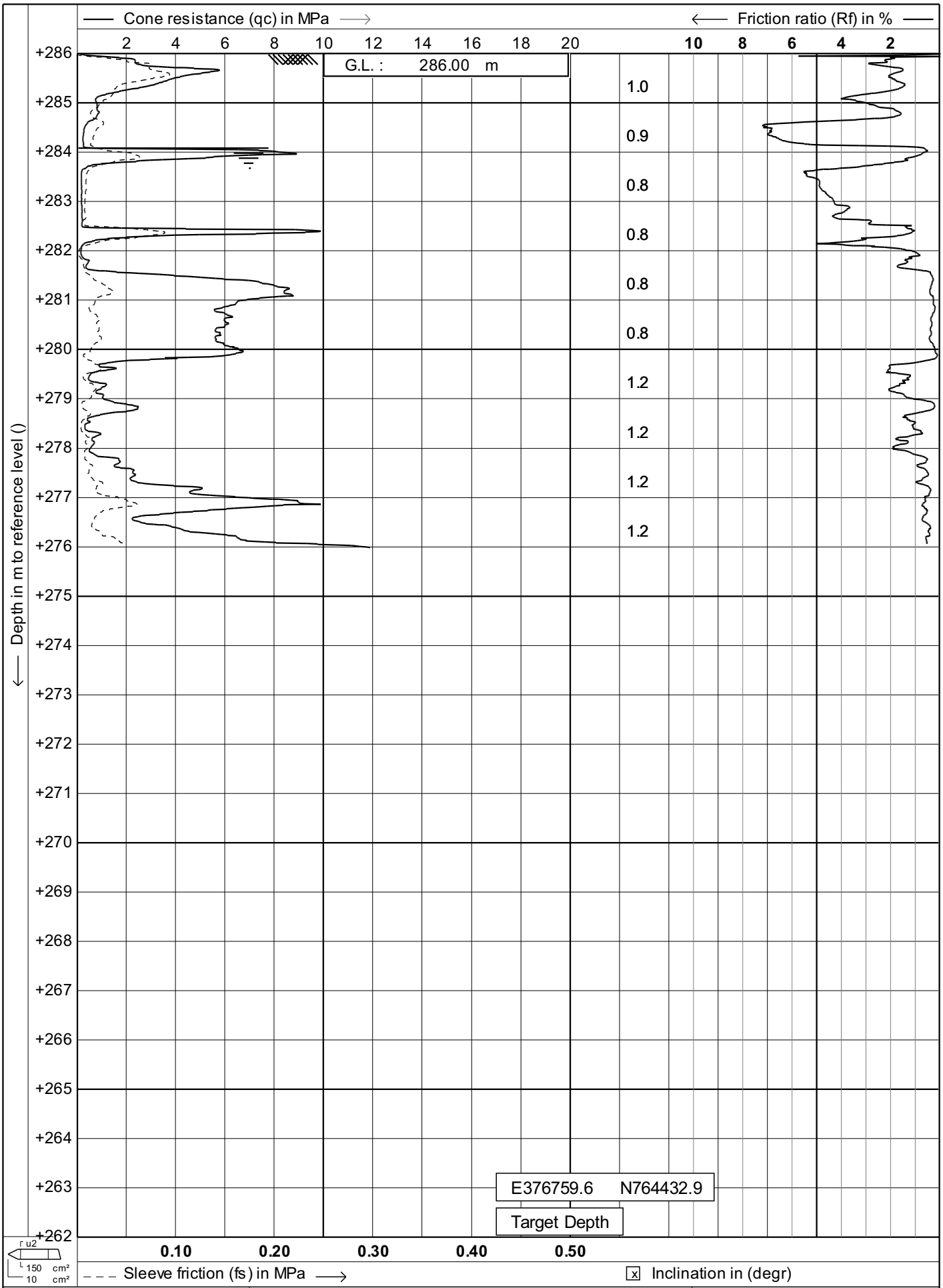
Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date	: **19-6-2008**
Cone no.	: **C10CFIIP.E59**
Project no.	: **02TT8**
CPT no.	: **3-41**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

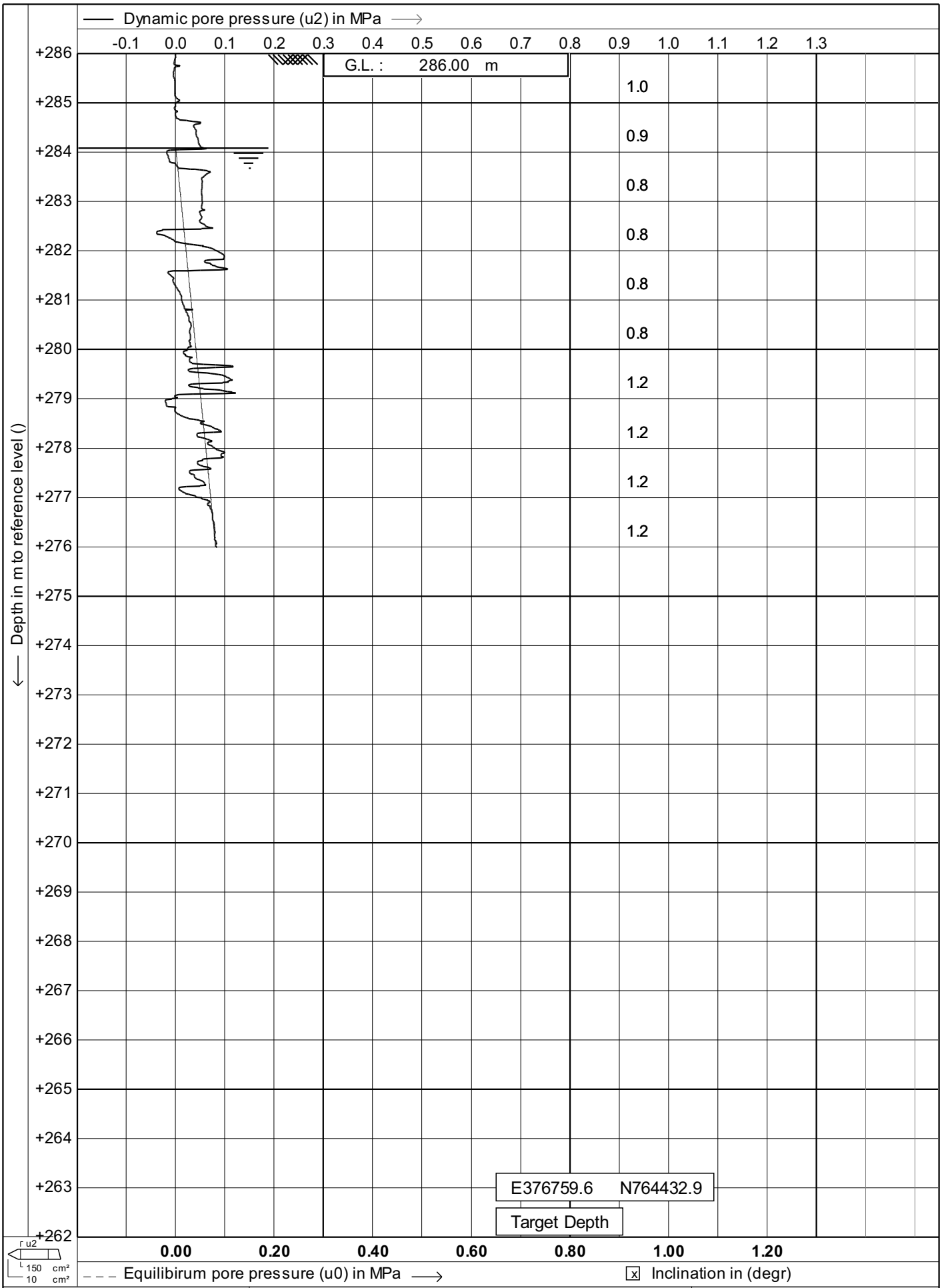
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-44** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

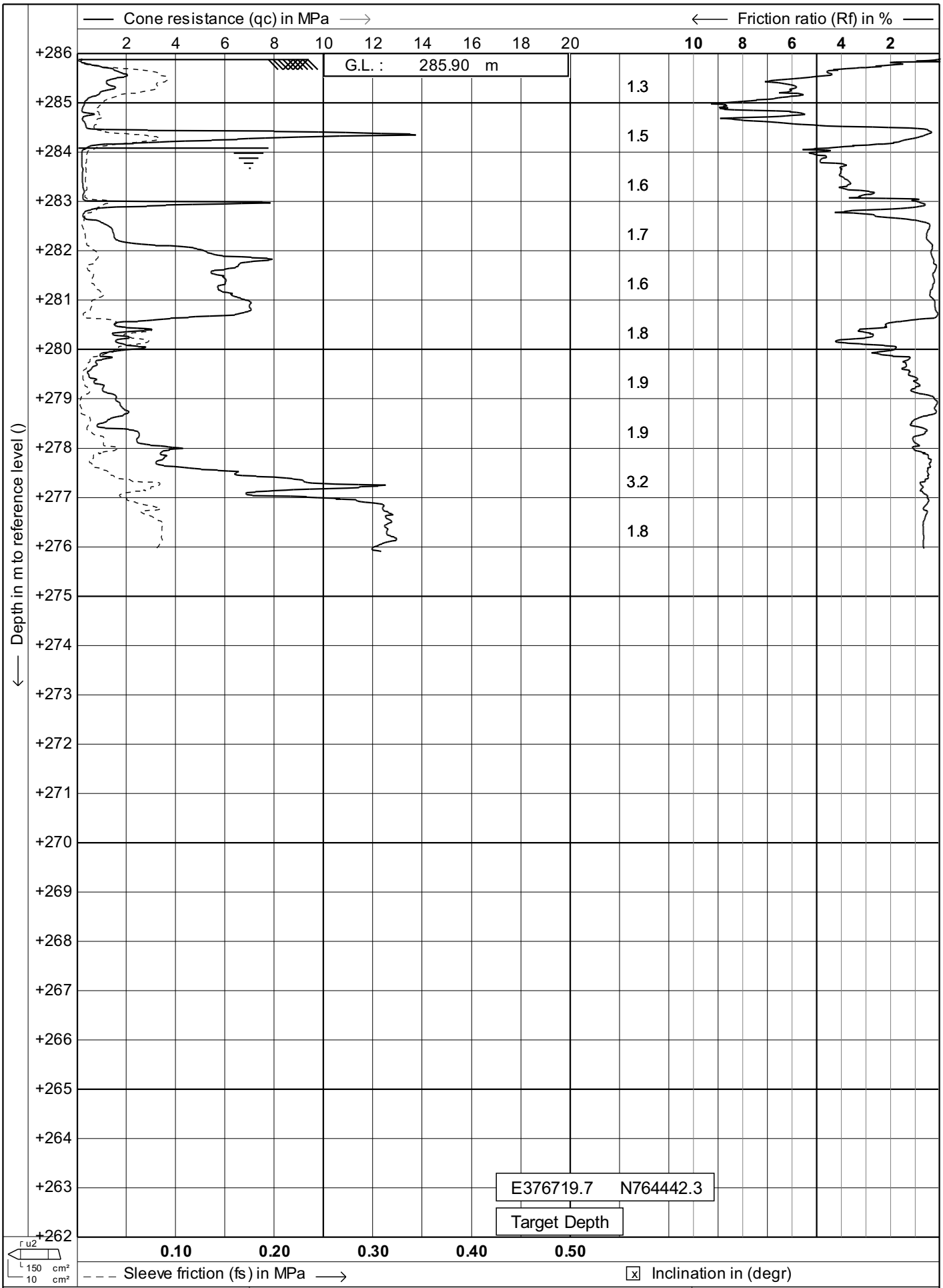
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-44** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

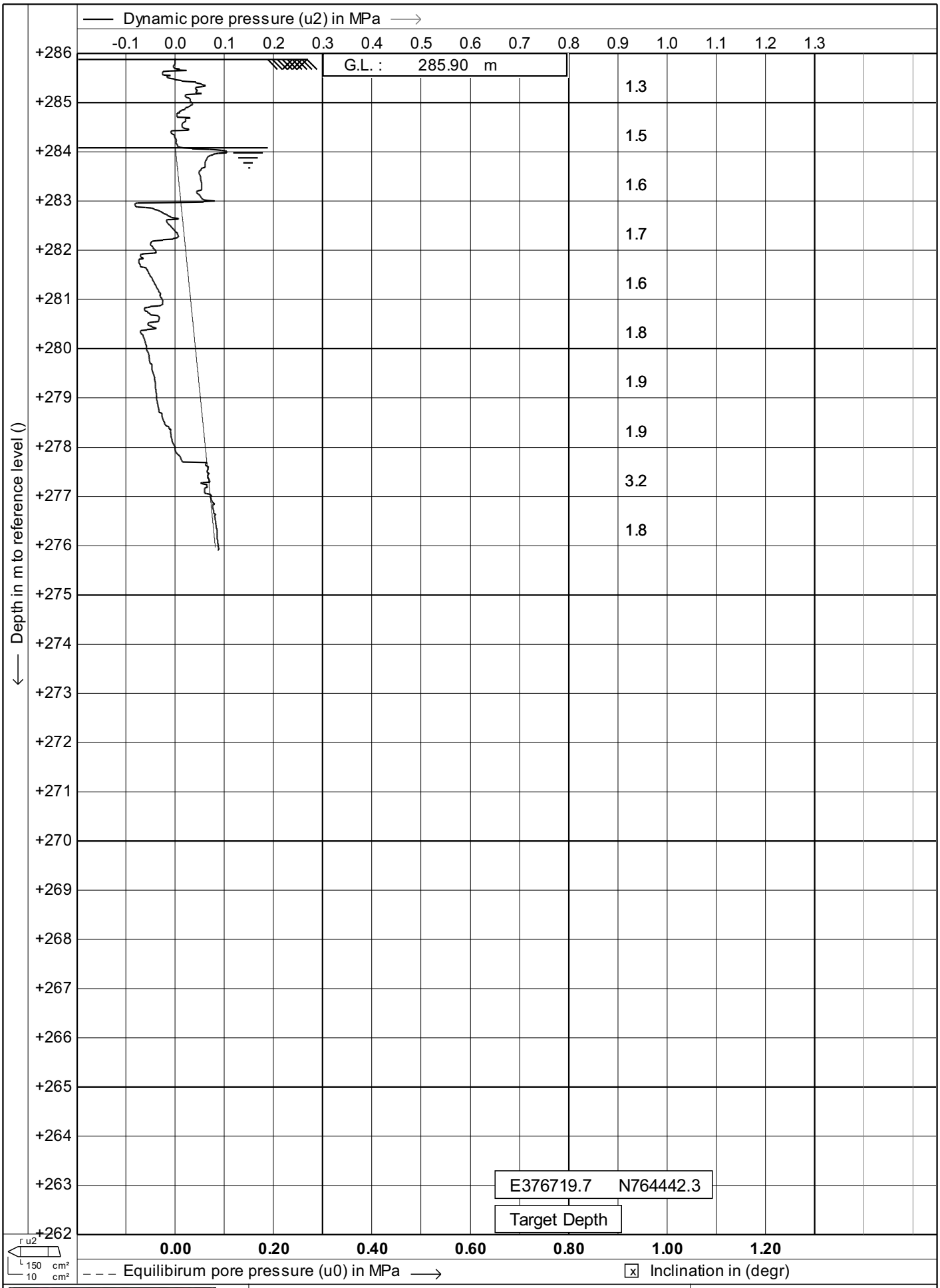
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-45** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

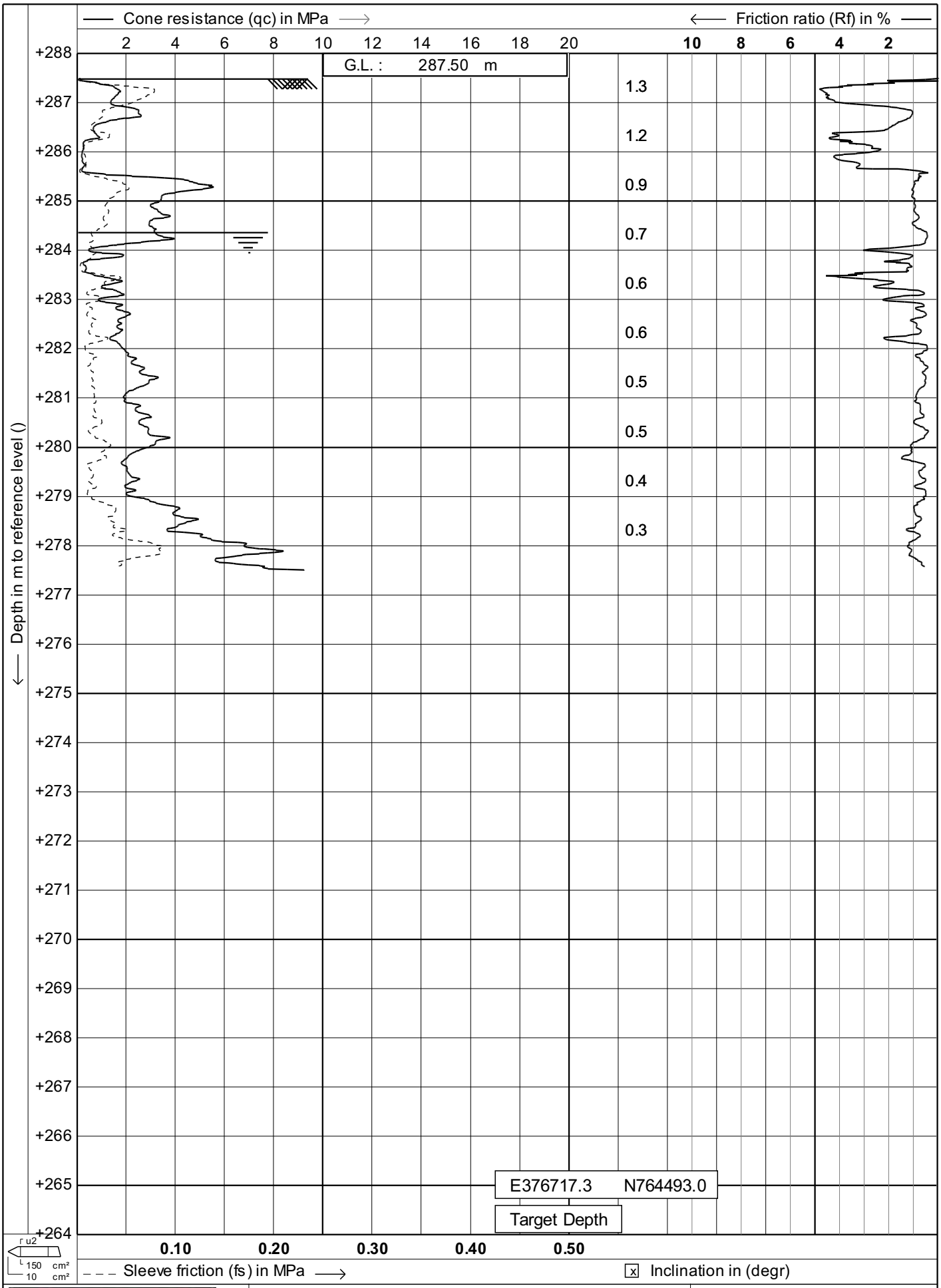
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Project no. : **02TT8**

CPT no. : **3-45** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

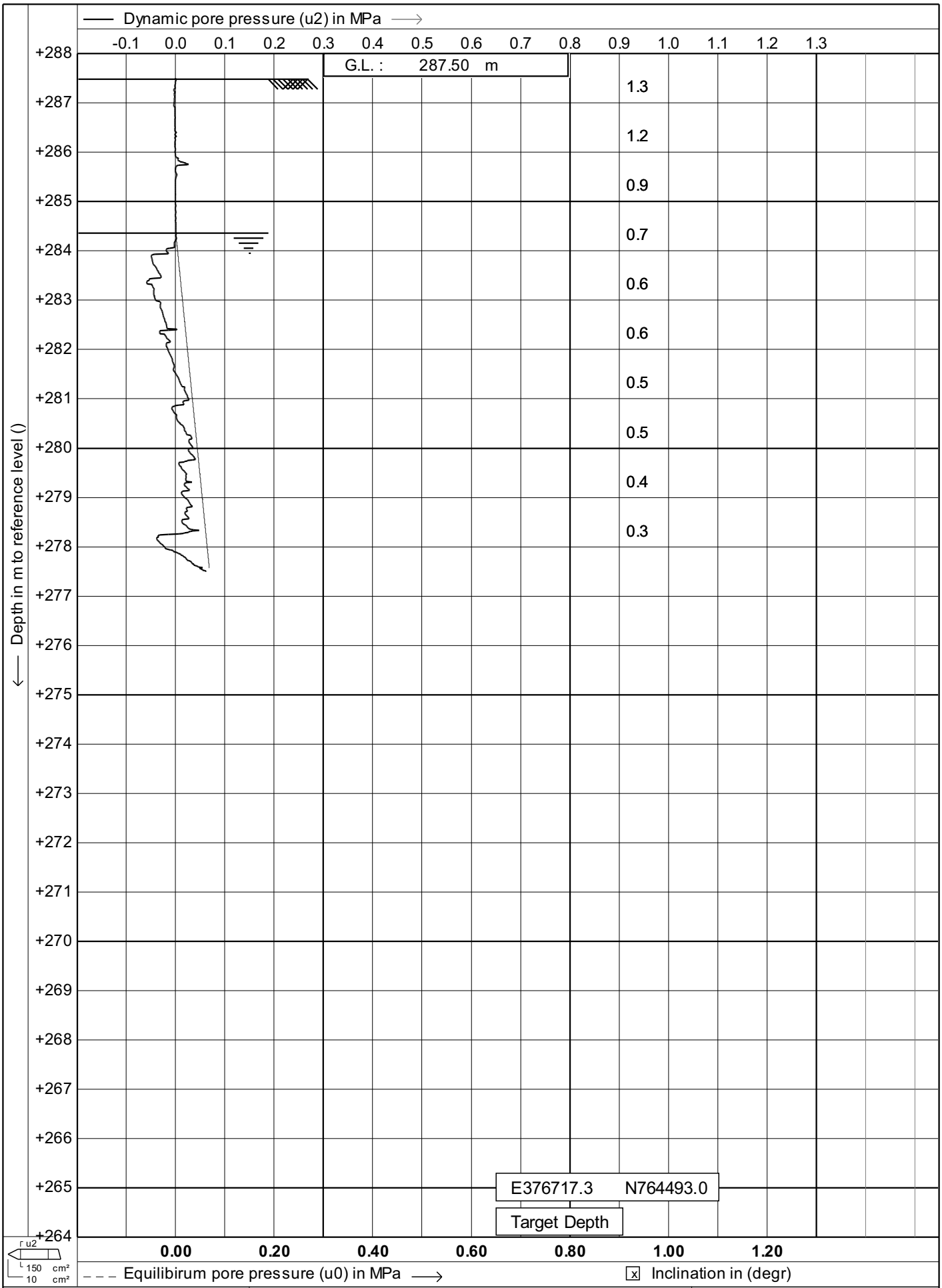
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-49** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **19-6-2008**

Cone no. : **C10CFIIP.E59**

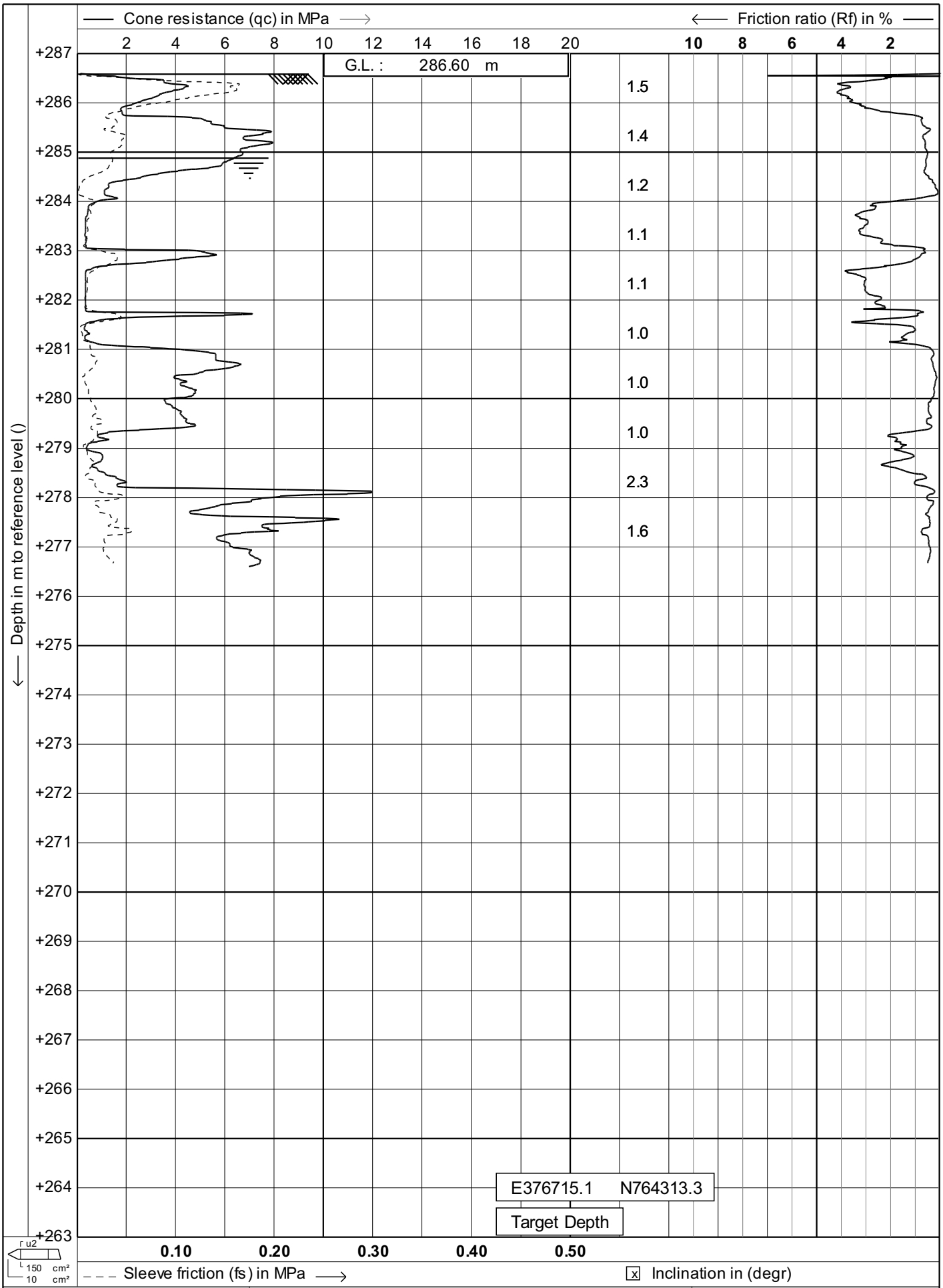
Project no. : **02TT8**

CPT no. : **3-49**

2/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

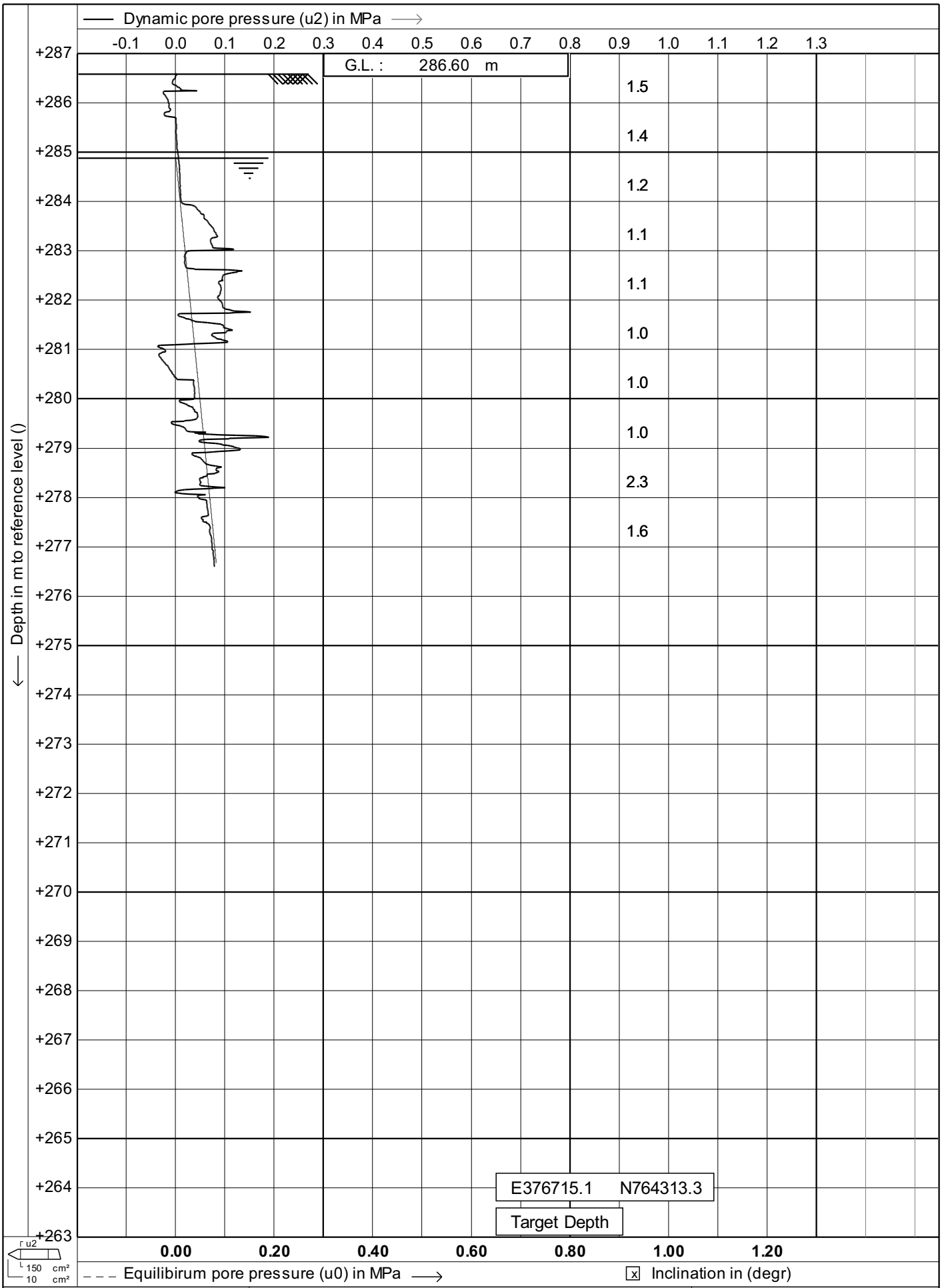
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-56** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

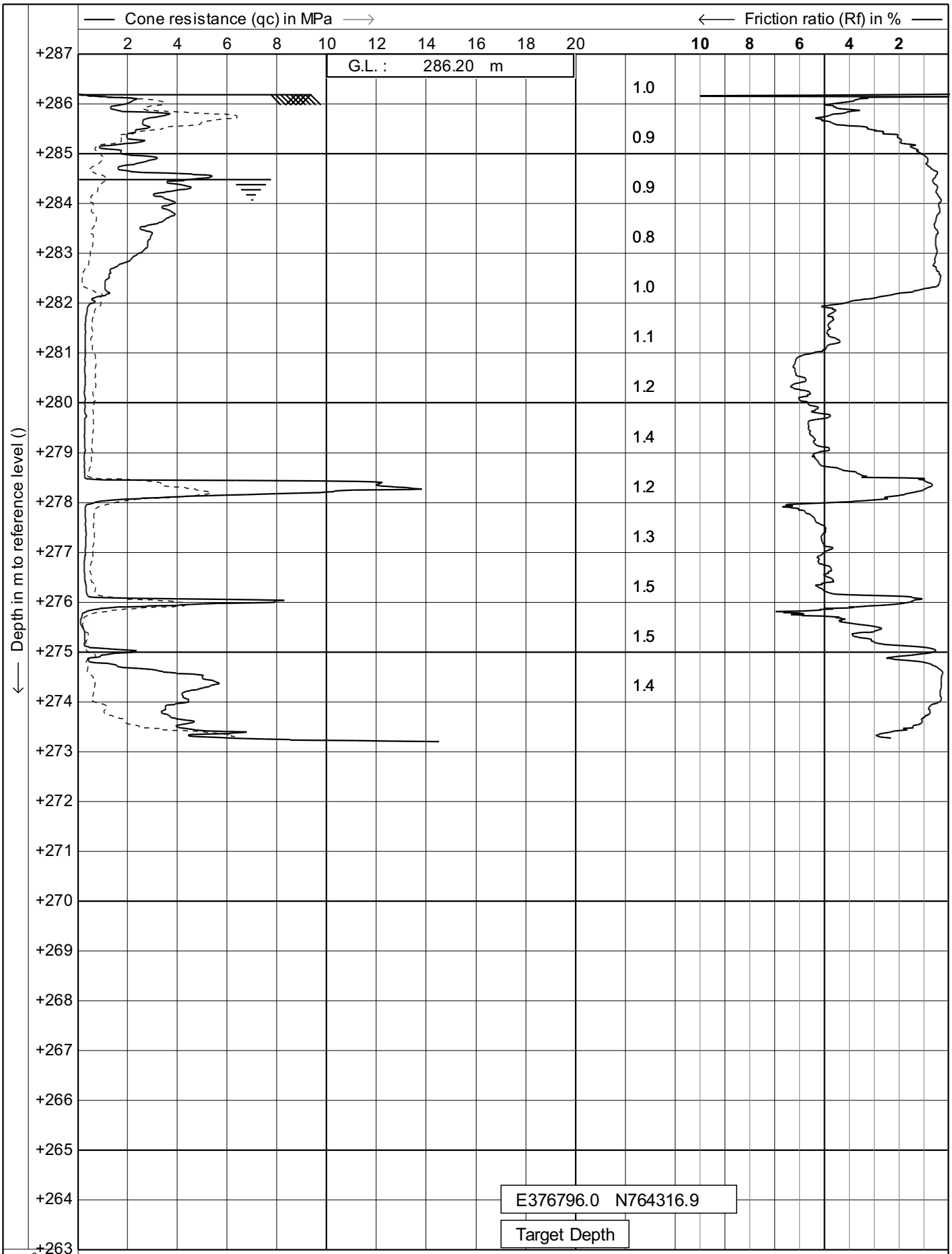
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-56** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

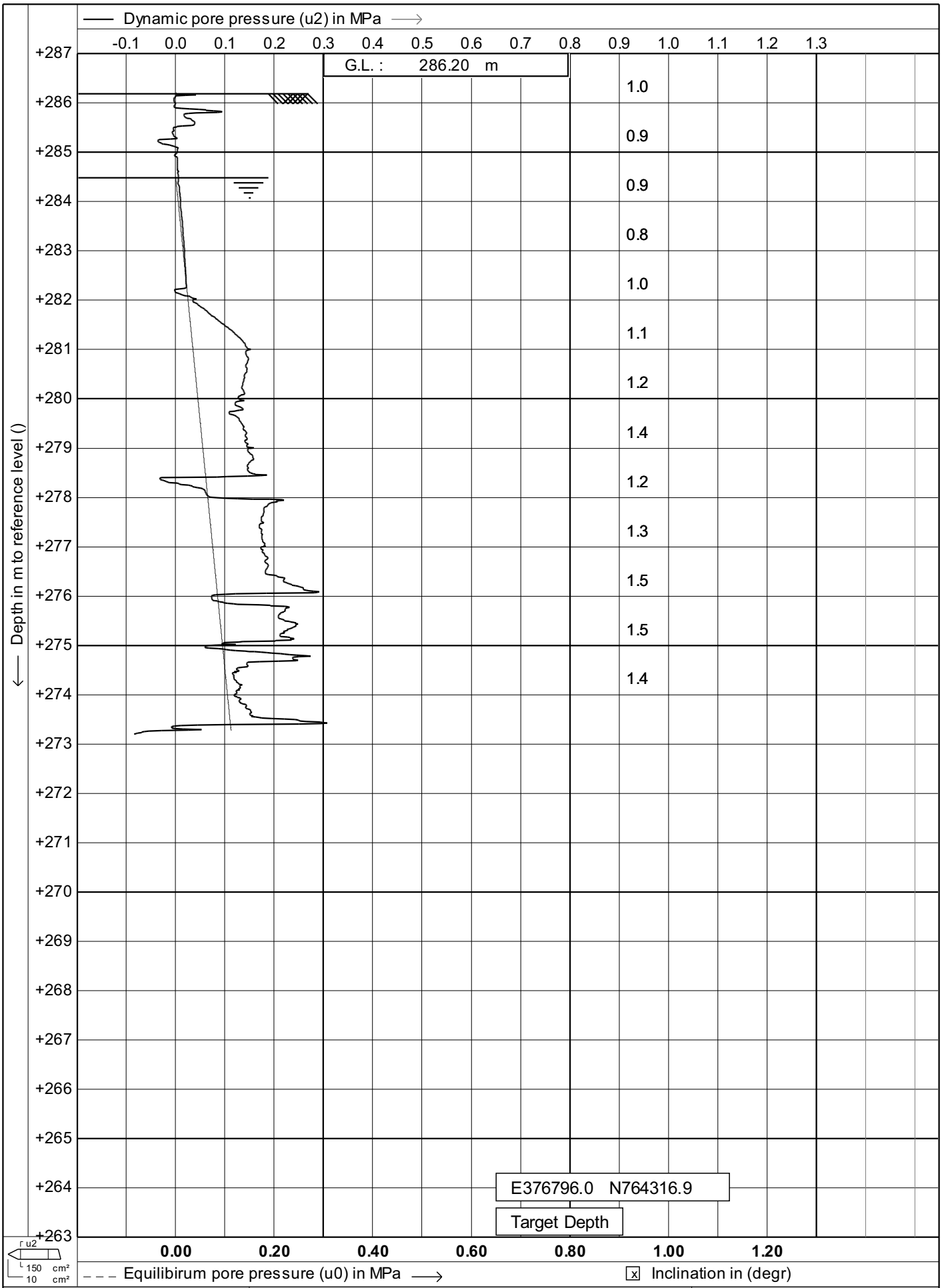
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-58** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

Cone no. : **C10CFIIP.E59**

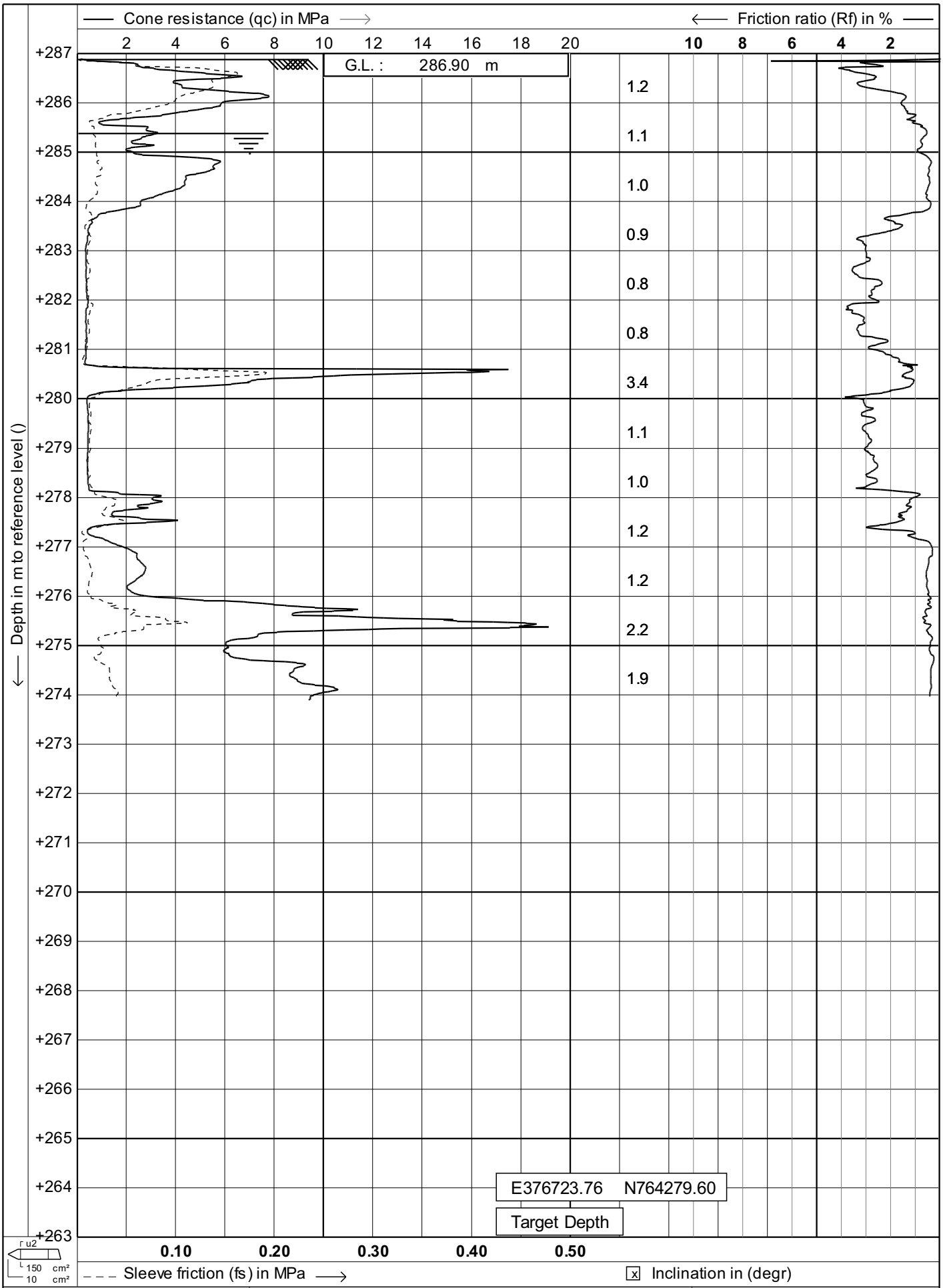
Project no. : **02TT8**

CPT no. : **3-58**

2/14

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

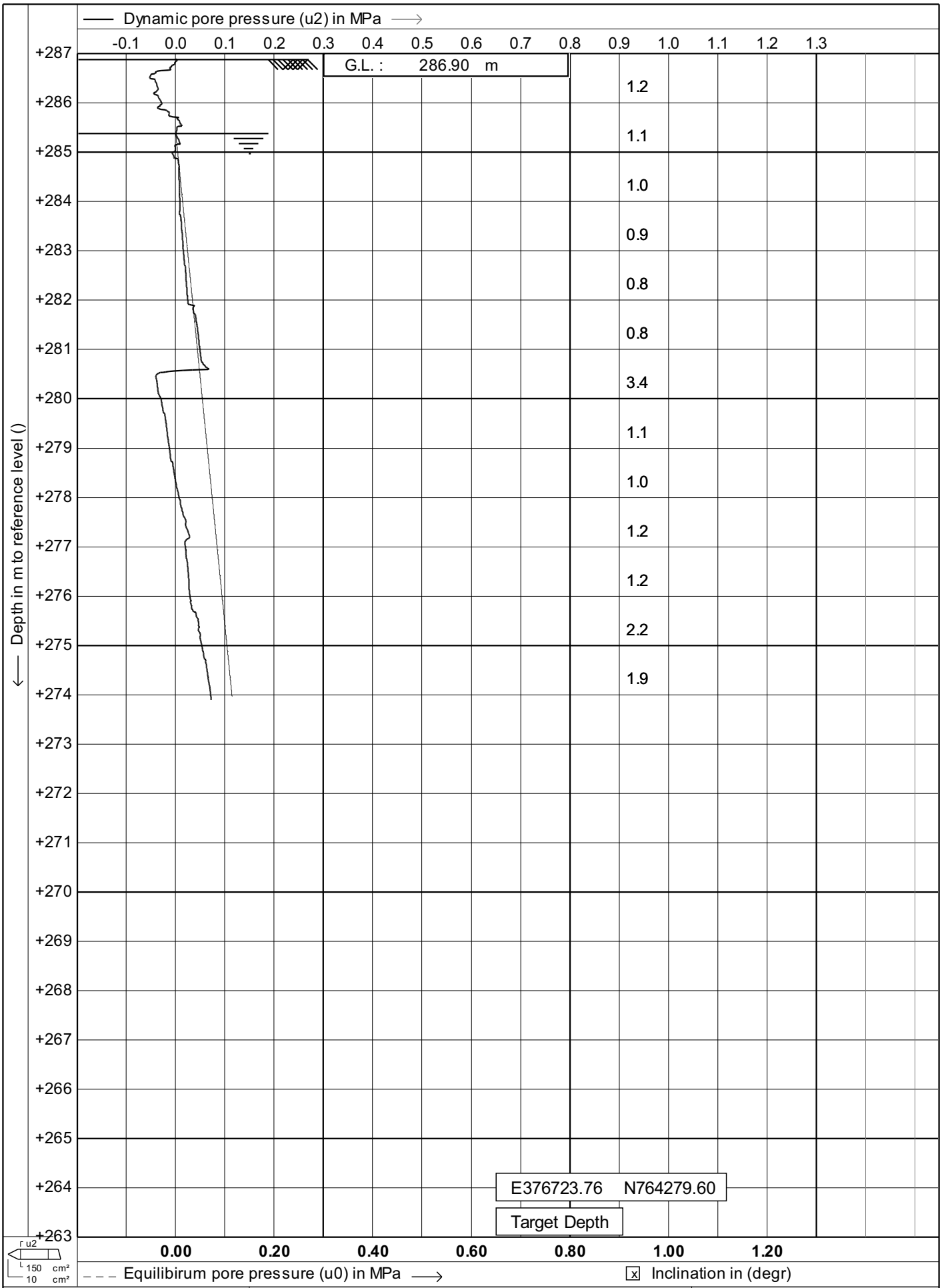
Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

CPT no. : **3-61** **1/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. Standard D 5778-95

Project : **Subdivision Investigations**

Location: **Western Road - Ngongotaha**

Date : **20-6-2008**

Cone no. : **C10CFIIP.E59**

Project no. : **02TT8**

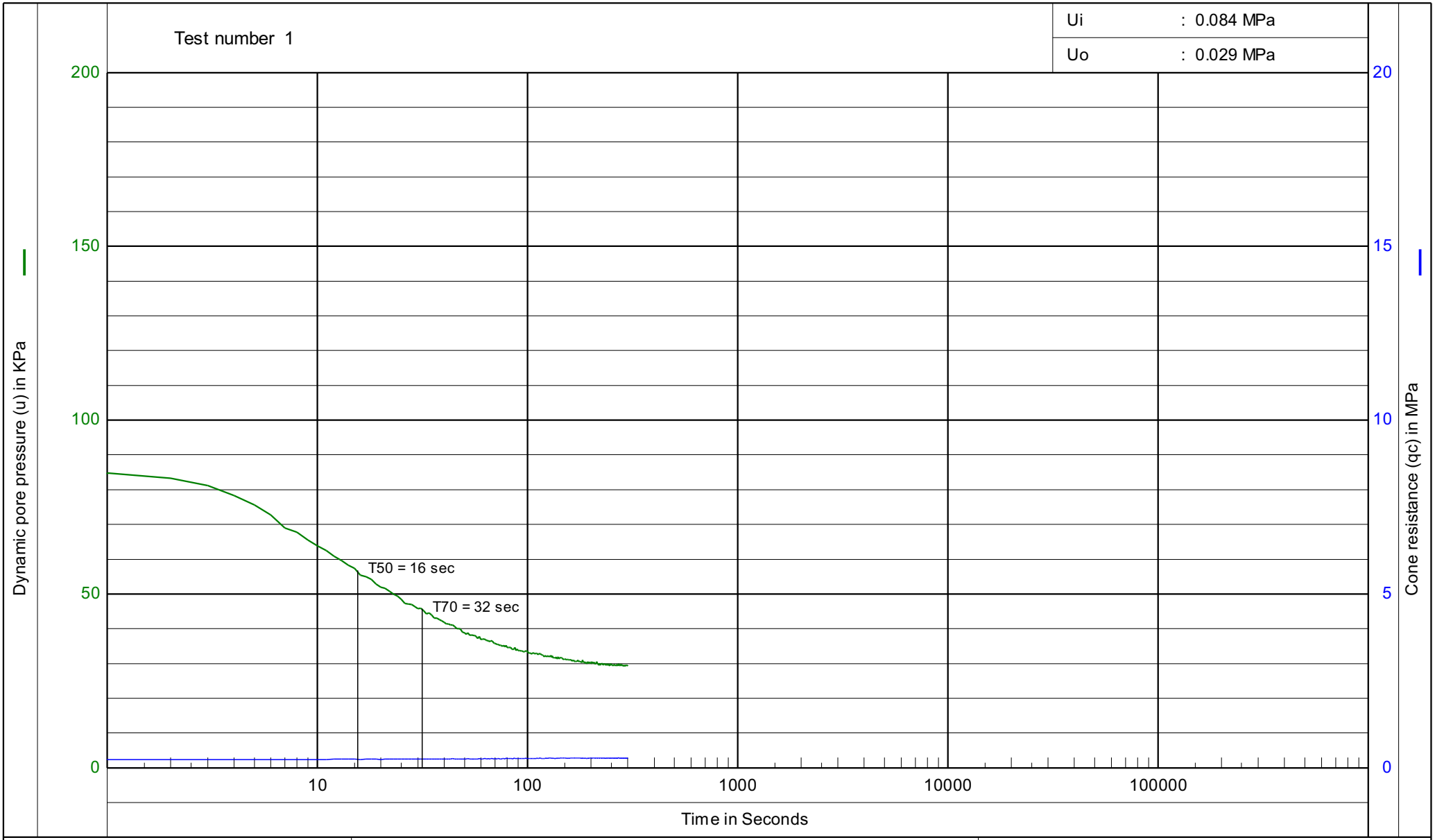
CPT no. : **3-61** **2/14**

CPTask V1.14a

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

Test number 1

Ui	: 0.084 MPa
Uo	: 0.029 MPa



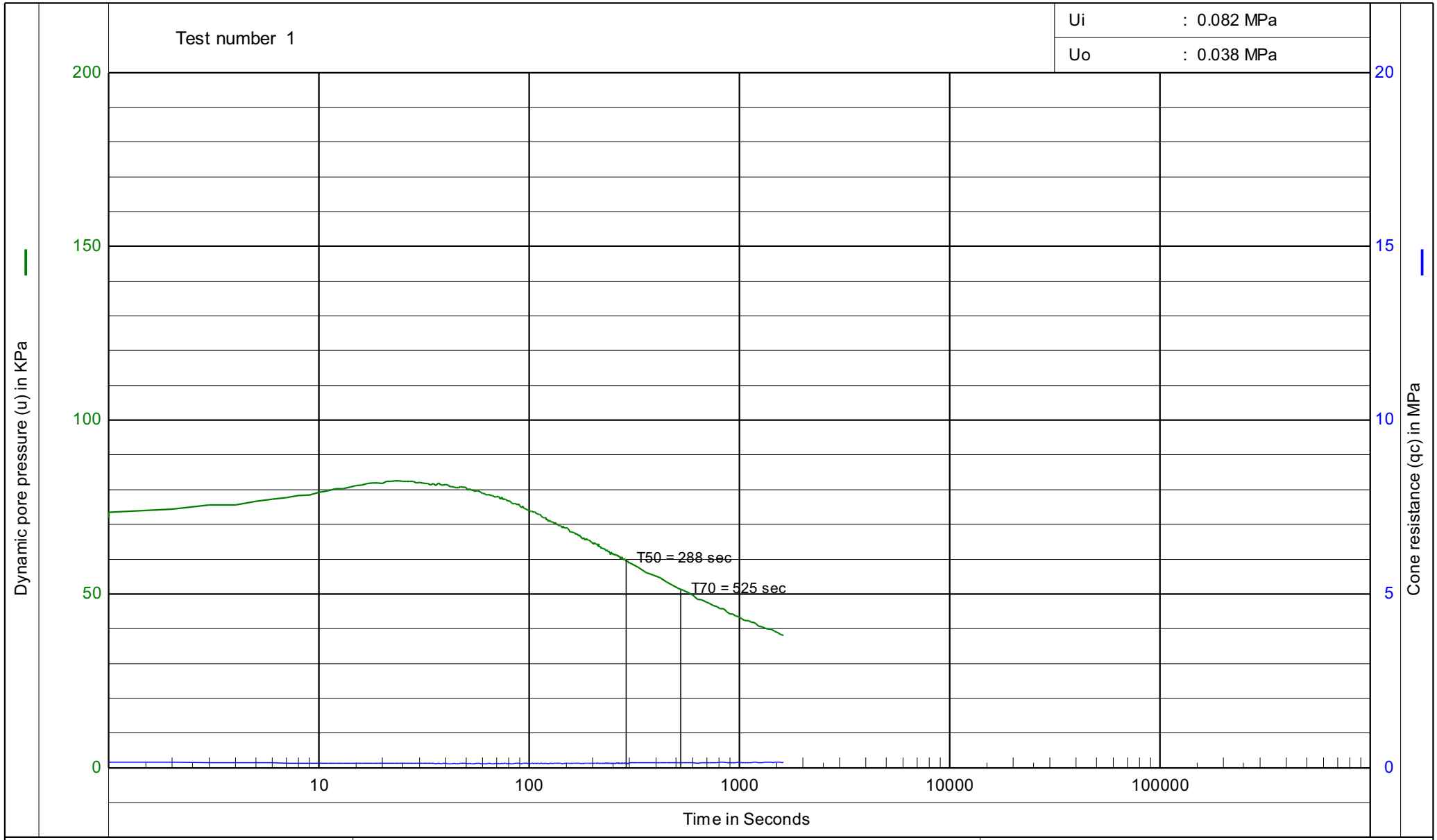
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 1-01
Test depth	: 5.24 m [m] -
Water level	: -2.7 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



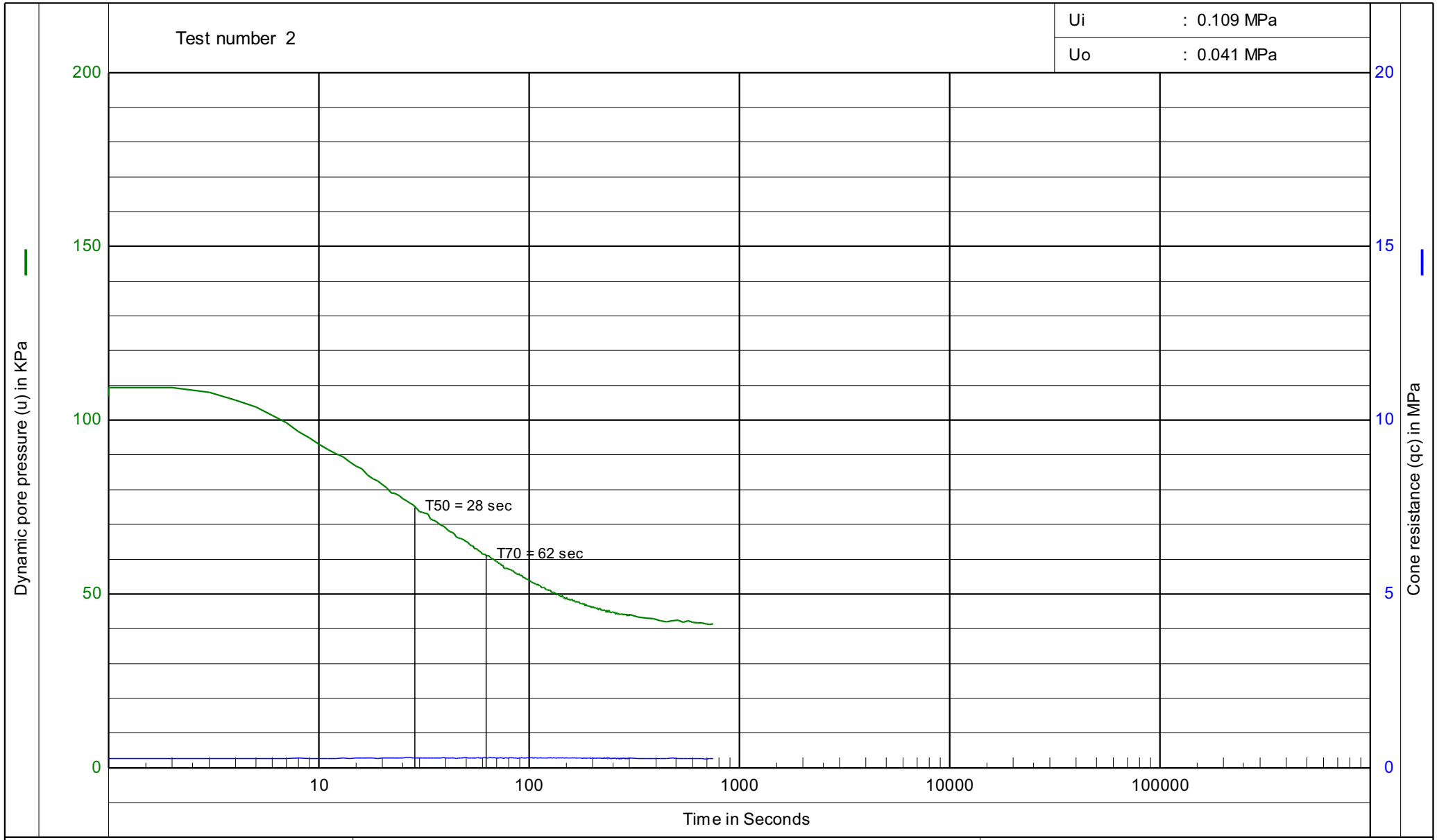
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 1-17
Test depth	: 4 m [m] -
Water level	: -1.2 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



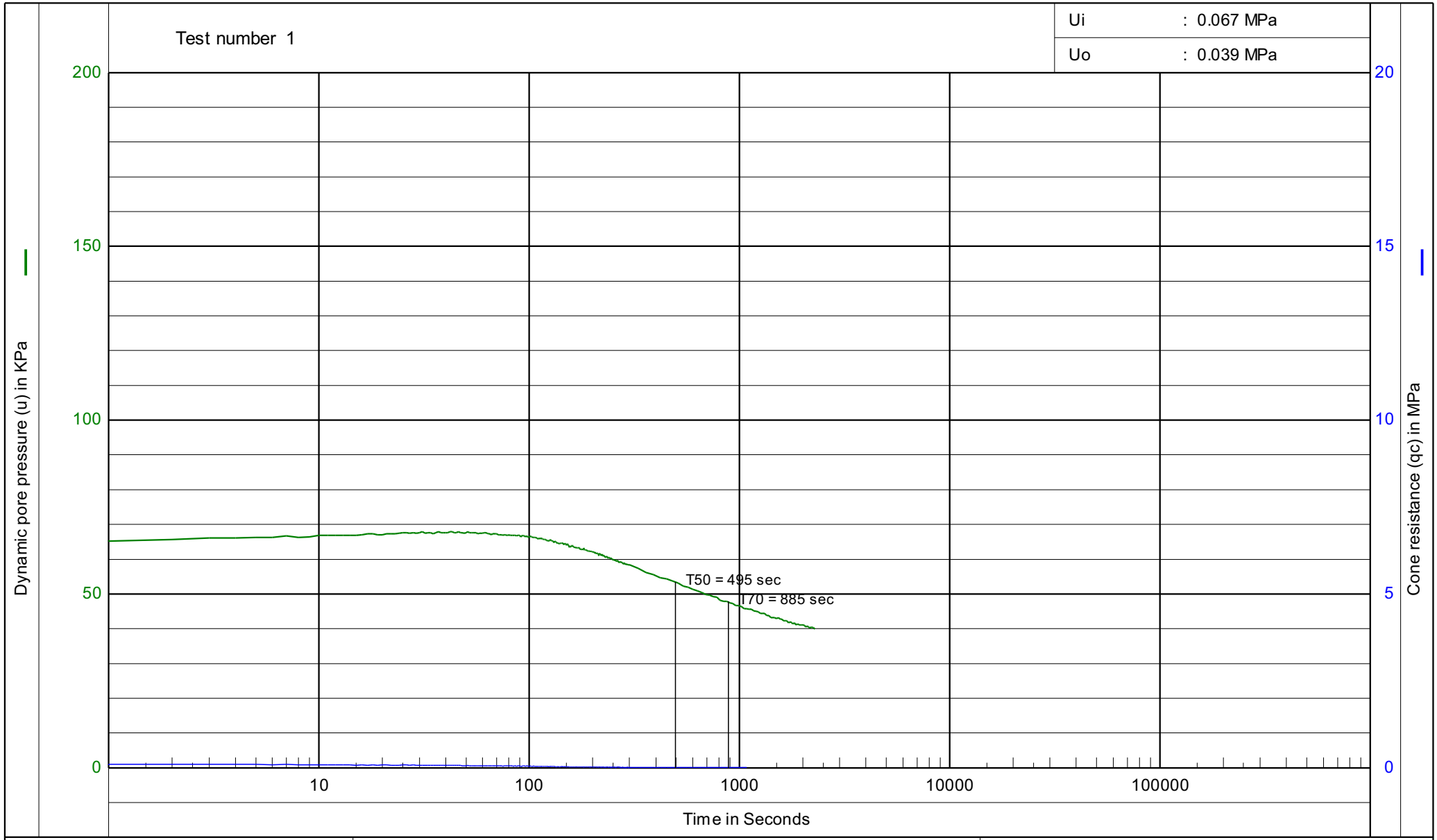
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 1-17
Test depth	: 6 m [m] -
Water level	: -1.2 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



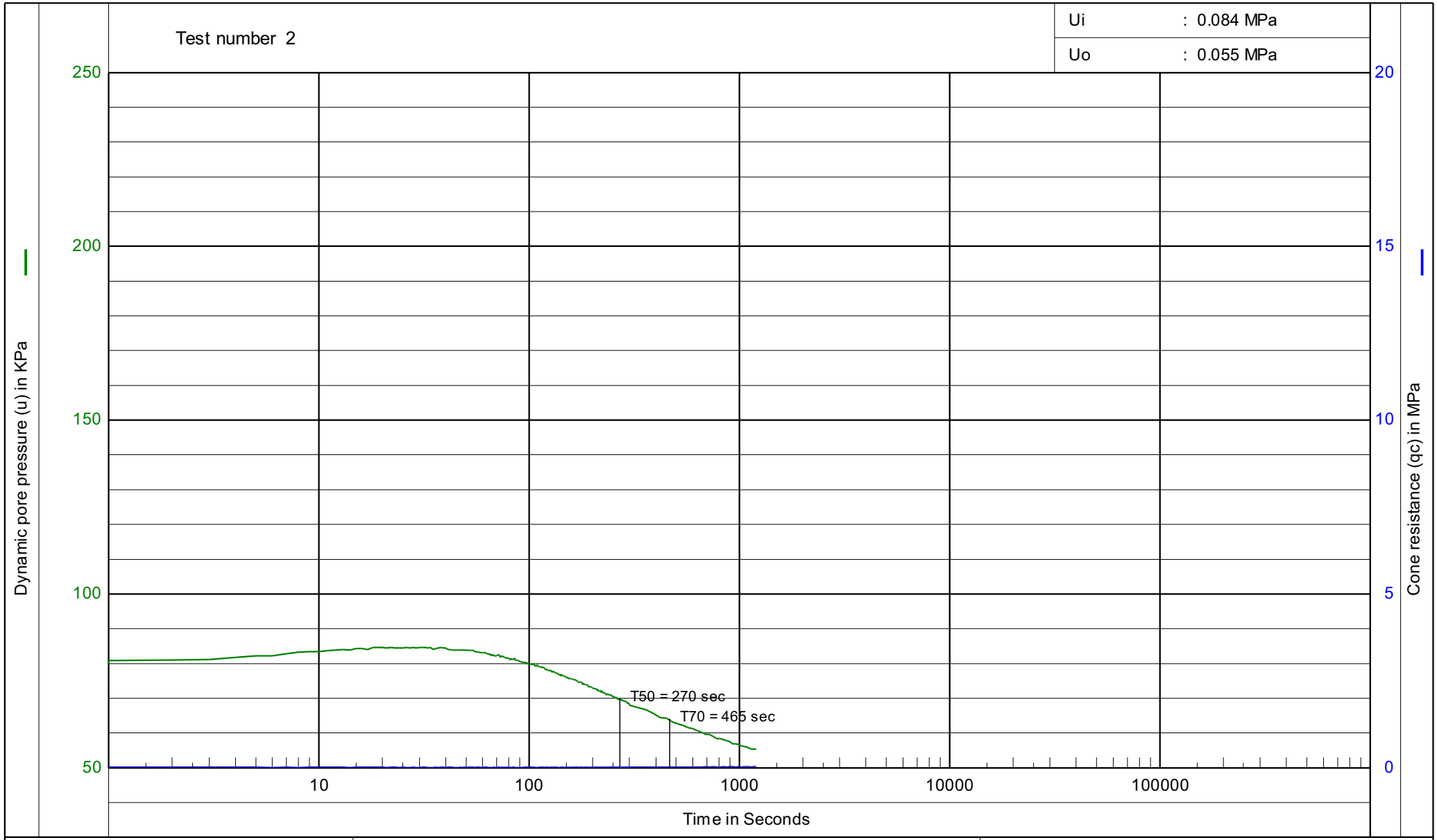
Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-16
Test depth	: 4 m [m] -
Water level	: -0.58 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

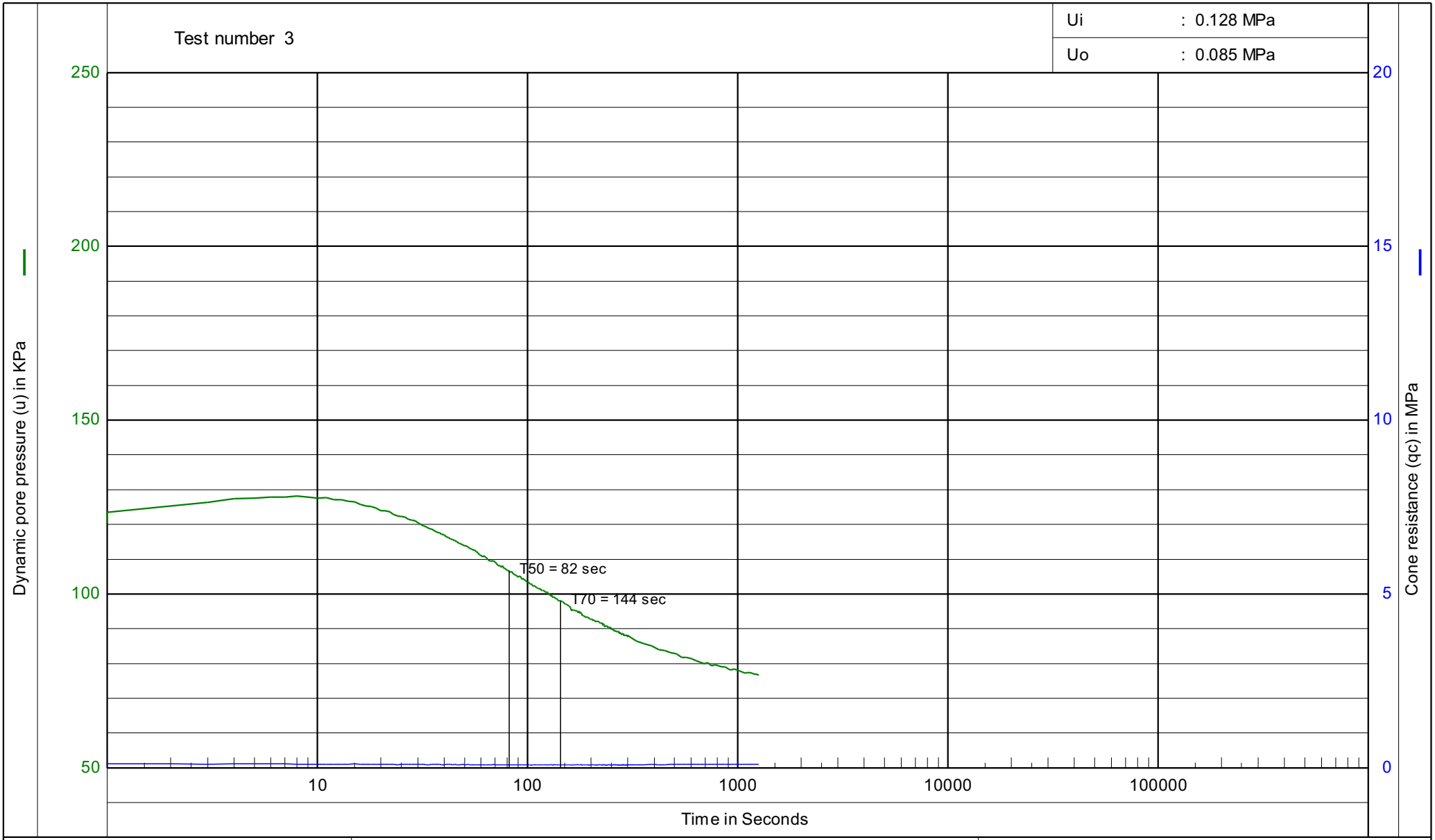
Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-16
Test depth	: 6 m [m] -
Water level	: -0.58 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

Test number 3

Ui	: 0.128 MPa
Uo	: 0.085 MPa



Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

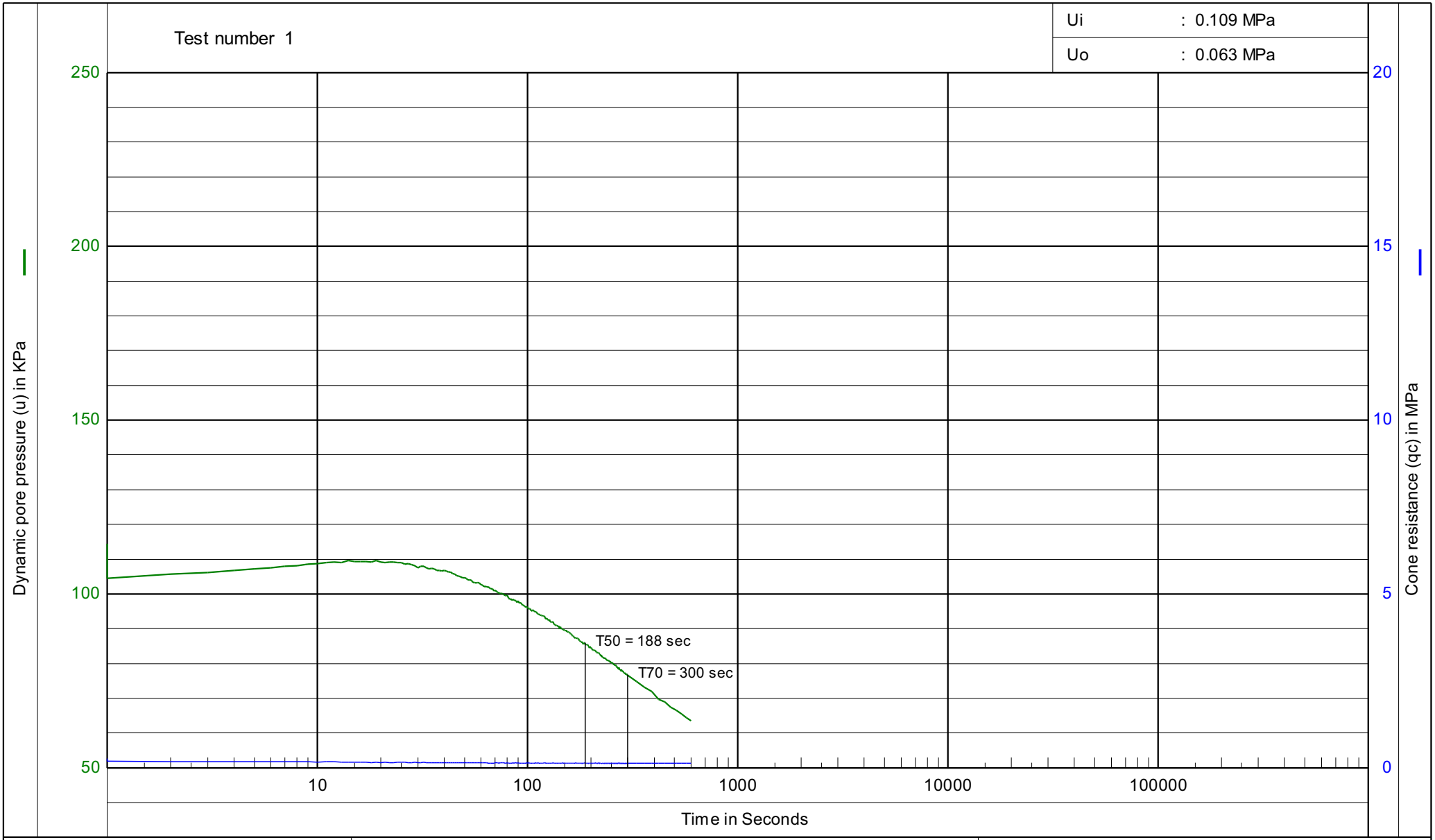
Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-16
Test depth	: 8.53 m[m] -
Water level	: -0.58 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

Test number 1

Ui	: 0.109 MPa
Uo	: 0.063 MPa



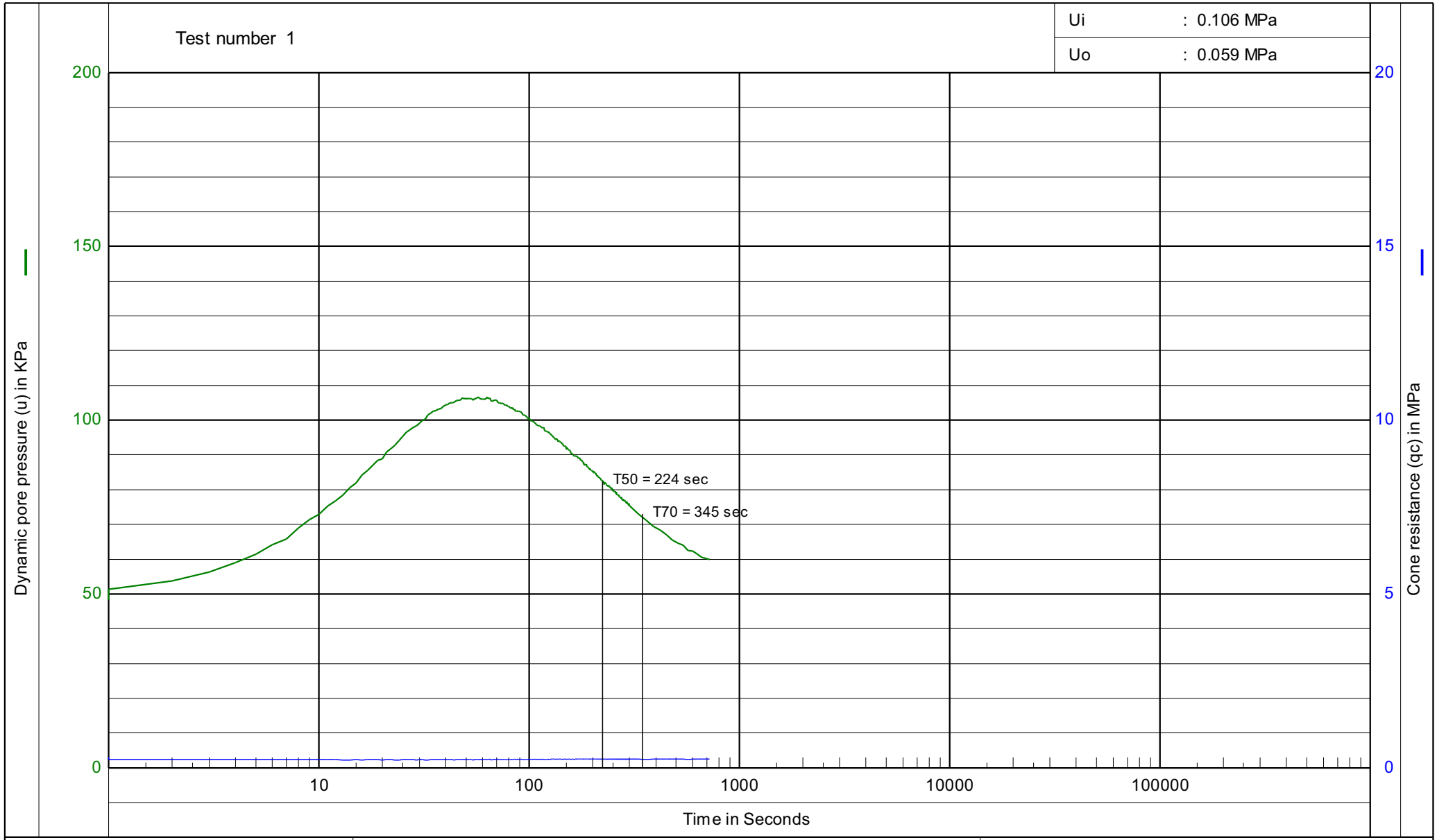
Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-68
Test depth	: 5 m [m] -
Water level	: -2.1 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



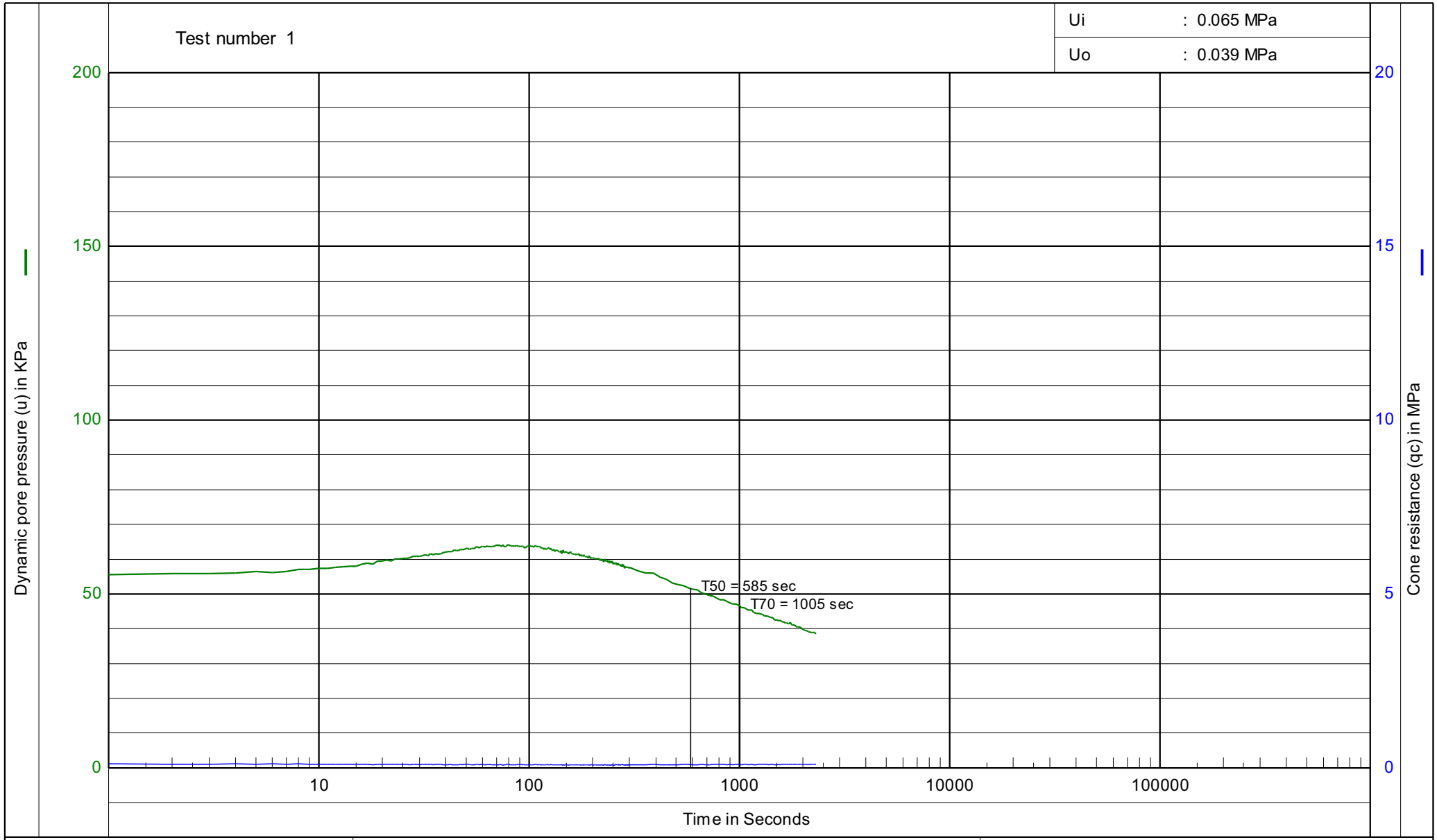
Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-73
Test depth	: 7 m [m] -
Water level	: -2.1 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



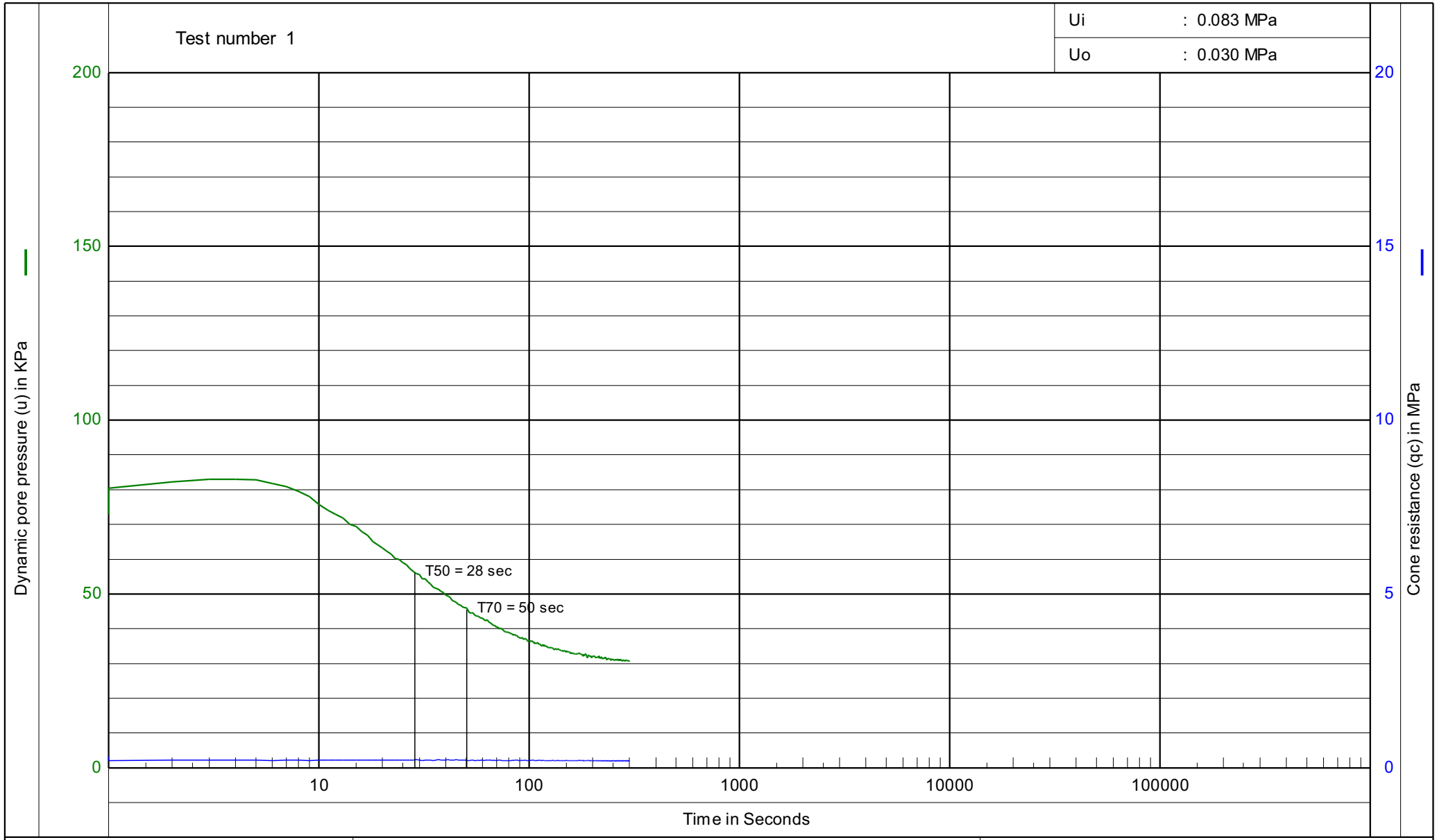
Test according A.S.T.M. standard D 5778-95

Project : Subdivsion Investigations

Location : Western Road - Ngongotaha

Date	: 19/06/2008
Project no.	: 02TT8
CPT no.	: 2-74
Test depth	: 4 m [m] -
Water level	: -2.3 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



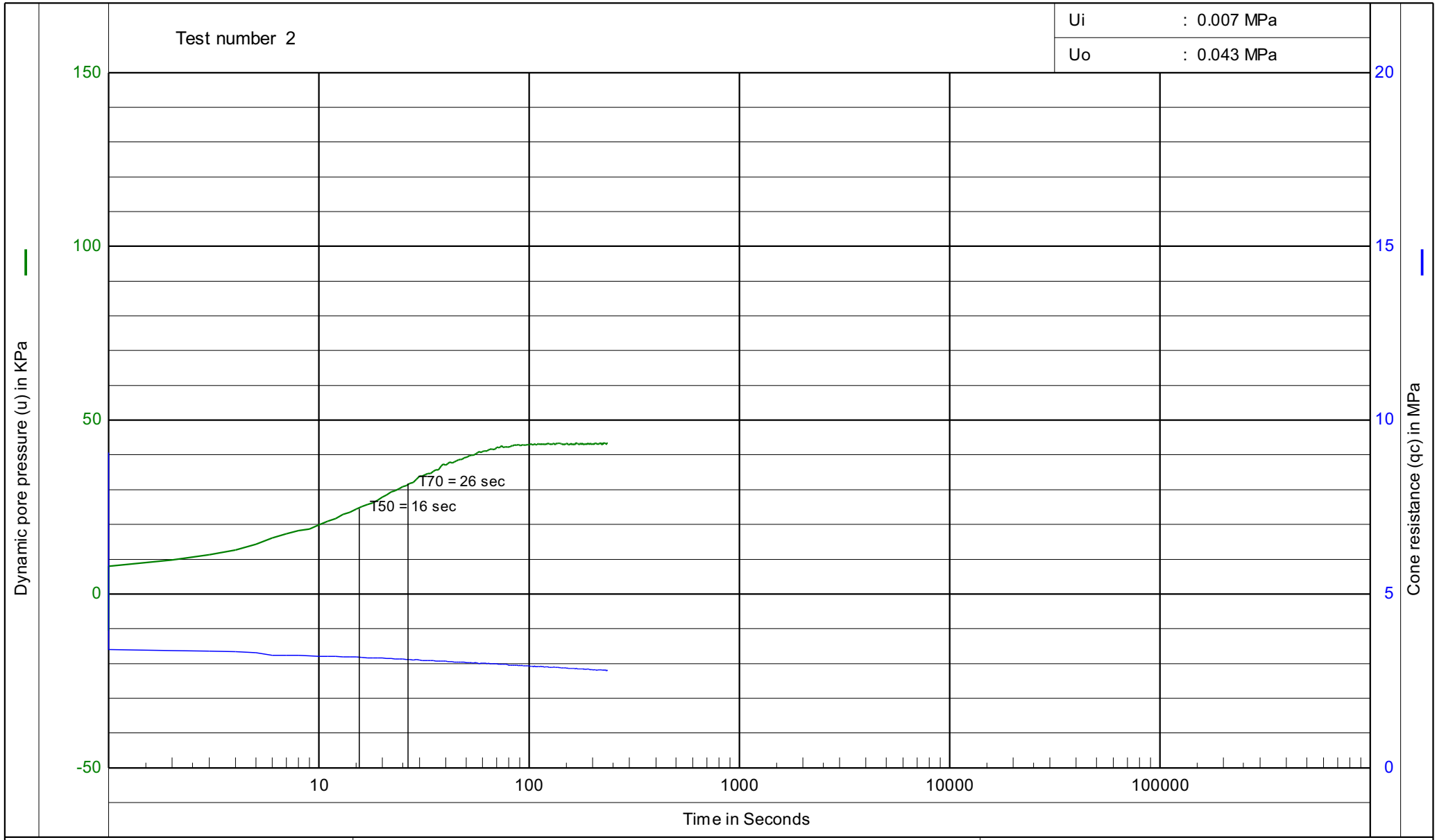
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-24
Test depth	: 5 m [m] -
Water level	: -1.47 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



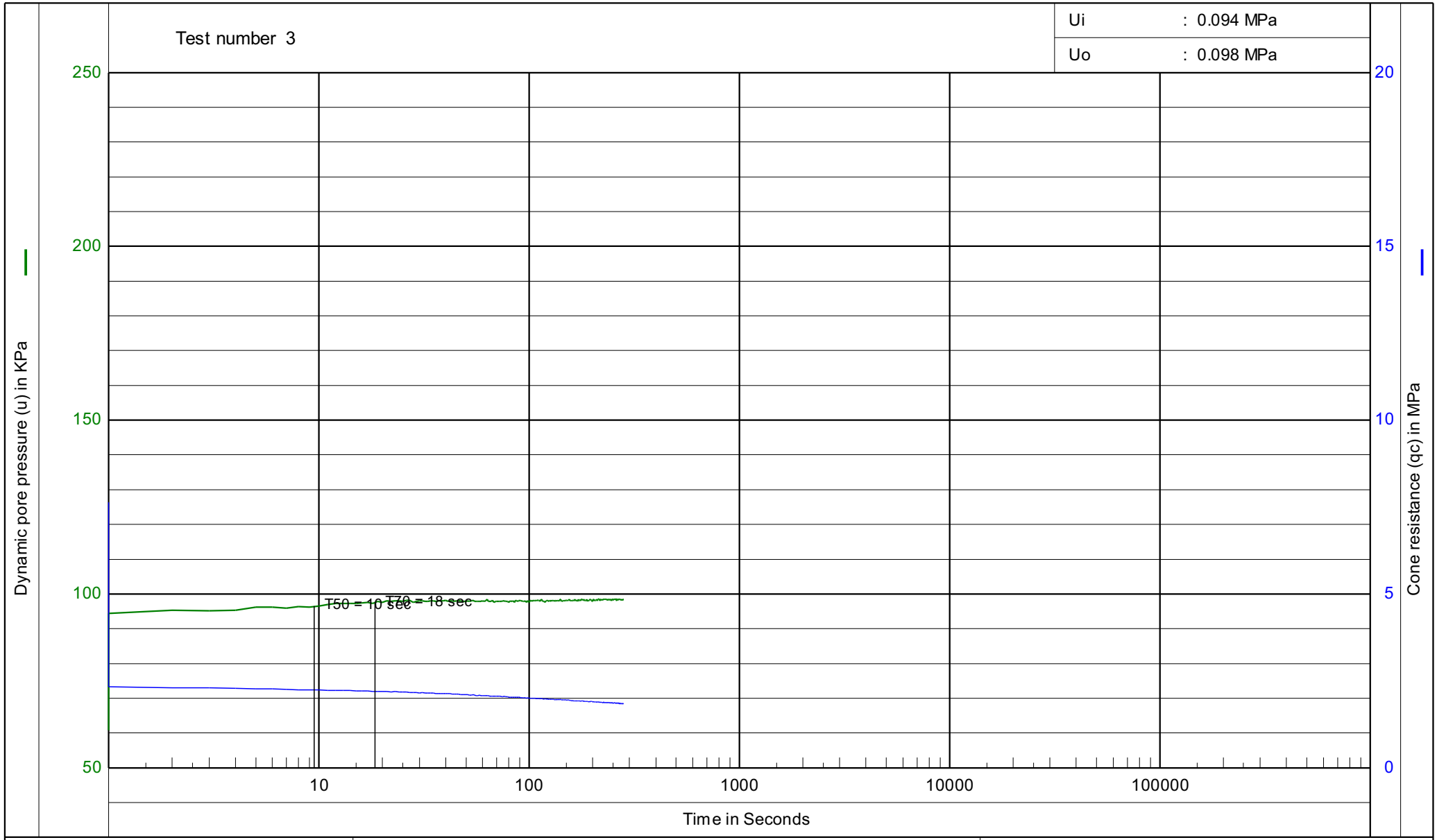
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-24
Test depth	: 6.7 m[m] -
Water level	: -1.47 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



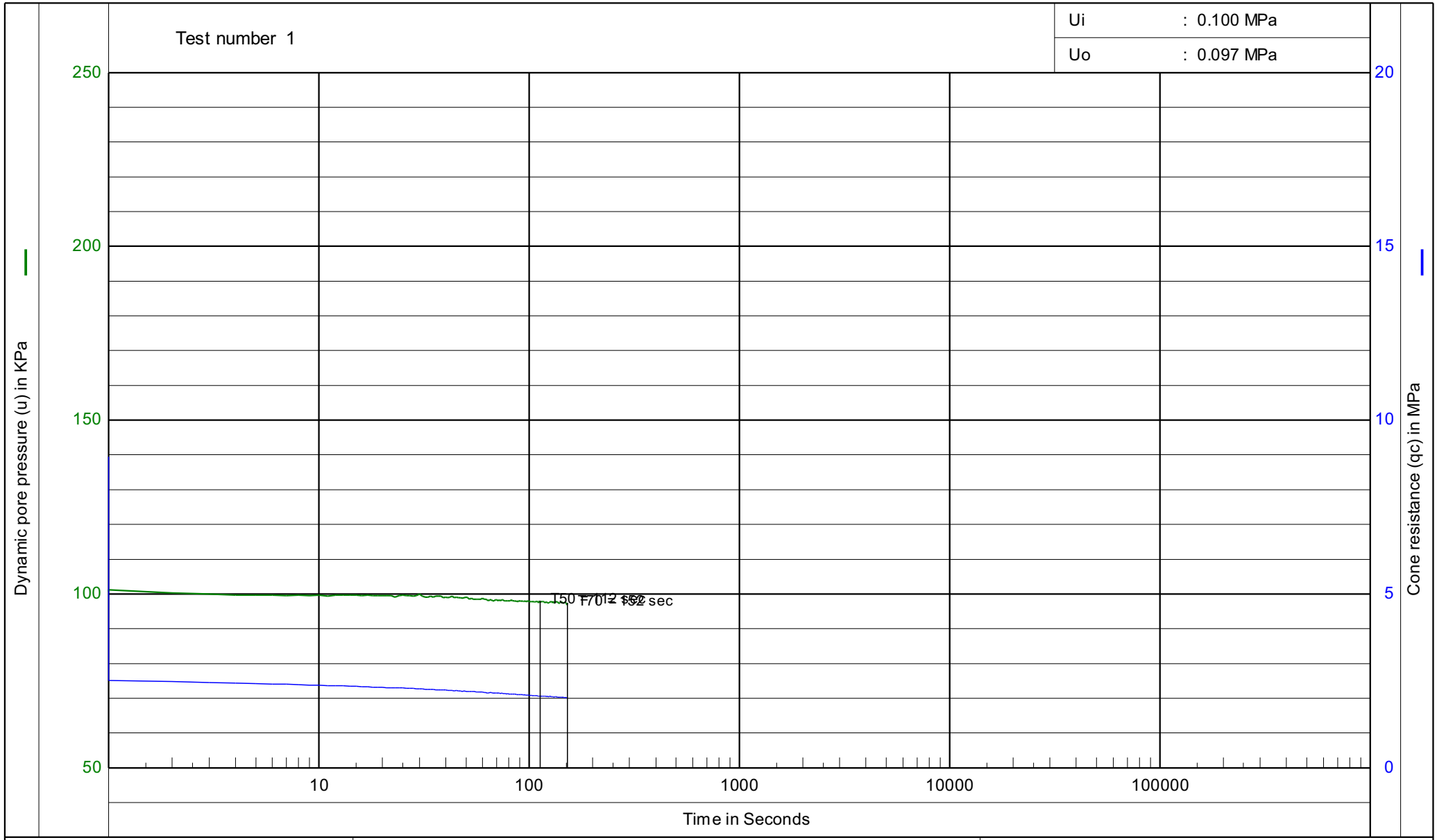
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-24
Test depth	: 13 m [m] -
Water level	: 1.47 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



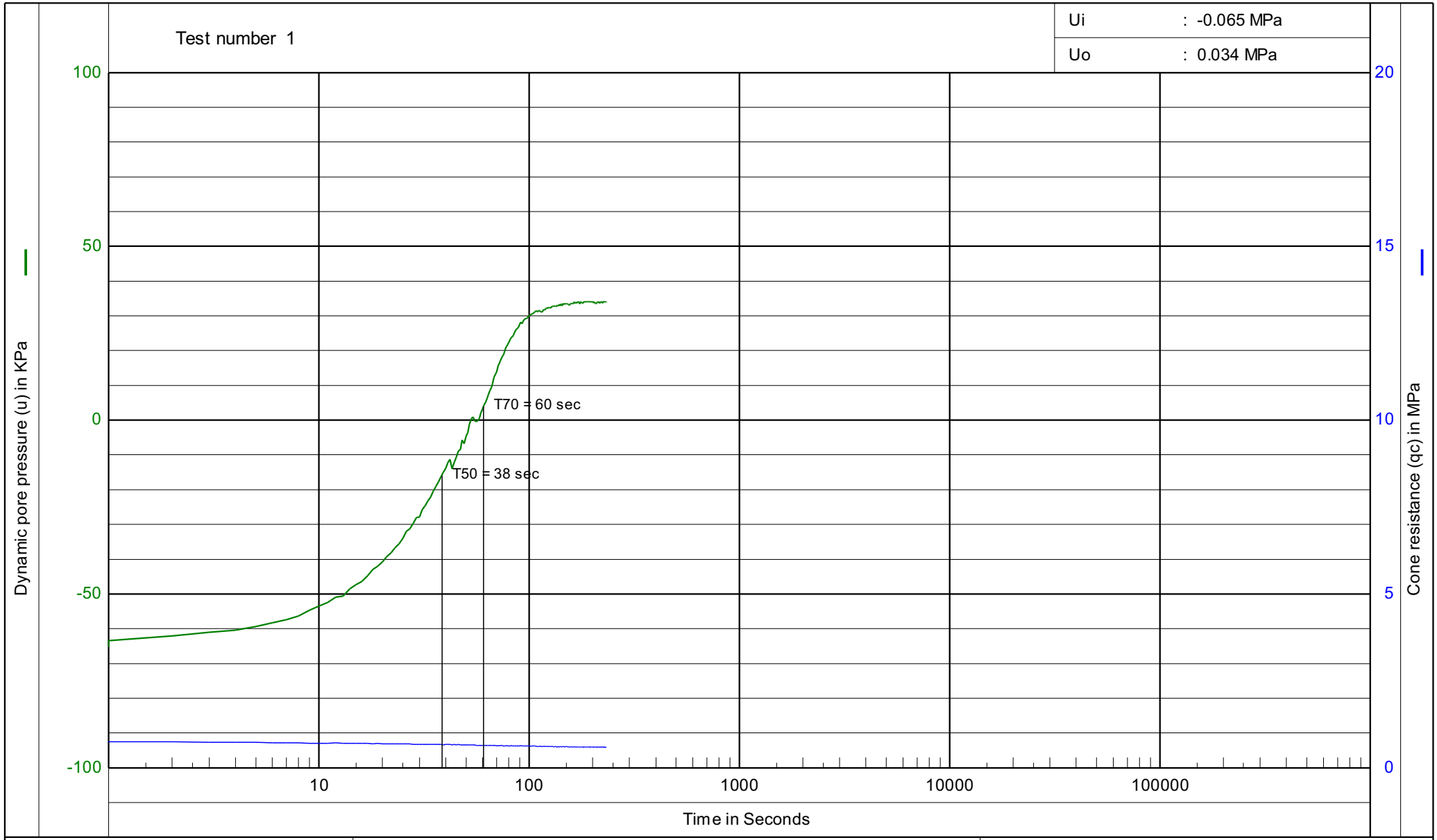
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-26
Test depth	: 12.5 m [m] -
Water level	: -1.46 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



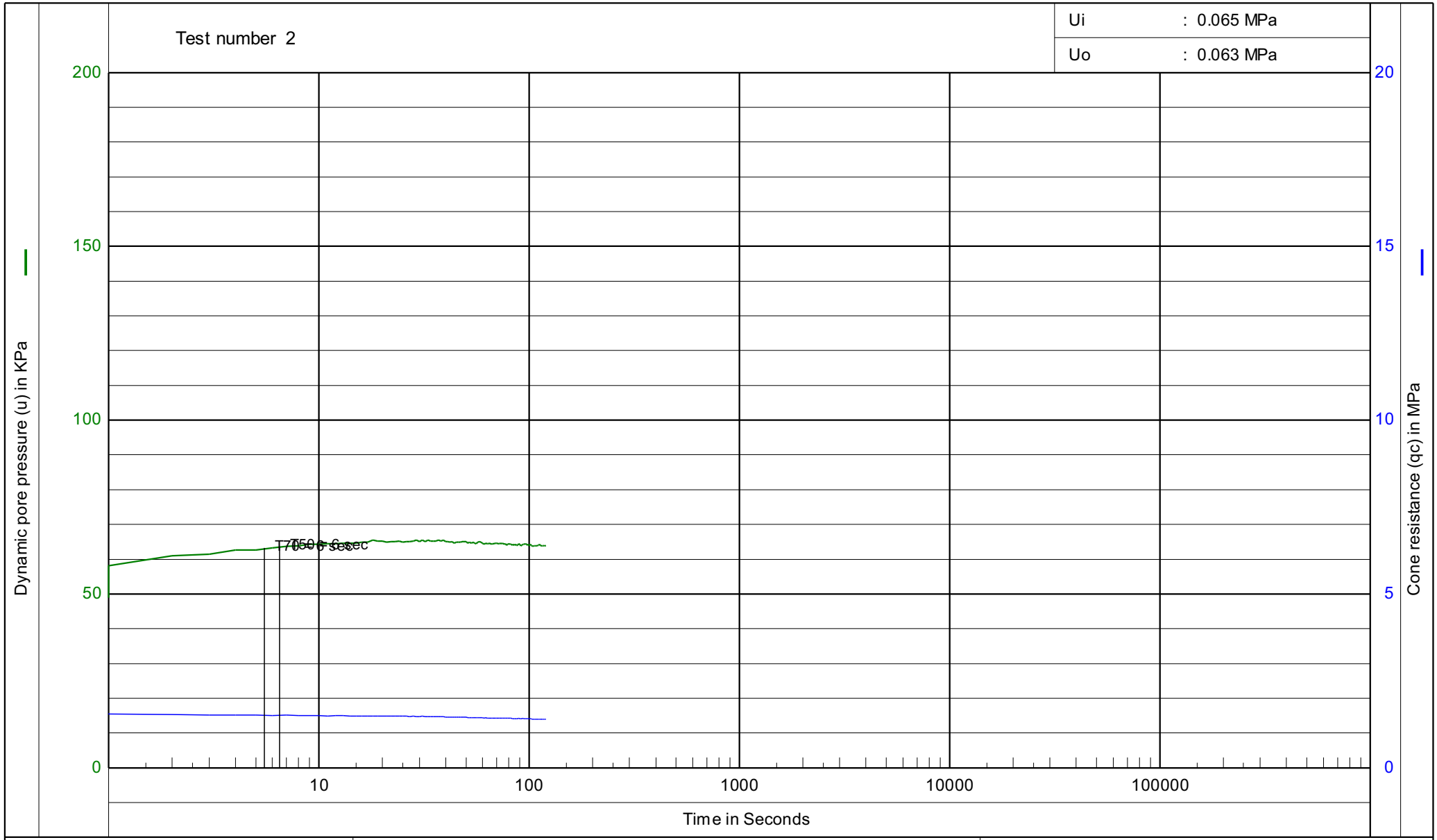
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-28
Test depth	: 6.01 m [m] -
Water level	: -1.4 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



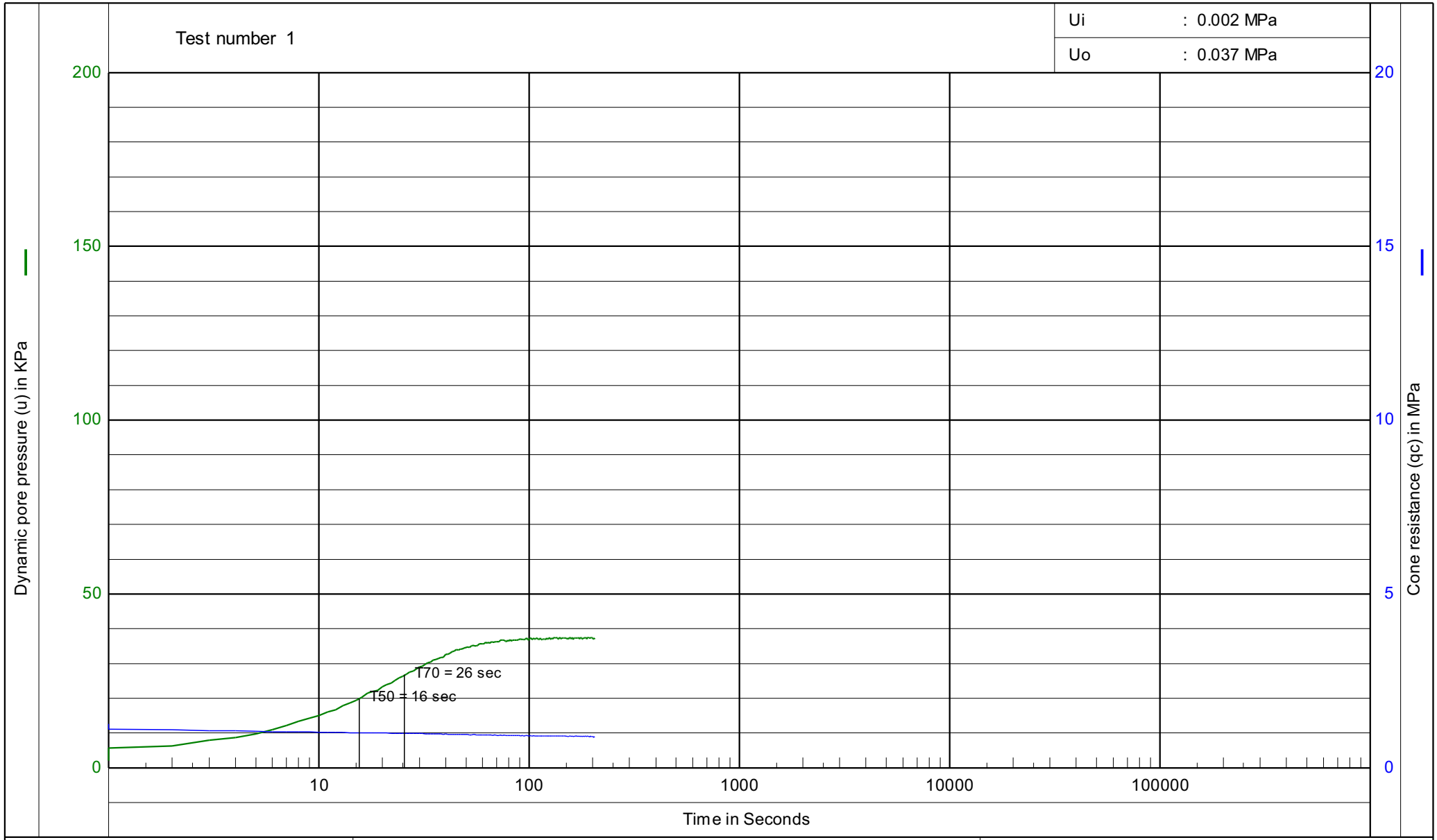
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-28
Test depth	: 9.01 m [m] -
Water level	: -1.4 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

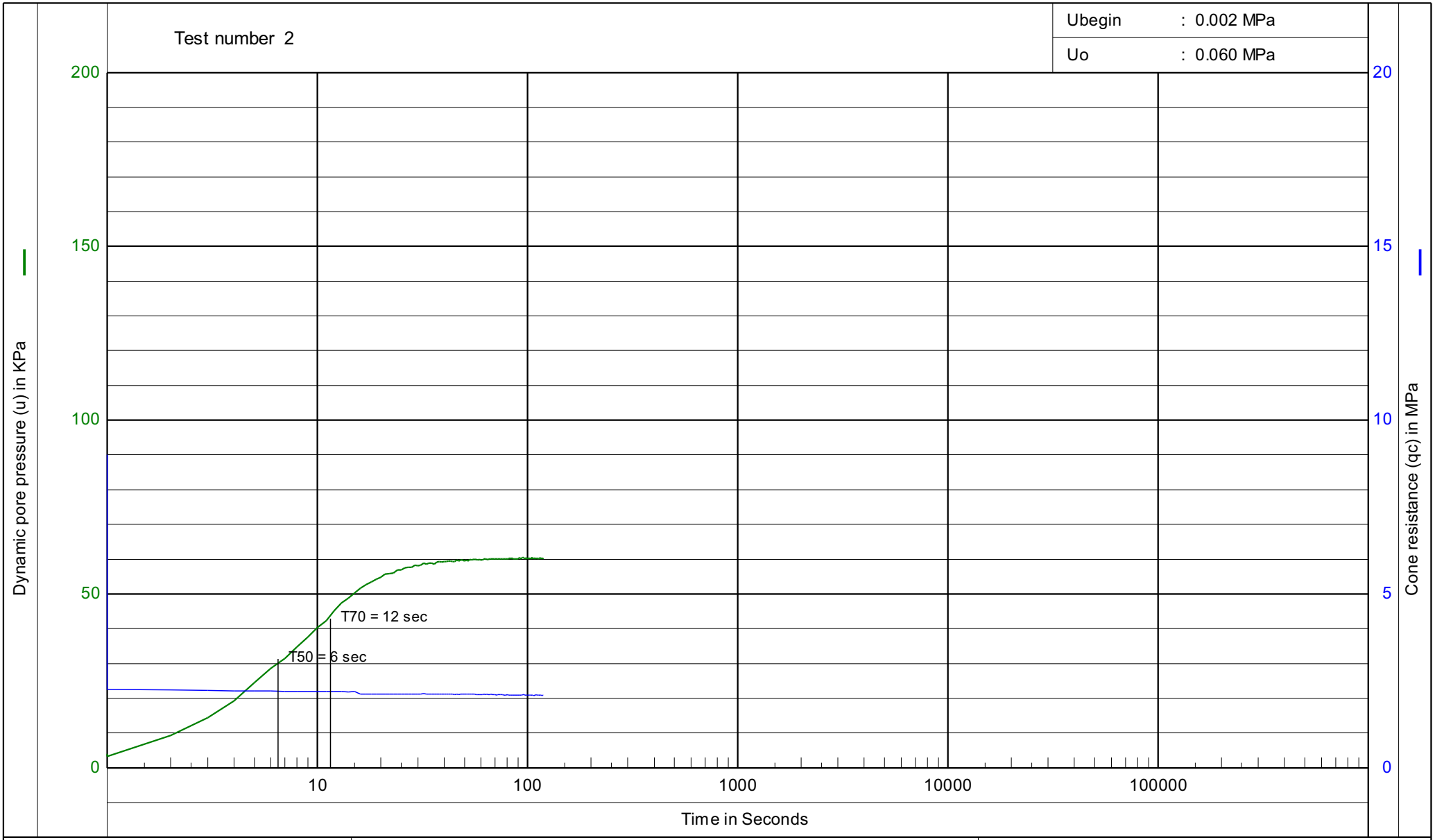
Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-56
Test depth	: 6.21 m [m] -
Water level	: -1.7 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

Test number 2

Ubegin	: 0.002 MPa
Uo	: 0.060 MPa



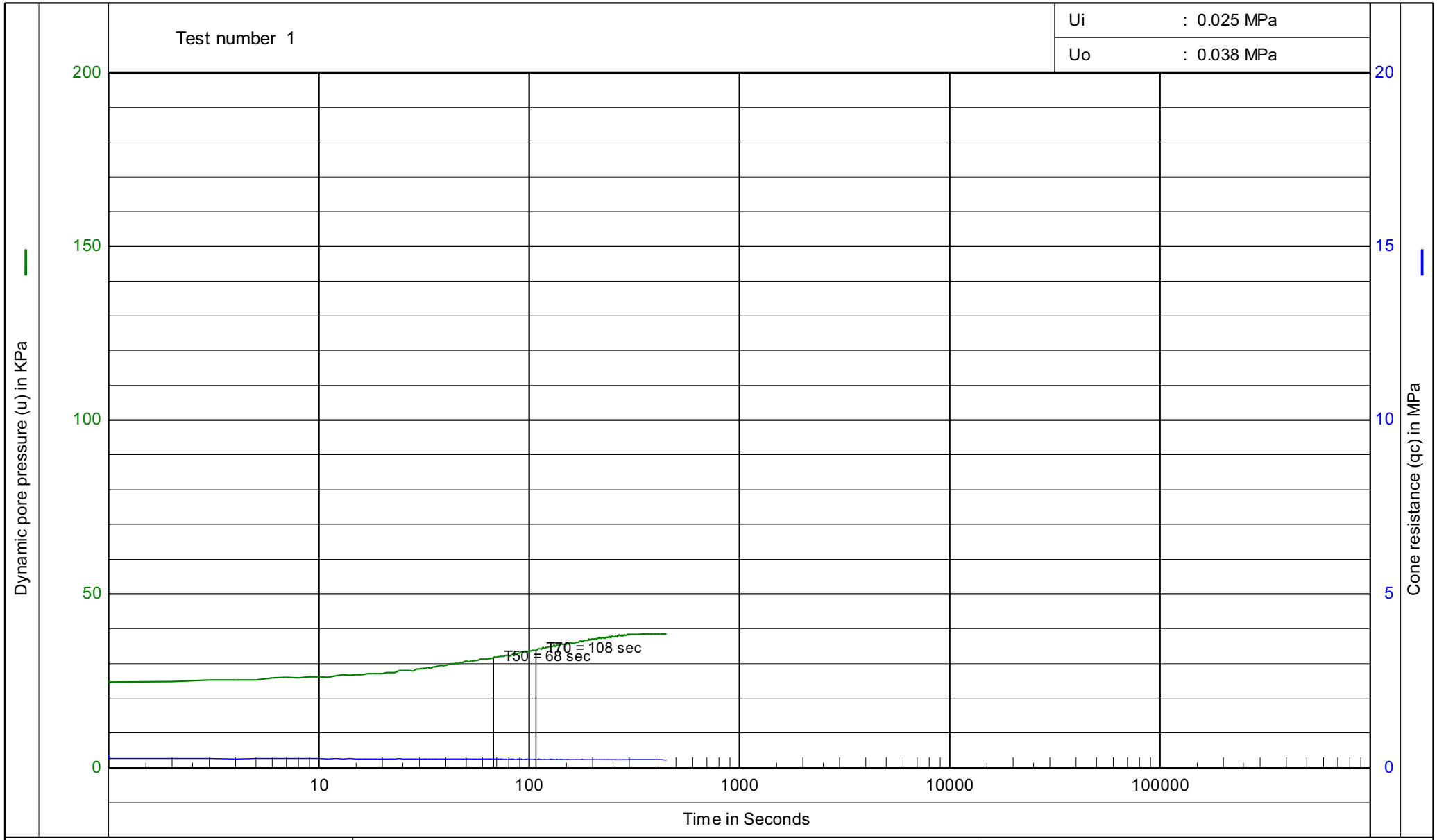
Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-56
Test depth	: 8.53 m [m] -
Water level	: -1.7 [m] -

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009



Test according A.S.T.M. standard D 5778-95

Project : Subdivision Investigations

Location : Western Road - Ngongotaha

Date	: 20/06/2008
Project no.	: 02TT8
CPT no.	: 3-61
Test depth	: 5 m [m] -
Water level	: -1.5 [m] -

Document Set ID: 2699211
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- **Borehole Logs**
- **Annotated Core Photographs**
- **Standpipe Installation Details**

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-64
Hole Location: Lot 64

SHEET 1 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764266.13 mN 376943.98 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 26/06/08 HOLE FINISHED: 26/06/08
R.L.	285.45 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

DEPTH (m)	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	CORE RECOVERY (%)	TESTS	DESCRIPTION
0.0	M.	S			SILT with some sand, mottled, soft, moist, plastic, slightly sensitive. Sand is fine to coarse, well graded. - 0.2m coarse, sub-rounded gravel
0.5	M.	S	66		Sandy SILT, light brown, soft, moist, slightly plastic, insensitive. Sand is fine to coarse, well graded pumice, interbedded.
1.0	M.	MD			Silty, fine to coarse SAND (interbedded) with gravel, yellowish brown, medium dense, moist, well graded. Silt is slightly plastic, insensitive. Gravel is fine to medium, well graded pumice.
1.5	M-W	S	53		Sandy SILT, soft, moist to wet, non-plastic, sensitive. Sand is fine to coarse, well graded, pockets.
1.5	M-W	VS-S			SILT, green-brown to dark brown, very soft to soft, moist to wet, slightly plastic, sensitive.
2.0					- 2m becomes green-brown
2.5					
3.0			100		
3.5			80	Falling Head Test	
4					

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-64
Hole Location: Lot 64

SHEET 2 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764266.13 mN 376943.98 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 26/06/08 HOLE FINISHED: 26/06/08
R.L.	285.45 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

CORE RECOVERY (%)	TESTS	R.L. (m)	DEPTH (m)	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ENGINEERING DESCRIPTION
0	Push Tube	281.0	4.5			
100		280.5	5.0			- 4.6m becomes dark brown
44	Falling Head Test	280.0	5.5			
0	Push Tube	279.5	6.0			
72		279.0	6.5			
		278.5	7.0			
		278.0	7.5	M-W	D	Fine SAND, light grey, dense, moist to wet, poorly graded, dilatant. (Airfall)
		277.5	8			

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-64
Hole Location: Lot 64

SHEET 3 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764266.13 mN 376943.98 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 26/06/08 HOLE FINISHED: 26/06/08
R.L.	285.45 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) | COMPRESSIVE STRENGTH (MPa) | DEFECT SPACING (mm)

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

		0					277.0	8.5			M.	VS-S				- 8.1m becomes coarse SILT, green-brown, very soft to soft, moist, plastic, sensitive. 8.5
		0			Push Tube		276.5	9.0								9.0
							276.0	9.5								9.5
		100					275.5	10.0			M-W	D				Gravelly, fine to coarse SAND, medium dense, moist to wet, dilatant, uniformly graded. Gravel is fine to coarse, water- and organically stained, sub-rounded to sub-angular and has water and organic stains. 10.0
							275.0	10.5								- 10.4 - 10.6m interbedded gravel 10.5
		80					274.5	11.0								- 10.9 - 11.7m interbedded gravel 11.0
							274.0	11.5								11.5
							273.5	12								

ejk

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-64
Hole Location: Lot 64

SHEET 4 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764266.13 mN 376943.98 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 26/06/08 HOLE FINISHED: 26/06/08
R.L.	285.45 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL									ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WEATHERING: MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
			100					273.0 12.5			M-W	L				Gravelly, fine to coarse SAND with cobbles, loose, moist to wet, well graded, slightly dilatant. 12.5
											W	L				- 12.75m 10-20cm layer of gravel (pumice), well graded Fine to coarse SAND, grey, loose, wet. 13.0
			60					272.0 13.5			M-W	L-MD				Fine to coarse SAND, brownish green, loose to medium dense, moist to wet, uniformly graded, uniformly bedded. 13.5
								271.5 14.0								14.0
								271.0 14.5								14.5
								270.5 15.0								**End of borehole at 15m.** 15.0
								270.0 15.5								15.5
								269.5 16								

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-79
Hole Location: Lot 79

SHEET 1 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764382.55 mN 376934.8 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 25/06/08 HOLE FINISHED: 25/06/08
R.L.	285.73 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL																ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
			79					285.5	0			M.	S-F				Sandy SILT, dark brown, soft to firm, moist, slightly plastic, insensitive. Sand is fine to coarse, well graded.
								285.0	0.5			D-M	F-St				Silty, very fine to fine SAND, light grey-brown, firm to stiff, dry to moist, uniform, chalky feel. Silt is non-plastic, insensitive. 0.5
								284.5	1.0			M.	L				Fine to coarse SAND, light grey-brown with some iron staining, loose, moist, well graded. (Alluvial sand). 1.0
			13					284.0	1.5								- 1.5m - 2.8m occasional patches of organic silt, sand is organic stained 1.5
								283.5	2.0								2.0
								283.0	2.5								2.5
			100			Falling Head Test		282.5	3.0			M-W	VS-S				SILT, dark brown (top) to light brown (bottom), very soft to soft, moist to wet, uniform, plastic, sensitive at 3.0 - 3.2m. 3.0
								282.0	3.5								- 3.3m - 3.5m greenish brown 3.5
									4								

ejk

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-79
Hole Location: Lot 79

SHEET 2 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764382.55 mN 376934.8 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 25/06/08 HOLE FINISHED: 25/06/08
R.L.	285.73 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

CORE RECOVERY (%)	TESTS	R.L. (m)	DEPTH (m)	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	
		281.5	4.5			No Recovery.
17						
0	Push Tube	281.0	5.0			
	Falling Head Test	280.5	5.5			
65		280.0	6.0	M-W	D	Very fine to coarse SAND, white and light grey, dense, moist to wet, slight interbedding, sensitive (volcanic). White sand is poorly graded. Light grey sand is well graded.
18		279.5	6.5	M-W	VS-S	SILT, brown to green-brown, very soft to soft, moist to wet, uniform, plastic, sensitive at 7.1m - 7.3m.
0	Push Tube	279.0	7.0			- 7.3m decomposed wood fragments
100		278.5	7.5	M-W	D	Fine to coarse SAND, light grey, dense, moist to wet, poorly graded (fine at top and coarse at bottom), sensitive.
		278.0	8	W	VS-S	SILT, dark brown-black, very soft to soft, wet, non-plastic, sensitive (organic amorphous peat).

4.5 5.0 5.5 6.0 6.5 7.0 7.5

gek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-79
Hole Location: Lot 79

SHEET 3 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764382.55 mN 376934.8 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 25/06/08 HOLE FINISHED: 25/06/08
R.L.	285.73 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

R.L. (m)	DEPTH (m)	CORE RECOVERY (%)	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	Description
277.5	8.5	100	M.	VS-S	Sandy SILT, brown, very soft to soft, moist to wet, uniform, plastic, slightly sensitive, dilatant. Sand is fine to medium with some coarse, well graded. - 8.1m wood fragments
	8.5		M-W	L-MD	Gravelly, fine to coarse SAND, grey with occasional yellow-orange iron staining, loose to medium dense, moist to wet, inderbedded with some sand layers (no gravel), well graded, highly pumiceous. Gravel is fine to coarse, rounded to sub-angular pumice.
277.0	9.0				- 9.0m - 9.3m slightly silty
276.5					- 9.3m - 9.6m fine to coarse sandy layer
	9.5	80			
276.0					
	10.0				
275.5					
	10.5				- 10.5m - 10.6m fine to coarse sand layer
275.0		53	M-W	MD-D	SILT, light grey, medium dense to dense, moist to wet, uniform, non-plastic, sensitive, quick, highly dilatant (airfall).
	11.0				
274.5					
	11.5				
274.0					
	12				

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH2-79
Hole Location: Lot 79

SHEET 4 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764382.55 mN 376934.8 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 25/06/08 HOLE FINISHED: 25/06/08
R.L.	285.73 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: QuickMud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | WEATHERING: MOISTURE CONDITION | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

DEPTH (m)	R.L. (m)	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	CORE RECOVERY (%)	DESCRIPTION
12.5	273.5	M-W	MD		Fine to medium SAND, light grey, medium dense, moist to wet, uniform, well graded, sensitive, quick.
		M-W	L		
13.0	273.0			73	Gravelly, fine to coarse SAND, dark grey to grey, loose, moist to wet, slightly bedded, well graded. Gravel is fine to coarse, well graded, sub-rounded to round (andesite).
13.5	272.5	M.	L-MD		Fine to coarse SAND, highly iron stained dark orange to light brown, loose to medium dense, moist, uniform, well graded. Some parts slightly welded.
14.0	272.0			100	
14.5	271.5				
15.0	271.0	M.	F		SILT with some sand, light yellowish brown, firm, moist, interbedded, non-plastic, insensitive. Sand is fine.
15.5	270.5				**End of borehole at 15m.**
16	270.0				

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH3-58
Hole Location: Lot 58

SHEET 1 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764315.18 mN 376794.36 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 24/06/08 HOLE FINISHED: 24/06/08
R.L.	286.32 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: Quickmud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

DEPTH (m)	R.L. (m)	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	CORE RECOVERY (%)	DESCRIPTION
0	286.0	M.	S		Sandy SILT, dark brown, to yellow-brown (mottled), soft, moist, slightly plastic. Sand is fine to coarse, well graded.
0.5	285.5	M.	D	95	Fine to medium SAND, light grey, dense, moist, poorly graded, uniform.
1.0	285.0	M.			- 0.9m sensitive
1.5	284.5		S.		Fine to coarse SAND, grey, moist, well graded, interbedded.
2.0	284.0		S	67	- 1.3m - 1.4m soft soft, non-plastic silt - 1.72m lense of fine silt, soft, sensitive - 1.75m - 2.5m sand becomes medium to coarse with some fine
2.5	283.5				- 2.45m iron fine welded seam - 2.5m - 3m sand is fine to medium
3.0	283.0			0	No Recovery
3.5	282.5				
4					

eek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH3-58
Hole Location: Lot 58

SHEET 2 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764315.18 mN 376794.36 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 24/06/08 HOLE FINISHED: 24/06/08
R.L.	286.32 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: Quickmud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

R.L. (m)	DEPTH (m)	CORE RECOVERY (%)	TESTS	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ENGINEERING DESCRIPTION
282.0	4.5		Falling Head Test	M-W	VS-S	SILT, dark green, very soft, to soft, moist to wet, uniform, slightly plastic, sensitive.
281.5	5.0	90				
281.0	5.5	0	Push Tube	W	VS	SILT, dark brown to brown, very soft, wet, uniform layer, slightly plastic, sensitive, dilatant.
280.5	6.0					
280.0	6.5	100	Falling Head Test			
279.5	7.0	53				
279.0	7.5			M-W	VD-D	Fine to medium SAND, white to light grey, very dense to dense, moist to wet, interbedded layers ranging from 2mm - 50mm, non-plastic, sensitive in fine sand. Fine sand at top with medium sand at the
278.5	8					

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH3-58
Hole Location: Lot 58

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764315.18 mN 376794.36 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 24/06/08 HOLE FINISHED: 24/06/08
R.L.	286.32 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: Quickmud	LOGGED BY: AJM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) | COMPRESSIVE STRENGTH (MPa) | DEFECT SPACING (mm)

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

R.L. (m)	DEPTH (m)	CORE RECOVERY (%)	TESTS	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	ENGINEERING DESCRIPTION
						bottom.
278.0	8.5	31				8.5
277.5			Falling Head Test			
	9.0			W	VS	9.0 SILT, dark brown to brown, very soft, wet, uniform layer, slightly plastic, sensitive, dilatant. - 9.12m 4cm layer of fine to medium sand, white to light grey, medium dense, wet, well graded, pumice
277.0		73				
	9.5					9.5 - 9.78m - 9.9m wood fragments
276.5				M.	VD-D	
	10.0					10.0 Fine to medium SAND, light grey, medium dense to dense, moist, uniform layer, non-plastic, sensitive at 10.5m - 10.9m.
276.0						
	10.5					- 10.4m - 10.5m some silt, mottled brown to light grey, non-plastic, insensitive 10.5
275.5						
	11.0	100		W	VS-S	SILT, brown, very soft to soft, wet, uniform, slightly plastic, sensitive. 11.0
275.0				W	L	Fine to medium SAND with organics, light brown, loose, wet, well graded. Organic material is wood fragments.
	11.5			W	L	11.5 Medium to coarse SAND with trace silt, loose, wet, poorly graded. Less silt at the bottom of the layer.
274.5						
	12					

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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GEOTECHNICS LTD

BOREHOLE LOG

BOREHOLE No: BH3-58
Hole Location: Lot 58

SHEET 4 OF 4

PROJECT: WESTERN ROAD		LOCATION: NGONGATOAHA	JOB No: 851126
CO-ORDINATES	764315.18 mN 376794.36 mE	DRILL TYPE: KUBOTO	HOLE STARTED: 24/06/08 HOLE FINISHED: 24/06/08
R.L.	286.32 m	DRILL METHOD: HQ3	DRILLED BY: Perry's
DATUM		DRILL FLUID: Quickmud	LOGGED BY: AJM CHECKED:

GEOLOGICAL																ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
								274.0			M-W	L				Fine to medium SAND interbedded with silt, grey, loose, moist to wet, well graded. Silt is grey, moist to wet, slightly plastic, insensitive.
								12.5			W	L				Fine to coarse SAND with gravel, grey, loose, wet, well graded. Gravel is fine to coarse. 12.5
			78					273.5			W	L				SAND with some gravel, green and yellow-brown, loose, wet, slightly interbedded. Gravel is fine to coarse, stained green (dark in some areas) well graded, rounded to sub-angular.
								13.0								13.0
								273.0								
								13.5								13.5
								272.5								
								14.0			W	D				- 14m 5cm layer of gravelly, fine to coarse sand, purple-brown, dense, wet, well graded. Gravewl is fine to coarse, angular so sub-angular, well graded. 14.0
			73					272.0								
								14.5								14.5
								271.5								
								15.0			M.	D				Fine to medium SAND, grey, dense, moist, poorly graded, interbedded. 15.0
								271.0								**End of borehole at 15m.**
								15.5								15.5
								270.5								
								16								

ek

Log Scale 1:20

BORELOG BORELOGS.GPJ 08/10/08

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Photograph 1: BH1-64 core from 0.0 to 4.0m below ground level.



Photograph 2: BH1-64 core from 4.0 to 9.6m below ground level.

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Photograph 3: BH1-64 core from 9.6 to 12.5m below ground level.



Photograph 4: BH1-64 core from 12.5 to EOH at 15.0m below ground level.

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Photograph 5: BH2-79 core from 0.0 to 6.0m below ground level.



Photograph 6: BH2-79 core from 6.0 to 9.3m below ground level.

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Photograph 7: BH2-79 core from 9.3 to 13.5m below ground level.



Photograph 8: BH2-79 core from 13.5 to EOH at 15.0m below ground level.

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Photograph 9: BH3-58 core from 0.0 to 4.9m below ground level.



Photograph 10: BH3-58 core from 4.9 to 9.6m below ground level.

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Photograph 11: BH3-58 core from 9.6 to 13.1m below ground level.



Photograph 12: BH3-58 core from 13.1 to EOH at 15.0m below ground level.

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GEO PROBE
A DIVISION OF PERRY DRILLING
Geotechnical Drilling and Environmental Specialists

Greerton, Tauranga
Tel: 07 578 0072
Fax: 07 577 1553
0274 941 174
0274 304 554
Email: office@perrydrilling.co
Website: www.perrydrilling.co

Date: 26/6/8 Client: TONKIN & TAYLOR Attention: RICHARD PHILLIPS

Rig: STEP Driller: WARD

BH 01

SITE LOCATION: WESTERN RD, NGONGOTAHA

Depth		Shear Vane	S.P.T
~~0.0-1.0~~	0.0-1.5 TOPSOIL / BROWN GRAVELLY SILT		
~~1.0-2.0~~	1.5-3.0 BROWN SILT		
~~2.0-3.0~~	3.0-3.5 BROWN SILT		
~~3.0-4.0~~	FALLING HEAD TEST @ 3.5m		
~~4.0-5.0~~	3.5-4.0 BROWN SILT		
~~5.0-6.0~~	4.0-4.6 PUSHTUBE		
~~6.0-7.0~~	4.6-5.0 BROWN SILT		
~~7.0-8.0~~	FALLING HEAD TEST @ 5.4m		
~~8.0-9.0~~	5.0-5.5 BROWN SILT		
~~9.0-10.0~~	5.5-6.1 PUSHTUBE		
~~10.0-11.0~~	6.1-7.5 BROWN SILT / WHITE SAND		
~~11.0-12.0~~	7.5-8.4 WHITE SAND		
~~12.0-13.0~~	8.4-9.0 PUSHTUBE LOST RECOVERY		
~~13.0-14.0~~	9.0-10.5 WHITE SAND		
~~14.0-15.0~~	10.5-12.0 WHITE PUMICE		
~~15.0-16.0~~	12.0-13.5 WHITE PUMICE / GREEN SAND		
~~16.0-17.0~~	13.5-15.0 GREEN SAND		
17.0-18.0			
18.0-19.0			
19.0-20.0			
20.0-21.0			
21.0-22.0			
22.0-23.0			
23.0-24.0			
24.0-25.0			
25.0-26.0			
26.0-27.0			
27.0-28.0			
28.0-29.0			
29.0-30.0			

Note:

HW. Depth 3.0

Mud used: DRILLPRO

Push Tube: 3
Number

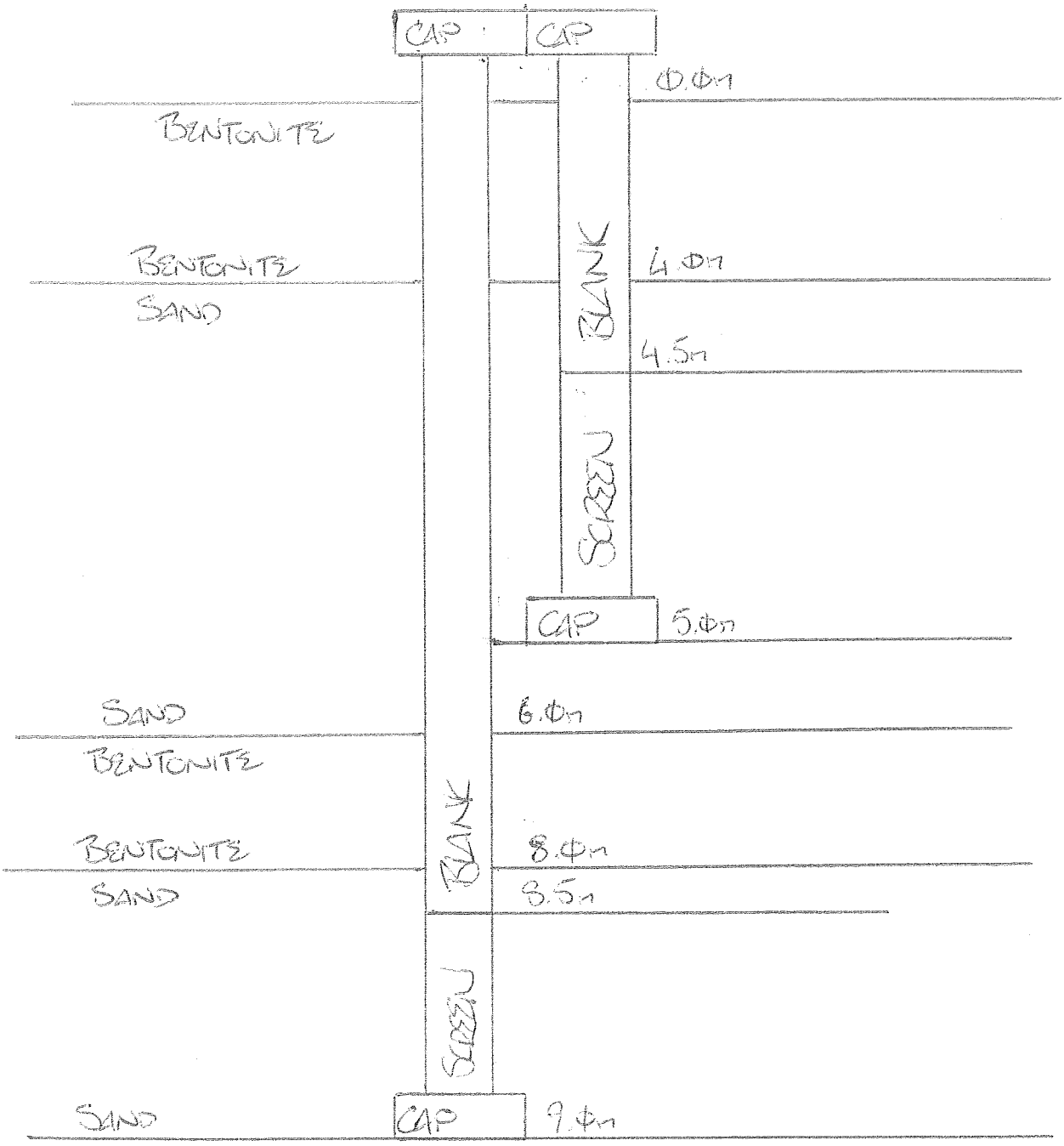
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S.W.L

Document Set ID: 2699211
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26/6/8 TONKIN & TAYLOR WESTERN RD, NGONGOTAHA BH01

Piezo Assault



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GEO PROBE A DIVISION OF PERRY DRILLING
Geotechnical Drilling and Environmental Specialists
Greerton Tauranga 3
Tel: 07 578 0072
Fax: 07 577 1553
0274 941 174
0274 304 554
Email: office@perrydrilling
Website: www.perrydrilling

Date: 25/6/18 Client: TONKIN & TAYLOR Attention: RICHARD PHILLIPS

Rig: ST30 Driller: JARED

BH @2

SITE LOCATION: WESTERN RD, NGONGOTAHA

Depth		Shear Vane	S.P.T
~~0.0-1.0~~	0-1.5 TOPSOIL/WHITE SILTY SAND/GREY SAND		
~~1.0-2.0~~	1.5-3.0 BROWN SAND / BROWN SILT		
~~2.0-3.0~~	3.0-3.5 BROWN SILT		
~~3.0-4.0~~	FALLING HEAD TEST @ 3.5m		
~~4.0-5.0~~	3.5-4.4 BROWN SILT		
~~5.0-6.0~~	4.4-5.0 PUSHTUBE		
~~6.0-7.0~~	FALLING HEAD TEST @ 5.0m		
~~7.0-8.0~~	5.0-6.0 BROWN SILT/WHITE SAND		
~~8.0-9.0~~	6.0-6.5 WHITE SAND / BROWN SILT		
~~9.0-10.0~~	6.5-7.1 PUSHTUBE		
~~10.0-11.0~~	7.1-7.5 BROWN SILT		
~~11.0-12.0~~	7.5-9.0 BROWN SILT/WHITE PUMICE		
~~12.0-13.0~~	9.0-10.5 WHITE PUMICE/YELLOW PUMICE		
~~13.0-14.0~~	10.5-12.0 YELLOW PUMICE/WHITE SILT		
~~14.0-15.0~~	12.0-13.5 WHITE SILT/GREY SAND		
~~15.0-16.0~~	13.5-15.0 BROWN SAND		
16.0-17.0			
17.0-18.0			
18.0-19.0			
19.0-20.0			
20.0-21.0			
21.0-22.0			
22.0-23.0			
23.0-24.0			
24.0-25.0			
25.0-26.0			
26.0-27.0			
27.0-28.0			
28.0-29.0			
29.0-30.0			

Note:

HW. Depth 3.0

Mud used: DRILL PRO

Push Tube: 2

Number

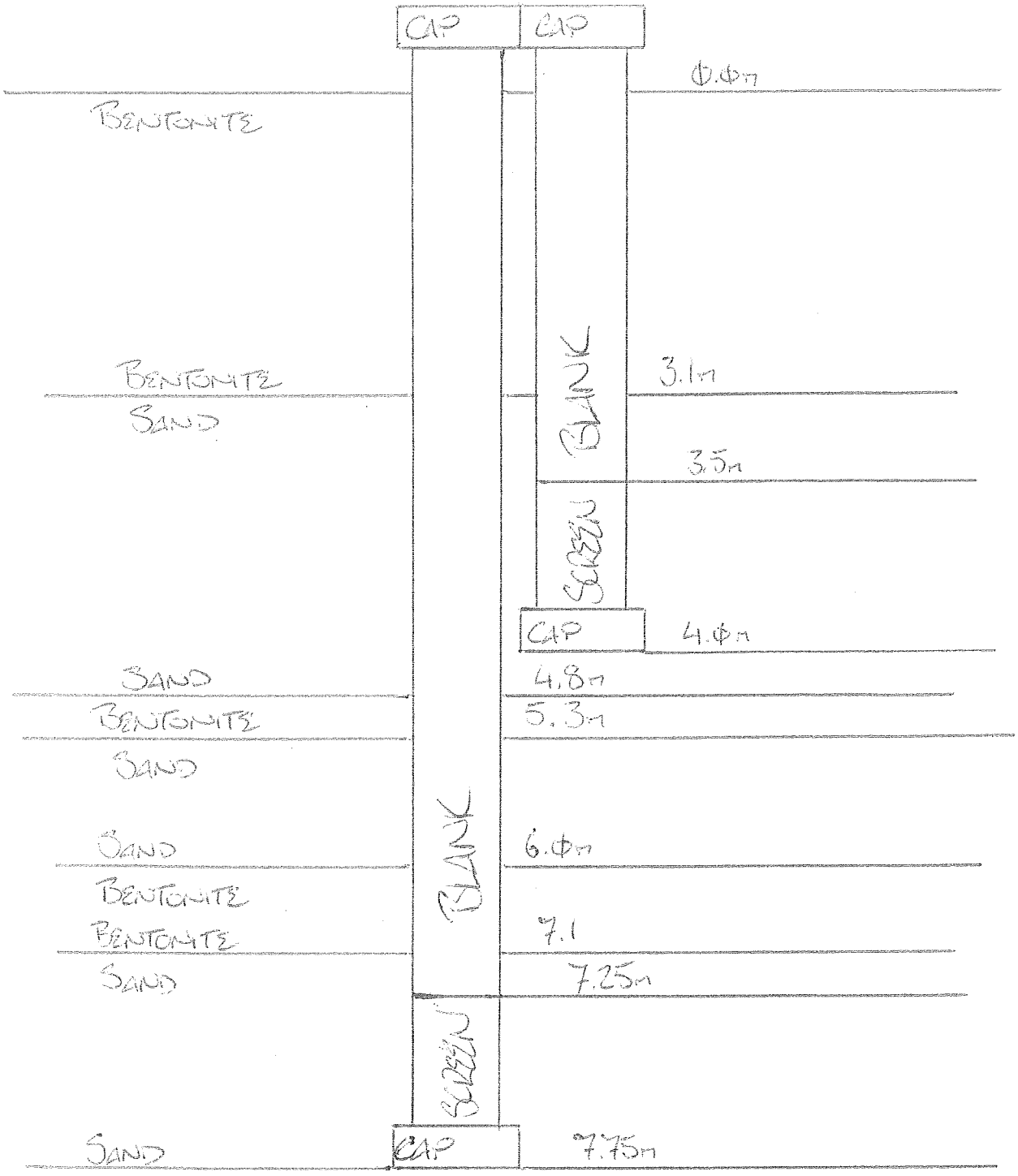
Core Boxes 4

S.W.L

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25/6/18 TONKIN & TAYLOR WESTERN RD, NGONGOTAHA BH02

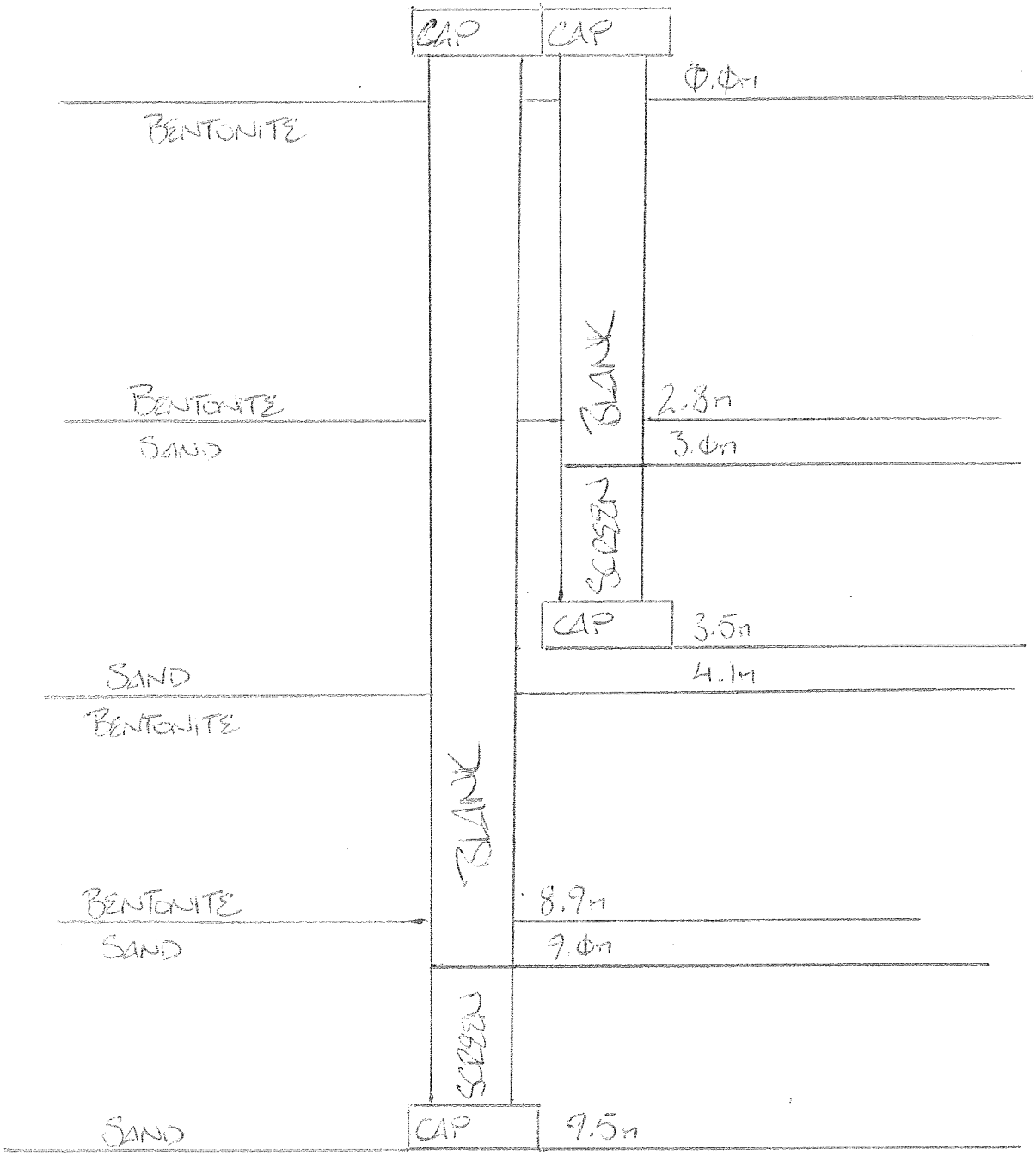
PIEZO ASBUILT



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24/6/8 TONKIN & TAYLOR WESTERN RD, NGONGOTAHA BH03

Piezo Assault



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Version: 2, Version Date: 27/04/2009

Appendix D: Laboratory Testing Results

- **Figure 6.2.1: BH2-64 Sample 4.10 to 4.60m below ground level (Applied Pressure vs Void Ratio Plot)**
- **Figure 6.2.2: BH2-64 Sample 5.71 to 5.73m below ground level (Applied Pressure vs Void Ratio Plot)**
- **Figure 6.2.3: BH2-64 Sample 5.95 to 5.97m below ground level (Applied Pressure vs Void Ratio Plot)**
- **Figure 6.2.4: BH2-64 Sample 4.10 to 4.60m below ground level**
- **Figure 6.2.5: Results for All Samples (50 or 60kPa Load Stage)**

- **Opus International Consultants Limited**

Natural Moisture Content

Atterberg Limits

One-Dimensional Consolidation

- **Geotechnics Ltd**

Atterberg Limits

Particle Size Distribution

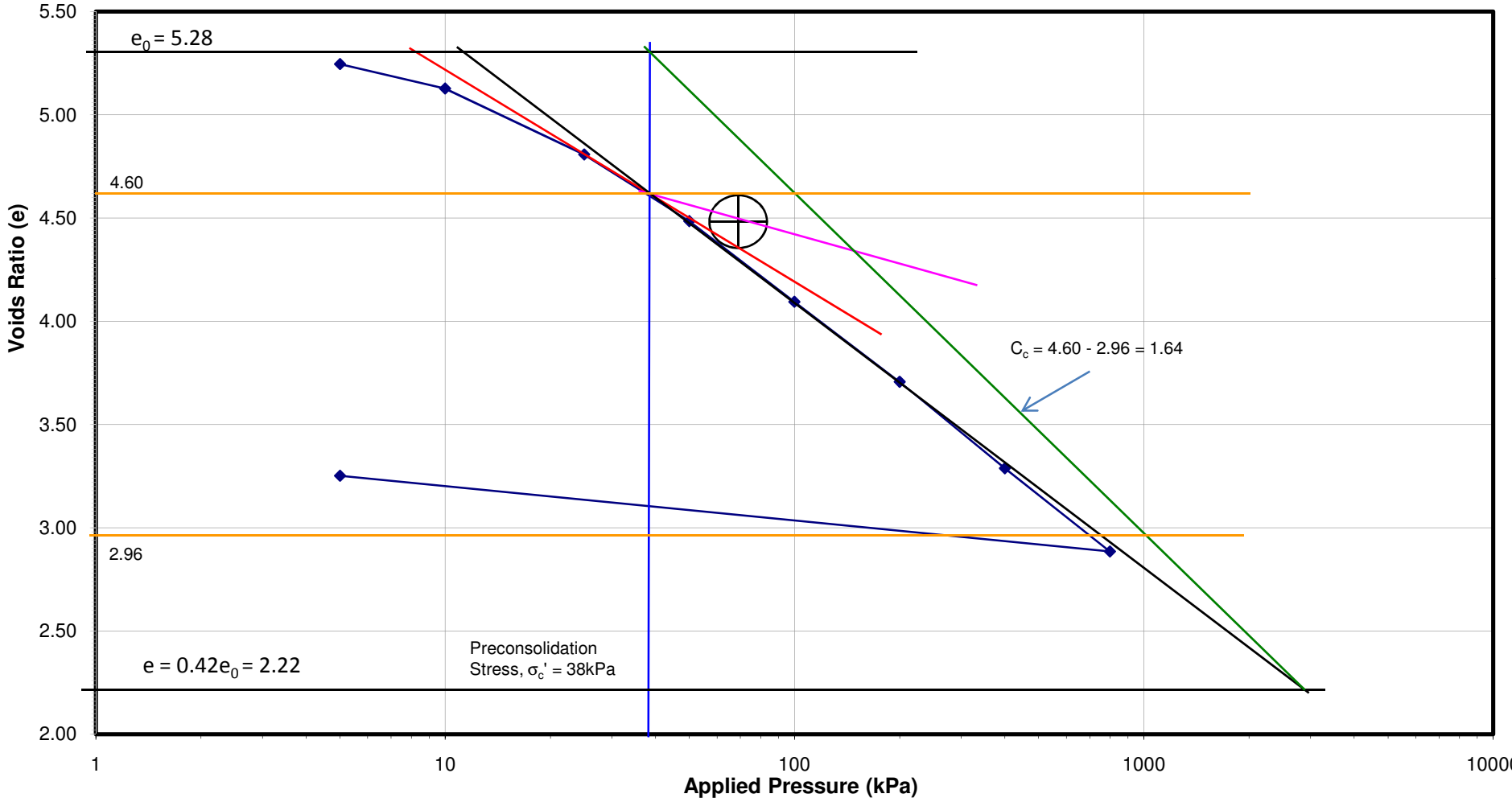
One-Dimensional Consolidation

- **SGS New Zealand Ltd**

Organic Content

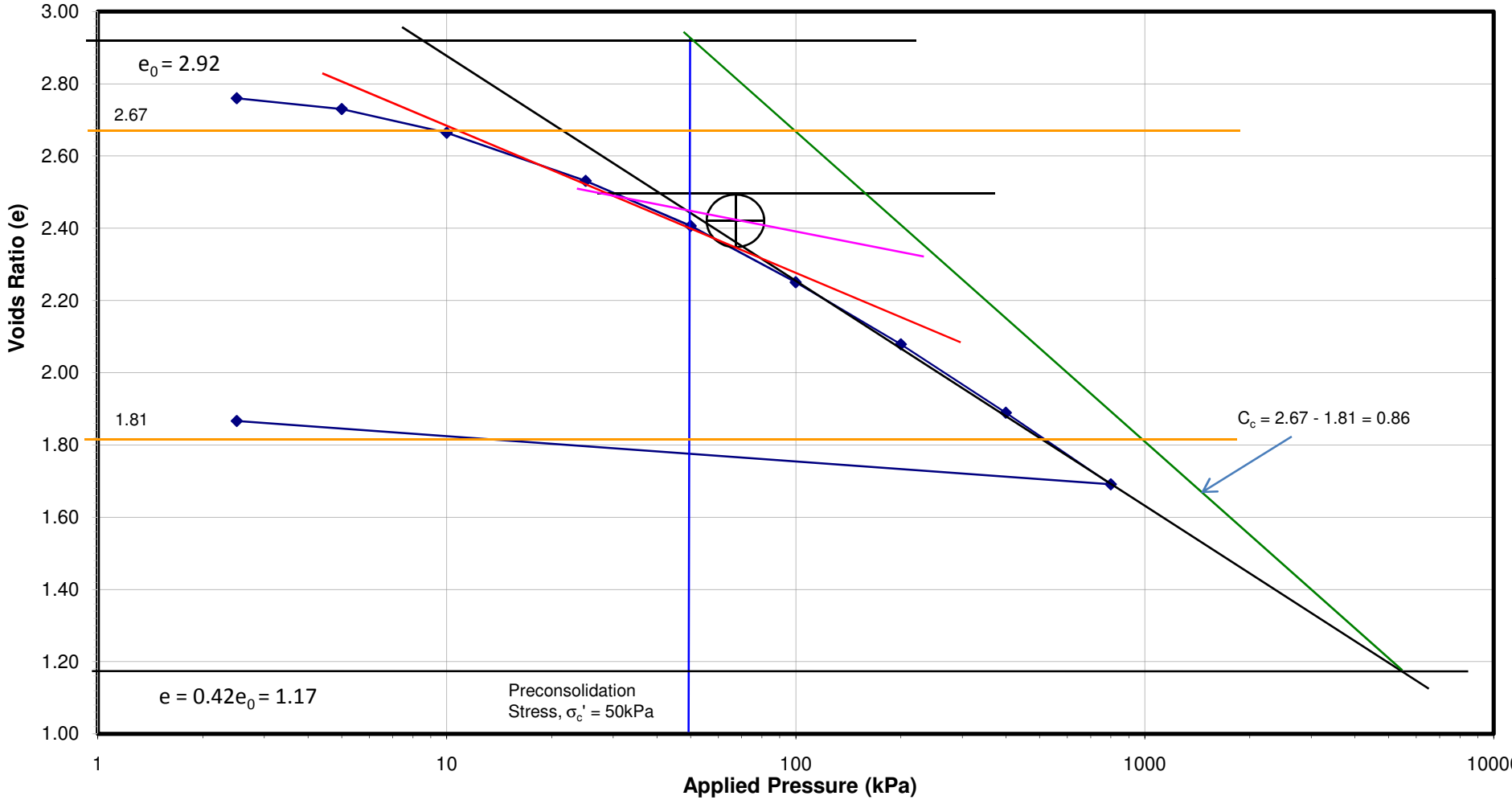
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Western Road, Ngongotaha
Geotechnical Assessment Report
One-Dimensional Consolidation Tests Results
Figure 6.2.1: BH2-64 Sample 4.10 to 4.60m below ground level (Applied Pressure vs Void Ratio Plot)



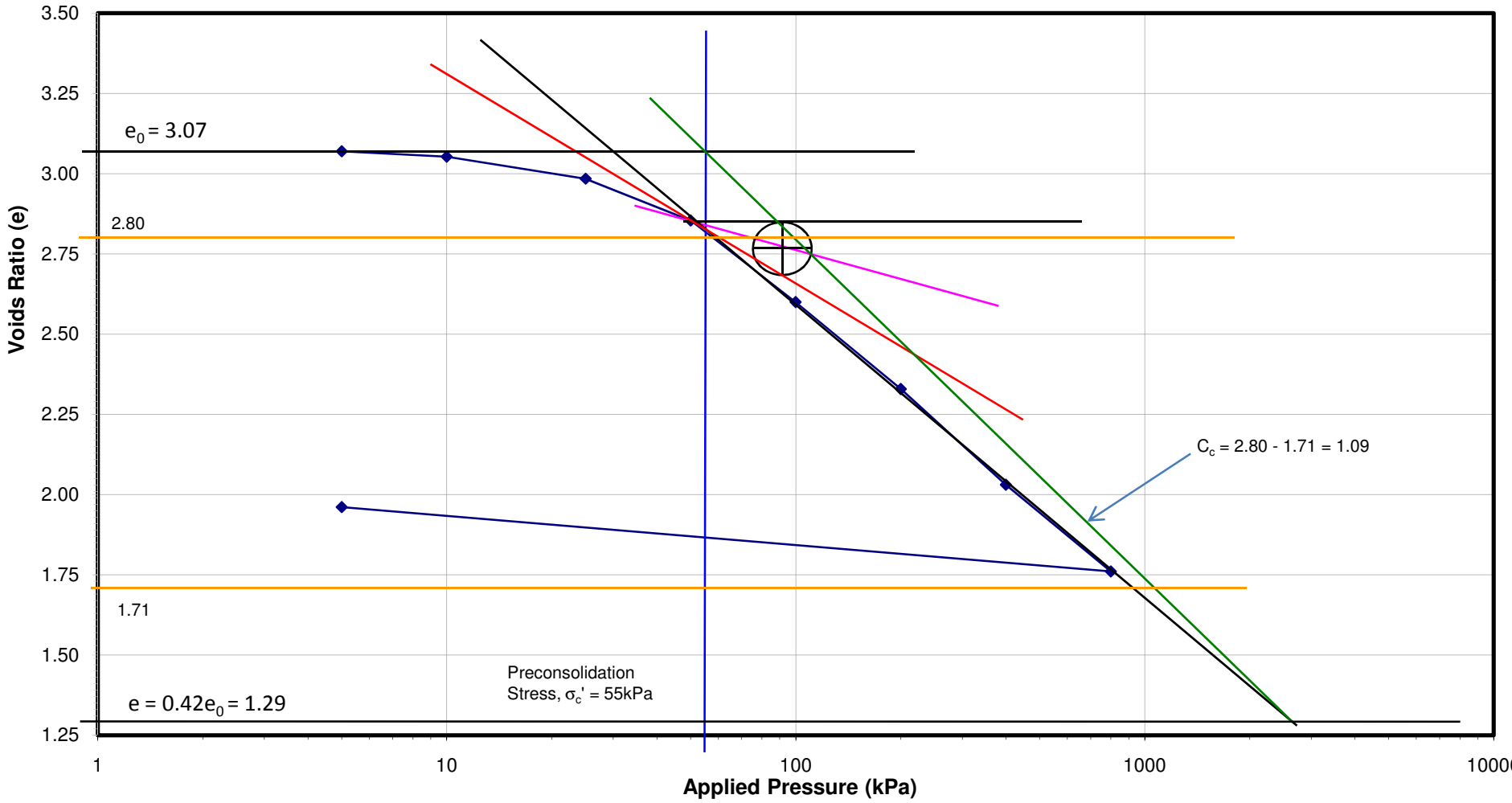
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Western Road, Ngongotaha
Geotechnical Assessment Report
One-Dimensional Consolidation Tests Results
Figure 6.2.2: BH2-64 Sample 5.71 to 5.73m below ground level (Applied Pressure vs Void Ratio Plot)



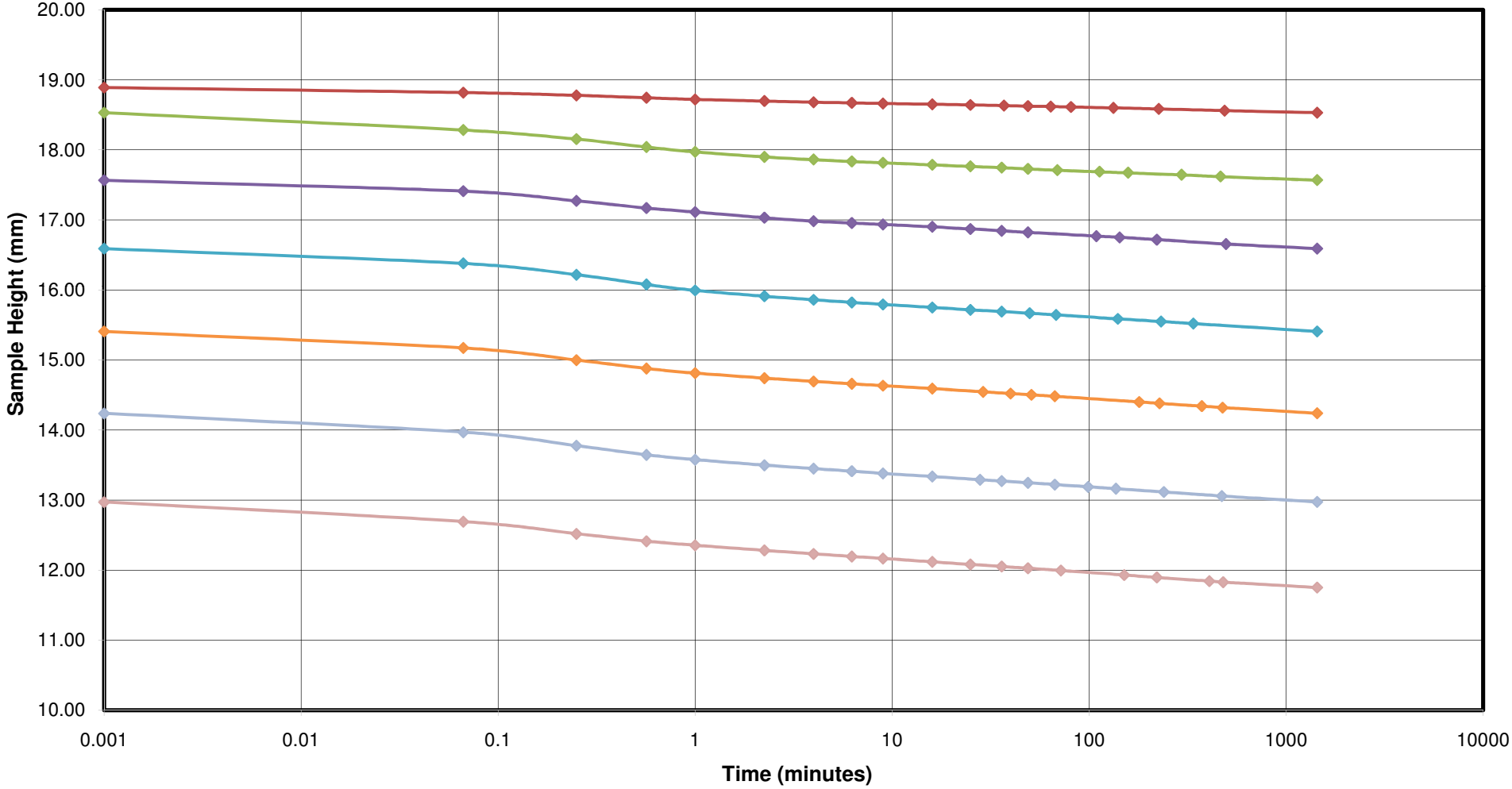
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Western Road, Ngongotaha
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One-Dimensional Consolidation Tests Results
Figure 6.2.3: BH2-64 Sample 5.95 to 5.97m below ground level (Applied Pressure vs Void Ratio Plot)



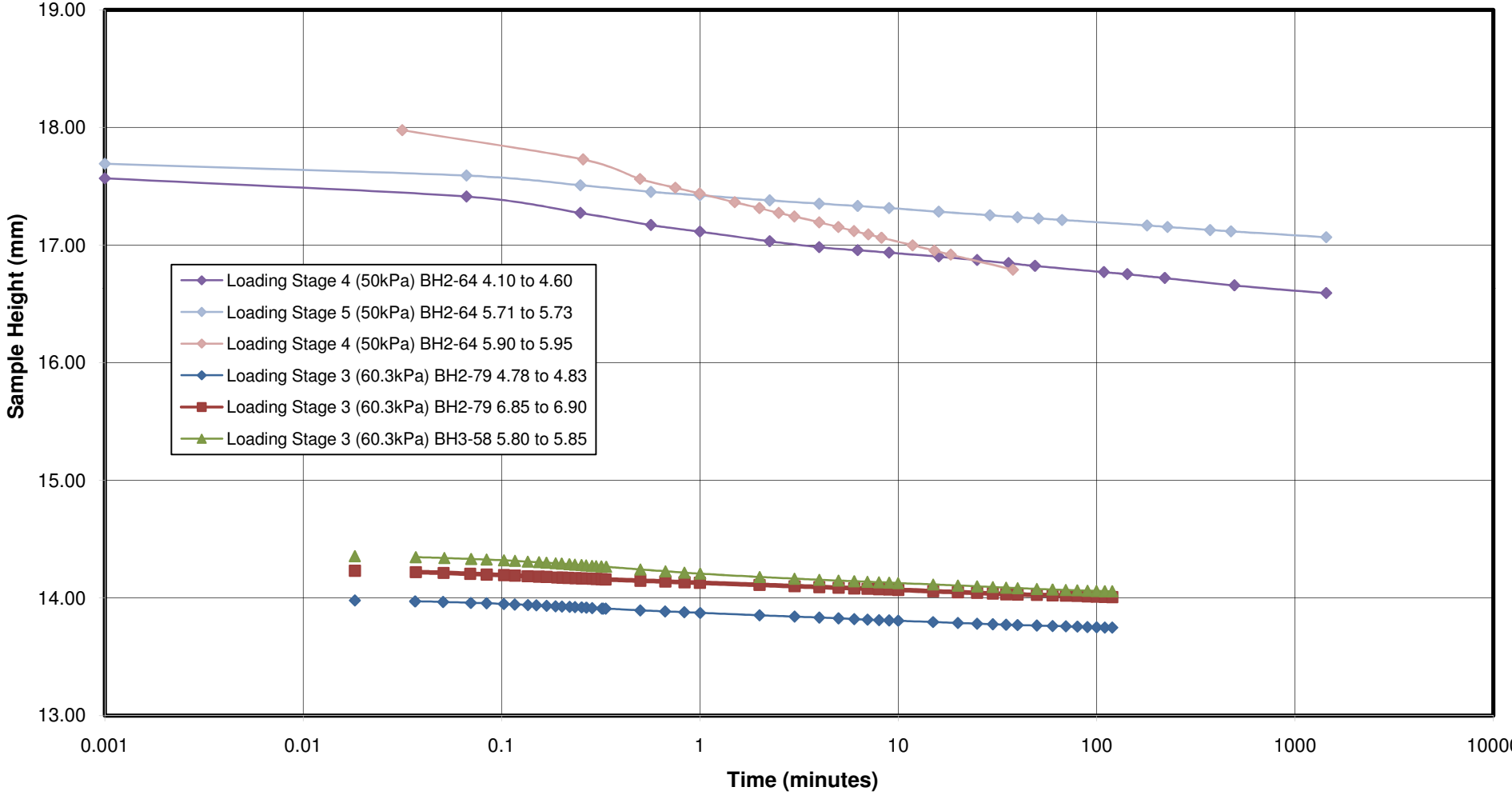
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Western Road, Ngongotaha
Geotechnical Assessment Report
One-Dimensional Consolidation Test Results
Figure 6.2.4: BH2-64 Sample 4.10 to 4.60m below ground level



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Western Road, Ngongotaha
Geotechnical Assessment Report
One-Dimensional Consolidation Test Results
Figure 6.2.5: Results for All Samples (50 or 60kPa Load Stage)



Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

- **Opus International Consultants Limited**

Natural Moisture Content and Atterberg Limits

One-Dimensional Consolidation

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	**Western Road**
Location :	**Ngongotaha**
Client :	**Tonkin & Taylor Ltd, Tauranga**
Contractor :	
Sampled by :	**Client**
Date received :	**14/07/08**
Sampling method :	**Pushtube**
Sample condition :	**As received**

Project No :	**2-68275.82**
Lab Ref No :	**08/275/003**
Client Ref No :	**851126**

Test Results

Sample No:	1	2
Soil Fraction Tested:	Whole Soil	Whole Soil
Borehole :	**BH 1**	**BH 1**
Depth (m) :	**4.1 - 4.6m**	**5.95m**
Liquid Limit :	148	127
Plastic Limit :	80	88
Plasticity Index :	**68**	**39**
Natural Water Content (%):	**206**	**123**

Test Methods		Notes
Water Content	NZS 4402 : 1986, Test 2.1	
Liquid Limit	NZS 4402 : 1986, Test 2.2	
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	

Date tested : 16/07/08
Date reported : 29/07/08

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IANZ Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Opus International Consultants Ltd
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

Fox Street
Private Bag 3057
Hamilton, New Zealand

Telephone +064 7 856 2870
Facsimile +064 7 856 2873
Website www.opus.co.nz

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project : **Western Road**
Location : **Ngongotaha**
Client : **Tonkin & Taylor Ltd, Tauranga**
Client/sample ref :
Contractor :
BH/TP/Sample ID: **BH 1** Depth: **4.1-4.6 metres**
Sampled by : **Client**
Date received : **14/07/08**
Sampling method : **Pushtube**
Sample condition : **As received**
Sample description : **Brown SILT. V. Soft.**

OEDOMETER APPARATUS No: Three

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**

SOIL PROPERTIES

Specimen Dimensions:	
Diameter (mm):	49.97
Initial height (mm):	19.00
Final height (mm):	12.86
Initial mass of sample (g):	43.53

Initial Wet Density	pbi (t/m³)	1.17
Initial Dry Density	pdi (t/m³)	0.38
Final Dry Density	pdf (t/m³)	0.56
Initial Void Ratio	eo	5.28
Final Void Ratio	ef	3.25
Initial Degree of Saturation	Si (%)	94
Final Degree of Saturation	Sf (%)	94
Solid Particle Density	*Gs (t/m³)	2.40
INITIAL Water Content	Wi (%)	205.8
FINAL Water Content	Wf (%)	127.9

*Gs is Assumed

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	Void Ratio (e)	Intercept t_{90} (min)	Volume Compressibilty Mv=m²/MN	Coefficient of Consolidation Cv=m²/year	Coefficient of Permeability k=m/year
0 - 5	5	5.246		-	-	-
5 - 10	5	5.127	1.00	3.8	40	1.5
10 - 25	15	4.808	1.00	3.5	38	1.3
25 - 50	25	4.485	0.64	2.2	54	1.2
50 - 100	50	4.094	1.00	1.4	31	0.43
100 - 200	100	3.707	0.56	0.76	47	0.35
200 - 400	200	3.288	0.56	0.44	40	0.17
400 - 800	400	2.885	0.56	0.24	33	0.077
800 - 5	-	3.252		-	-	-
-	-	-		-	-	-

Test Methods:		**Notes:**
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	**Load Increments applied at 24 hr intervals**

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Date tested : 15-25/07/08
Date reported : 29/07/08

IANZ Approved Signatory

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

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Opus International Consultants Limited
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001
Fox Street
Private Bag 3057
Hamilton, New Zealand
Telephone +64 7 856 2870
Facsimile +64 7 856 2873
Website www.opus.co.nz

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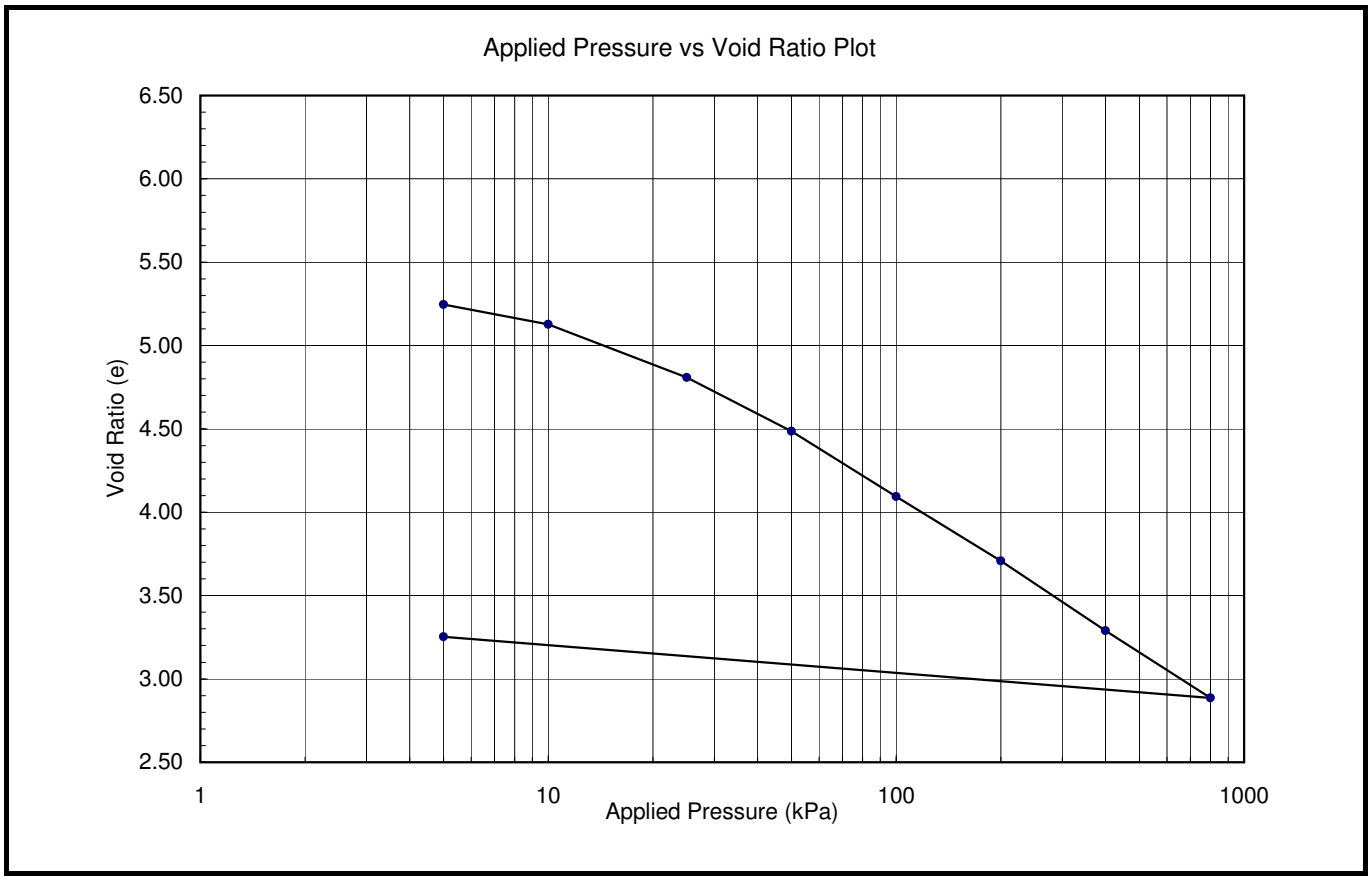
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project : **Western Road**
Location : **Ngongotaha**
Client : **Tonkin & Taylor Ltd, Tauranga**
Client/sample ref :
Contractor :
BH/TP/Sample ID: **BH 1** Depth: **4.1-4.6 metres**
Sampled by : **Client** Date received : **14/07/08**
Sample description : **Brown SILT. V. Soft.**

Sampling method : **Pushtube**
Sample condition : **As received**

OEDOMETER APPARATUS No: Three

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals

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Date tested : 15-25/07/08
Date reported : 29/07/08

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Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

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Opus International Consultants Limited
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001
Fox Street
Private Bag 3057
Hamilton, New Zealand
Telephone +64 7 856 2870
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Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project :	**Western Road**
Location :	**Ngongotaha**
Client :	**Tonkin & Taylor Ltd, Tauranga**
Client/sample ref :	**S#B**
Contractor :	
BH/TP/Sample ID:	**BH 1** Depth: **5.71- 5.73 metres**
Sampled by :	**Client**
Date received :	**14/07/08**
Sampling method :	**Pushtube (5.5- 6.1m)**
Sample condition :	**As received**
Sample description :	**V. dk. Brown SILT. V.soft- soft.**

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**

OEDOMETER APPARATUS No: Five

SOIL PROPERTIES

Specimen Dimensions:

Diameter	(mm):	50.06
Initial height	(mm):	18.99
Final height	(mm):	14.36
Initial mass of sample (g):		50.26

Initial Wet Density	pbi (t/m³)	1.34
Initial Dry Density	pdi (t/m³)	0.63
Final Dry Density	pdf (t/m³)	0.84
Initial Void Ratio	eo	2.79
Final Void Ratio	ef	1.87
Initial Degree of Saturation	Si (%)	97
Final Degree of Saturation	Sf (%)	94
Solid Particle Density	*Gs (t/m³)	2.40
INITIAL Water Content	Wi (%)	112.4
FINAL Water Content	Wf (%)	73.1

*Gs is Assumed

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	Void Ratio (e)	Intercept t_{90} (min)	Volume Compressibilty Mv=m²/MN	Coefficient of Consolidation Cv=m²/year	Coefficient of Permeability k=m/year
0 - 2.5	2.5	2.760	0.81	-	-	-
2.5 - 5	2.5	2.730	1.00	3.2	39	1.2
5 - 10	5	2.665	1.10	3.5	35	1.2
10 - 25	15	2.531	0.72	2.4	52	1.2
25 - 50	25	2.406	0.56	1.4	62	0.86
50 - 100	50	2.251	0.56	0.91	57	0.51
100 - 200	100	2.079	0.56	0.53	52	0.27
200 - 400	200	1.889	0.49	0.31	54	0.16
400 - 800	400	1.691	0.42	0.17	55	0.093
800 - 2.5	-	1.867		-	-	-

Test Methods:		**Notes:**
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	**Load Increments applied at 24 hr intervals**

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Date tested : 15-29/07/08

Date reported : 29/07/08

IANZ Approved Signatory

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Designation : *Senior Civil Engineering Technician*

Date : 29/07/08

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Fox Street
Private Bag 3057
Hamilton, New Zealand

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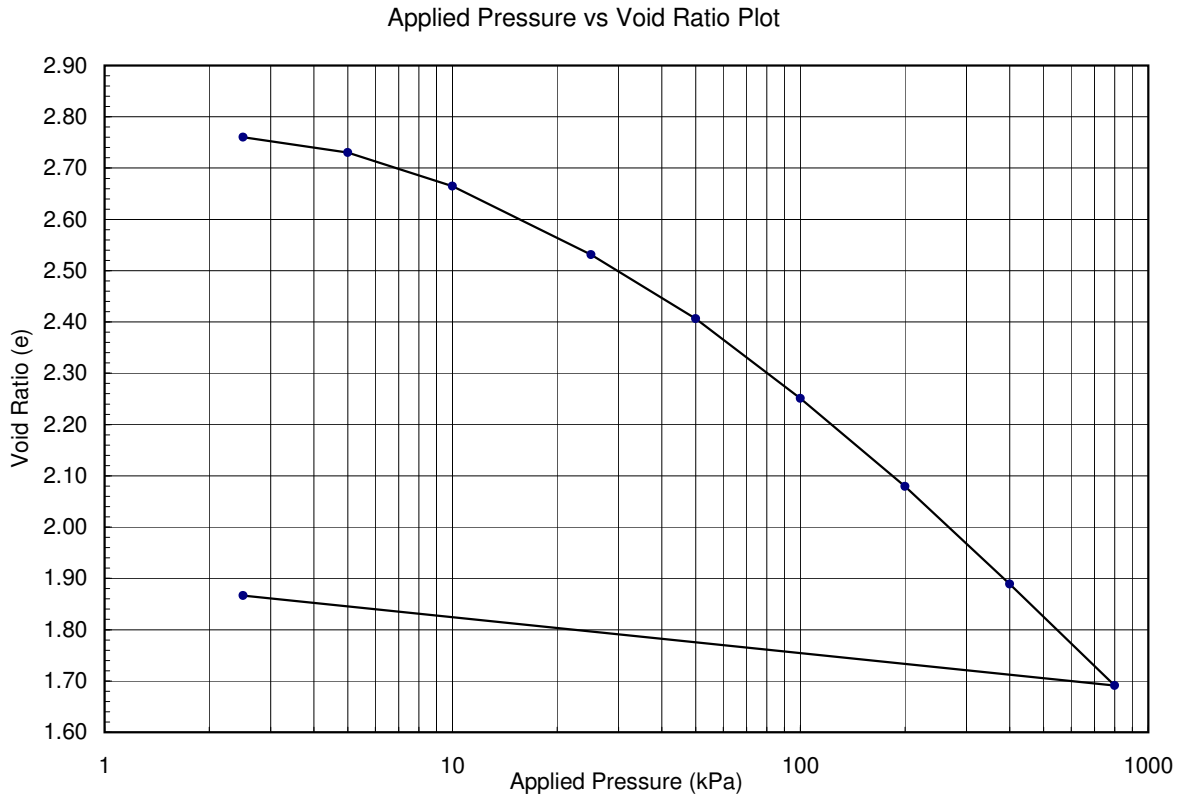
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project : **Western Road**
Location : **Ngongotaha**
Client : **Tonkin & Taylor Ltd, Tauranga**
Client/sample ref : **S#B**
Contractor :
BH/TP/Sample ID: **BH 1** Depth: **5.71- 5.73 metres**
Sampled by : **Client** Date received : **14/07/08**
Sample description : **V. dk. Brown SILT. V.soft- soft.**

Sampling method : **Pushtube (5.5- 6.1m)**
Sample condition : **As received**

OEDOMETER APPARATUS No: Five

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals

Date tested : 15-29/07/08
Date reported : 29/07/08

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Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

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Private Bag 3057
Hamilton, New Zealand
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Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

ONE DIMENSIONAL CONSOLIDATION PROPERTIES
TEST RESULT REPORT

Project :	**Western Road**
Location :	**Ngongotaha**
Client :	**Tonkin & Taylor Ltd, Tauranga**
Client/sample ref :	**S#A**
Contractor :	
BH/TP/Sample ID:	**BH 1** Depth: **5.95-5.97 metres**
Sampled by :	**Client**
Date received :	**14/07/08**
Sampling method :	**Pushtube (5.1- 6.1m)**
Sample condition :	**As received**
Sample description :	**V. dk. Brown SILT.Soft- v. soft.**

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**

OEDOMETER APPARATUS No: Four

SOIL PROPERTIES

Specimen Dimensions:

Diameter	(mm):	49.94
Initial height	(mm):	18.99
Final height	(mm):	14.01
Initial mass of sample (g):		48.89

Initial Wet Density	pbi (t/m³)	1.31
Initial Dry Density	pdi (t/m³)	0.59
Final Dry Density	pdf (t/m³)	0.80
Initial Void Ratio	eo	3.07
Final Void Ratio	ef	2.00
Initial Degree of Saturation	Si (%)	96
Final Degree of Saturation	Sf (%)	98
Solid Particle Density	*Gs (t/m³)	2.40
INITIAL Water Content	Wi (%)	123.0
FINAL Water Content	Wf (%)	81.7

*Gs is Assumed

CONSOLIDATION PROPERTIES

PRESSURE RANGE (kPa)	Pressure Increment (dp)	Void Ratio (e)	Intercept t_{90} (min)	Volume Compressibilty Mv=m²/MN	Coefficient of Consolidation Cv=m²/year	Coefficient of Permeability k=m/year
0 - 5	5	3.070		-	-	-
5 - 10	5	3.053	0.81	0.82	49	0.40
10 - 25	15	2.984	0.36	1.1	110	1.2
25 - 50	25	2.854	0.49	1.3	78	1.0
50 - 100	50	2.600	0.42	1.3	85	1.1
100 - 200	100	2.329	0.49	0.75	64	0.47
200 - 400	200	2.031	0.42	0.45	63	0.28
400 - 800	400	1.803	0.49	0.19	45	0.083
800 - 5	-	2.003		-	-	-
-	-	-		-	-	-

Test Methods:		**Notes:**
One Dimensional Consolidation Test.	NZS 4402:1986 Test 7.1	Sample is saturated during test.
Water Content	NZS 4402:1986 Test 2.1	**Load Increments applied at 24 hr intervals**

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Date tested : 15-25/07/08
Date reported : 29/07/08

IANZ Approved Signatory

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Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

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Opus International Consultants Limited
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001
Fox Street
Private Bag 3057
Hamilton, New Zealand
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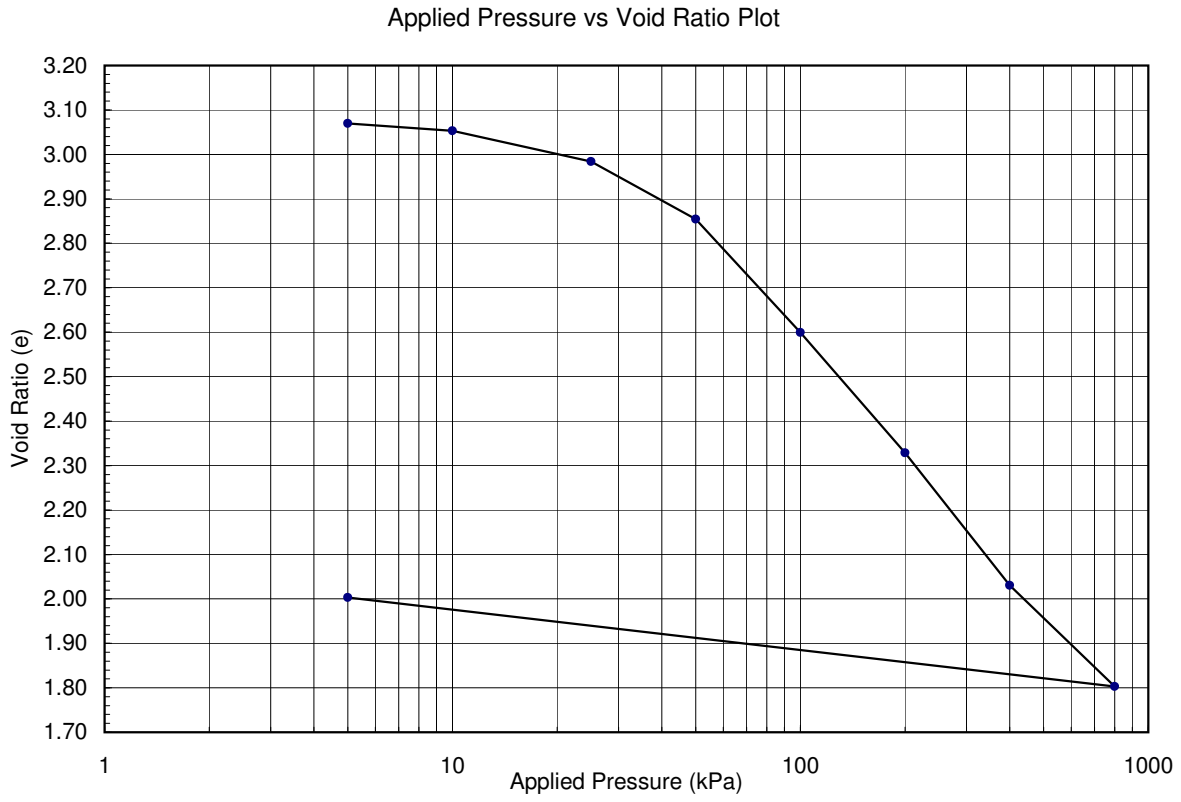
ONE DIMENSIONAL CONSOLIDATION PROPERTIES
Applied Pressure vs Void Ratio TEST REPORT

Project : **Western Road**
Location : **Ngongotaha**
Client : **Tonkin & Taylor Ltd, Tauranga**
Client/sample ref : **S#A**
Contractor :
BH/TP/Sample ID: **BH 1** Depth: **5.95-5.97 metres**
Sampled by : **Client** Date received : **14/07/08**
Sample description : **V. dk. Brown SILT.Soft- v. soft.**

Sampling method : **Pushtube (5.1- 6.1m)**
Sample condition : **As received**

OEDOMETER APPARATUS No: Four

Project No:	**2-68275.82**
Lab Ref No:	**08/275/003**
Client Ref:	**851126**



Test Method:		Notes:
One Dimensional Consolidation Test:	NZS 4402:1986 Test 7.1	Load Increments applied at 24 hr intervals

Date tested : 15-25/07/08
Date reported : 29/07/08

IANZ Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 29/07/08

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Private Bag 3057
Hamilton, New Zealand

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- **Geotechnics Ltd**

Atterberg Limits

Particle Size Distribution

One-Dimensional Consolidation

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

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Auckland 1023, New Zealand
p. +64 9 356 3510
w. www.geotechnics.co.nz

Form No.: S2
Form Date: January 2004
File: M:\Atterberg limits\614732.000\summary

Plate No.: Page of Your Job No.: **851126**

Site : **Western Road, Ngongotaha** Our Job No.: **614732.000**

Test Method Used: NZS 4402:1986 **Test 2.2 Determination of the Liquid Limit**
Test 2.3 Determination of the Plastic Limit
Test 2.4 Determination of the Plasticity Index

TEST RESULTS

Table 1: Atterberg Test Results Summary

BH. No.		BH2-71	BH2-71	BH3-58
Sample No.		---	---	---
Depth	(m)	4.7-4.9	6.75-6.95	5.7-5.9
Liquid Limit		146	182	143
Plastic Limit		Unable to roll	Unable to roll	Unable to roll
Plasticity Index		non-plastic(NP)	non-plastic(NP)	non-plastic(NP)

Description:

BH2-71_4.7-4.9m : sandy SILT with trace of clay/minor organics, very soft to soft, medium to dark brown.

BH2-71_6.75-6.95m : sandy SILT with trace of clay/minor organics, very soft to soft, medium to dark brown with dark grey.

BH3-5.80_5.85m : sandy SILT with trace of clay/minor organics, very soft to soft, medium to dark brown.

Remarks : Atterberg limits were performed on material passing 0.425mm sieve.

Liquid and Plastic Limit: Due to the nature of the soil, it was difficult to cut a smooth groove in the soil in the liquid limit cup with a standard grooving tool. Therefore the alternative grooving tool was used to cut a smooth groove in the soil and to prevent tearing of the soil in the liquid limit cup.
The samples cannot be rolled down to 3mm diameter thread to perform a plastic limit. Therefore the samples are reported as non-plastic (NP).
Sample descriptions are not IANZ endorsed.

Tested by: ST Date: 23/7/08 Checked by: SJA Date: 23/7/08

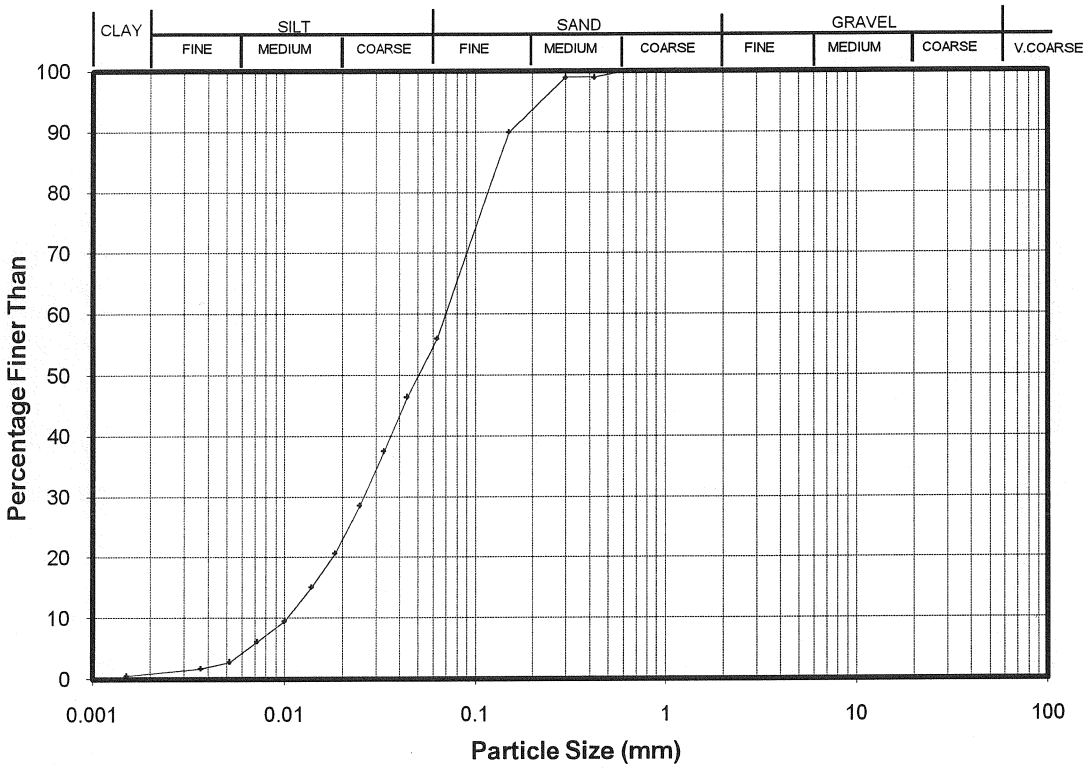
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Form No.: P6
Form Date: January 2004
File: P:\614910.000\Working Material\Sample1_Hydro.xls

Plate No.: Page of Your Job No.: **650229.002**
Site Location: **Western Road, Ngongotaha** Our Job No.: **614910.000**
Test Pit No.: --- Sample No.: **1 (Lot 61-Stage 3)** Depth: **--- (m)**
Test Method Used : NZS 4402:1986 Test 2.8.1 Wet Sieve Test 2.8.4 Hydrometer

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
2.36	100		
1.18	100		
0.600	100		
0.425	99		
0.300	99		
0.150	90		
0.063	56		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0437	46
0.0330	38
0.0247	29
0.0183	21
0.0138	15
0.0100	10
0.0072	6
0.0052	3
0.0037	2
0.0015	1

Sample history : As received.
Solid Density (assumed) : 2.65 t/m^3
Description : sandy SILT with trace clay, soft, light grey, mottled brown.

Remarks : The sample was washed over 0.063mm test sieve.The material passing 0.063mm test sieve was collected, from which a sub sample was taken for hydrometer analysis. The material retained on 0.063mm test sieve was dry sieved and the data was combined with the hydrometer analysis to give a continuous curve. Dry mass was used for hydrometer calculations.
Suspension pH 8.0
The classification of sand,silt and clay is described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 20/1/09 Checked by : JHC Date : 20/1/09

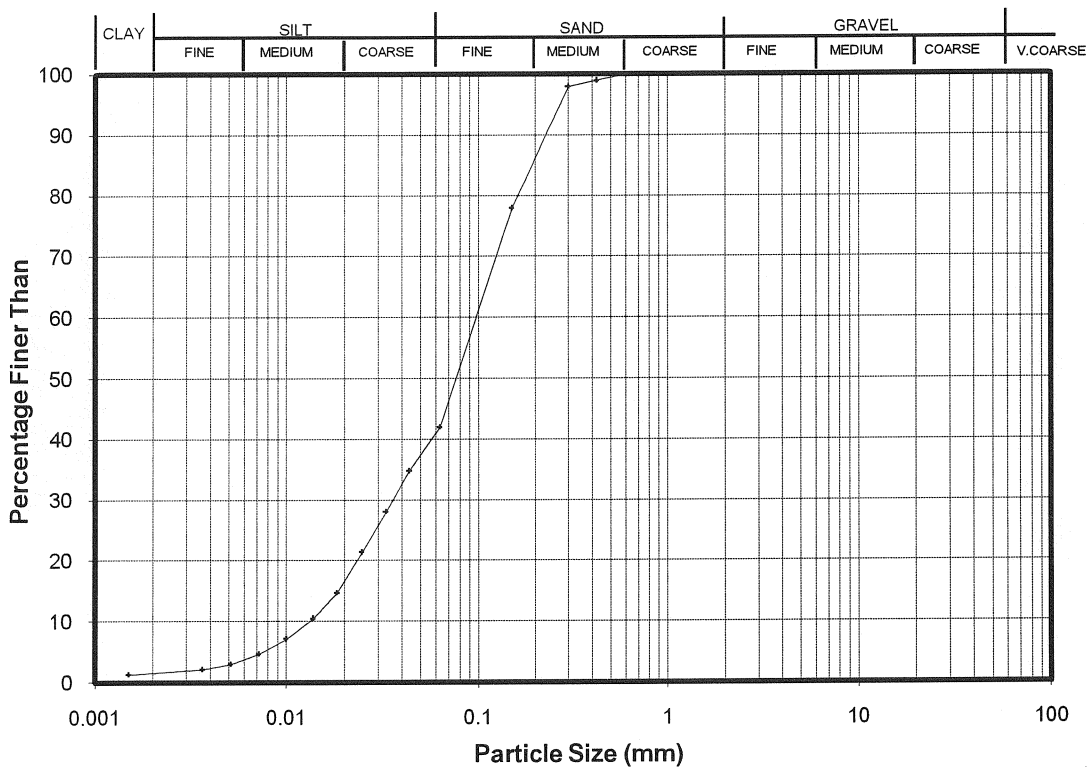
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Version: 2, Version Date: 27/04/2009

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Form No.: P6
Form Date: January 2004
File: P:\614910.000\Working Material\Sample2_Hydro.xls

Plate No.: Page of Your Job No.: **650229.002**
Site Location: **Western Road, Ngongotaha** Our Job No.: **614910.000**
Test Pit No.: --- Sample No.: **2 (Lot 59-Stage 3)** Depth: **--- (m)**
Test Method Used : NZS 4402:1986 Test 2.8.1 Wet Sieve Test 2.8.4 Hydrometer

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
2.36	100		
1.18	100		
0.600	100		
0.425	99		
0.300	98		
0.150	78		
0.063	42		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0437	35
0.0330	28
0.0247	21
0.0184	15
0.0138	11
0.0100	7
0.0072	5
0.0051	3
0.0037	2
0.0015	1

Sample history : As received.
Solid Density (assumed) : 2.65 t/m^3
Description : silty SAND with trace clay, loosely packed, light yellowish orange brown.

Remarks : The sample was washed over 0.063mm test sieve.The material passing 0.063mm test sieve was collected, from which a sub sample was taken for hydrometer analysis. The material retained on 0.063mm test sieve was dry sieved and the data was combined with the hydrometer analysis to give a continuous curve. Dry mass was used for hydrometer calculations.
Suspension pH 8.0
The classification of sand,silt and clay is described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : ST Date : 20/1/09 Checked by : JME Date : 20/1/09

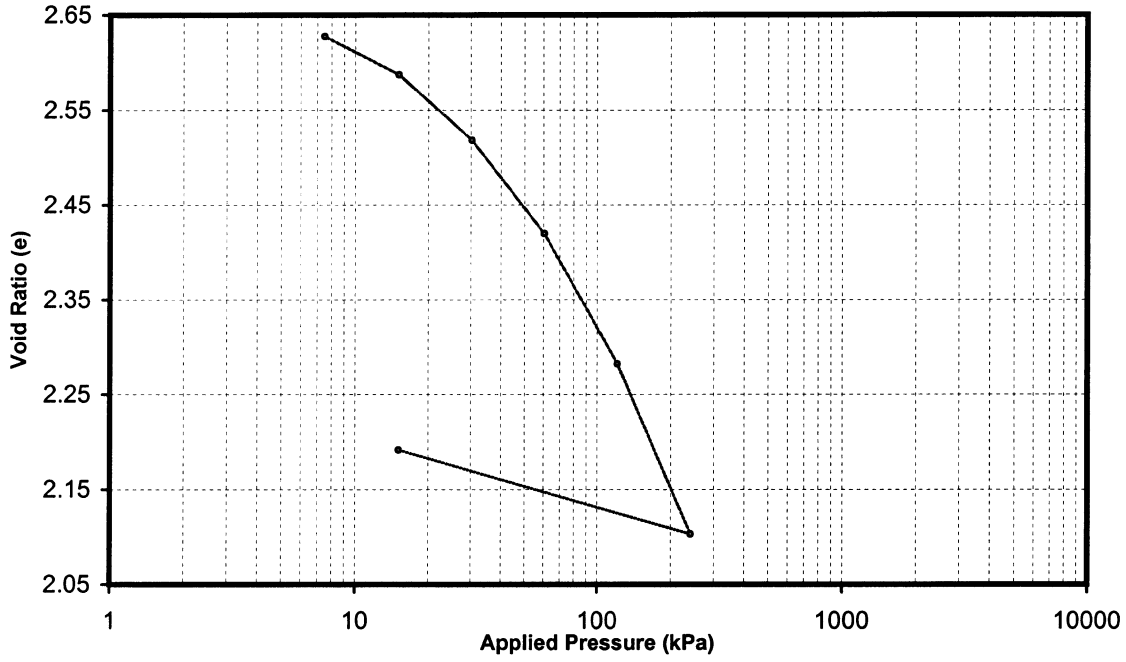
Document Set ID: 2699211
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Form No.: P13 B
Form Date.: Sep 2001
File:P:\614732_BH2_71_4.78-4.83m_Consol.xls

Plate No.: Page of Your Job No.: **851126**
Site: **Western Road, Ngongotaha** Our Job No.: **614732.000**
BH No.: **BH2-71** Sample No.: **---** Depth: **4.78-4.83 (m)**
Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	2.673			
Preload	7.5	2.628	0 to 7.5	NA	1.7
	15.1	2.587	7.5 to 15.1	37	1.5
	30.2	2.519	15.1 to 30.2	31	1.3
	60.3	2.420	30.2 to 60.3	29	0.93
	121	2.282	60.3 to 121	25	0.66
	241	2.103	121 to 241	22	0.45
Unload	15.1	2.191	241 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.
Description: sandy SILT with trace of clay/organics, very soft to soft, medium to dark brown.

Initial Dry Density (t/m³): 0.65 Initial Water Content: 108%
Solid Density (t/m³): 2.40 (Assumed) Initial Saturation: 97%
Temperature During Testing: Max = 22 °C Min = 21 °C
Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.40 t/m³.

Entered by: ST Date: 7/7/08 Checked by: JHe Date: 7/7/08

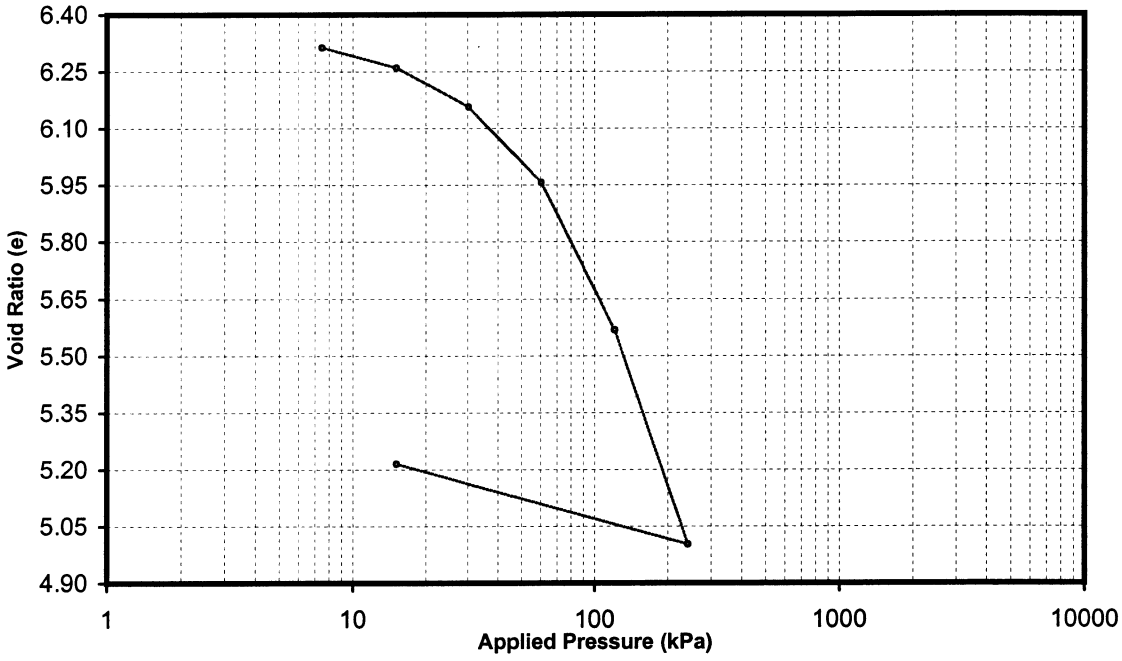
Document Set ID: 2699211
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Form No.: P13 B
Form Date.: Sep 2001
File:P:\614732_BH2_71_6.85-6.90m_Consol.xls

Plate No.: Page of Your Job No.: **851126**
Site: **Western Road, Ngongotaha** Our Job No.: **614732.000**
BH No.: **BH2-71** Sample No.: **---** Depth: **6.85-6.90 (m)**
Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	6.352			
Preload	7.5	6.314	0 to 7.5	NA	0.69
	15.1	6.260	7.5 to 15.1	35	0.96
	30.2	6.157	15.1 to 30.2	32	0.94
	60.3	5.957	30.2 to 60.3	30	0.93
	121	5.568	60.3 to 121	26	0.92
	241	5.002	121 to 241	21	0.72
Unload	15.1	5.215	241 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.
Description: sandy SILT with trace of clay and minor organics, very soft to soft, medium to dark brown with dark grey.

Initial Dry Density (t/m³): 0.33 Initial Water Content: 254%
Solid Density (t/m³): 2.40 (Assumed) Initial Saturation: 96%
Temperature During Testing: Max = 22 °C Min = 21 °C
Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.40 t/m³.

Entered by: SJ Date: 7/7/08 Checked by: JME Date: 7/7/08

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Form No.: P13 B
Form Date.: Sep 2001
File:P:\614732_BH3_58_5.80-5.85m_Consol.xls

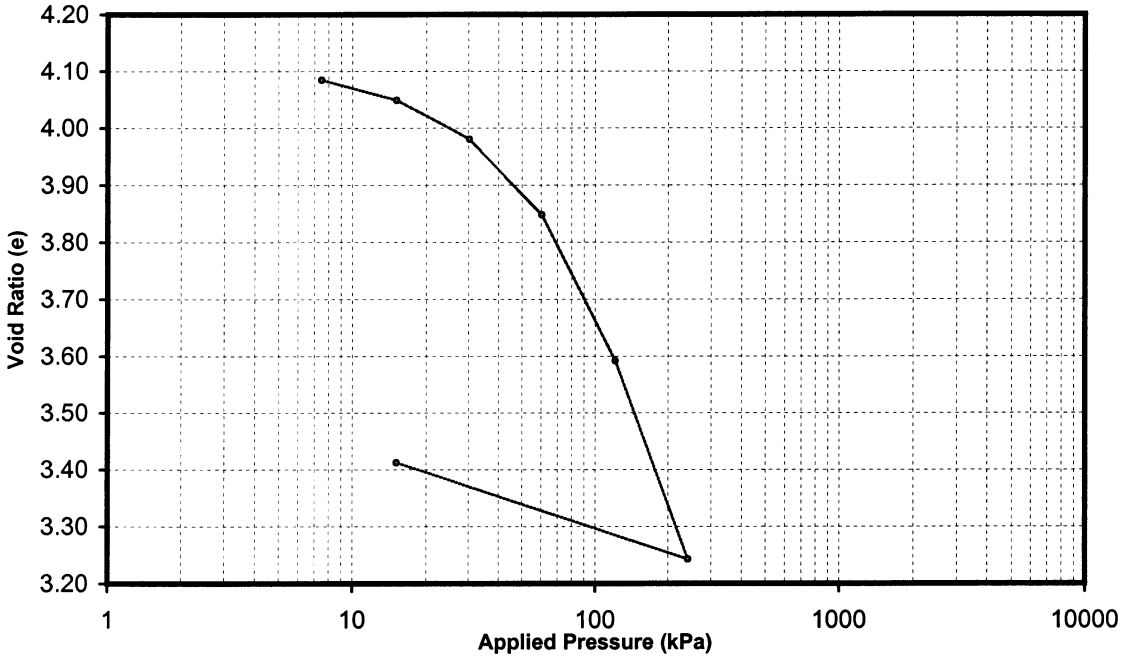
Plate No.: Page of Your Job No.: **851126**

Site: **Western Road, Ngongotaha** Our Job No.: **614732.000**

BH No.: **BH3-58** Sample No.: **---** Depth: **5.80-5.85 (m)**

Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	4.116			
Preload	7.5	4.085	0 to 7.5	NA	0.83
	15.1	4.049	7.5 to 15.1	22	0.92
	30.2	3.980	15.1 to 30.2	19	0.90
	60.3	3.848	30.2 to 60.3	18	0.88
	121	3.592	60.3 to 121	16	0.87
	241	3.243	121 to 241	15	0.63
Unload	15.1	3.412	241 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.

Description: sandy SILT with trace of clay/organics, very soft to soft, medium to dark brown.

Initial Dry Density (t/m³): 0.47 Initial Water Content: 165%

Solid Density (t/m³): 2.40 (Assumed) Initial Saturation: 96%

Temperature During Testing: Max = 22 °C Min = 21 °C

Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.40 t/m³.

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Version: 2, Version Date: 27/04/2009

- **SGS New Zealand Ltd**

Organic Content

FOOD & ENVIROMENTAL
LABORATORIES

17 Maurice Road
Penrose, Auckland
Tel: (09) 634 2593
Fax: (09) 634 6728
eb: www.sgs.com

ANALYSIS REPORT

9 uly 2008

Geotechnics Ltd
P Box 9360
Newmarket
Auckland 1149
Attention: Simon Tirunahari

Date Received: 7/07/08
Lab Number: 19428
Order Number/Ref: 614732.000
Date Completed: 9/07/08

The Results of analysis on the sample/s as received from Geotechnics Ltd and described above, are as follows. The Sample/s were received in good condition. Analysis of the sample/s commenced on 9/07/2008.

Sample Description	rganic Matter Content % N S 4402 1986
Soil Sample B 2 4.78-4.83m estern Road Ngongotaha	6.5
Soil Sample B 2 6.85-6.90m estern Road Ngongotaha	7.6
Soil Sample B 3 5.80-5.85m estern Road Ngongotaha	7.4

Legend: less than limit of detection > greater than [ND] not detected

Approved by:
Henry Cao PGDipSci
On behalf of SGS New Zealand Ltd

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DISCLAIMER

The Company undertakes to exercise due care and skill in the performance of its services and accepts responsibility only for gross negligence proven by Principals.

The liability of the Company to the Principal in respect of any claims for loss, damage or expense of whatsoever nature and howsoever arising shall in no circumstances exceed a total aggregate sum equal to ten times the amount of the fee or commission payable in respect of the specific service required under the particular contract with gives rise to such claims. Where the fee or commission payable relates to a number of services and a claim arises in respect of one of those services the fee or commission shall be apportioned for the purposes of this paragraph by reference to the estimated time involved in the performance of each service.

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Appendix E: Groundwater Monitoring Results

- **Table 5.2.1: Groundwater Levels Observed in Original Ground Investigation (October 2004)**
- **Table 5.2.2: Borehole Groundwater Level Monitoring Data.**
- **Table 5.2.3: CPT Hole Groundwater Level Monitoring Data.**
- **Table 5.2.4: Window Sample Hole Groundwater Level Monitoring Data.**
- **Figure 5.2.1: Borehole Groundwater Monitoring Data (Depth with Time).**
- **Figure 5.2.2: Borehole Groundwater Monitoring Data (Elevation with Time).**
- **Figure 5.2.3: CPT Hole Groundwater Monitoring Data (Depth with Time).**
- **Figure 5.2.4: CPT Hole Groundwater Monitoring Data (Elevation with Time).**
- **Figure 5.2.5: Window Sample Hole Groundwater Monitoring Data (Depth with Time).**
- **Figure 5.2.6: Window Sample Hole Groundwater Monitoring Data (Elevation with Time).**

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Western Road, Ngongotaha
Geotechnical Assessment Report
Table 5.2.1: Groundwater Levels Observed in Original Ground Investigation (October 2004)

Hand Auger	Stage	Location	Estimated Pre-Earthworks Ground Level	Estimated Current Ground Level	Estimated Depth of Cut/Fill	Depth of Hand Auger	Groundwater Depth	Estimated Groundwater Elevation
			(m AMD)	(m AMD)	(m)	(m bgl)	(m bgl)	(m AMD)
BH1	1	Road 1	286.5	287.5	1.0	2.10	0.55	285.95
BH2	1	Lot 8	286.0	287.2	1.3	2.10	1.80	284.15
BH3	1	Lot 14	285.1	286.6	1.5	2.10	0.80	284.30
BH4	1	Road 2	286.5	286.5	0.0	5.00	1.40	285.10
BH5	3	Road 1	287.0	287.0	0.0	1.80	0.68	286.32
BH6	3	Lot 57	287.0	286.5	-0.5	2.10	1.30	285.70
BH7	2	Lot 70	285.6	285.6	0.0	2.10	0.25	285.35
BH8	2	Road 2	284.5	285.0	0.5	2.10	0.40	284.10
BH9	3	Road 1	286.0	286.5	0.5	2.10	0.18	285.82
BH10	3	Lot 88	285.5	287.5	2.0	2.10	0.20	285.30
BH11	2	Road 2	286.5	285.5	-1.0	2.10	1.05	285.45
BH12	2	Road 2	286.0	285.5	-0.5	2.10	1.40	284.60
BH13	3	Road 1	285.5	286.0	0.5	2.10	0.64	284.86
BH14	3	Loop Road	285.5	285.5	0.0	2.10	1.60	283.90
BH15	3	Road 1	286.0	286.5	0.5	2.10	1.50	284.50
BH16	3	Loop Road	288.5	287.5	-1.0	2.10		
BH17	3	Road 1	287.5	288.5	1.0	6.00	4.00	283.50
BH18	3	Lot 40	290.0	289.5	-0.5	6.00	4.50	285.50
Count			18	18			17	17
Maximum			290.00	289.50			4.50	286.32
Minimum			284.50	285.00			0.18	283.50
Average			286.40	286.69			1.31	284.96

Note: Values in red relate to materials described as 'wet' on auger hole logs and may not indicate groundwater levels.

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Western Road, Ngongotaha
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Table 5.2.2: Borehole Groundwater Level Monitoring Data.

Borehole	Ground Level	Date	Time	Standpipe	Depth of Groundwater from Top of Standpipe Tube	Depth of Hole from Top of Standpipe Tube	Elevation at Top of Standpipe Tube	Groundwater Elevation
	(m AMD)				(m)	(m)	(m AMD)	(m AMD)
BH2-79 Shallow	285.73	17/07/2008	8.30am	S	1.63	4.32	285.73	284.10
		18/07/2008	4.30pm	S	3.17	6.38	288.11	284.94
		21/07/2008	3.00pm	S	3.40	6.38	288.11	284.71
		22/07/2008	9.30am	S	3.43	6.38	288.11	284.68
		29/08/2008	3.00pm	S	3.40	6.38	288.11	284.71
		3/10/2008	10.00am	S	3.55		288.11	284.56
		15/12/2008	2:00pm	S	3.61		288.11	284.50
		8/01/2009	5.00pm	S	3.84		288.11	284.27
		22/01/2009	2:00pm	S	3.90	6.34	288.11	284.21
BH2-79 Deep		17/07/2008	8.30am	D	1.62	8.02	285.73	284.11
		18/07/2008	4.30pm	D	3.63	10.08	288.11	284.48
		21/07/2008	3.00pm	D	3.56	10.08	288.11	284.55
		22/07/2008	9.30am	D	3.57	10.10	288.11	284.54
		29/08/2008	3.00pm	D	3.12	10.08	288.11	284.99
		3/10/2008	10.00am	D	3.12		288.11	284.99
		15/12/2008	2:00pm	D	4.02		288.11	284.09
		8/01/2009	5.00pm	D	3.51		288.11	284.60
		22/01/2009	2:00pm	D	3.61	9.94	288.11	284.50
BH3-58 Shallow	286.32	18/07/2008	8.15am	S	1.77	3.70	286.32	284.55
		18/07/2008	4.30pm	S	3.65	5.60	288.53	284.88
		21/07/2008	3.00pm	S	3.39	5.61	288.53	285.14
		22/07/2008	10.30am	S	3.40	5.61	288.53	285.13
		25/07/2008	12.00pm	S	3.51		288.53	285.02
		29/08/2008	3.00pm	S	3.49	5.60	288.53	285.04
		3/10/2008	10.00am	S	3.80		288.53	284.73
		26/11/2008	11:00am	S	3.97		288.53	284.56
		15/12/2008	2:00pm	S	4.06		288.53	284.47
		8/01/2009	5.00pm	S	4.00		288.53	284.53
		22/01/2009	2:00pm	S	4.11	5.57	288.53	284.42
BH3-58 Deep		18/07/2008	8.15am	D	1.98	9.42	286.32	284.34
		18/07/2008	4.30pm	D	3.32	11.35	288.53	285.21
		21/07/2008	3.00pm	D	3.75	11.32	288.53	284.78
		22/07/2008	10.30am	D	3.77	11.31	288.53	284.76
		25/07/2008	12.00pm	D	3.90		288.53	284.63
		29/08/2008	3.00pm	D	3.40	11.32	288.53	285.13
		3/10/2008	10.00am	D	3.39		288.53	285.14
		26/11/2008	11:00am	D	3.59		288.53	284.94
		15/12/2008	2:00pm	D	3.74		288.53	284.79
		8/01/2009	5.00pm	D	3.73		288.53	284.80
		22/01/2009	2:00pm	D	3.84	11.14	288.53	284.69
BH2-64 Shallow	285.45	21/07/2008	12.00pm	S	0.10	5.30	285.45	285.35
		21/07/2008	3.00pm	S	1.24	5.30	285.45	284.21
		25/07/2008	12.00pm	S	0.80		285.45	284.65
		29/08/2008	3.00pm	S	0.98	5.30	285.45	284.47
		3/10/2008	10.00am	S	0.98		285.45	284.47
		15/12/2008	2:00pm	S	1.26		285.45	284.19
		8/01/2009	5.00pm	S	1.47		285.45	283.98
		22/01/2009	2:00pm	S	1.59	5.25	285.45	283.86
BH2-64 Deep		21/07/2008	12.00pm	D	0.99	9.42	285.45	284.46
		21/07/2008	3.00pm	D	1.52	9.41	285.45	283.93
		25/07/2008	12.00pm	D	0.90		285.45	284.55
		29/08/2008	3.00pm	D	0.91	9.45	285.45	284.54
		3/10/2008	10.00am	D	1.13		285.45	284.32
		15/12/2008	2:00pm	D	1.47		285.45	283.98
		8/01/2009	5.00pm	D	1.25		285.45	284.20
		22/01/2009	2:00pm	D	1.44	9.33	285.45	284.01

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Western Road, Ngongotaha
Geotechnical Assessment Report
Table 5.2.3: CPT Hole Groundwater Level Monitoring Data.

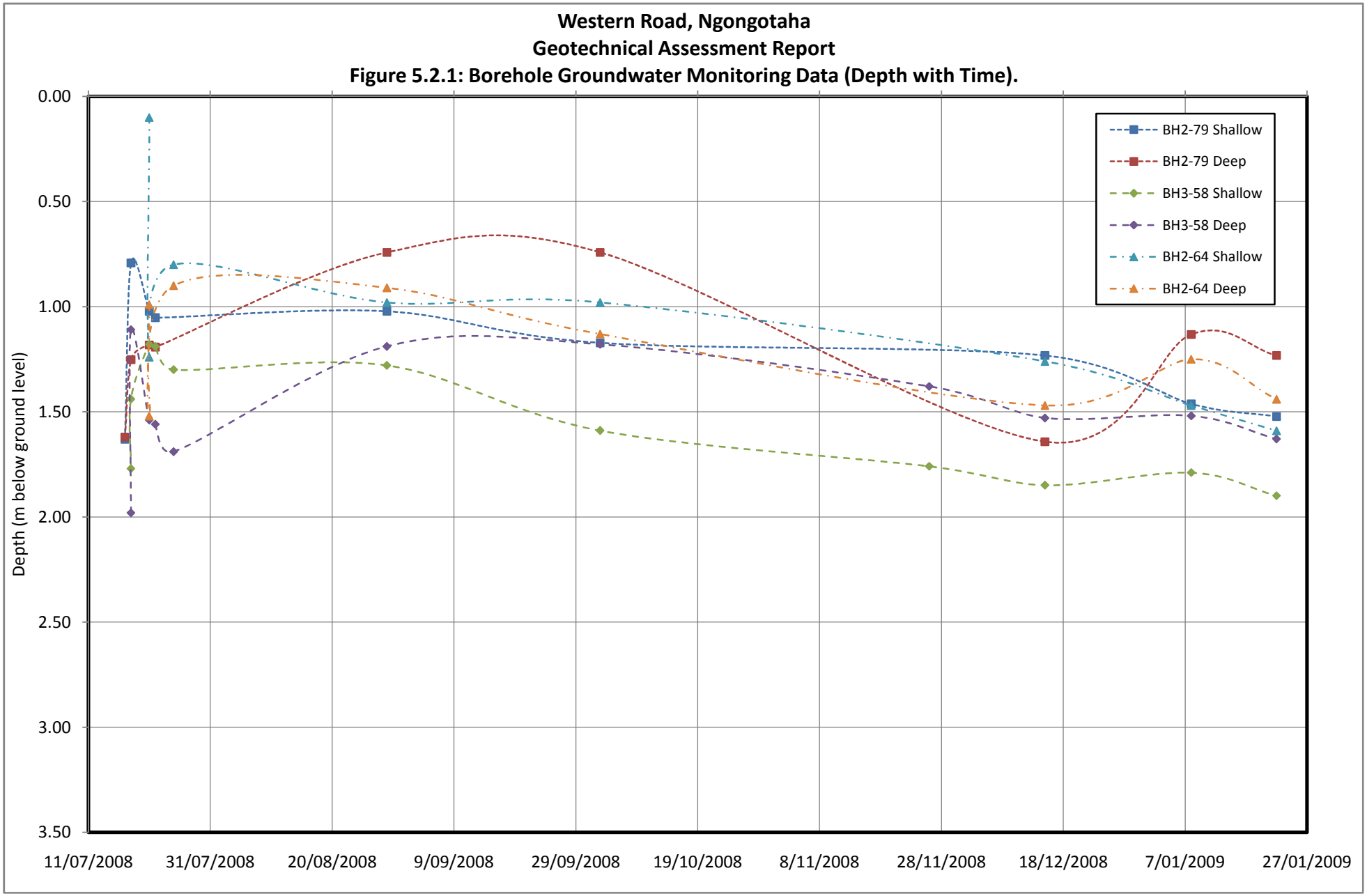
CPT	Ground Level	Date																
		Drilled Date		17/07/2008		29/08/2008		BOH	3/10/2008		26/11/2008		15/12/2008		8/01/2009		22/01/2009	
	(m AMD)	(m bgl)	(m amsl)	(m bgl)	(m amsl)	(m bgl)	(m amsl)		(m bgl)	(m amsl)	(m bgl)	(m amsl)	(m bgl)	(m amsl)	(m bgl)	(m amsl)	(m bgl)	(m amsl)
CPT1-01	287.59	2.70	284.89															
CPT1-03	287.43	2.50	284.93															
CPT1-07	287.17	2.30	284.87															
CPT1-11	286.74	2.30	284.44															
CPT1-17	286.35	1.20	285.15															
CPT1-20	286.15	2.00	284.15															
CPT2-16	285.40	0.58	284.82	0.21	285.19	0.32	285.08	2.62	0.94	284.46	1.12	284.28	1.32	284.08	1.25	284.15	1.46	283.94
CPT2-68	285.84	2.10	283.74															
CPT2-71	286.12	2.10	284.02															
CPT2-74	285.94	2.30	283.64	0.58	285.36	0.60	285.34	3.36	1.03	284.91	1.30	284.64	1.52	284.42	1.50	284.44	1.74	284.20
CPT3-24	287.27	1.27	286.00															
CPT3-26	287.07	1.46	285.61	0.15	286.92	0.11	286.96	5.80	1.37	285.70	1.62	285.45	1.85	285.22	1.65	285.42	1.94	285.13
CPT3-28	286.89	1.40	285.49															
CPT3-31	286.27	1.47	284.80	0.46	285.81	0.76	285.51	5.66	0.94	285.33	1.24	285.03	1.48	284.79	1.40	284.87	1.61	284.66
CPT3-34	286.56	3.83	282.73															
CPT3-36	288.26	3.83	284.43			3.01	285.25	5.81	2.84	285.42	3.23	285.03	3.32	284.94	3.42	284.84	3.49	284.77
CPT3-39	288.97	4.80	284.17															
CPT3-41	289.54	5.20	284.34															
CPT3-44	286.08	1.90	284.18															
CPT3-45	285.90	1.80	284.10															
CPT3-49	287.51	3.12	284.39						2.18	285.33	Lost							
CPT3-56	286.69	1.70	284.99															
CPT3-58	286.20	1.70	284.50															
CPT3-61	286.69	1.50	285.19															
Count				4	4	5	5	5	6	6	5	5	5	5	5	5	5	5
Maximum				0.58	286.92	3.01	286.96	5.81	2.84	285.70	3.23	285.45	3.32	285.22	3.42	285.42	3.49	285.13
Minimum				0.15	285.19	0.11	285.08	2.62	0.94	284.46	1.12	284.28	1.32	284.08	1.25	284.15	1.46	283.94
Average				0.35	285.82	0.96	285.63	4.65	1.55	285.19	1.70	284.89	1.90	284.69	1.84	284.74	2.05	284.54

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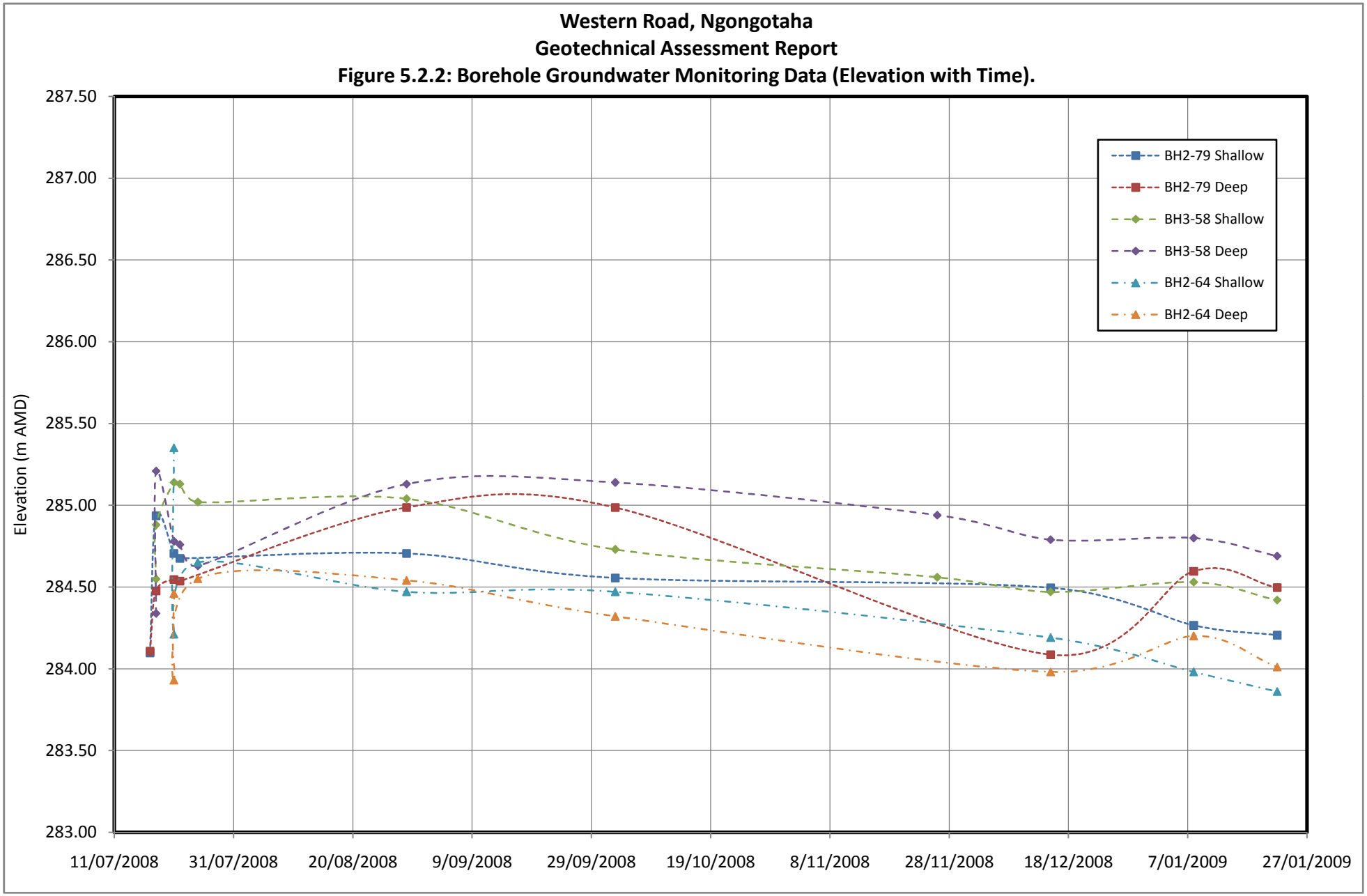
Western Road, Ngongotaha
Geotechnical Assessment Report
Table 5.2.4: Window Sample Hole Groundwater Level Monitoring Data.

Standpipe	Ground Level	15/12/2008		8/01/2009		22/01/2009	
		(m bgl)	(m amsl)	(m bgl)	(m amsl)	(m bgl)	(m amsl)
SP1-02	287.47	2.13	285.34	2.05	285.42	2.24	285.23
SP1-14	286.69	1.88	284.81	1.55	285.14	2.09	284.60
SP2-67	285.70	2.10	283.60	1.12	284.58	2.21	283.49
SP2-70	286.07	2.46	283.61	1.50	284.57	2.55	283.52
SP2-77	285.92	1.83	284.09	1.91	284.01	1.98	283.94
SP2-83	285.22	1.20	284.02	1.12	284.10	1.40	283.82
SP2-86	285.15	1.32	283.83	1.11	284.04	1.50	283.65
SP3-29	286.79	1.84	284.95	1.74	285.05	1.97	284.82
SP3-34	286.67	1.70	284.97	1.78	284.89	1.87	284.80
SP3-39	289.06						
SP3-42	287.93	3.03	284.90	3.10	284.83		
SP3-46	286.24	2.27	283.97	1.55	284.69	1.79	284.45
SP3-52	286.65	1.88	284.77	1.89	284.76	2.04	284.61
SP3-55	287.07	1.88	285.19	1.84	285.23	1.99	285.08
SP3-57	286.53	1.65	284.88	1.64	284.89	1.99	284.54
SP3-59	286.27	1.82	284.45	1.81	284.46	1.92	284.35
SP3-63	286.83	1.67	285.16	1.61	285.22	1.75	285.08
Count	17	16	16	16	16	15	15
Maximum	289.06	3.03	285.34	3.10	285.42	2.55	285.23
Minimum	285.15	1.20	283.60	1.11	284.01	1.40	283.49
Average	286.60	1.92	284.53	1.71	284.74	1.95	284.40

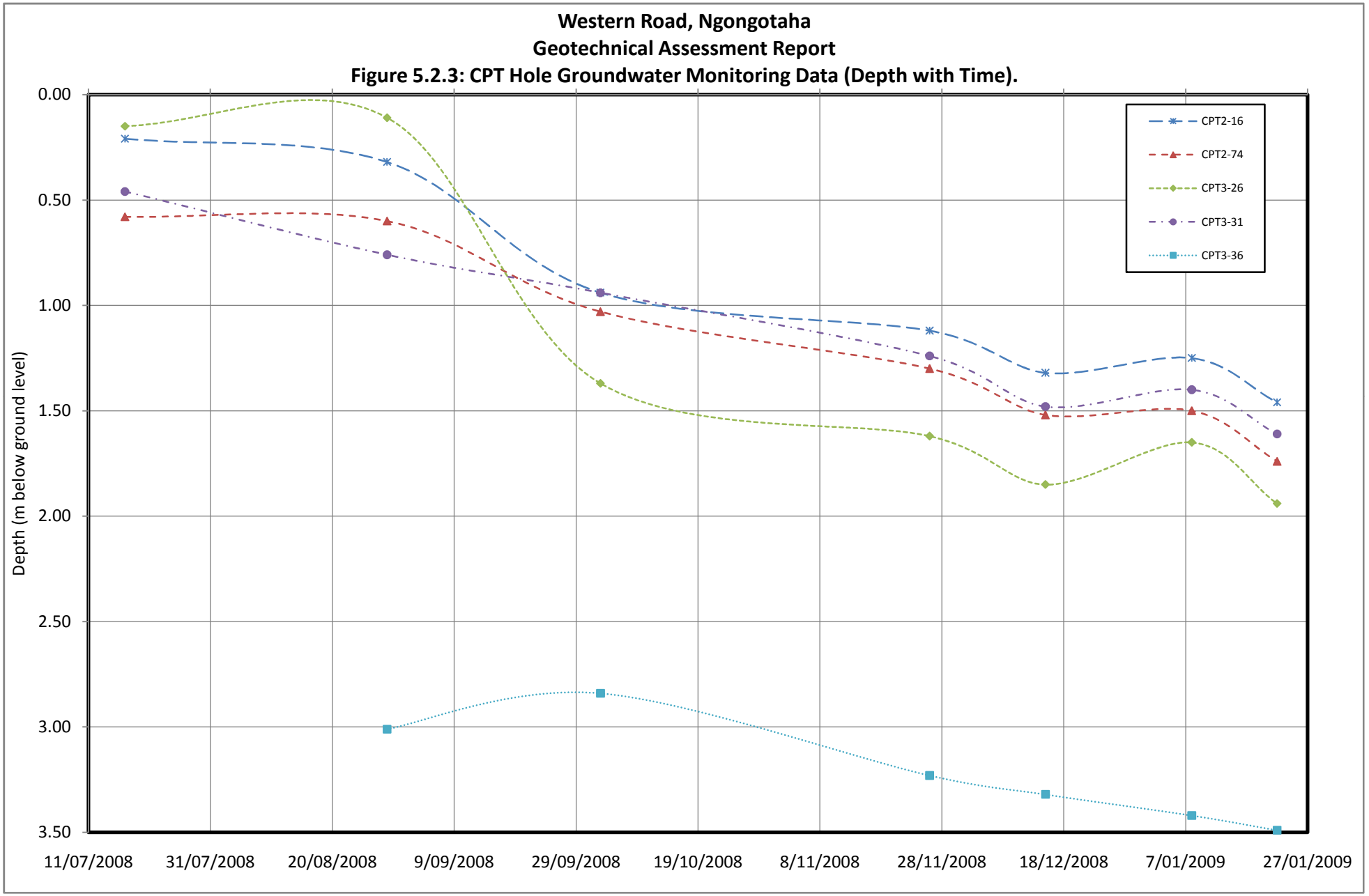
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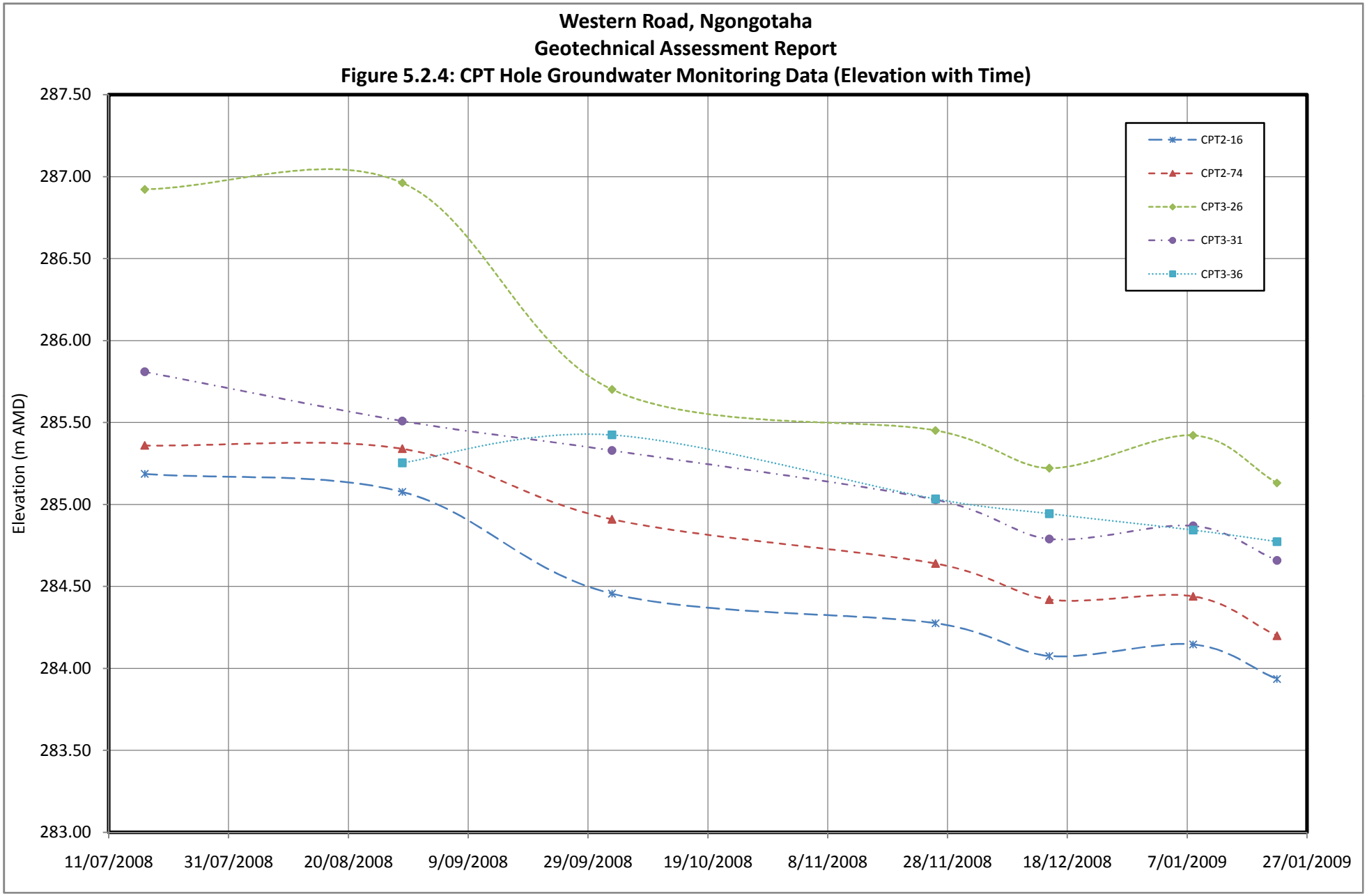
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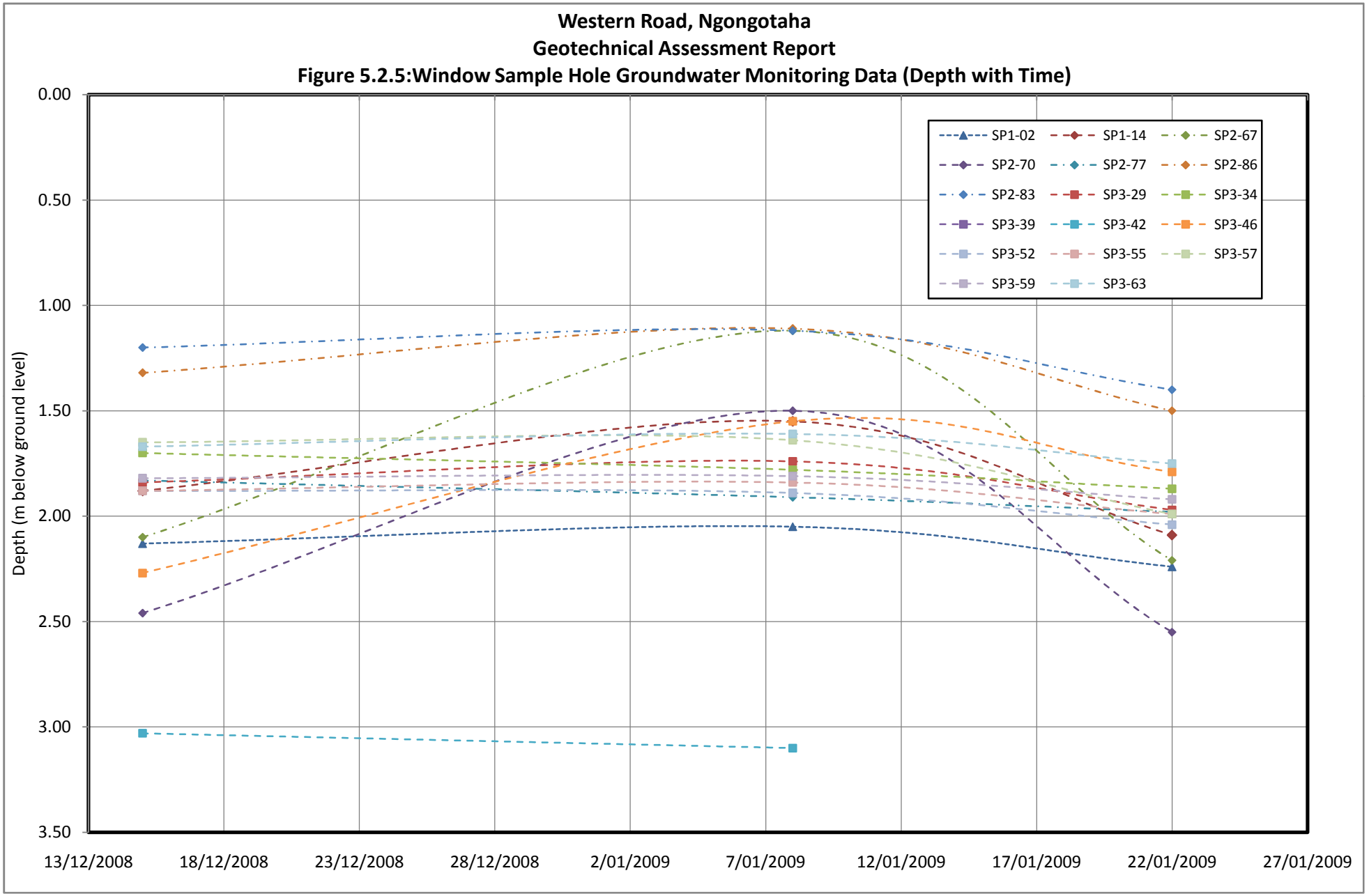
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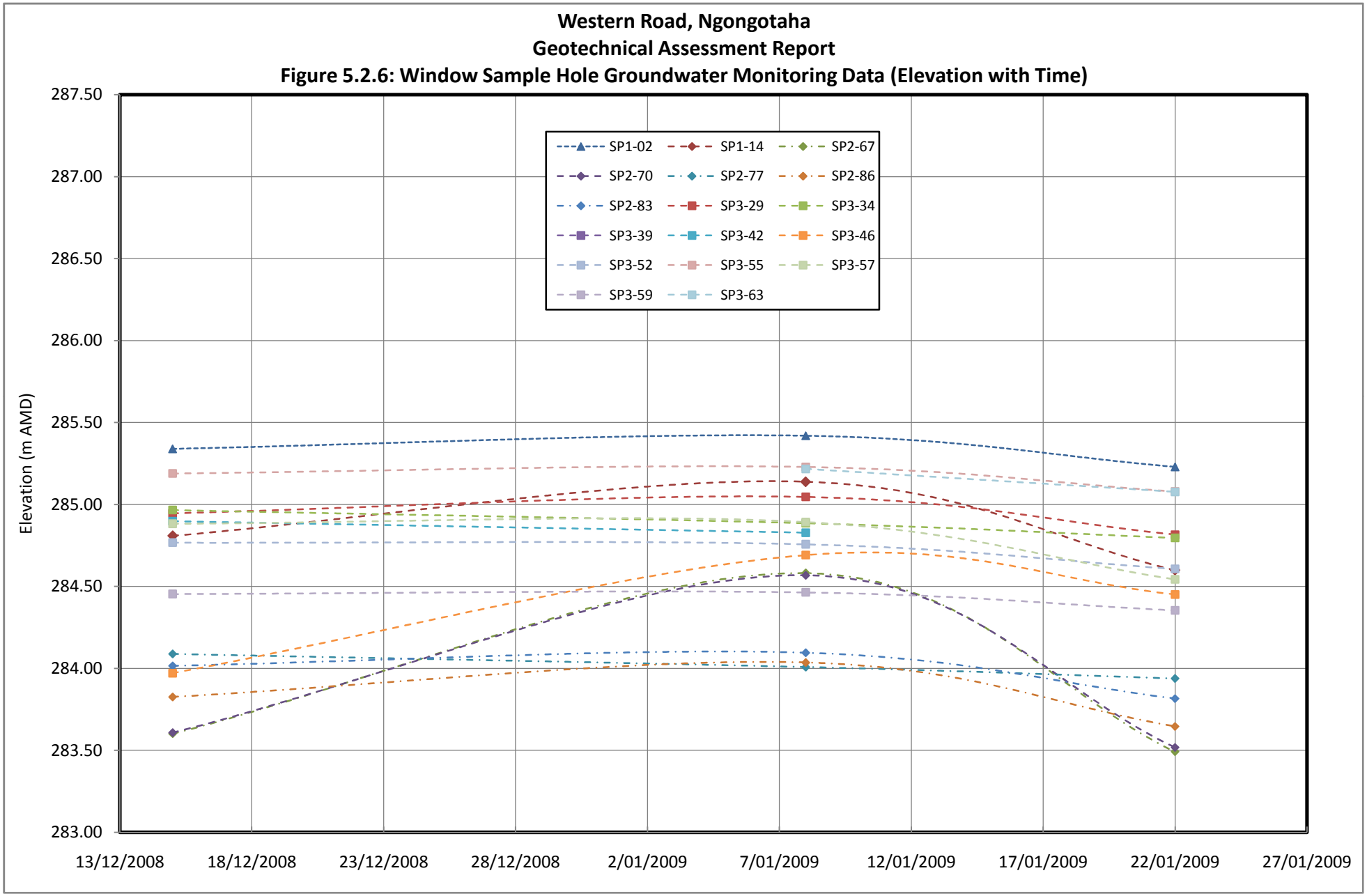
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Appendix F: Settlement Monitoring Results

- **Table 7.1.1: Settlement Monitoring Data for Stages One, Two and Three**
- **Table 7.1.2: Settlement Monitoring Data for Stages One, Two and Three (Cumulative Settlement)**
- **Figure 7.1.1: Settlement Monitoring Data for Stage One**
- **Figure 7.1.2: Monitoring Data for Stage Two**
- **Figure 7.1.3: Settlement Monitoring Data for Stage Three**

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Table 7.1.1: Settlement Monitoring Data for Stages One, Two and Three

Settlement Marker	Coordinates BoP 2000		Estimated Cut/Fill Depth	Week	1	1	1	2	2	3	4	6	10	14	19	23	27
	Eastings	Northings		Day	1	2	5	8	12	19	26	40	65	97	132	155	187
				Survey	1	2	3	4	5	6	7	8	9	10	10	10	10
			(m)	Date	17/07/08	18/07/08	21/07/08	24/07/08	28/07/08	04/08/08	11/08/08	25/08/08	19/09/08	21/10/08	25/11/08	18/12/08	19/01/2009
					Elevation (m AMD)												
Stage 1																	
SMP1-01	764214.19	376606.44	0.63		287.522	287.522	287.522	287.522	287.522	287.523	287.522	287.523	287.522	287.522	287.521	287.522	287.521
SMP1-03	764217.88	376673.57	0.00		287.425	287.424	287.425	287.425	287.425	287.425	287.424	287.425	287.425	287.425	287.424	287.424	287.423
SMP1-07	764228.24	376734.55	-0.25		287.115	287.115	287.115	287.115	287.115	287.115	287.116	287.116	287.116	287.115	287.114	287.113	
SMP1-11	764224.98	376825.02	-0.25		286.501	286.501	286.501	286.501	286.502	286.502	286.503	286.503	286.503	286.502	286.500	286.499	286.498
SMP1-17	764222.83	376914.25	-0.25		286.149	286.149	286.150	286.150	286.151	286.153	286.153	286.154	286.154	286.152	286.149	286.148	286.146
SMP1-20	764228.60	376979.45	-0.25		286.002	286.003	286.002	286.003	286.004	286.005	286.006	286.007	286.007	286.005	286.004	286.003	286.002
SMP1-18A	764218.67	376944.64	1.00											286.652	286.650	286.649	286.648
SMP1-18B	764219.72	376930.37	1.00											286.635	286.633	286.632	286.630
SMP1-18C	764236.00	376934.87	1.25											286.599	286.596	286.595	286.593
SMP1-18D	764236.74	376942.79	1.25											286.508	286.506	286.504	286.502
SMP1-9A	764210.68	376790.72	0.50											287.401			
SMP1-9B	764213.12	376776.63	0.50											287.423	287.423		287.422
SMP1-9C	764220.10	376776.65	0.75											287.386			
SMP1-9D	764228.89	376790.70	1.00											287.271			
14																	
Stage 2																	
SMP2-16	764279.19	376912.09	0.63		285.215	285.216	285.218	285.218	285.218	285.219	285.218	285.220	285.219	285.218	285.211	285.209	285.208
SMP2-68	764330.40	376902.16	0.00		285.768	285.768	285.769	285.768	285.768	285.769	285.768	285.769	285.769	285.769	285.769	285.769	285.769
SMP2-72A	764289.61	376827.62	-0.25		286.181	286.181	286.182	286.182	286.181	286.182	286.182	286.182	286.182	286.183	286.182	286.183	286.183
SMP2-72B	764285.45	376840.21	-0.25		286.191	286.191	286.192	286.193	286.192	286.193	286.192	286.192	286.193	286.193	286.192	286.192	286.193
SMP2-72C	764266.21	376824.16	-0.25		286.251	286.251	286.253	286.253	286.252	286.254	286.252	286.253	286.253	286.253	286.252	286.252	286.252
SMP2-72D	764265.10	376834.62	-0.25		286.117	286.117	286.119	286.119	286.118	286.120	286.118	286.119	286.118	286.119	286.117	286.117	286.117
SMP2-74	764398.75	376831.56	0.63		285.794	285.795	285.796	285.796	285.796	285.797	285.797	285.798	285.798	285.798	285.794	285.793	285.792
SMP2-85	764288.02	377023.32	0.88		285.059	285.060	285.060	285.061	285.062	285.063	285.064	285.065	285.066	285.064	285.060	285.057	285.056
Road 2-1	764211.93	377004.79	-0.63		286.569	286.569	286.569	286.569	286.569	286.569	286.570	286.570	286.569	286.570	286.569	286.569	286.570
Road 2-2	764265.30	376998.06	-1.38		285.054	285.055	285.055	285.057	285.057	285.059	285.060	285.062	285.063	285.060	285.057	285.055	285.054
Road 2-3	764298.70	376994.35	0.25		284.608	284.608	284.608	284.610	284.610	284.611	284.610	284.612	284.612	284.611	284.608	284.607	284.606
Road 2-4	764360.79	376945.99	0.38		284.924	284.924	284.925	284.924	284.924	284.925	284.925	284.926	284.926	284.926	284.925	284.926	284.925
Road 2-5	764366.88	376900.04	-1.50		285.198	285.198	285.199	285.198	285.198	285.198	285.198	285.199	285.199	285.199	285.198	285.198	285.198
Road 2-6	764365.36	376822.63	-0.50		285.389	285.390	285.391	285.391	285.390	285.393	285.391	285.393	285.392	285.391	285.389	285.388	285.388
14																	
Stage 3																	
SMP3-24	764250.56	376623.98	0.50		287.103	287.103	287.104	287.104	287.104	287.105	287.104	287.106	287.105	287.104	287.103	287.102	287.101
SMP3-28	764337.36	376622.69	0.50		286.707	286.707	286.707	286.708	286.707	286.708	286.707	286.708	286.708	286.708	286.707	286.707	286.707
SMP3-31	764405.36	376622.37	0.50		286.100	286.100	286.100	286.100	286.100	286.101	286.100	286.101	286.101	286.102	286.101	286.101	286.101
SMP3-34	764474.44	376625.40	0.25		286.376	286.377	286.376	286.376	286.376	286.377	286.376	286.377	286.377	286.377	286.377	286.377	286.377
SMP3-37	764504.46	376665.43	0.75		287.496	287.496	287.496	287.495	287.496	287.495	287.496	287.495	287.496	287.496	287.496	287.496	287.497
SMP3-41	764500.63	376753.40	-1.00		289.359	289.359	289.359	289.359	289.359	289.358	289.359	289.358	289.358	289.359	289.359	289.360	289.361
SMP3-44	764433.43	376760.35	0.50		285.917	285.918	285.918	285.918	285.918	285.919	285.918	285.919	285.919	285.919	285.918	285.918	285.918
SMP3-45	764442.52	376720.72	0.00		285.670	285.669	285.670	285.670	285.670	285.671	285.670	285.670	285.671	285.671	285.670	285.670	285.671
SMP3-51	764396.28	376673.21	0.75		286.346	286.346	286.346	286.346	286.346	286.347	286.347	286.346	286.347	286.348	286.346	286.346	286.346
SMP3-55	764314.09	376670.99	-0.13		286.784	286.784	286.785	286.785	286.785	286.785	286.784	286.785	286.785	286.785	286.785	286.785	286.785
SMP3-61	764278.78	376723.66	-0.50		286.555	286.556	286.556	286.556	286.556	286.557	286.556	286.556	286.557	286.557	286.556	286.556	286.556
SMP3-88	764368.01	376740.06	1.75		287.197	287.199	287.199	287.199	287.198	287.199	287.198	287.199	287.199	287.199	287.197	287.197	287.196
Road 1-1	764271.09	376639.54	0.00		286.985	286.985	286.986	286.986	286.985	286.987	286.985	286.987	286.986	286.987	286.986	286.986	286.986
Road 1-1A	764295.51	376639.74	0.00		286.747	286.746	286.747	286.747	286.747	286.747	286.746	286.747	286.747	286.748	286.747	286.747	286.747
Road 1-2	764419.68	376639.77	-0.13		286.083	286.083	286.083	286.083	286.083	286.084	286.083	286.084	286.084	286.085	286.084	286.084	286.083
Road 1-2A	764515.56	376639.63	0.75		287.749	287.749	287.748	287.748	287.748	287.748	287.748	287.748	287.748	287.748	287.748	287.748	287.749
Road 1-3	764561.82	376647.83	1.50		293.243	293.243	293.243	293.242	293.242	293.242	293.242	293.241	293.241	293.241	293.242	293.242	293.243
Loop Road 1	764512.15	376734.71	-0.88		288.433	288.433	288.433	288.432	288.432	288.432	288.433	288.432	288.432	288.433	288.433	288.434	288.435
Loop Road 2	764424.25	376735.42	-0.13		285.457	285.457	285.457	285.457	285.457	285.458	285.458	285.459	285.458	285.459	285.458	285.458	285.458
19																	

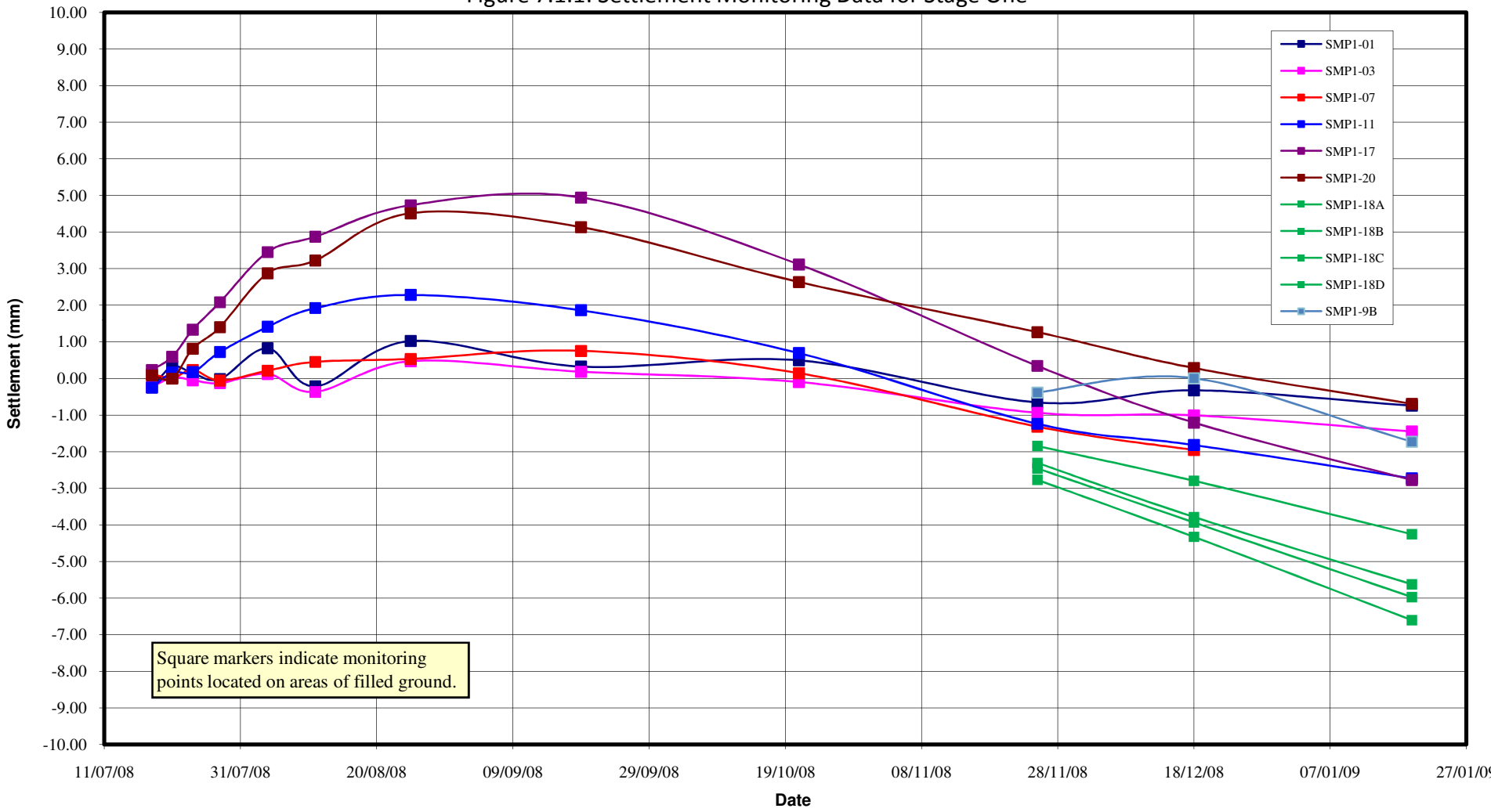
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Geotechnical Assessment Report
Table 7.1.2: Settlement Monitoring Data for Stages One, Two and Three (Cumulative Settlement)

Settlement Marker	Coordinates BoP 2000		Estimated Cut/Fill Depth	Week	1	1	1	2	2	3	4	6	10	14	19	23	27	Maximum Change
	Eastings	Northings		Day	1	2	5	8	12	19	26	40	65	97	132	155	187	
				Survey	1	2	3	4	5	6	7	8	9	10	10	10	10	
			(m)	Date	17/07/08	18/07/08	21/07/08	24/07/08	28/07/08	04/08/08	11/08/08	25/08/08	19/09/08	21/10/08	25/11/08	18/12/08	19/01/2009	(mm)
					Settlement (mm)													
Stage 1																		
SMP1-01	764214.19	376606.44	0.63			0	0	0	0	1	0	1	0	0	-1	0	-1	2
SMP1-03	764217.88	376673.57	0.00			0	0	0	0	0	0	0	0	0	-1	-1	-1	2
SMP1-07	764228.24	376734.55	-0.25			0	0	0	0	0	0	1	1	0	-1	-2		3
SMP1-11	764224.98	376825.02	-0.25			0	0	0	1	1	2	2	2	1	-1	-2	-3	5
SMP1-17	764222.83	376914.25	-0.25			0	1	1	2	3	4	5	5	3	0	-1	-3	8
SMP1-20	764228.60	376979.45	-0.25			0	0	1	1	3	3	5	4	3	1	0	-1	5
SMP1-18A	764218.67	376944.64													-2	-3	-4	4
SMP1-18B	764219.72	376930.37													-2	-4	-6	6
SMP1-18C	764236.00	376934.87													-2	-4	-6	6
SMP1-18D	764236.74	376942.79													-3	-4	-7	7
SMP1-9A	764210.68	376790.72																0
SMP1-9B	764213.12	376776.63													0		-2	2
SMP1-9C	764220.10	376776.65																0
SMP1-9D	764228.89	376790.70																0
Stage 2																		
SMP2-16	764279.19	376912.09	0.63			1	2	2	2	3	3	4	3	2	-4	-6	-8	12
SMP2-68	764330.40	376902.16	0.00			0	1	0	1	1	0	1	1	1	1	1	1	1
SMP2-72A	764289.61	376827.62	-0.25			0	0	0	0	1	0	1	1	1	1	1	2	2
SMP2-72B	764285.45	376840.21	-0.25			0	1	1	1	2	1	1	1	1	1	1	1	2
SMP2-72C	764266.21	376824.16	-0.25			0	2	2	1	3	1	2	2	2	0	1	1	3
SMP2-72D	764265.10	376834.62	-0.25			0	2	2	1	3	1	2	1	2	0	0	0	3
SMP2-74	764398.75	376831.56	0.63			0	1	2	2	3	2	3	4	3	0	-2	-2	6
SMP2-85	764288.02	377023.32	0.88			0	1	1	2	3	4	6	7	5	1	-2	-3	10
Road 2-1	764211.93	377004.79	-0.63			0	0	0	0	0	1	1	0	1	0	0	0	1
Road 2-2	764265.30	376998.06	-1.38			0	1	2	3	4	5	7	8	6	3	1	-1	9
Road 2-3	764298.70	376994.35	0.25			0	0	2	2	3	2	4	4	3	0	-1	-2	6
Road 2-4	764360.79	376945.99	0.38			1	1	1	1	1	1	2	2	3	1	2	2	3
Road 2-5	764366.88	376900.04	-1.50			0	1	0	0	1	0	1	1	2	1	1	0	2
Road 2-6	764365.36	376822.63	-0.50			0	2	2	1	3	1	4	3	2	-1	-1	-2	5
Stage 3																		
SMP3-24	764250.56	376623.98	0.50			0	1	1	1	2	1	3	2	1	0	-1	-2	5
SMP3-28	764337.36	376622.69	0.50			0	1	1	1	2	0	1	1	2	0	0	1	2
SMP3-31	764405.36	376622.37	0.50			0	1	1	0	1	1	1	2	3	1	1	1	3
SMP3-34	764474.44	376625.40	0.25			0	0	0	0	0	0	0	1	1	1	0	1	1
SMP3-37	764504.46	376665.43	0.75			0	-1	-1	-1	-1	-1	-1	-1	0	-1	0	0	2
SMP3-41	764500.63	376753.40	-1.00			0	0	0	0	-1	-1	-1	-1	0	0	1	2	3
SMP3-44	764433.43	376760.35	0.50			0	1	1	1	2	1	2	2	2	1	1	1	2
SMP3-45	764442.52	376720.72	0.00			-1	0	0	0	1	0	0	1	1	0	0	1	2
SMP3-51	764396.28	376673.21	0.75			0	0	0	0	1	1	0	1	2	0	0	0	2
SMP3-55	764314.09	376670.99	-0.13			0	0	0	0	1	0	0	0	1	1	1	1	1
SMP3-61	764278.78	376723.66	-0.50			0	1	1	0	1	1	1	1	2	1	1	1	2
SMP3-88	764368.01	376740.06	1.75			1	1	2	1	2	1	2	1	1	0	-1	-1	3
Road 1-1	764271.09	376639.54	0.00			0	1	1	0	1	0	2	1	1	0	0	1	2
Road 1-1A	764295.51	376639.74	0.00			0	0	0	0	1	0	1	0	1	0	0	0	1
Road 1-2	764419.68	376639.77	-0.13			0	0	0	0	1	0	1	1	1	1	0	0	2
Road 1-2A	764515.56	376639.63	0.75			0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	1
Road 1-3	764561.82	376647.83	1.50			0	-1	-1	-1	-1	-1	-2	-2	-2	-1	-1	0	2
Loop Road 1	764512.15	376734.71	-0.88			0	0	0	0	-1	0	-1	-1	0	0	1	2	3
Loop Road 2	764424.25	376735.42	-0.13			0	0	0	0	1	1	2	1	1	1	1	1	2

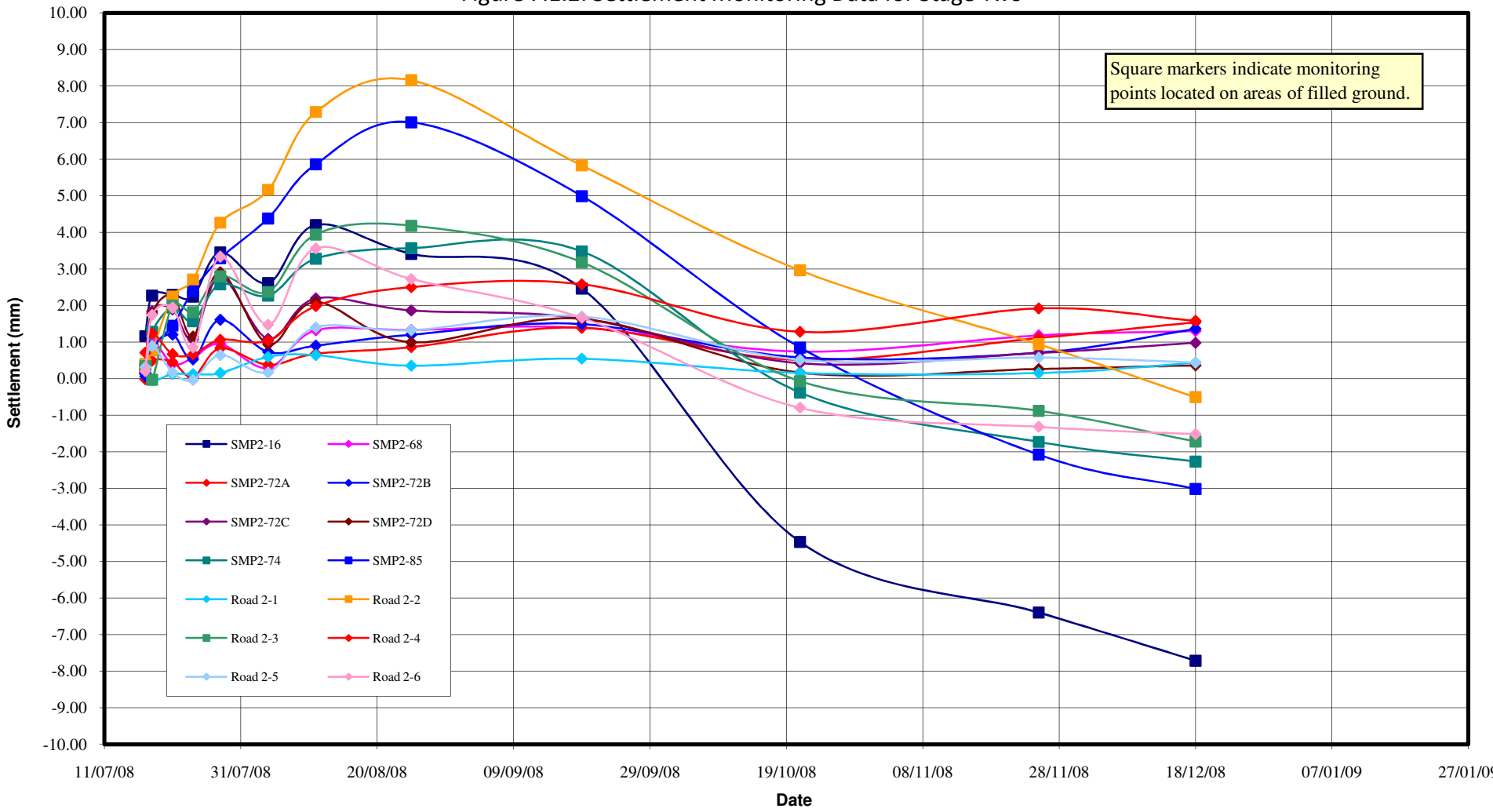
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Figure 7.1.1: Settlement Monitoring Data for Stage One



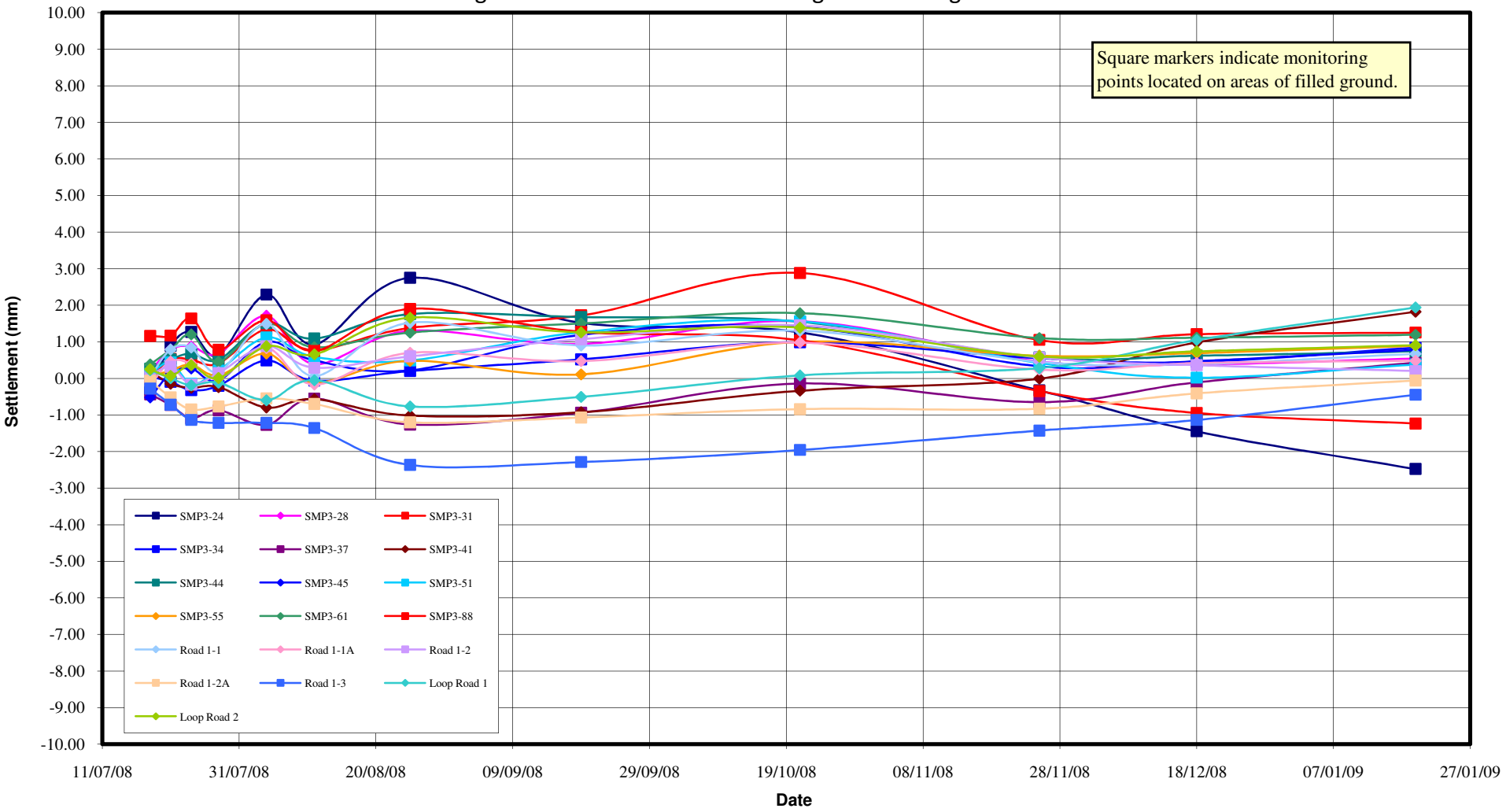
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Figure 7.1.2: Settlement Monitoring Data for Stage Two



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Figure 7.1.3: Settlement Monitoring Data for Stage Three



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Appendix G: Trial Load Monitoring Results

- **Table 7.2.2: Trial Load Monitoring Data**
- **Table 7.2.3: Trial Load Monitoring Data (Cumulative Settlement)**
- **Figure 7.2.1: Settlement Monitoring Point Layout for Trial Load 1 – Lot 64**
- **Figure 7.2.2: Settlement Monitoring Point Layout for Trial Load 2 – Lot 79**
- **Figure 7.2.3: Settlement Monitoring Point Layout for Trial Load 3 – Lot 58**
- **Figure 7.2.4: Settlement Monitoring Data for Trial Load 1 – Lot 64 (Settlement against Time)**
- **Figure 7.2.5: Settlement Monitoring Data for Trial Load 2 – Lot 79 (Settlement against Time)**
- **Figure 7.2.6: Settlement Monitoring Data for Trial Load 3 – Lot 58 (Settlement against Time)**
- **Figure 7.2.7: Settlement Monitoring Data for Trial Load 1 – Lot 64 (Settlement against Log Time)**
- **Figure 7.2.8: Settlement Monitoring Data for Trial Load 1 – Lot 64 (Settlement against Log Time)**
- **Figure 7.2.9: Settlement Monitoring Data for Trial Load 1 – Lot 64 (Settlement against Log Time)**
- **Figure 7.2.10: Settlement Monitoring Data for Trial Load 1 – Lot 64 (Settlement against Square Root Time)**
- **Figure 7.2.11: Hyperbolic Model of Settlement Monitoring Data for Trial Load 1 – Lot 64**
- **Figure 7.2.12: Assumed Pressure Distribution Beneath Trial Load 1, Lot 64**
- **Hyperbolic Settlement Curve Explanation Sheet**

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Table 7.2.2: Trial Load Monitoring Data

Settlement Marker	Coordinates BoP 2000		Estimated Cut/Fill Depth	Week	1	1	1	1	1	1	1	1	1	2	2	3	4	6	10	14	19	23	27
				Day	1	1	1	2	2	5	5	5	5	8	12	19	26	40	65	97	132	155	187
	Eastings	Northings		Survey	1	1A	1B	2	2A	3	3A	3B	3C	4	5	6	7	8	9	10	11	12	13
			(m)	Date	17/07/08	17/07/08	17/07/08	18/07/08	18/07/08	21/07/08	21/07/08	21/07/08	21/07/08	24/07/08	28/07/08	04/08/08	11/08/08	25/08/08	19/09/08	21/10/08	25/11/08	18/12/08	19/01/2009
Trial Load 2-64																							
SMP2-64-A	764254	376970	0.50							285.40	285.40	285.40	285.40	285.40	285.40	285.40	285.39	285.39	285.39	285.39	285.38	285.38	285.38
SMP2-64-B	764257	376970	0.50							285.36	285.36	285.36	285.35	285.35	285.34	285.34	285.33	285.33	285.33	285.32	285.31	285.30	285.29
SMP2-64-C	764266	376955	0.50							284.84	284.85	284.85	284.85	284.85	284.85	284.84	284.84	284.84	284.83	284.83	284.82	284.81	284.81
SMP2-64-D	764266	376953	0.50							284.93	284.95	284.96	284.96	284.96	284.96	284.96	284.96	284.96	284.96	284.96	284.95	284.95	284.95
SMP2-64-E	764276	376968	0.50							284.90	284.90	284.90	284.90	284.89	284.88	284.87	284.87	284.87	284.86	284.85	284.85	284.84	284.83
SMP2-64-F	764278	376968	0.50							284.84	284.85	284.85	284.85	284.85	284.85	284.84	284.84	284.84	284.84	284.84	284.83	284.82	284.82
SMP2-64-G	764266	376984	0.50							284.76	284.76	284.76	284.76	284.75	284.75	284.74	284.74	284.74	284.74	284.73	284.73	284.72	284.71	284.71
SMP2-64-H	764266	376986	0.50							284.86	284.86	284.86	284.86	284.86	284.86	284.86	284.86	284.86	284.86	284.86	284.85	284.85	284.84
SMP2-64-1	764267	376970	0.50							286.67	286.64	286.63	286.63	286.60	286.58	286.56	286.55	286.53	286.52	286.50	286.48	286.47	286.45
SMP2-64-2	764273	376968	0.50							286.63	286.61	286.61	286.60	286.59	286.57	286.56	286.55	286.54	286.53	286.52	286.51	286.50	286.49
SMP2-64-3	764266	376982	0.50							286.57	286.56	286.55	286.55	286.53	286.52	286.51	286.50	286.50	286.49	286.48	286.47	286.46	286.45
SMP2-64-4	764259	376970	0.50							286.82	286.81	286.81	286.80	286.79	286.78	286.76	286.76	286.75	286.74	286.73	286.71	286.70	286.69
SMP2-64-5	764266	376958	0.50							286.65	286.63	286.62	286.62	286.61	286.60	286.59	286.58	286.58	286.57	286.56	286.55	286.54	286.53
Trial Load 2-79																							
SMP2-79-A	764369	376933	-0.50		285.04	285.04		285.04	285.04	285.04				285.04	285.04	285.04	285.04	285.04	285.04	285.04	285.04	285.04	285.04
SMP2-79-B	764371	376934	-0.50		285.18	285.17		285.17	285.17	285.17				285.17	285.17	285.17	285.17	285.17	285.17	285.17	285.17	285.17	285.17
SMP2-79-C	764381	376924	-0.50		285.60	285.60		285.60	285.60	285.60				285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60
SMP2-79-D	764381	376922	-0.50		285.61	285.61		285.61	285.61	285.61				285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61
SMP2-79-E	764390	376934	-0.50		285.61	285.61		285.61	285.61	285.61				285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61
SMP2-79-F	764393	376934	-0.50		285.60	285.61		285.61	285.61	285.61				285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61	285.61
SMP2-79-G	764380	376944	-0.50		285.63	285.63		285.63	285.63	285.63				285.63	285.63	285.63	285.63	285.63	285.63	285.63	285.63	285.63	285.63
SMP2-79-H	764380	376946	-0.50		285.60	285.60	285.60	285.60	285.60	285.60				285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60	285.60
SMP2-79-1	764381	376934	-0.50		288.14	288.13	288.14	288.13	288.13	288.12				288.12	288.12	288.12	288.12	288.11	288.11	288.11	288.11	288.11	288.10
SMP2-79-2	764387	376934	-0.50		288.24	288.23	288.23	288.23	288.23	288.23				288.23	288.23	288.23	288.23	288.23	288.23	288.23	288.22	288.22	288.22
SMP2-79-3	764380	376941	-0.50		288.16	288.15	288.15	288.15	288.15	288.14				288.14	288.14	288.14	288.14	288.14	288.14	288.14	288.13	288.13	288.13
SMP2-79-4			-0.50		287.94	287.93	287.93	287.93															
SMP2-79-4A	764373	376934	-0.50						287.92	287.92				287.92	287.92	287.92	287.91	287.91	287.91	287.91	287.91	287.91	287.91
SMP2-79-5	764381	376927	-0.50		288.19	288.18	288.18	288.18	288.18	288.18				288.17	288.17	288.17	288.17	288.17	288.17	288.17	288.17	288.17	288.17
Trial Load 3-58																							
SMP3-58-A	764304	376791	-0.50					286.02	286.02	286.02				286.02	286.02	286.02	286.02	286.02	286.02	286.02	286.02	286.02	286.02
SMP3-58-B	764306	376791	-0.50					286.05	286.04	286.04				286.04	286.04	286.04	286.04	286.04	286.04	286.04	286.04	286.04	286.04
SMP3-58-C	764316	376781	-0.50					285.74	285.75					285.74	285.74	285.74	285.74	285.75	285.74	285.74	285.74	285.74	285.74
SMP3-58-D	764316	376778	-0.50					285.78	285.78	285.78				285.78	285.78	285.78	285.78	285.78	285.78	285.78	285.78	285.78	285.78
SMP3-58-E	764325	376789	-0.50					285.96	285.95	285.95				285.95	285.95	285.95	285.95	285.95	285.95	285.95	285.94	285.94	285.94
SMP3-58-F	764328	376789	-0.50					285.85	285.85	285.85				285.85	285.85	285.85	285.85	285.85	285.85	285.85	285.84	285.84	285.84
SMP3-58-G	764316	376800	-0.50					285.97	285.97	285.97				285.97	285.97	285.97	285.97	285.97	285.97	285.97	285.96	285.96	285.96
SMP3-58-H	764316	376802	-0.50					286.03	286.03	286.03				286.03	286.03	286.03	286.03	286.03	286.03	286.03	286.03	286.03	286.03
SMP3-58-1	764316	376790	-0.50					287.63	287.62	287.62				287.62	287.62	287.62	287.62	287.62	287.62	287.61	287.61	287.61	287.61
SMP3-58-2	764323	376790	-0.50					287.55	287.54	287.53				287.53	287.53	287.53	287.53	287.53	287.53	287.53	287.53	287.52	287.52
SMP3-58-3	764316	376797	-0.50					287.56	287.55	287.55				287.55	287.55	287.55	287.55	287.55	287.55	287.55	287.55	287.55	287.55
SMP3-58-4	764309	376791	-0.50					287.67	287.66	287.66				287.66	287.66	287.66	287.66	287.66	287.66	287.66	287.66	287.66	287.66
SMP3-58-5	764316	376783	-0.50					287.59	287.59	287.59				287.59	287.58	287.58	287.58	287.58	287.58	287.58	287.58	287.58	287.58

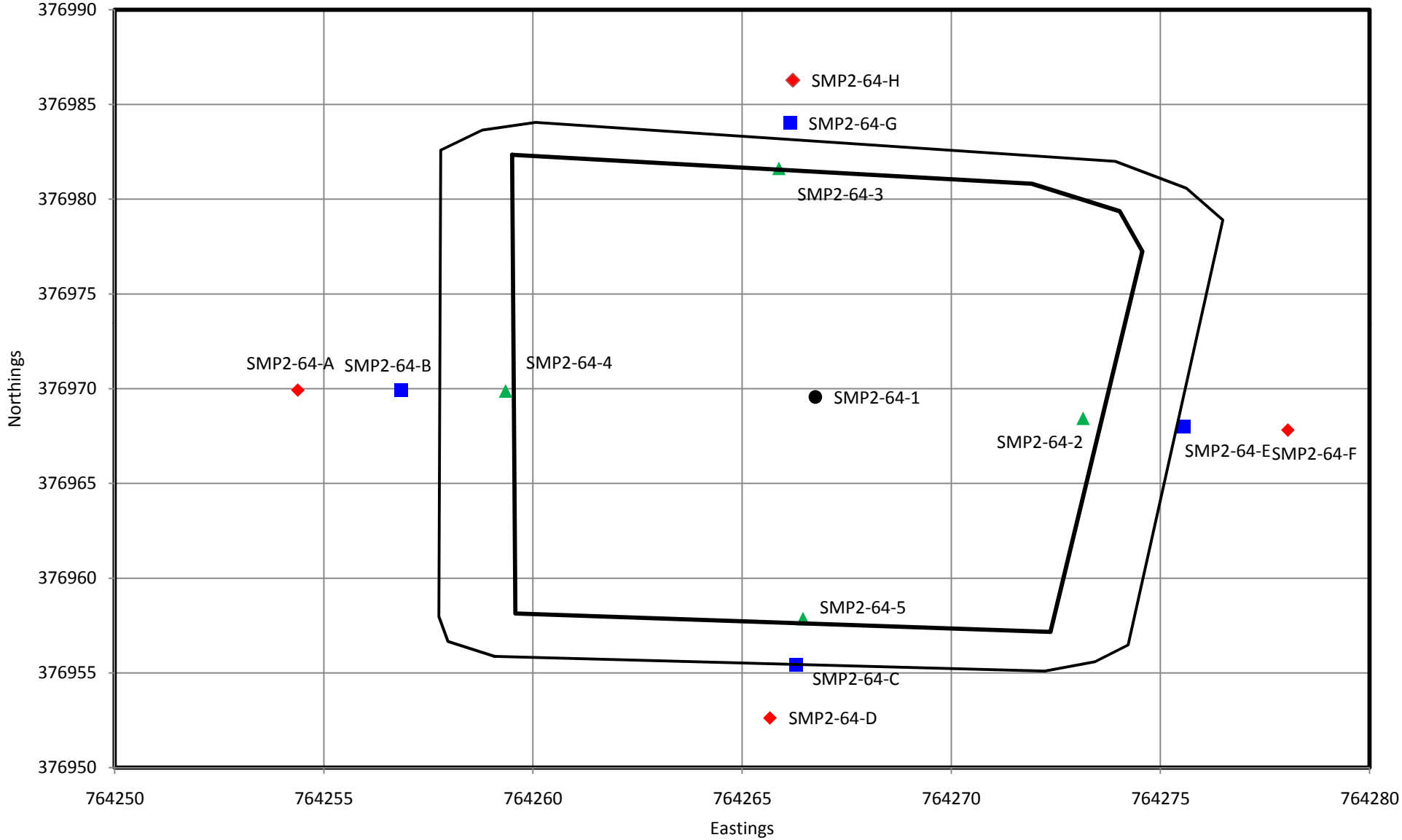
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Table 7.2.3: Trial Load Monitoring Data (Cumulative Settlement)

Settlement Marker	Coordinates BoP 2000		Estimated Cut/Fill Depth	Week	1	1	1	1	1	1	1	1	1	2	2	3	4	6	10	14	19	23	27
				Day	1	1	1	2	2	5	5	5	5	8	12	19	26	40	65	97	132	155	187
	Eastings	Northings		Survey	1	1A	1B	2	2A	3	3A	3B	3C	4	5	6	7	8	9	10	11	12	13
			(m)	Date	17/07/08	17/07/08	17/07/08	18/07/08	18/07/08	21/07/08	21/07/08	21/07/08	21/07/08	24/07/08	28/07/08	04/08/08	11/08/08	25/08/08	19/09/08	21/10/08	25/11/08	18/12/08	19/01/2009
					Settlement (mm)																		
Trial Load 2-64																							
SMP2-64-A	764254	376970	0.5								0		-1	-4	-5	-7	-7	-8	-11	-17	-21	-26	
SMP2-64-B	764257	376970	0.5								-6		-12	-18	-24	-27	-30	-34	-41	-50	-57	-66	
SMP2-64-C	764266	376955	0.5								10		9	6	2	-1	-3	-6	-11	-20	-25	-32	
SMP2-64-D	764266	376953	0.5								33		35	35	35	35	34	34	31	24	22	18	
SMP2-64-E	764276	376968	0.5								-6		-13	-21	-28	-32	-37	-41	-48	-57	-65	-75	
SMP2-64-F	764278	376968	0.5								5		3	1	-2	-4	-5	-5	-9	-15	-20	-27	
SMP2-64-G	764266	376984	0.5								-5		-9	-15	-20	-23	-25	-27	-34	-42	-49	-57	
SMP2-64-H	764266	376986	0.5								1		1	-1	-3	-3	-3	-4	-7	-13	-17	-22	
SMP2-64-1	764267	376970	0.5								-39		-62	-85	-106	-118	-133	-147	-165	-184	-199	-218	
SMP2-64-2	764273	376968	0.5								-27		-42	-57	-71	-79	-88	-97	-108	-121	-132	-146	
SMP2-64-3	764266	376982	0.5								-23		-35	-47	-58	-64	-71	-78	-88	-100	-109	-122	
SMP2-64-4	764259	376970	0.5								-22		-35	-49	-61	-69	-77	-85	-97	-111	-121	-135	
SMP2-64-5	764266	376958	0.5								-31		-40	-50	-60	-65	-71	-77	-86	-99	-108	-118	
Trial Load 2-79																							
SMP2-79-A	764369	376933	-0.5						0	0			-1	-1	0	0	0	1	-1	-2	-1	-2	
SMP2-79-B	764371	376934	-0.5						-4	-5			-6	-6	-6	-6	-6	-6	-6	-7	-7	-7	
SMP2-79-C	764381	376924	-0.5						-3	-3			-4	-4	-4	-4	-4	-3	-3	-5	-4	-5	
SMP2-79-D	764381	376922	-0.5						0	0			-1	-1	0	-1	0	0	0	-1	0	0	
SMP2-79-E	764390	376934	-0.5						2	2			1	1	1	1	1	2	2	1	2	1	
SMP2-79-F	764393	376934	-0.5						8	8			7	7	7	7	8	7	8	7	8	8	
SMP2-79-G	764380	376944	-0.5						-3	-5			-5	-5	-5	-6	-5	-6	-6	-7	-7	-8	
SMP2-79-H	764380	376946	-0.5						0	-1			-1	-1	-1	-1	-1	0	0	-1	-1	-1	
SMP2-79-1	764381	376934	-0.5						-16	-21			-23	-25	-26	-28	-29	-31	-33	-36	-38	-41	
SMP2-79-2	764387	376934	-0.5						-7	-9			-10	-11	-11	-11	-11	-12	-12	-14	-14	-15	
SMP2-79-3	764380	376941	-0.5						-11	-14			-15	-16	-17	-18	-18	-19	-20	-23	-23	-25	
SMP2-79-4	0	0	-0.5																				
SMP2-79-4A	764373	376934	-0.5																				
SMP2-79-5	764381	376927	-0.5						-10	-12			-12	-13	-13	-14	-14	-14	-14	-16	-15	-16	
Trial Load 3-58																							
SMP3-58-A	764304	376791	-0.5						1	0			0	-1	1	0	0	1	1	0	1	0	
SMP3-58-B	764306	376791	-0.5						-1	-2			-3	-3	-2	-3	-3	-2	-2	-3	-3	-3	
SMP3-58-C	764316	376781	-0.5						0				0	-1	0	-1	0	0	0	-1	-1	-1	
SMP3-58-D	764316	376778	-0.5						4	5			5	5	6	5	6	6	6	5	6	6	
SMP3-58-E	764325	376789	-0.5						-3	-5			-5	-6	-5	-7	-6	-7	-9	-13	-15	-18	
SMP3-58-F	764328	376789	-0.5						0	0			0	-2	0	-2	-1	-2	-4	-9	-11	-14	
SMP3-58-G	764316	376800	-0.5						-2	-3			-4	-4	-3	-4	-4	-3	-4	-5	-5	-5	
SMP3-58-H	764316	376802	-0.5						-1	-1			-1	-2	0	-1	-1	-1	-1	-2	-2	-2	
SMP3-58-1	764316	376790	-0.5						-11	-15			-15	-16	-16	-17	-17	-17	-18	-21	-21	-22	
SMP3-58-2	764323	376790	-0.5						-8	-12			-12	-14	-13	-14	-14	-15	-17	-21	-23	-25	
SMP3-58-3	764316	376797	-0.5						-6	-8			-8	-9	-8	-9	-9	-9	-9	-11	-11	-12	
SMP3-58-4	764309	376791	-0.5						-6	-8			-8	-9	-8	-9	-8	-8	-9	-10	-9	-10	
SMP3-58-5	764316	376783	-0.5						-6	-8			-8	-9	-8	-9	-9	-9	-9	-11	-11	-11	

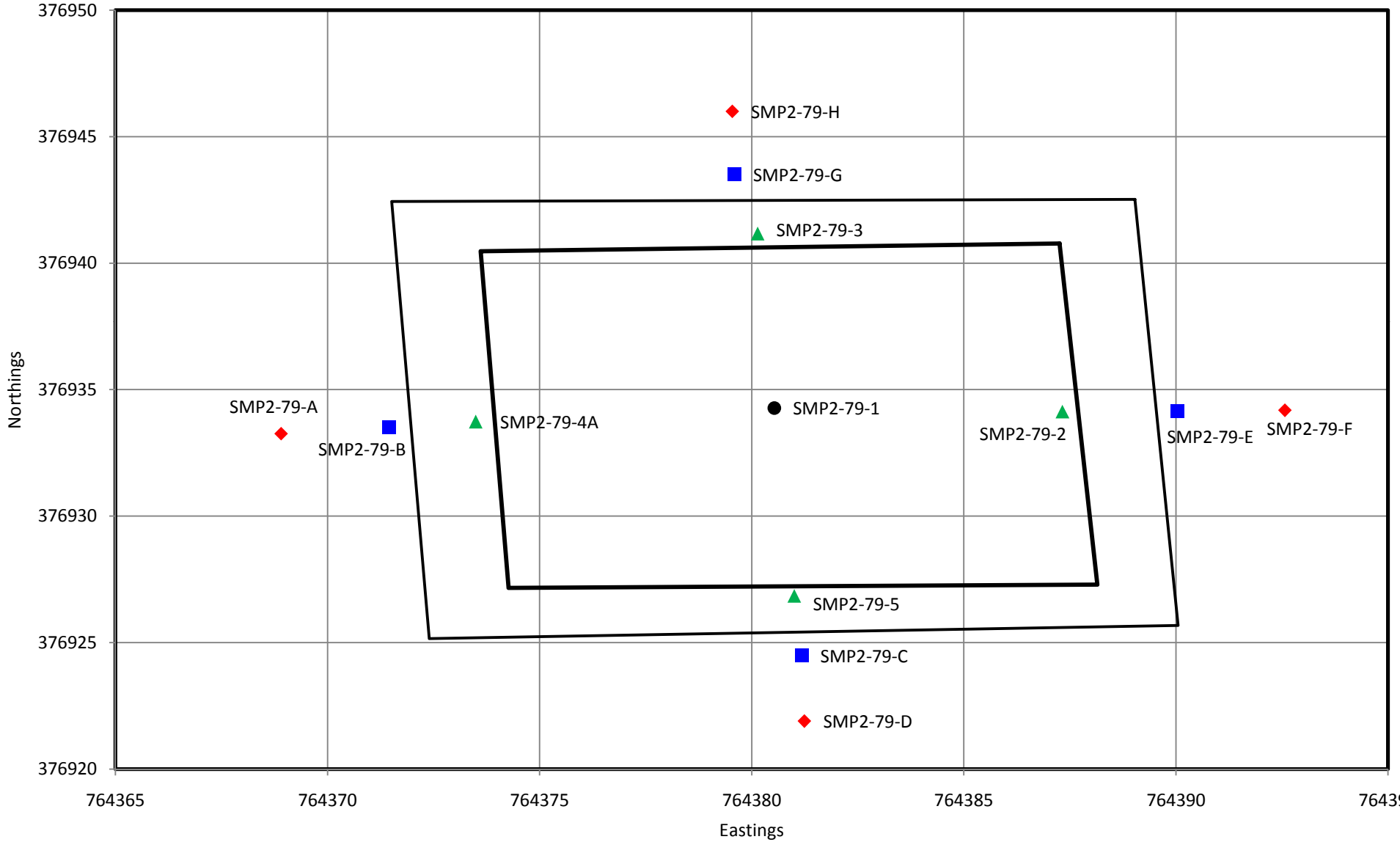
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Figure 7.2.1: Settlement Monitoring Point Layout for Trial Load 1 - Lot 64



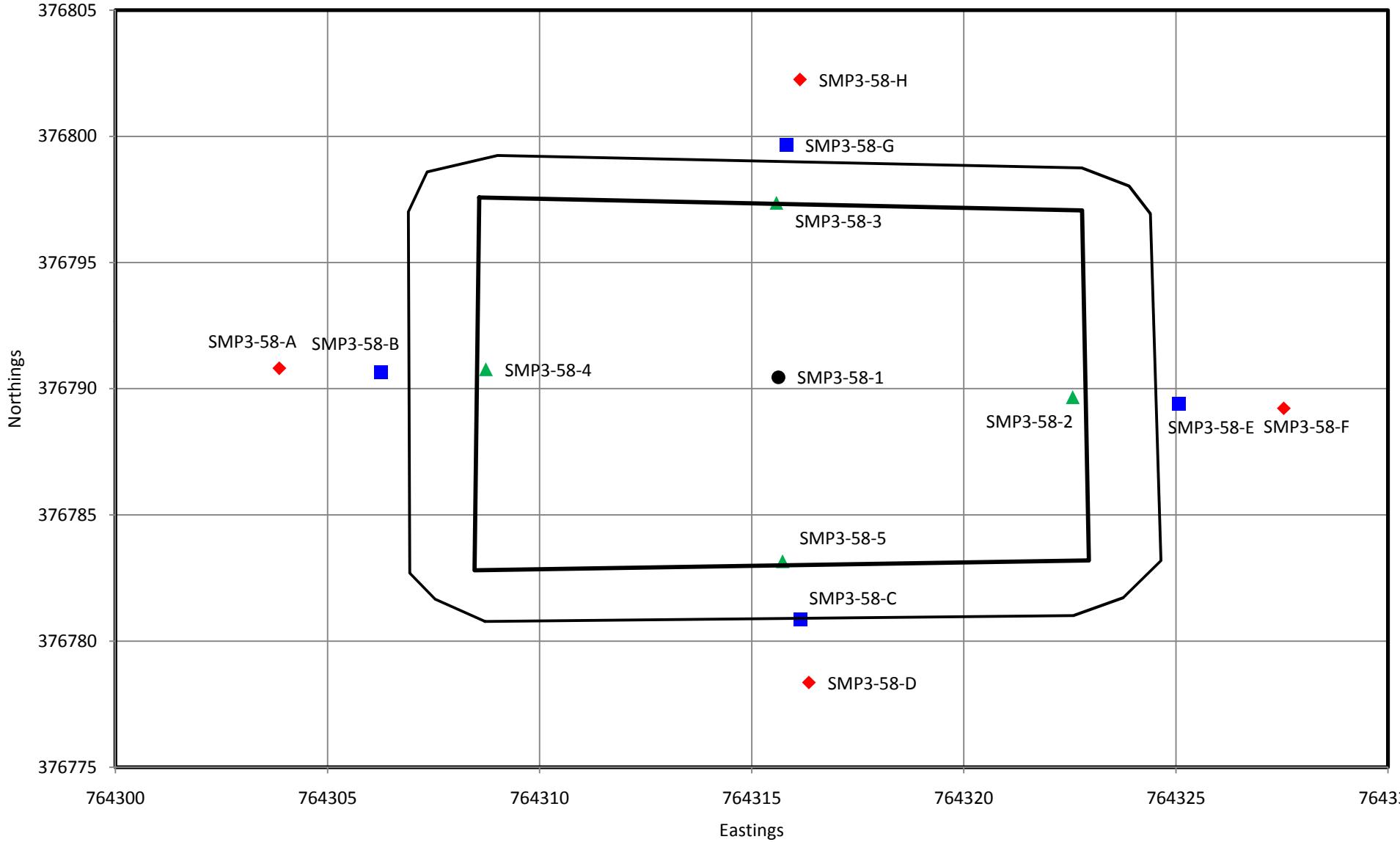
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Figure 7.2.2: Settlement Monitoring Point Layout for Trial Load 2 - Lot 79



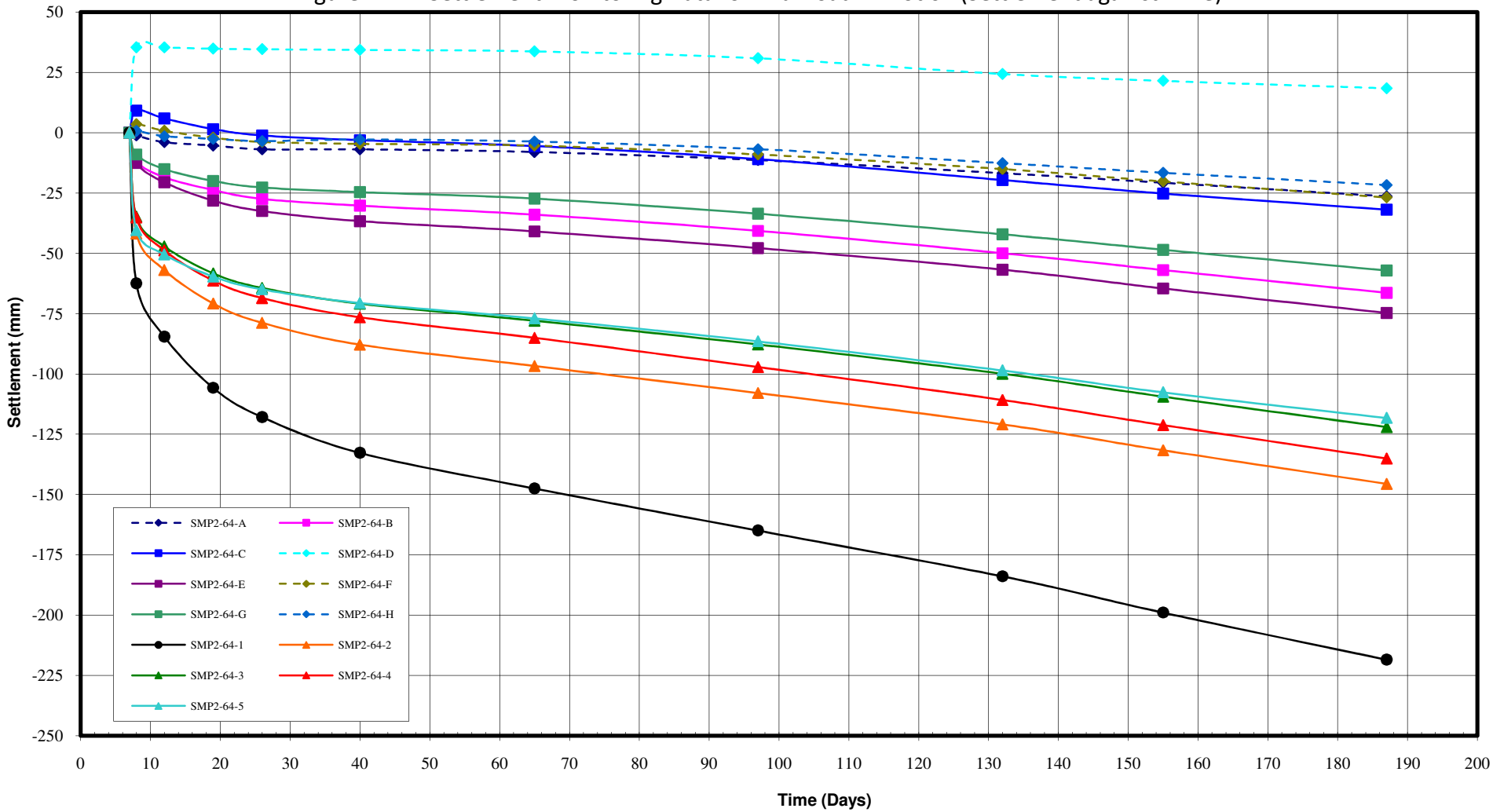
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Figure 7.2.3: Settlement Monitoring Point Layout for Trial Load 3 - Lot 58



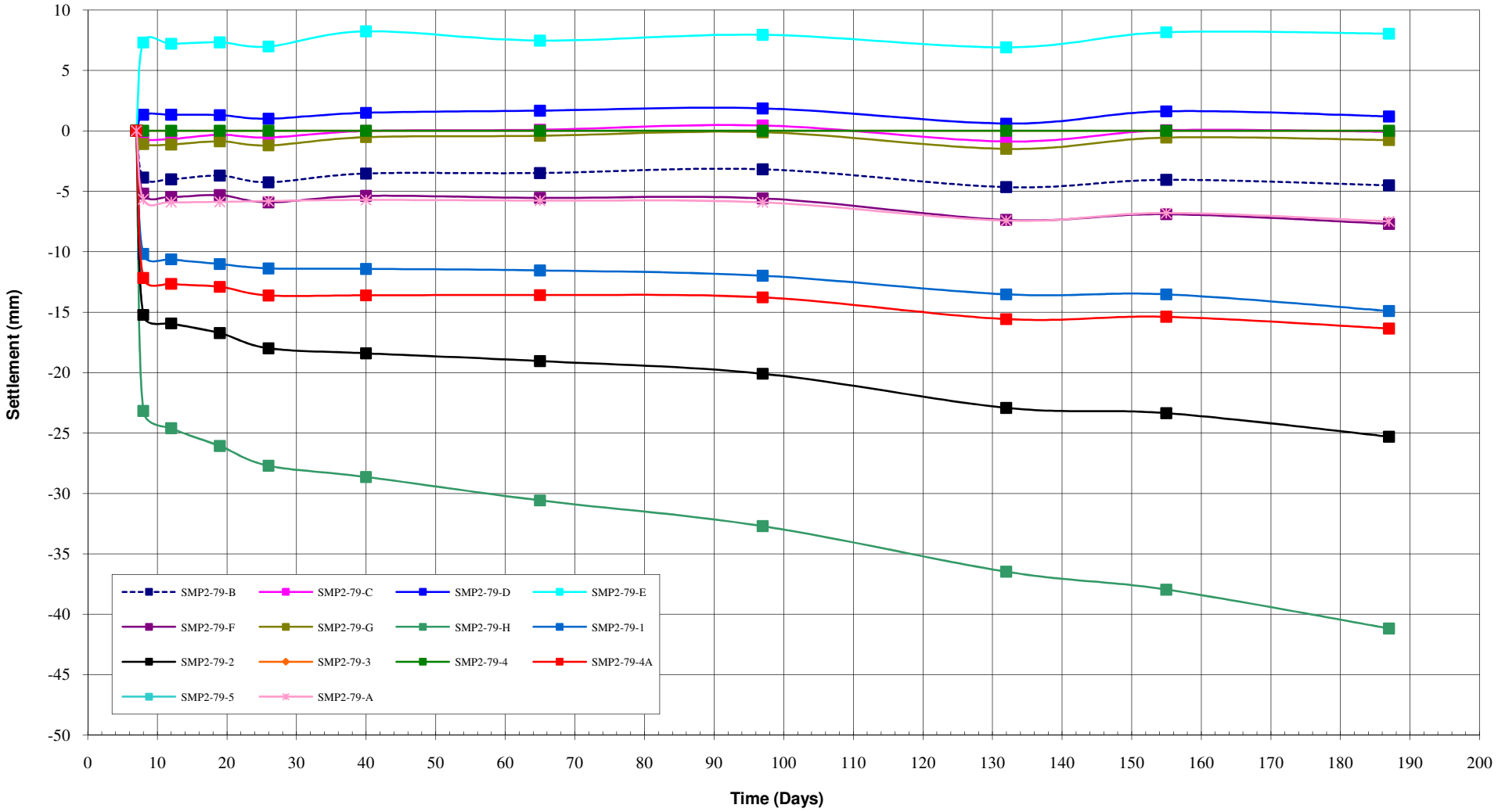
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Figure 7.2.4: Settlement Monitoring Data for Trial Load 1 - Lot 64 (Settlement against Time)



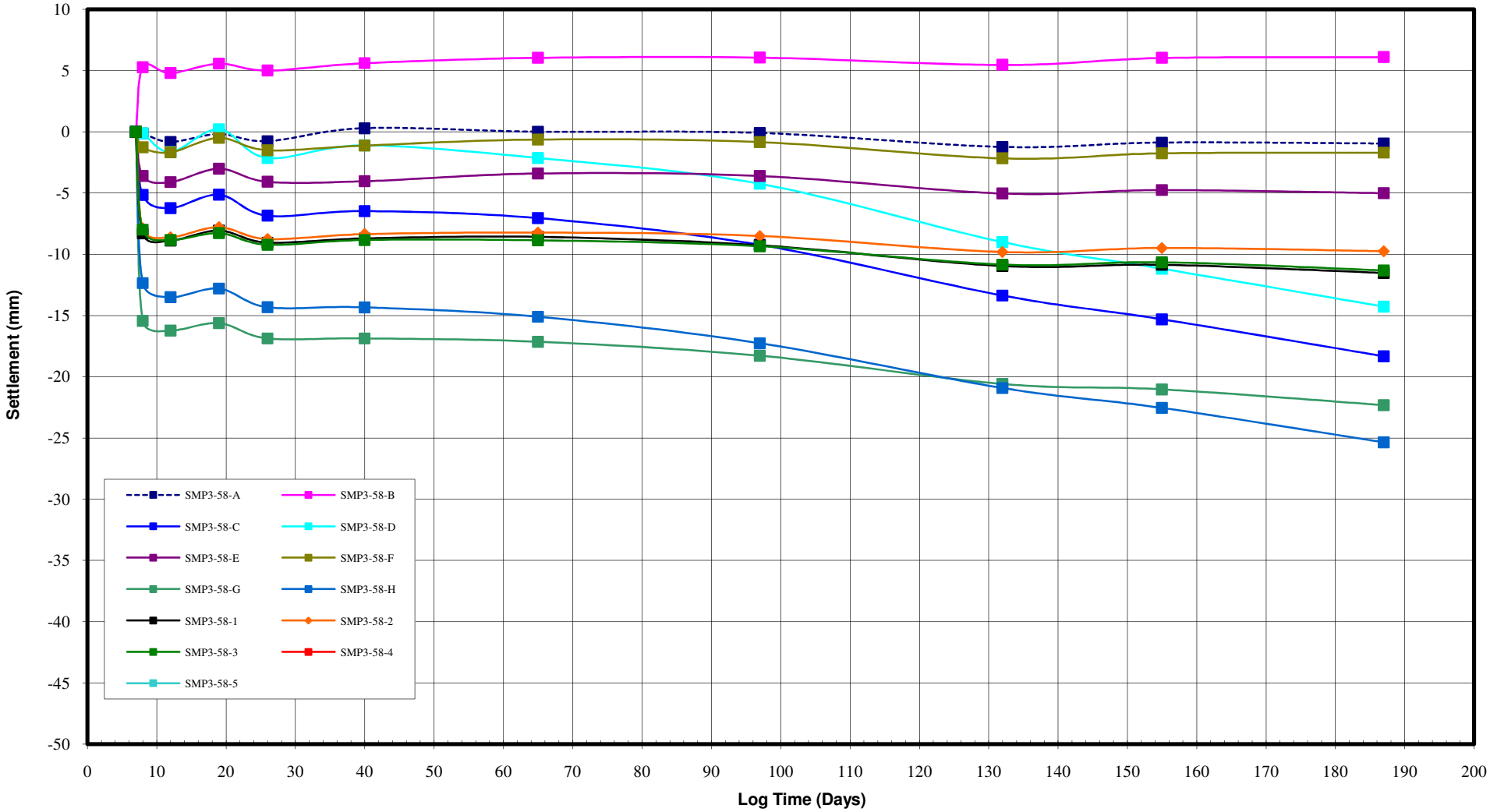
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Figure 7.2.5: Settlement Monitoring Data for Trial Load 2 - Lot 79 (Settlement against Time)



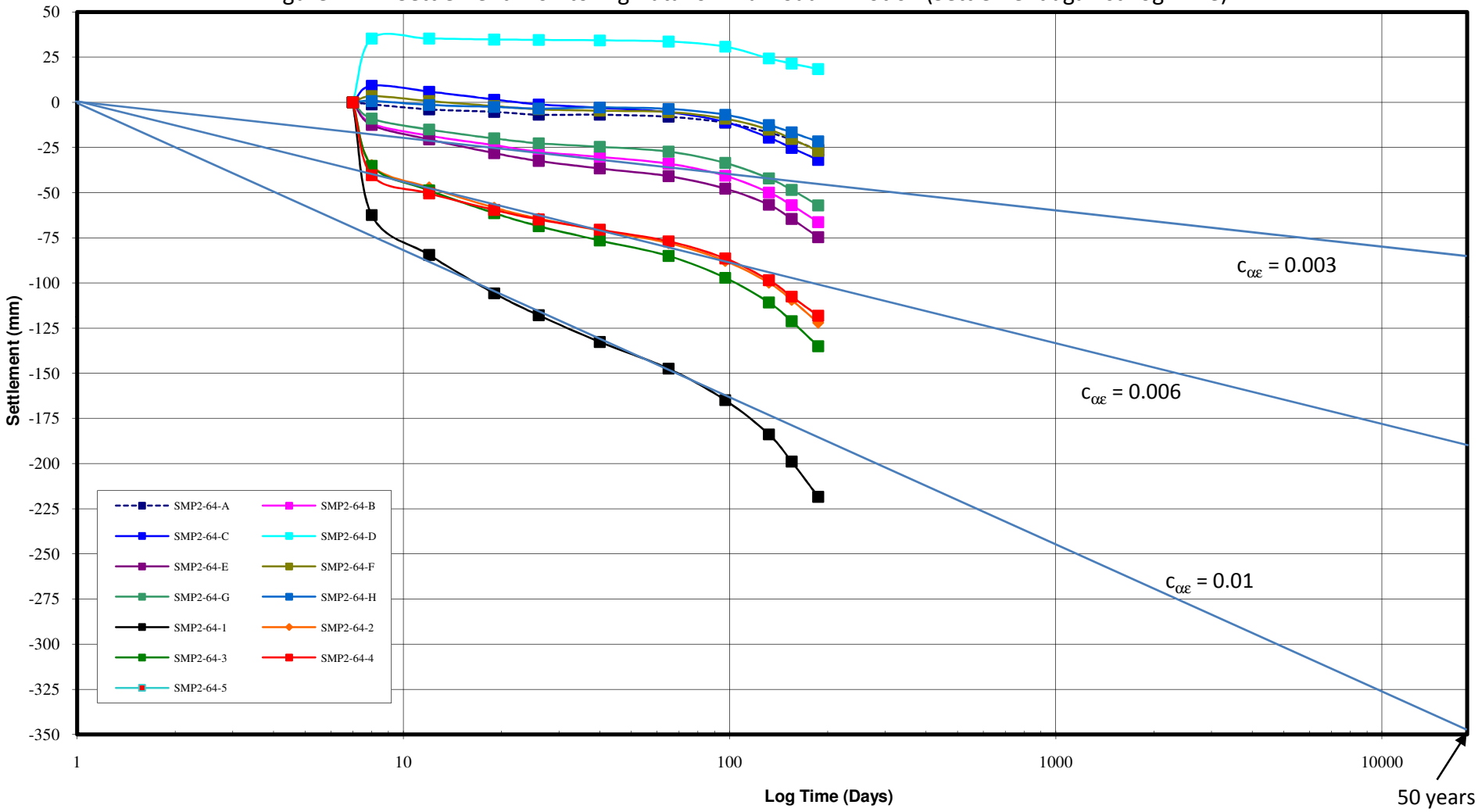
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Figure 7.2.6: Settlement Monitoring Data for Trial Load 3 - Lot 58 (Settlement against Time)



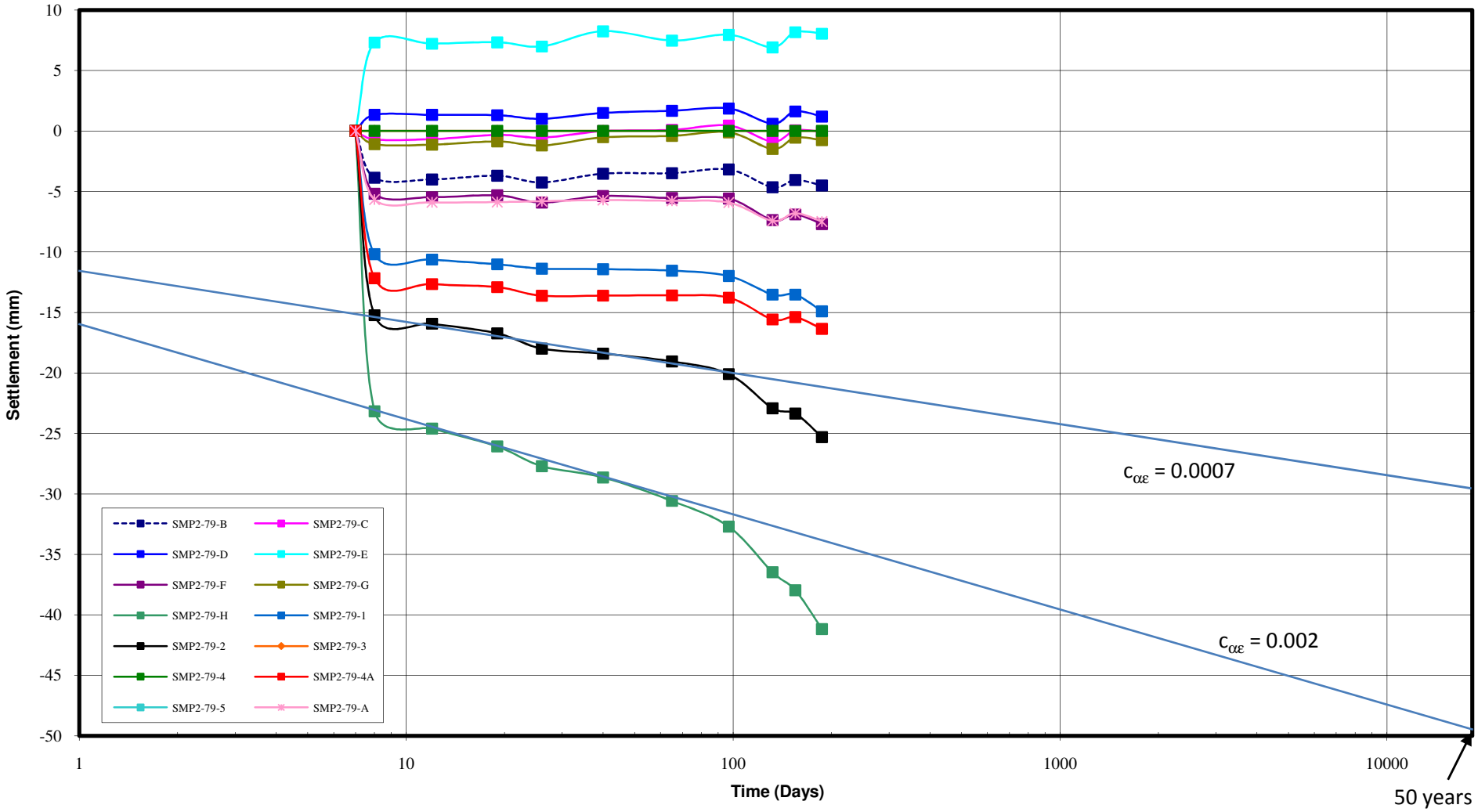
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Figure 7.2.7: Settlement Monitoring Data for Trial Load 1 - Lot 64 (Settlement against Log Time)



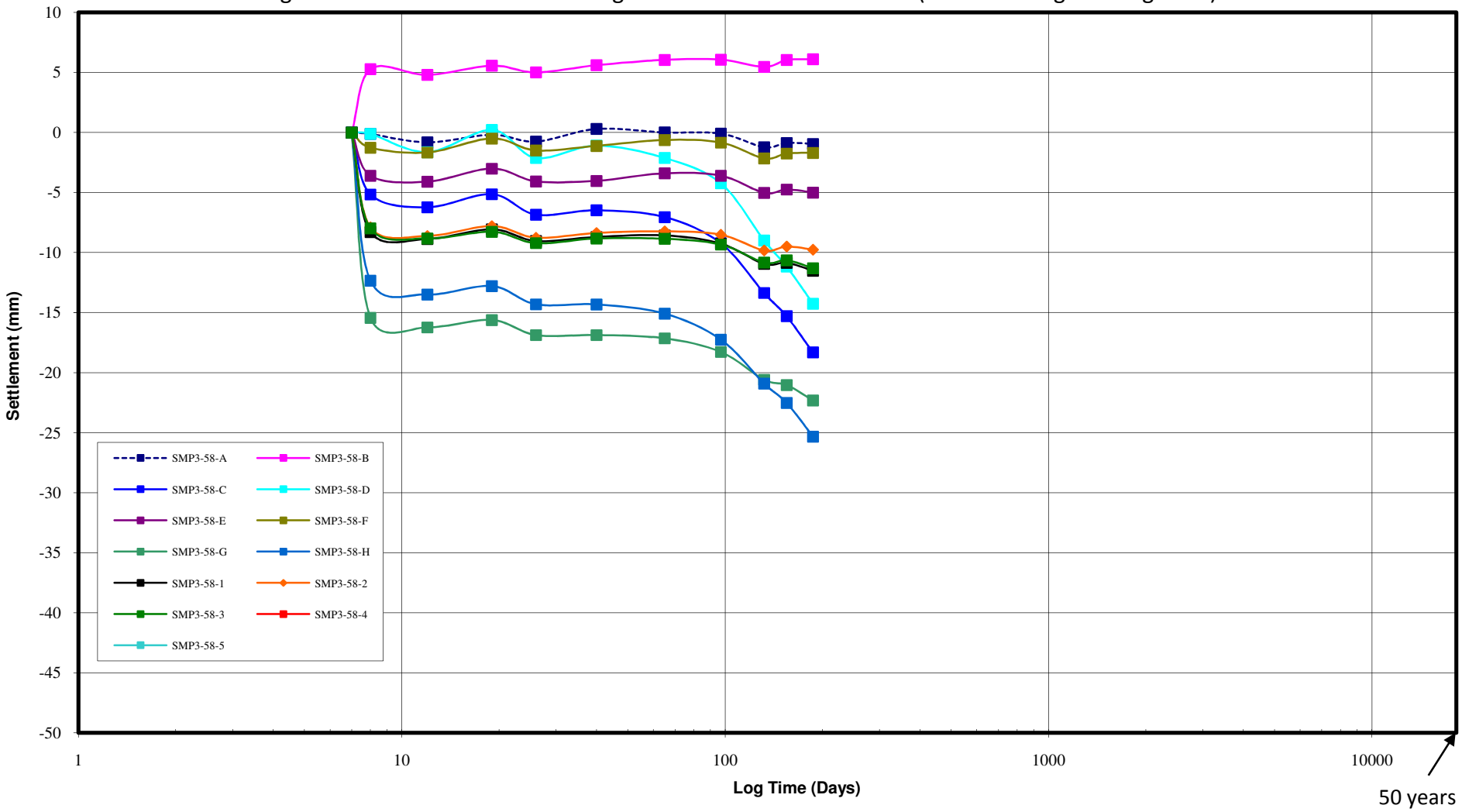
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Version: 2, Version Date: 27/04/2009

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Figure 7.2.8: Settlement Monitoring Data for Trial Load 2 - Lot 79 (Settlement against Log Time)



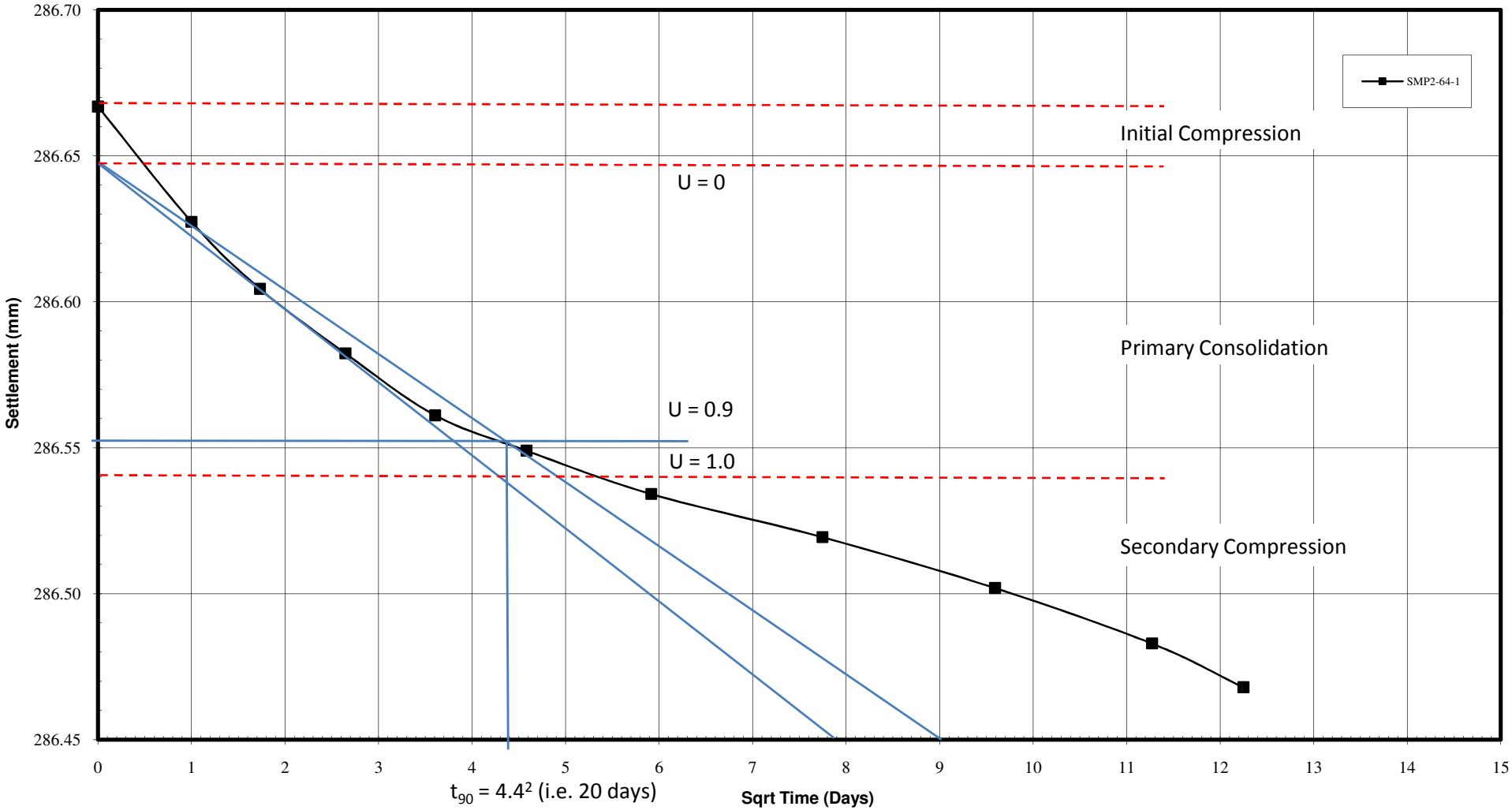
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Figure 7.2.9: Settlement Monitoring Data for Trial Load 3 - Lot 58 (Settlement against Log Time)



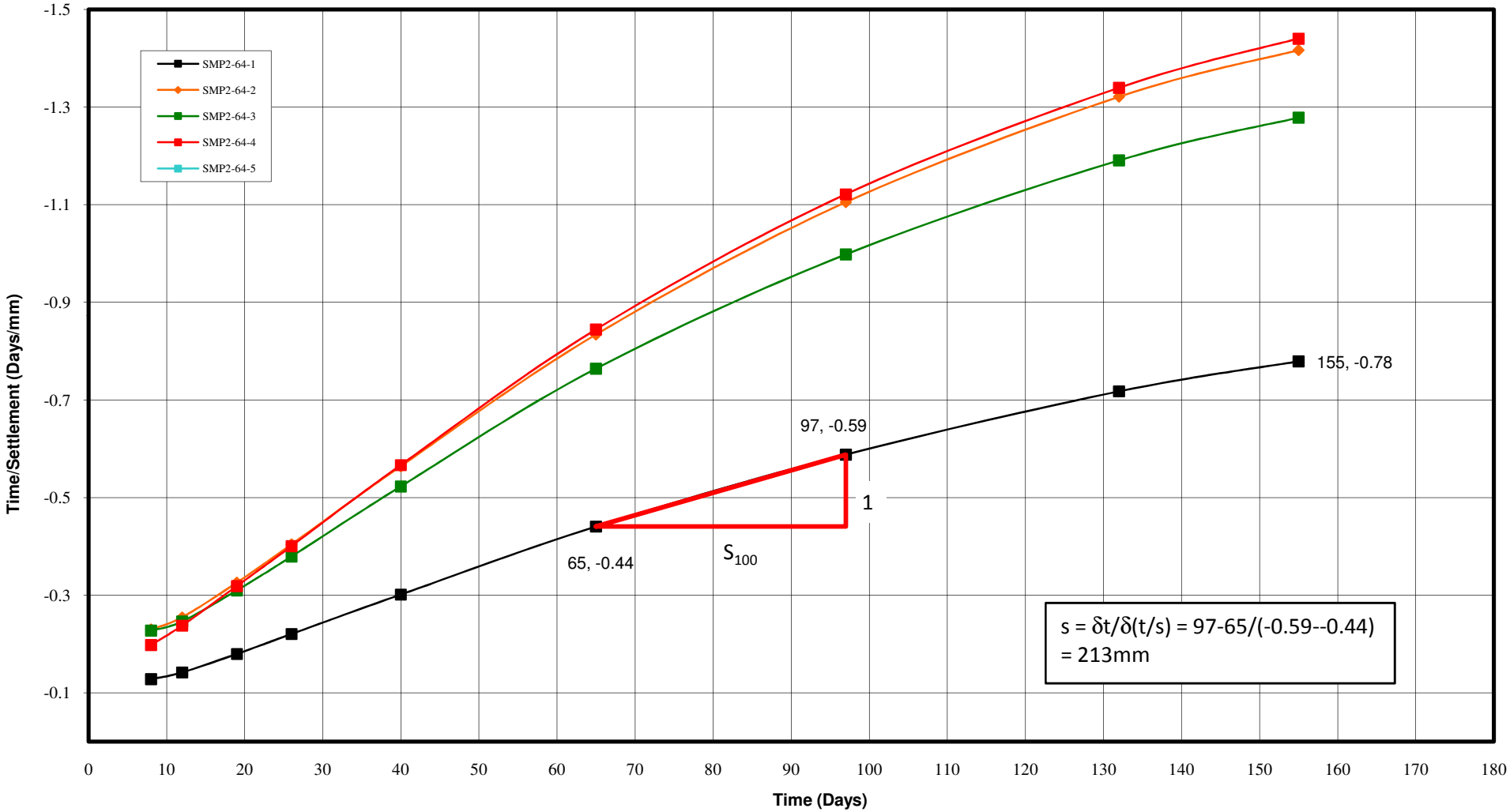
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Figure 7.1.10: Settlement Monitoring Data for Trial Load 1 - Lot 64 (Settlement against Square Root Time)



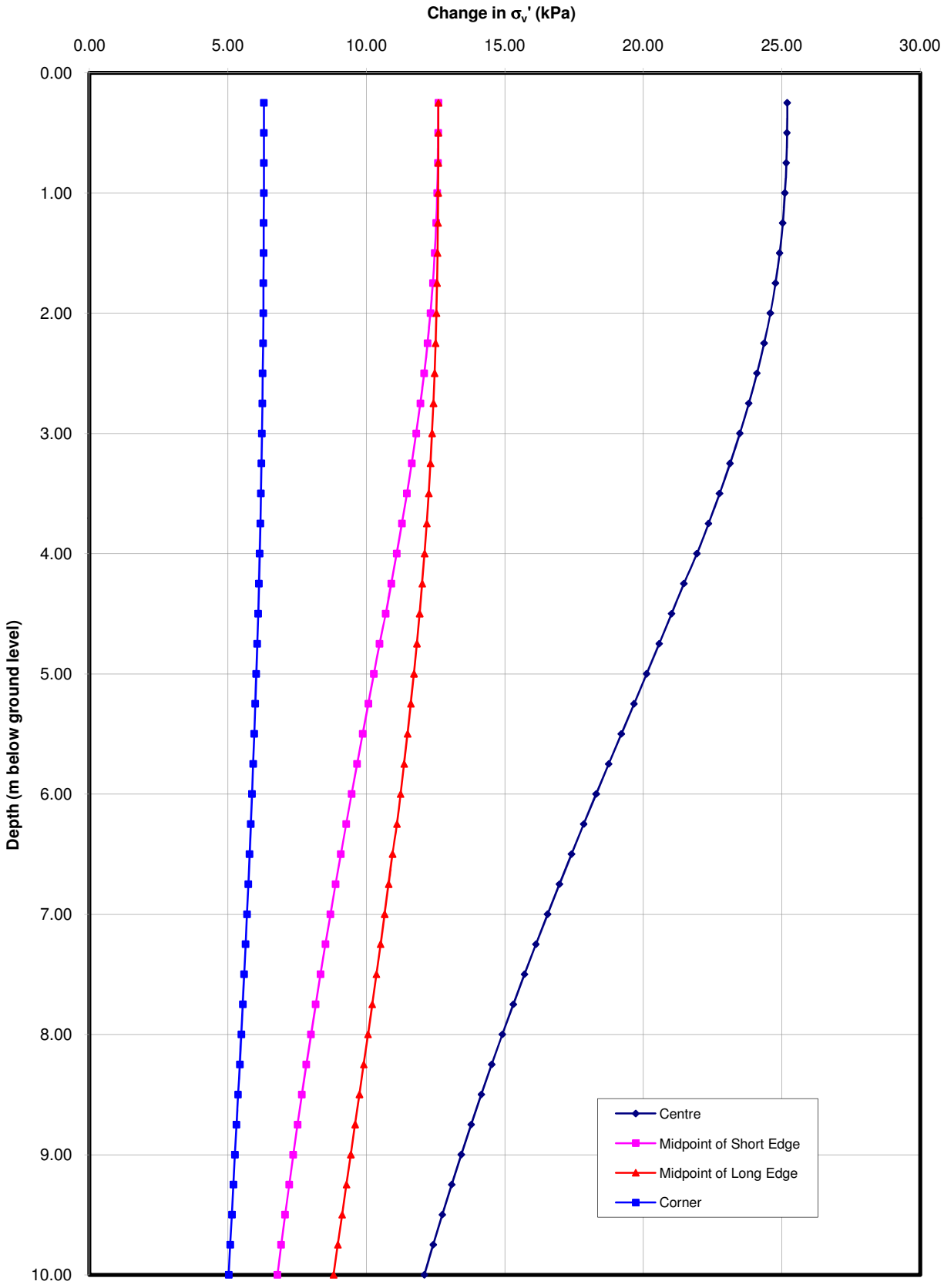
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Figure 7.2.11: Hyperbolic Model of Settlement Monitoring Data for Trial Load 1 - Lot 64



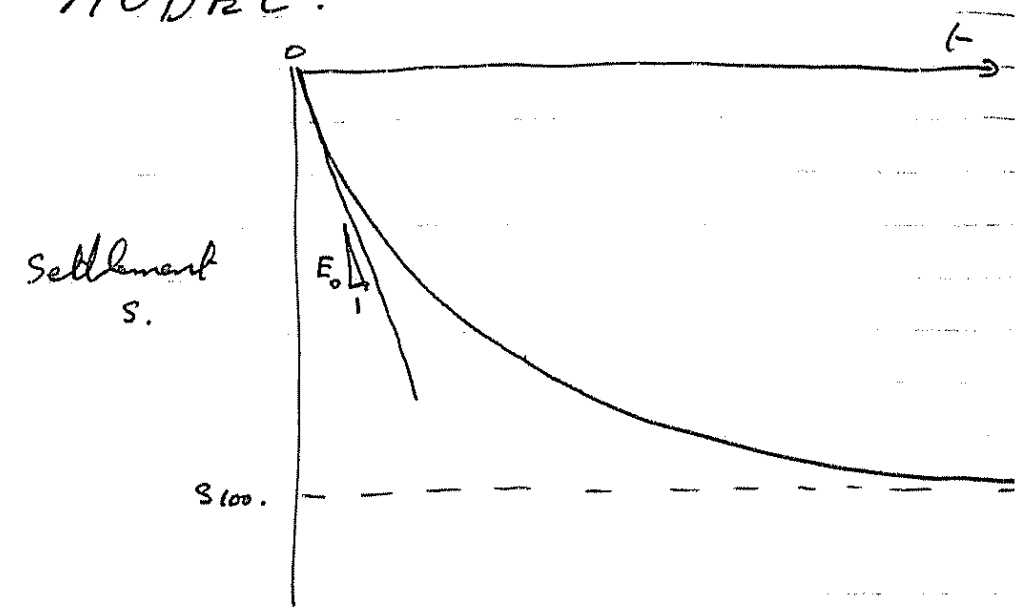
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Figure 7.2.12: Assumed Pressure Distribution Beneath Trial Load 1, Lot 64



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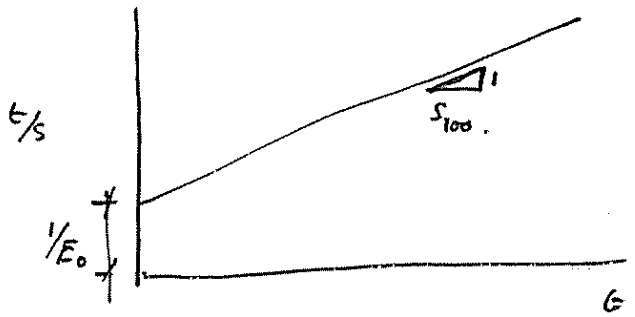
HYPERBOLIC MODEL.



Hyperbolic settlement curve.

$$s = \frac{t}{1/E_0 + \frac{t}{s_{100}}} \rightarrow \frac{t}{s} = \left(\frac{1}{E_0} + \frac{t}{s_{100}}\right)$$

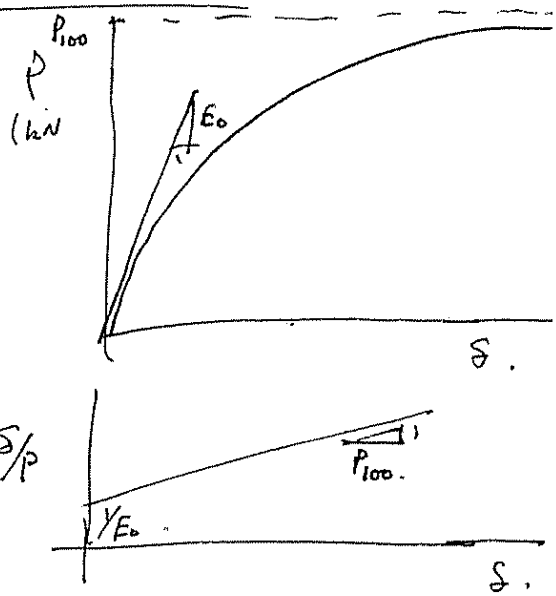
So $\frac{d(t/s)}{dt} = \frac{1}{s_{100}}$ & a plot of t/s v. t



gives a straight line for which s_{100} is reciprocal of slope & zero intercept is reciprocal of initial settlement rate.

Also pile load Cat

$$P = \frac{\delta}{1/E_0 + \frac{\delta}{P_{100}}}$$



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Appendix H: Infrastructure Testing and Level Survey Results

- **Table 8.5.1: Roading Test Results for Stage Three**
- **Table 8.5.2: Summary Table of Manhole Lid and Pipe Invert Levels**
- **Table 8.5.3: Summary Table of Sewer Gradients**
- **Table 8.5.4: Summary Table of Sewer Gradients**
- **Figure 8.5.1: Difference in Survey Levels of Sewer and Stormwater Invert Levels**
- **Figure 8.5.2: Schematic of Subdivision Sewer System**
- **Figure 8.5.3: Schematic of Subdivision Stormwater System**
- **Geotechnics Ltd Geobeam Test Results**

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Table 8.5.1: Roading Test Results for Stage Three

MTEC Consultants Ltd
Benkelman Beam Testing (17 & 18 March and 12 May 2008)

Road One				
Chainage (m)	Left Side	Right Side	Variation (mm)	Pass/Fail
0	R	0.00		
20	R	1.20	0.200	Pass
40	R	1.00	0.400	Pass
60	R	1.40	1.100	Fail
80	R	2.50	0.300	Pass
100	R	2.80	0.200	Pass
120	R	2.60	0.200	Pass
140	R	2.80	0.000	Pass
160	R	2.80	0.200	Pass
180	R	2.60	0.800	Pass
200	R	3.40	0.800	Pass
220	R	2.60	0.800	Pass
240	R	3.40	0.100	Pass
260	R	3.50	0.000	Pass
280	R	3.50	0.300	Pass
300	R	3.20	0.400	Pass
320	R	3.60	0.400	Pass
340	R	3.20	0.000	Pass
360	R	3.20	0.400	Pass
380	R	2.80		
0	L	0.00		
20	L	1.50	0.500	Pass
40	L	1.00	0.400	Pass
60	L	1.40	1.200	Fail
80	L	2.60	0.400	Pass
100	L	2.20	0.000	Pass
120	L	2.20	0.600	Pass
140	L	2.80	0.200	Pass
160	L	2.60	0.100	Pass
180	L	2.50	0.300	Pass
200	L	2.80	0.600	Pass
220	L	3.40	0.000	Pass
240	L	3.40	0.400	Pass
260	L	3.00	0.000	Pass
280	L	3.00	0.200	Pass
300	L	2.80	0.300	Pass
320	L	2.50	0.100	Pass
340	L	2.60	0.000	Pass
360	L	2.60	0.200	Pass
380	L	2.80		
Count		39	36	
Maximum		3.60	1.20	
Average		2.56	0.34	

Loop Road				
Chainage (m)	Left Side	Right Side	Variation (mm)	Pass/Fail
0	R	2.6	0.800	Pass
20	R	3.4	0.400	Pass
40	R	3.8	1.400	Fail
60	R	2.4	0.200	Pass
80	R	2.6	0.400	Pass
100	R	2.2	0.400	Pass
120	R	2.6	0.000	Pass
140	R	2.6	0.200	Pass
160	R	2.4	1.000	Fail
180	R	3.4	0.000	Pass
200	R	3.4	0.600	Pass
220	R	2.8	0.600	Pass
240	R	2.2		
0	L	3.2	0.400	Pass
20	L	3.6	0.400	Pass
40	L	3.2	0.400	Pass
60	L	2.8	0.200	Pass
80	L	2.6	0.600	Pass
100	L	2	0.400	Pass
120	L	2.4	0.000	Pass
140	L	2.4	0.200	Pass
160	L	2.6	0.200	Pass
180	L	2.8	0.200	Pass
200	L	2.6	0.000	Pass
220	L	2.6	0.000	Pass
240	L	2.6		
Count		26	24	
Maximum		3.80	1.40	
Average		2.76	0.38	

Geotechnics Ltd (on behalf of Tonkin & Taylor Ltd)
Geobeam Testing (02 December 2008)

Road One					
Chainage (m)	Carriageway	Side of Road	Geobeam Deflection (mm)	Variation (mm)	Pass/Fail
10	RH	R	2.61	1.060	Fail
20	LH	R	1.55	0.620	Pass
30	RH	L	0.93	0.700	Pass
40	LH	L	1.63	0.440	Pass
50	RH	R	2.07	0.370	Pass
60	LH	R	1.70	0.100	Pass
70	RH	L	1.80	0.960	Fail
80	LH	L	2.76	0.010	Pass
90	RH	R	2.75	0.580	Pass
100	LH	R	3.33	0.810	Pass
110	RH	L	2.52	0.860	Pass
120	LH	L	3.38	0.510	Pass
130	RH	R	3.89	0.520	Pass
140	LH	R	3.37	1.210	Fail
150	RH	L	2.16	0.530	Pass
160	LH	L	2.69	0.010	Pass
170	RH	R	2.70	0.080	Pass
180	LH	R	2.78	0.000	Pass
190	RH	L	2.78	0.220	Pass
200	LH	L	2.56	0.440	Pass
210	RH	R	3.00	0.080	Pass
220	LH	R	3.08	0.840	Pass
230	RH	L	2.24	0.080	Pass
240	LH	L	2.32	0.300	Pass
250	RH	R	2.62	0.200	Pass
260	LH	R	2.82	0.060	Pass
270	RH	L	2.88	0.400	Pass
280	LH	L	2.48	0.070	Pass
290	RH	R	2.41	0.410	Pass
300	LH	R	2.82	0.210	Pass
310	RH	L	2.61	0.670	Pass
320	LH	L	1.94	0.400	Pass
330	RH	R	1.54	0.020	Pass
340	LH	R	1.56	1.100	Fail
350	RH	L	2.66	1.280	Fail
360	LH	L	1.38	0.390	Pass
370	RH	R	1.77		
			37	36	
			3.89	1.28	
			2.43	0.46	

Loop Road					
Chainage (m)	Carriageway	Side of Road	Geobeam Deflection (mm)	Variation (mm)	Pass/Fail
10	RH	L	1.96	0.530	Pass
50	RH	L	1.43	0.150	Pass
90	RH	L	1.58	0.560	Pass
130	RH	L	2.14	0.760	Pass
170	RH	L	1.38	1.020	Fail
210	RH	L	2.40	0.440	Pass
30	RH	R	1.96	0.240	Pass
70	RH	R	2.20	0.010	Pass
110	RH	R	2.19	0.060	Pass
150	RH	R	2.13	0.510	Pass
190	RH	R	2.64	0.280	Pass
230	RH	R	2.92	0.020	Pass
40	LH	L	2.94	0.470	Pass
80	LH	L	2.47	0.290	Pass
120	LH	L	2.18	1.270	Fail
160	LH	L	3.45	0.360	Pass
0	LH	L	3.09	0.640	Pass
240	LH	L	2.45	0.880	Fail
20	LH	R	1.57	0.860	Pass
60	LH	R	2.43	0.000	Pass
100	LH	R	2.43	0.490	Pass
140	LH	R	1.94	0.260	Pass
180	LH	R	2.20	0.380	Pass
220	LH	R	2.58	0.940	Fail
260	LH	R	3.52		
			25	24	
			3.52	1.27	
			2.20	0.46	

ROW					
Chainage (m)	Carriageway	Side of Road	Geobeam Deflection (mm)	Variation (mm)	Pass/Fail
20		Centre	1.96	0.530	Pass
60		Centre	1.43	0.150	Pass
100		Centre	1.58	0.560	Pass
140		Centre	2.14		
Count			4	3	
Maximum			2.14	0.56	
Average			1.77	0.53	

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Table 8.5.2: Infrastructure Level Survey - Surveyed October 2008

Number	Manhole Reference	Cut / Fill Depth	Eastings BOP 2000	Northings BOP 2000	Centre Lid Level GeoMatics GPS	Monitored Level - Oct 08	MTEC LL	Difference (mm)	MTEC IL	Size (mm)	Difference (mm)	Geomatics IL	Size (mm)	Depth (m)	MTEC IL	Size (mm)	Difference (mm)	Geomatics IL	Size (mm)	Depth (m)	MTEC IL	Size (mm)	Difference (mm)	Geomatics IL	Size (mm)	Depth (m)	MTEC IL	Size (mm)	Difference (mm)	Geomatics IL	Size (mm)	Depth (m)	MTEC IL	Size (mm)	Difference (mm)	Geomatics IL	Size (mm)	Depth (m)
Stage 1																																				
1	SSMH Z1	Grade	377064.00	764221.57	286.59	286.60	286.57	16	284.93	100 (in)	10	284.92	100 (in)	1.67	284.84	150 (in)	0	284.84	150 (in)	1.75	284.81	150 (out)	-10	284.82	150 (out)	1.77	0.00	0.00									
2	EXTG SSMH	Grade	377065.64	764203.32	286.57	286.56	286.59	-21	284.73	150 (in)	0	284.73	150 (in)	1.84	0.00	150 (out)																					
3	SSMH Z2	Grade	376990.14	764214.84	286.68	286.70	286.67	13	285.28	150 (in)	10	285.27	150 (in)	1.41	285.25	150 (out)	-10	285.26	150 (out)	1.42																	
4	SSMH Z3	0.75	376898.82	764207.20	286.87	286.87	286.86	13	285.81	100 (in)	50	285.76	100 (in)	1.11	285.77	150 (in)	20	285.75	150 (in)	1.12	285.74	150 (out)	40	285.70	150 (out)	1.17											
5	SSMH Z4	0.25	376798.13	764204.39	287.46		287.47	-10	286.36	150 (in)	20	286.34	150 (in)	1.12	286.33	150 (out)	0	286.33	150 (out)	1.13																	
6	SSMH Z5	Grade	376698.45	764203.00	287.75	287.74	287.74	11	286.93	100 (in)	20	286.91	100 (in)	0.84	286.90	150 (out)	10	286.89	150 (out)	0.86																	
7	SSMH Y1	0.5	376655.83	764202.39	287.73	287.71	287.73	0	286.60	100 (in)	30	286.57	100 (in) E	1.16	286.55	150 (out)	10	286.54	150 (out)	1.19				286.65	100 (in) NE	1.08											
8	EXTG SSMH SH005985	0.25	376594.92	764202.72	288.03	288.02	288.22	-189	286.06	150 (in)	-20	286.08	150 (in)	1.95				286.06	150 (out)	1.97																	
9	SW Outlet	N/A					0.00		282.08	1200 (In)																											
10	SWMH A1(1)	Grade	377075.68	764183.00	285.02		285.03	-9	282.06	1200 (In)	-20	282.08	1200 (in)	2.94	282.03	1200 (Out)	-30	282.06	1200 (out)	2.96	284.20	375 (In)															
11	SWMH A2(1)	Grade	377072.61	764227.59	286.35		286.35	-5	282.20	1200 (In)	20	282.18	1200 (in)	4.17	282.12	1200 (Out)	-20	282.14	1200 (out)	4.21																	
12	SWMH A3(1)	0.5	377058.22	764269.76	285.13		285.21	-77	282.40	1200 (In)	0	282.40	1200 (in)	2.73	282.38	1200 (Out)	120	282.26	1200 (out)	2.87	283.28	300 (In)	60	283.22	300 (in)	1.91	283.28	100 (In subsoil	60	283.22	100 (in)	1.91					
13	SWMH K(1)	0.5	377041.92	764267.69	285.15	285.15	284.18	972	284.35	100 (in)	120	284.23	100 (in)	0.92	284.31	1000 (in)	80	284.23	100 (in)	0.92	284.21	300 (out)	50	284.16	300 (out)	0.99											
14	SWMH J(1)	1	376941.56	764253.24	285.51		285.54	-35	283.89	100 (in)	35	283.86	100 (in) E	1.65	283.72	300 (in)	35	283.69	300 (in)	1.82	283.66	300 (out)	35	283.63	300 (out)	1.88				283.87	100 (in)	1.64					
15	SWMH J1(1)	0.75	376899.46	764252.50	285.70	285.72	285.73	-28	284.09	100 (in)	50	284.04	100 (in) SW	1.66	283.92	100 (in)	-90	284.01	100 (in) W	1.69	283.90	300 (out)	10	283.89	300 (out)	1.81											
16	SWMH G2(1)	0.25					285.94		284.83	100 (in)					284.40	525 (in)					284.38	525 (out)															
17	SWMH G3(1)	Grade	376748.72	764250.42	286.75	286.75	286.94	-195	285.29	100 (in)	0	285.29	100 (in)	1.45	285.03	525 (in)	0	285.03	525 (in)	1.72	285.01	525 (out)	10	285.00	525 (out)	1.75											
18	SWMH G4(1)	0.5	376650.40	764248.87	287.18	287.15	287.15	26	285.59	300 (in)	40	285.55	300 (in)	1.63	285.46	450 (in)	0	285.46	450 (in)	1.72	285.44	525 (out)	80	285.36	525 (out)	1.82				285.93	225 (in)	1.25					
19	SWMH H(1)	0.75	376636.34	764237.32	287.27	287.26	287.42	-147	286.17	300 (in)	60	286.11	300 (in)	1.16	286.14	300 (out)	50	286.09	300 (out)	1.18																	
20	SWMH H1(1)	0.75	376595.68	764238.51	287.35	287.25	287.35	-2	286.41	300 (in)	10	286.40	300 (in)	0.95	286.39	300 (out)	60	286.33	300 (out)	1.02																	
21	SWMH H2(1)	0.25	376595.81	764255.51	287.44	287.40	287.44	-1	286.54	300 (in)	60	286.48	300 (in)	0.96	286.46	300 (out)	30	286.43	300 (out)	1.01																	
Stage 2																																				
22	SWMH B1(2)	0.5	376996.30	764305.18	284.64	284.65	284.68	-42	282.70	1050 (out)	30	282.67	1050 (out)	1.97	282.84	675 (in)	40	282.80	675 (in)	1.84	282.76	825 (in)	30	282.73	825 (in)	1.91											
23	SWMH A4(2)	Grade	377043.66	764312.08	284.13	284.13	284.12	7	282.88	675 (in)	0	282.88	675 (in)	1.25	282.52	1050 (in)	0	282.52	1050 (in)	1.61	282.52	1200 (out)	0	282.52	1200 (out)	1.61											
24	SWMH D1(2)	-0.5	376959.93	764358.41	285.07	285.08	285.07	2	282.94	825 (out)	-80	283.02	825 (out)	2.05	282.97	825 (in)	-60	283.03	825 (in)	2.04	283.52	100 (in)	0	283.52	100 (in)	1.55											
25	SWMH D2(2)	-1.5	376905.87	764362.35	285.21	285.20	285.05	162	283.12	825 (out)	-150	283.27	825 (out)	1.94	283.14	750 (in)	-150	283.29	750 (in)	1.92	283.61	225 (cp leads)	-110	283.72	225 (in)	1.49	283.61	300 (cp leads)	-140	283.75	300 (in)	1.46					
26	SWMH F(2)	-1.5	376898.62	764368.34	285.26	285.24	285.24	21	283.95	300 (out)	0	283.95	300 (out)	1.31	283.97	300 (cp leads)	0	283.97	300 (in)	1.29																	
27	SWMH D3(2)	-0.5	376820.52	764369.49	285.56	285.54	285.46	98	283.50	750 (out)	-80	283.58	750 (out)	1.98	283.55	750 (in)	-90	283.64	750 (in)	1.92	284.08	300 (in)	-80	284.16	300 (in)	1.40	283.93	100 (in)	-70	284.00	100 (in)	1.56					
28	SWMH B2(2)	0.5	376938.29	764301.47	284.78	284.81	284.85	-68	283.09	675 (out)	70	283.02	675 (out)	1.76	283.23	525 (in)	40	283.19	525 (in)	1.59	283.23	300 (in)	70	283.16	300 (in)	1.62											
29	SWMH B3(2)	Grade	376882.44	764300.29	285.29	285.30	285.29	-3	283.73	525 (out)	30	283.70	525 (out)	1.59	283.75	525 (in)	0	283.75	525 (in)	1.54	283.75	100 (in)					284.49	200 (cp leads)	0	284.49	200 (in)	0.80					
30	SSMH T1	0.75	376998.90	764284.27	284.86	284.87	284.86	0	283.30	100 (in)	0	283.30	100 (in)	1.56	283.29	150 (out)	0	283.29	150 (out)	1.57																	
31	SSMH V1	0.5	376997.82	764308.39	284.65	284.67	284.71	-57	282.28	150 (in)	40	282.24	150 (in) W	2.41	282.25	150 (out)	40	282.21	150 (out) E	2.44				282.24	150 (in) N	2.41				282.25	150 (in) South	2.40					
32	SSMH V2	0.5	376983.57	764301.43	284.74	284.75	284.76	-19	282.49	150 (in)	-10	282.50	150 (in)	2.24	282.47	150 (out)	10	282.46	150 (out)	2.28																	
33	SSMH U1	-0.5	376958.72	764363.95	285.29	285.30	285.30	-10	282.71	150 (in)	-90	282.80	150 (in)	2.49	282.64	150 (out)	-130	282.77	150 (out)	2.52																	
34	SSMH U2	-1	376880.53	764371.00	285.40	285.39	285.38	16	283.28	150 (in)	0	283.28	150 (in)	2.12	283.26	150 (out)	0	283.26	150 (out)	2.14																	
35	SSMH U3	0.5	376808.32	764381.17	285.86	285.86	285.86	-2	283.71	150 (in)	40	283.67	150 (in)	2.19	283.66	150 (out)	10	283.65	150 (out)	2.21																	
36	SSMH V3	0.5	376919.29	764297.02	284.91	284.93	284.85	57	282.96	150 (in)	-10	282.97	150 (in)	1.94	282.97	150 (out)	10	282.96	150 (out)	1.95																	
37	SSMH V4	-1	376820.07	764295.34	286.15	286.15	286.12	26	283.72	150 (in)	-20	283.74	150 (in)	2.41	283.76	150 (out)	30	283.73	150 (out)	2.42																	
38	SS Pump Station	0.75	377006.19	764314.12	284.67	284.67	284.80	-132	282.18	150 (in)																											
Stage 3																																				
39	SWMH A1(3)	0.5	376650.40	764248.87	287.18	287.15	286.94	236	285.93	225 (cp leads)	0	285.93	225 (in)	1.25	285.93	225 (cp leads)	0	285.93	225 (in)	1.25	285.59	300 (in)	40	285.55	300 (in)	1.63	285.46	450 (in)	0	285.46	450 (in)	1.72	285.44	525 (out)	80	285.36	525 (out)	1.82
40	SWMH A2(3)	Grade	376650.12	764301.39	286.85	286.83	286.85	-5	285.59	375 (in)	40	285.55	375 (in)	1.30	285.58	450 (out)	50	285.53	450 (out)	1.32																	
41	SWMH B7(3)	0.25	376642.31	764349.84	286.54	286.52	286.54	0	285.57	225 (cp leads)	70	285.50	225 (in) E	1.04	285.56	225 (cp leads)	70	285.49	225 (in) W	1.05	285.33	100 (in)	30	285.30	100 (in)	1.24	285.24	375 (out)	70	285.17	375 (out)	1.37					
42	SW INLET 1(3)	Grade	376594.17	764300.79	287.13				286.24	375 (out)	14	286.23	375 (out)	0.90	0.00	0.00																					
43	SW INLET 2(3)	0.25	376596.09	764400.71	286.00	285.98	286.18	-184	285.20	525 (out)	40	285.16	525 (out)	0.84	0.00	0.00																					
44	SWMH B6(3)	0.25	376642.23	764400.83	286.25	286.23	286.25	1	285.23	225 (cp leads)	0	285.23	225 (in)	1.02	285.03	375 (in)	80	284.95	375 (in)	1.30	284.92	525 (in)	50	284.87	525 (in)	1.38	284.85	525 (out)	30	284.82	525 (out)	1.43					
45	SWMH B5(3)	0.25	376642.44	764421.56	286.22	286.21	286.23	-10	285.08	225 (cp leads)	50	285.03	225 (in)	1.19	285.08	300 (cp leads)	60	285.02	300 (in)	1.20	284.76	525 (in)	0	284.76	525 (in) S	1.46	284.51	525 (in)	0	284.51	525 (in) N	1.71	284.51	750 (out)	0	284.51	750 (out)	1.71
46	SWMH C1(3)	0.25	376642.54	764475.20	286.63	286.61	286.64	-6	285.14	450 (in)	60	285.08	450 (in)	1.55	285.06	300 (in)	10	285.05	300 (in)	1.58	285.04	525 (out)	10	285.03	525 (out)	1.60											
47	SWMH C2(3)	0.75	376641.88	764512.83	287.65	287.62	287.67	-16	286.29	225 (cp leads)	320	285.97	225 (in) W	1.68	285.86	225 (cp leads)	-20	285.88	225 (in) E	1.77	285.87	300 (cp leads)	20	285.85	300 (in)	1.80	285.50	450 (in)	40	285.46	450 (in) N	2.19	285.47	450 (out)	50	285.42	450 (out)	2.23
48	SWMH H1(3)	0.5	376678.73	764475.95	286.77	286.76	286.78	-9	285.48	100 (in)	70	285.41	100 (in) E	1.36	285.45	100 (in)	60	285.39	100 (in) N	1.38	285.27	300 (out)	60	285.21	300 (out)	1.56											
49	SWMH D3(3)	-0.5	376711.93	764522.42	288.65	288.63	288.65	0	287.67	100 (in)	130	287.54	100 (in) W	1.11	287.62	100 (in)	20	287.60	100 (in) N	1.05	287.50	300 (out)	20	287.48	300 (out)	1.17											
50	SWMH D2(3)	-0.75	376733.33	764500.03	288.28	288.26	288.29	-15	287.23	300 (in)	50	287.18	300 (in)	1.09	287.20	375 (out)	40	287.16	375 (out)	1.11																	
51	SWMH D1(3)	-0.25	376733.86	764437.11	285.76	285.77	285.79	-27	284.74	375 (in)	40	284.70	375 (in)	1.06	284.70	450 (out)	20	284.68	450 (out)	1.08																	
52	SWMH B4(3)	Grade	376733.93	764421.49	285.56	285.54	285.57	-8	284.50	300 (cp leads)	50	284.45	300 (in)	1.11	284.50	300 (cp leads)	50	284.45	300 (in)	1.11	284.09	750 (in)	60	284.03	750 (in)	1.53	284.10	450 (in)	20	284.08	450 (in)	1.48	284.06	750 (out)	-10	284.07	750 (out)	1.49
53	SWMH B3(3)	0.75	376775.15	764399.61	286.31	286.30	286.30	8	284.28	225 (cp leads)	0	284.28	225 (in)	2.03	283.86	750 (in)	10	283.85	750 (in)	2.46	283.83	750 (out)	0	283.83	750 (out)	2.48											
54	SWMH F1(3)	0.5	376773.12	764331.84	285.97	285.97	286.00	-35	284.54	225 (cp leads)	10	284.53	225 (in)	1.44	284.53	300 (in)	10	284.52	300 (in) W	1.44	284.47	300 (in)	-10	284.48	300 (cp leads)	1.48	284.44	300 (out)	0	284.44	300 (out)	1.52					
55	SWMH F2(3)	0.25	376712.35	764331.11	286.22	286.20	286.23	-11	284.86	100 (in)	0	284.86	100 (in) W	1.36	284.80	100 (in)	0	284.80	100 (in) S	1.42	284.72	300 (out)	50	284.67	300 (out)	1.55											
56	SSMH Z4(3)	0.25	376645.99	764260.22	287.10	287.07	287.08	15	285.63	100 (in)	40	285.59	100 (in)	1.51	285.58	150 (out)	40	285.54	150 (out)	1.56																	
57	SSMH Z3(3)	Grade	376646.06	764292.64	286.87	286.87	286.89	-16	285.10	150 (in)	40	285.06	150 (in)	1.81	285.07	150 (in)	10	285.06	150 (in)	1.81	285.06	150 (out)	20	285.04	150 (out)	1.83											
58	SSMH Z2(3)	-0.5	376743.24	764294.41	286.55	286.55	286.58	-28	284.32	150 (in) E	0	284.32	150 (in) E	2.23	284.32	150 (out)	40	284.28	150 (out)	2.27																	
59	SSMH W1	0.25	376645.05	764361.43	286.48	286.47	286.50	-21	285.64	100 (in)	70	285.57	100 (in) NW	0.91	285.64	100 (in)	100	285.54	100 (in) NE	0.94	285.60	150 (out)	70	285.53	150 (out)	0.95											
60	SSMH Y3	0.25	376646.07	764425.24	286.25	286.23	286.25	-1	285.03	150 (in)	20	285.01	150 (in)	1.24	285.02	150 (out)	40	284.98	150 (out)	1.27																	
61	SSMH Y4	0.75	376646.89	764523.04	288.39	288.37	288.41	-18	285.77	150 (in)	70	285.70	150 (in) N	2.69	285.75	150 (in)	100	285.65	150 (in) E	2.74	285.75	150 (out)	80	285.67	150 (out)	2.72											
62	SSMH V1(3)	-0.6	376709.96	764522.16	288.61	288.58	288.60	11	287.05	100 (in)	30	287.02	100 (in)	1.59	287.04	150 (out)	30	287.01	150 (out)	1.60																	
63	SSMH Y5	Grade					????		291.82	150 (out)																											
64	SSMH X1	-0.5	376736.76	764475.22	287.01	287.00	287.02	-8	285.42	150 (in)	40	285.38	150 (in)	1.63	285.42	100 (in)	40	285.38	100 (in)	1.63	285.39	150 (out)	50	285.34	150 (out)	1.67											
65	SSMH X2	Grade	376704.52	764475.24	286.96	286.95	286.97	-11	285.75	100 (in)	40	285.71	100 (in)	1.25	285.74	100 (in)					285.73	150 (out)	40	285.69	150 (out)	1.27											
66	SSMH Y2	0.25	376736.62	764424.48	285.59	285.57	285.61	-20	284.42	150 (in)	80	284.34	150 (in) N	1.25	284.35	150 (in)	20	284.33	150 (in) W	1.26	284.32	150 (out)	10	284.31	150 (out)	1.28											
67	SSMH Y1(3)	0.5	376808.32	764381.17	285.86	285.86	285.86	-2	283.71	150 (in)	40	283.67	150 (in)	2.19	283.66	150 (out)	10	283.65	150 (out)	2.21	0.00	0.00															

Notes:
1. The MTEC As-Built drawings do not indicate which IL refers to which pipe. Where there are two or more incoming or outgoing pipes of the same diameter entering a single manhole, we have therefore had to assume which of the MTEC levels relates to which of the Geomatics levels (this has basically been done on the closest match in levels). However, generally speaking, the difference in ILs of the different same size pipes is minimal so this does not have a big impact on the assessed gradients.

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Table 8.5.3: Infrastructure Level Survey - Surveyed October 2008

Table 6.1 (RCEIS, p.137)

Pipe ϕ (mm)	Min Gradient (%)
100	1.67
150	0.75
200	0.5
225	0.43
300	0.3

Manhole		Geomatic Surveys						Cut / Fill	MTEC As-Built Drawings							Design	
	Distance (assumed)	Elevation	Pipe Size	Elevation Difference	Gradient	Elevation	Pipe Size	Depth	Distance	Elevation	Pipe Size	Elevation Difference	Gradient	Elevation	Pipe Size	Line	Gradient
	(m)	(m amd)	(mm)	(mm)	(%)	(m amd)	(mm)	(m)	(m)	(m amd)	(mm)	(mm)	(%)	(m amd)	(mm)		(%)
System One (Stages Two & Three connecting to Pump Station)																	
SSMH Y5								Grade						291.82	150 (out)		
									45.70			6.05	**13.24%**			Line Y	**13.43%**
SSMH Y4		285.70	150 (in) N			285.67	150 (out)	0.75		285.77	150 (in)			285.75	150 (out)		
	97.80			0.66	**0.67%**				97.80			0.72	**0.74%**			Line Y	**0.75%**
SSMH Y3		285.01	150 (in)			284.98	150 (out)	0.25		285.03	150 (in)			285.02	150 (out)		
	90.55			0.65	**0.72%**				90.50			0.67	**0.74%**			Line Y	**0.75%**
SSMH Y2		284.33	150 (in) W			284.31	150 (out)	0.25		284.35	150 (in)			284.32	150 (out)		
	83.77			0.64	**0.76%**				83.80			0.61	**0.73%**			Line Y	**0.75%**
SSMH Y1(3)		283.67	150 (in)			283.65	150 (out)	0.50		283.71	150 (in)			283.66	150 (out)		
	72.93			0.37	**0.51%**				72.90			0.38	**0.52%**			Line U	**0.56%**
SSMH U2		283.28	150 (in)			283.26	150 (out)	-1.00		283.28	150 (in)			283.26	150 (out)		
	78.51			0.46	**0.59%**				78.50			0.55	**0.70%**			Line U	**0.56%**
SSMH U1		282.80	150 (in)			282.77	150 (out)	-0.50		282.71	150 (in)			282.64	150 (out)		
	67.93			0.53	**0.78%**				67.90			0.36	**0.53%**			Line U	**0.56%**
SSMH V1		282.24	150 (in) N			282.21	150 (out) E	0.50		282.28	150 (in)			282.25	150 (out)		
	15.86			0.22	**1.39%**				15.92			0.19	**1.19%**			Line V	**0.75%**
SSMH V2		282.50	150 (in)			282.46	150 (out)	0.50		282.49	150 (in)			282.47	150 (out)		
	64.43			0.46	**0.71%**				64.40			0.48	**0.75%**			Line V	**0.75%**
SSMH V3		282.97	150 (in)			282.96	150 (out)	0.50		282.96	150 (in)			282.97	150 (out)		
	99.24			0.76	**0.77%**				99.30			0.80	**0.81%**			Line V	**0.75%**
SSMH V4		283.74	150 (in)			283.73	150 (out)	-1.00		283.72	150 (in)			283.76	150 (out)		
	76.83			0.54	**0.70%**				76.70			0.60	**0.78%**			Line V	**0.75%**
SSMH Z2(3)		284.32	150 (in) E			284.28	150 (out)	-0.50		284.32	150 (in) E			284.32	150 (out)		
	97.20			0.72	**0.74%**				97.20			0.74	**0.76%**			Line Z	**0.75%**
SSMH Z3(3)		285.06	150 (in)			285.04	150 (out)	Grade		285.10	150 (in)			285.06	150 (out)		
	68.80			0.47	**0.68%**				68.80			0.50	**0.73%**			Line W	**0.75%**
SSMH W1						285.53	150 (out)	0.25						285.60	150 (out)		
	32.42			0.48	**1.48%**				32.50			0.48	**1.48%**			Line Z	**1.56%**
SSMH Z4(3)						285.54	150 (out)	0.25						285.58	150 (out)		
SSMH V1		282.25	50 (in) South			282.21	150 (out) E	0.50		282.28	150 (in)			282.25	150 (out)		
	24.14			1.04	**4.31%**				24.20			1.01	**4.17%**			Line T	**4.10%**
SSMH T1						283.29	150 (out)	0.75						283.29	150 (out)	.	
SSMH Y4		285.65	150 (in) E			285.67	150 (out)	0.75		285.75	150 (in)			285.75	150 (out)		
	63.07			1.36	**2.16%**				63.10			1.29	**2.04%**			Line V	**2.11%**
SSMH V1(3)						287.01	150 (out)	-0.60						287.04	150 (out)		
SSMH Y2		284.34	150 (in) N			284.31	150 (out)	0.25		284.42	150 (in)			284.32	150 (out)		
	50.74			1.00	**1.97%**				50.70			0.97	**1.91%**			Line X	**2.00%**
SSMH X1		285.38	150 (in)			285.34	150 (out)	-0.50		285.42	150 (in)			285.39	150 (out)		
	32.24			0.31	**0.96%**				32.20			0.31	**0.96%**			Line X	**1.00%**
SSMH X2						285.69	150 (out)	Grade						285.73	150 (out)		
System Two (Stage 1)																	
SSMH Z5						286.89	150 (out)	Grade						286.90	150 (out)		
	99.69			0.55	**0.55%**				99.70			0.54	**0.54%**			Line Z	**0.56%**
SSMH Z4		286.34	150 (in)			286.33	150 (out)	0.25		286.36	150 (in)			286.33	150 (out)		
	100.72			0.58	**0.58%**				100.70			0.56	**0.56%**			Line Z	**0.56%**
SSMH Z3		285.75	150 (in)			285.70	150 (out)	0.75		285.77	150 (in)			285.74	150 (out)		
	91.64			0.43	**0.47%**				91.60			0.46	**0.50%**			Line Z	**0.56%**
SSMH Z2		285.27	150 (in)			285.26	150 (out)	Grade		285.28	150 (in)			285.25	150 (out)		
	74.16			0.42	**0.57%**				74.30			0.41	**0.55%**			Line Z	**0.56%**
SSMH Z1		284.84	150 (in)			284.82	150 (out)	Grade		284.84	150 (in)			284.81	150 (out)		
	18.33			0.09	**0.49%**				18.20			0.08	**0.44%**			Line Z	**0.50%**
EXTG SSMH		284.73	150 (in)					Grade		284.73	150 (in)						
System Three (Stage 1)																	
SSMH Y1						286.54	150 (out)	0.50						286.55	150 (out)		
	60.91			0.46	**0.76%**				60.90			0.49	**0.80%**			Line Y	**0.75%**
EXTG SSMH SH005985		286.08	150 (in)					0.25		286.06	150 (in)						

Notes:
1. Cells with red borders indicate where gradients are below the design value.
2. Cells highlighted yellow indicate where gradients indicated by recent survey are slacker than design and MTEC as-built survey.
3. Cells highlighted green indicate where gradients indicated on MTEC as-built survey are slacker than design and recent survey.
4. Pipe lengths for Geomatics survey data are determined directly from the coordinates. Gradients for MTEC survey data are taken from as-built drawings. These are in close agreement.

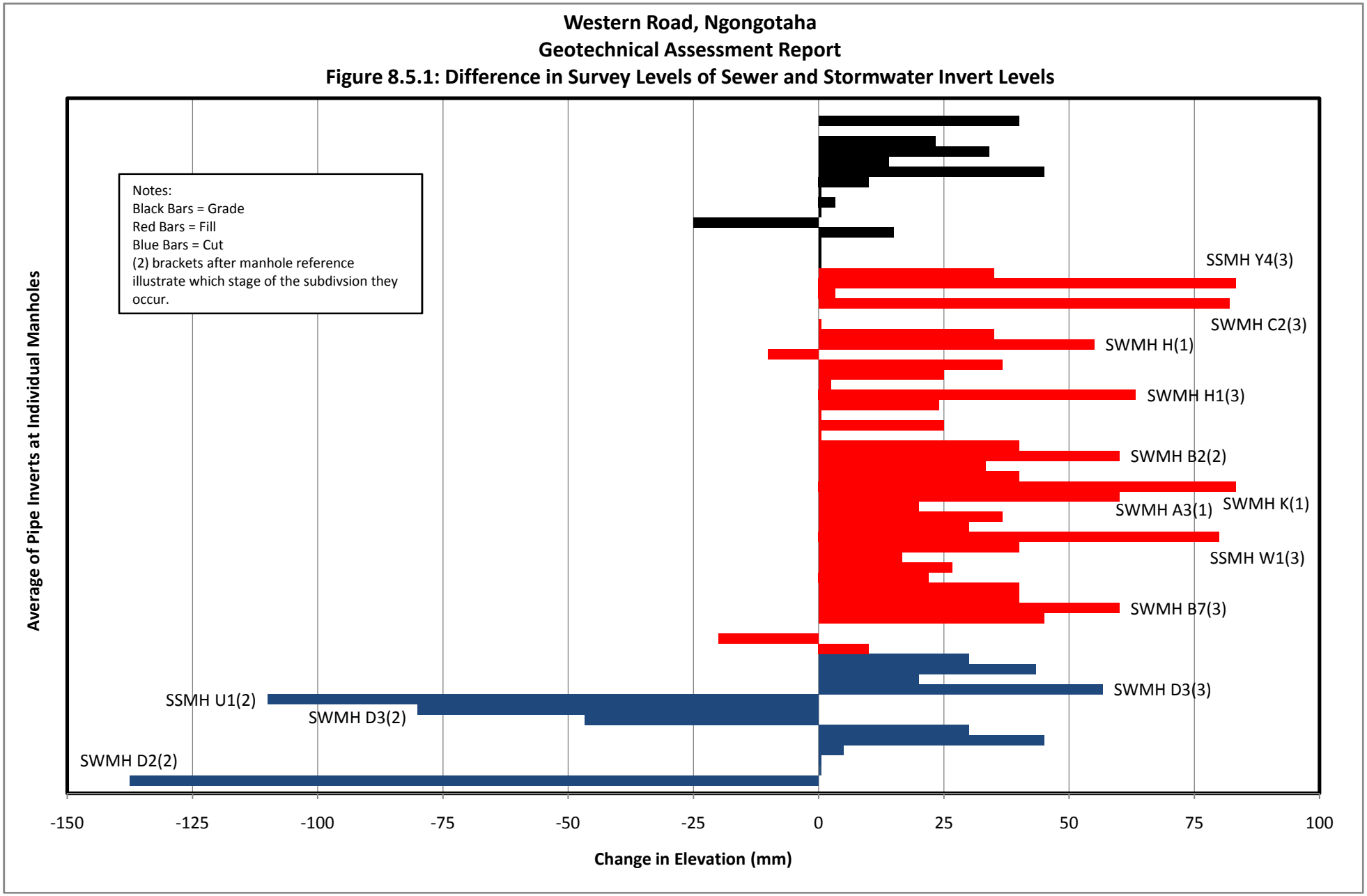
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Table 8.5.4: Infrastructure Level Survey - Surveyed October 2008

Manhole / Cess Pit	Geomatic Surveys								MTEC As-Built Drawings							Design	
	Distance	Elevation	Pipe Size	Elevation Difference	Gradient	Elevation	Pipe Size		Distance	Elevation	Pipe Size	Elevation Difference	Gradient	Elevation	Pipe Size	Line	Gradient
	(m)	(m amd)	(mm)	(mm)	(%)	(m amd)	(mm)		(m)	(m amd)	(mm)	(mm)	(%)	(m amd)	(mm)		(%)
SWMH C2(3)		285.46	450 (in) N			285.42	450 (out)			285.50	450 (in)			285.47	450 (out)		
	37.64			0.34	**0.90%**				36.70			0.33	**0.90%**			Line C	**0.94%**
SWMH C1(3)		285.08	450 (in)			285.03	525 (out)			285.14	450 (in)			285.04	525 (out)		
	53.64			0.52	**0.97%**				53.10			0.53	**1.00%**			Line C	**0.60%**
SWMH B5(3)		284.51	525 (in) N			284.51	750 (out)			284.51	525 (in)			284.51	750 (out)		
	91.49			0.48	**0.52%**				90.10			0.42	**0.47%**			Line B	**0.47%**
SWMH B4(3)		284.03	750 (in)			284.07	750 (out)			284.09	750 (in)			284.06	750 (out)		
	46.67			0.22	**0.47%**				46.00			0.20	**0.43%**			Line B	**0.45%**
SWMH B3(3)		283.85	750 (in)			283.83	750 (out)			283.86	750 (in)			283.83	750 (out)		
	54.46			0.19	**0.35%**				36.51			0.28	**0.77%**			Line B	**0.45%**
SWMH D3(2)		283.64	750 (in)			283.58	750 (out)			283.55	750 (in)			283.50	750 (out)		
	85.64			0.29	**0.34%**				85.70			0.36	**0.42%**			Line D	**0.34%**
SWMH D2(2)		283.29	750 (in)			283.27	825 (out)			283.14	750 (in)			283.12	825 (out)		
	54.21			0.24	**0.44%**				54.10			0.15	**0.28%**			Line D	**0.35%**
SWMH D1(2)		283.03	825 (in)			283.02	825 (out)			282.97	825 (in)			282.94	825 (out)		
	64.47			0.29	**0.45%**				64.60			0.18	**0.28%**			Line D	**0.27%**
SWMH B1(2)		282.73	825 (in)			282.67	1050 (out)			282.76	825 (in)			282.70	1050 (out)		
	47.85			0.15	**0.31%**				47.40			0.18	**0.38%**			Line B	**0.42%**
SWMH A4(2)		282.52	1050 (in)			282.52	1200 (out)			282.52	1050 (in)			282.52	1200 (out)		
	44.76			0.12	**0.27%**				44.60			0.12	**0.27%**			Line A	**0.46%**
SWMH A3(1)		282.40	1200 (in)			282.26	1200 (out)			282.40	1200 (In)			282.38	1200 (Out)		
	44.55			0.08	**0.18%**				44.60			0.18	**0.40%**			Line A	**0.46%**
SWMH A2(1)		282.18	1200 (in)			282.14	1200 (out)			282.20	1200 (In)			282.12	1200 (Out)		
	44.69			0.06	**0.13%**				45.00			0.06	**0.13%**			Line A	**0.46%**
SWMH A1(1)		282.08	1200 (in)			282.06	1200 (out)			282.06	1200 (In)			282.03	1200 (Out)		
				282.06					3.00			-0.05				Line A	**0.46%**
SW OUTLET										282.08	1200 (In)						
SWMH B1(2)		282.80	675 (in)			282.67	1050 (out)			282.84	675 (in)			282.70	1050 (out)		
	58.13			0.52	**0.89%**				58.20			0.53	**0.91%**			Line B	**0.30%**
SWMH B2(2)		283.19	525 (in)			283.02	675 (out)			283.23	525 (in)			283.09	675 (out)		
	55.87			0.73	**1.31%**				55.70			0.66	**1.18%**			Line B	**0.80%**
SWMH B3(2)		283.75	525 (in)			283.70	525 (out)			283.75	525 (in)			283.73	525 (out)		
				-283.70					68.30			0.67	**0.98%**			Line B	**0.84%**
SWMH G2(1)		0.00	0.00			0.00	0.00			284.40	525 (in)			284.38	525 (out)		
				285.03					85.70			0.65	**0.76%**			Line G	**0.66%**
SWMH G3(1)		285.03	525 (in)			285.00	525 (out)			285.03	525 (in)			285.01	525 (out)		
	98.34			0.55	**0.56%**				98.30			0.58	**0.59%**			Line G	**0.39%**
SWMH A1(3)		285.55	300 (in)			285.36	525 (out)			285.59	300 (in)			285.44	525 (out)		
	18.19			0.75	**4.12%**				18.30			0.73	**3.99%**			Line H	**3.30%**
SWMH H(1)		286.11	300 (in)			286.09	300 (out)			286.17	300 (in)			286.14	300 (out)		
	40.68			0.31	**0.76%**				40.80			0.27	**0.66%**			Line H	**0.50%**
SWMH H1(1)		286.40	300 (in)			286.33	300 (out)			286.41	300 (in)			286.39	300 (out)		
	17.00			0.15	**0.88%**				17.00			0.15	**0.88%**			Line H	**0.50%**
SWMH H2(1)		286.48	300 (in)			286.43	300 (out)			286.54	300 (in)			286.46	300 (out)		
SWMH A1(3)		285.46	450 (in)			285.36	525 (out)			285.46	450 (in)			285.44	525 (out)		
	52.52			0.19	**0.36%**				51.50			0.15	**0.29%**			Line A	**0.21%**
SWMH A2(3)		285.55	375 (in)			285.53	450 (out)			285.59	375 (in)			285.58	450 (out)		
SWMH C1(3)		285.05	300 (in)			285.03	525 (out)			285.06	300 (in)			285.04	525 (out)		
	36.20			0.16	**0.44%**				35.30			0.21	**0.59%**			Line H	**0.40%**
SWMH H1(3)						285.21	300 (out)							285.27	300 (out)		
SWMH B5(3)		284.51	525 (in) S			284.51	750 (out)			284.51	525 (in)			284.51	750 (out)		
	20.74			0.31	**1.50%**				19.50			0.34	**1.74%**			Line B	**0.50%**
SWMH B6(3)		284.95	375 (in)			284.82	525 (out)			285.03	375 (in)			284.85	525 (out)		
	50.99			0.22	**0.43%**				49.90			0.21	**0.42%**			Line B	**0.43%**
SWMH B7(3)						285.17	375 (out)							285.24	375 (out)		
SWMH D3(3)						287.48	300 (out)							287.50	300 (out)		
	30.98			0.30	**0.97%**				30.90			0.27	**0.87%**			Line D	**0.97%**
SWMH D2(3)		287.18	300 (in)			287.16	375 (out)			287.23	300 (in)			287.20	375 (out)		
	62.92			2.46	**3.91%**				62.90			2.46	**3.91%**			Line D	**3.94%**
SWMH D1(3)		284.70	375 (in)			284.68	450 (out)			284.74	375 (in)			284.70	450 (out)		
	15.62			0.60	**3.84%**				14.20			0.60	**4.23%**			Line D	**0.50%**
SWMH B4(3)		284.08	450 (in)			284.07	750 (out)			284.10	450 (in)			284.06	750 (out)		
SWMH D3(2)		284.16	300 (in)			283.58	750 (out)			284.08	300 (in)			283.50	750 (out)		
	60.53			0.28	**0.46%**				60.50			0.36	**0.60%**			Line F	**0.54%**
SWMH F1(3)		284.52	300 (in) W			284.44	300 (out)			284.53	300 (in)			284.44	300 (out)		
	60.77			0.15	**0.25%**				60.70			0.19	**0.31%**			Line F	**0.33%**
SWMH F2(3)						284.67	300 (out)							284.72	300 (out)		
SWMH D2(2)		283.75	300 (in)			283.27	825 (out)			283.61	00 (cp leads)			283.12	825 (out)		
	9.40			0.20	**2.13%**				9.40			0.34	**3.62%**			Line ?	**1.89%**
SWMH F(2)						283.95	300 (out)							283.95	300 (out)		
SWMH A3(1)		283.22	300 (in)							283.28	300 (In)						
	16.44			0.94	**5.72%**				16.20			0.93	**5.74%**			Line K	**5.26%**
SWMH K(1)						284.16	300 (out)							284.21	300 (out)		
SWMH B2(2)		283.16	300 (in)							283.23	300 (in)						
	48.33			0.46	**0.96%**				48.10			0.43	**0.89%**			Line C	**0.89%**
SWMH J(1)		283.69	300 (in)			283.63	300 (out)			283.72	300 (in)			283.66	300 (out)		
	42.10			0.20	**0.49%**				42.10			0.18	**0.43%**			Line J	**0.31%**
SWMH J1(1)						283.89	300 (out)							283.90	300 (out)		

Notes:
1. Cells with red borders indicate where gradients are below the design value.
2. Cells highlighted yellow indicate where gradients indicated by recent survey are slacker than design and MTEC as-built survey.
3. Cells highlighted green indicate where gradients indicated on MTEC as-built survey are slacker than design and recent survey.
4. Pipe lengths for Geomatics survey data are determined directly from the coordinates. Gradients for MTEC survey data are taken from as-built drawings. These are generally in close agreement.

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Geotechnics Ltd Geobeam Test Results

Document Set ID: 2699211
Version: 2, Version Date: 27/04/2009

Geobeam Report

GEOTECHNICS
PO Box 9360, Newmarket Auckland 1149
Ph +64 9 356 3510 Fax 64 9 356 3511

Printed: 02-Dec-2008
Geotechnics Job No. 614173.007
Source File: tontayrotorua.txt

Customer:	Tonkin & Taylor	**Customer Ref:**	n/a	**Radius Loaded Area (m)**	0.15
Site:	Western Road sub-di	**Weather:**	Overcast	**Rear Axle Load (kN):**	82
Suburb/City:	Rotorua	**Road Temp. C:**	40	**Tyre Pressure (kPa):**	825
Road:	Road 1	**Surface Type:**	Asphalt	**Transducer ID:**	130606
Test Date:	28/11/2008	**RL:**	n/a	**Transducer Plate Dia (mm):**	60
Test Time:	11:36	**Geobeam No:**	1	**Calibration :**	1.27
Operator:	pdj	**Checked:**		**Cable ID:**	1
				Date Checked:	

Statistical Data

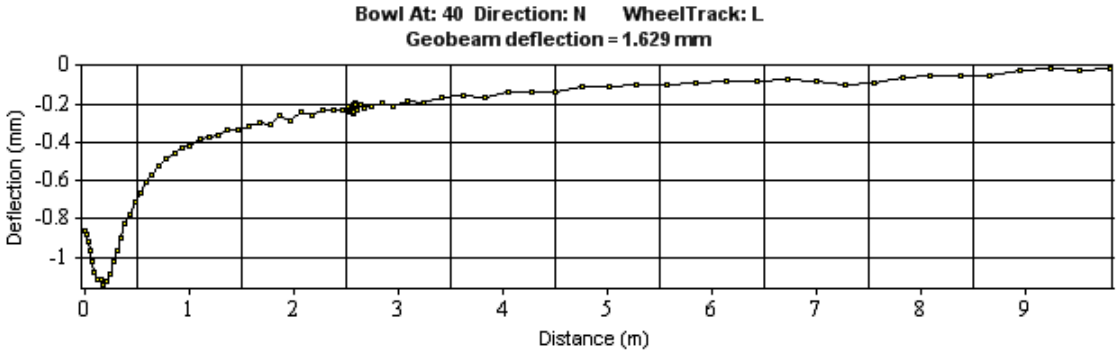
Number of deflection readings	37	
Mean of deflections	2.44	mm
Deflections standard deviation	0.65	mm
Deflections 95th percentile	3.50	mm

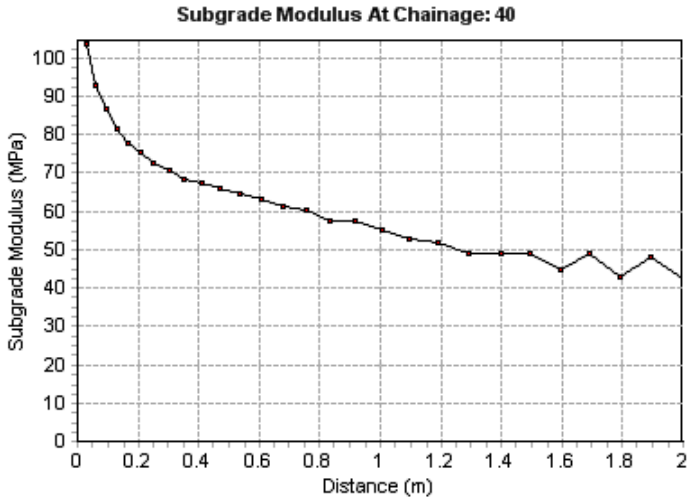
Chainage (m)	Lane	Wheel Track	Geobeam Deflection (mm)	Curvature Function (d0-d200)	Composite Modulus (MPa)	Uncorrected Raw Deflections (mm) 0.0 m	0.2 m	0.9 m	2.7 m
Direction: N									
40	LH	L	1.63	0.27	130	1.143	0.898	0.416	0.198
80	LH	L	2.76	0.39	77	2.599	2.222	0.690	0.125
120	LH	L	3.38	0.17	63	2.374	2.256	0.983	0.418
160	LH	L	2.69	0.43	79	2.259	1.847	0.767	0.184
200	LH	L	2.56	0.25	83	2.168	1.939	0.745	0.151
240	LH	L	2.32	0.20	91	1.992	1.809	0.581	0.144
280	LH	L	2.48	0.34	86	2.436	2.098	0.804	0.128
320	LH	L	1.94	0.29	109	1.679	1.405	0.521	0.097
360	LH	L	1.38	0.44	154	1.381	0.933	0.119	0.008
20	LH	R	1.55	0.30	137	1.285	0.997	0.397	0.133
60	LH	R	1.70	0.35	125	1.252	0.928	0.471	0.200
100	LH	R	3.33	0.55	64	2.574	2.061	0.911	0.286
140	LH	R	3.37	0.63	63	2.748	2.145	0.944	0.245
180	LH	R	2.78	0.53	76	2.338	1.833	0.753	0.178
220	LH	R	3.08	0.35	69	2.131	1.830	0.875	0.350
260	LH	R	2.82	0.33	75	2.513	2.195	0.718	0.134
300	LH	R	2.92	0.24	73	2.450	2.230	0.757	0.176
340	LH	R	1.56	0.13	136	1.463	1.342	0.293	0.071
		Mean =	2.46						
		Stand. Dev. =	0.68						
Direction: S									
30	RH	L	0.93	0.26	229	0.845	0.588	0.124	0.032
70	RH	L	1.80	0.22	118	1.236	1.047	0.559	0.209
110	RH	L	2.52	0.22	84	2.165	1.963	0.633	0.215
150	RH	L	2.16	0.27	98	2.180	1.916	0.629	0.079
190	RH	L	2.78	0.39	76	2.199	1.837	0.769	0.222
230	RH	L	2.24	0.07	95	1.816	1.771	0.794	0.156
270	RH	L	2.88	0.34	74	2.625	2.296	0.878	0.106
310	RH	L	2.61	0.43	81	2.297	1.882	0.719	0.117
350	RH	L	2.66	0.50	80	2.299	1.821	0.747	0.141
10	RH	R	2.61	0.31	81	2.120	1.836	0.571	0.194
50	RH	R	2.07	0.27	103	1.304	1.071	0.690	0.276
90	RH	R	2.75	0.61	77	2.264	1.680	0.704	0.185

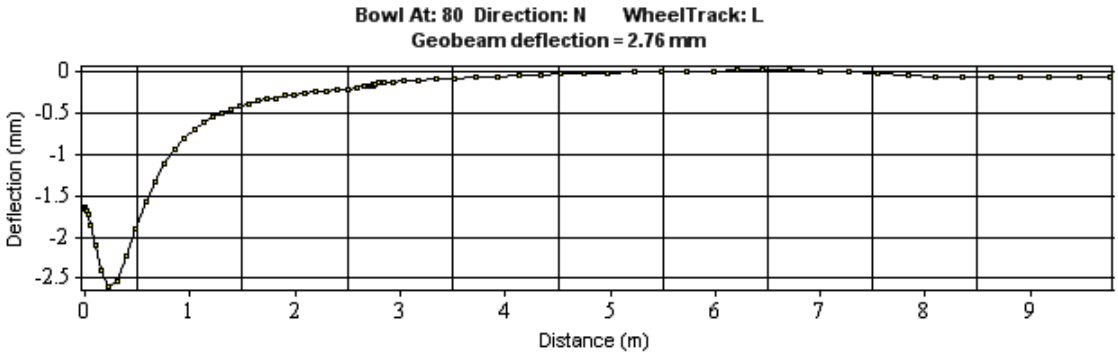
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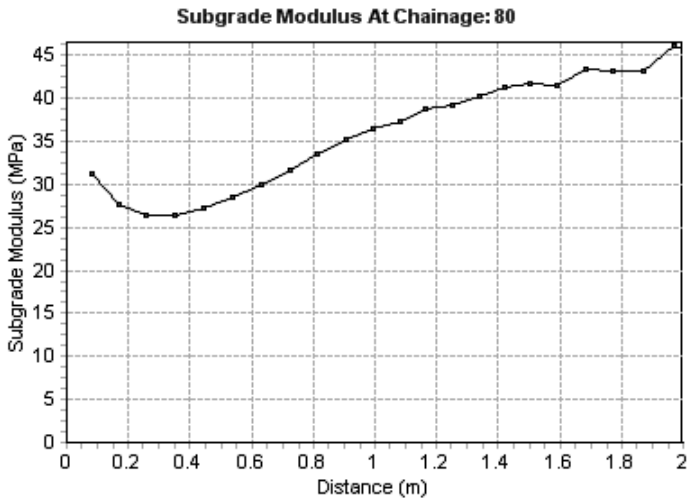
Chainage (m)	Lane	Wheel Track	Geobeam Deflection (mm)	Curvature Function (d0-d200)	Composite Modulus (MPa)	Uncorrected Raw Deflections (mm) 0.0 m	0.2 m	0.9 m	2.7 m
Direction: S									
130	RH	R	3.89	0.40	55	2.754	2.413	1.013	0.422
170	RH	R	2.70	0.37	79	2.147	1.806	0.863	0.207
210	RH	R	3.00	0.23	71	2.332	2.136	0.919	0.248
250	RH	R	2.62	0.24	81	2.249	2.028	0.884	0.150
290	RH	R	2.41	0.40	88	2.181	1.797	0.747	0.127
330	RH	R	1.54	0.12	137	1.327	1.213	0.342	0.083
370	RH	R	1.77	0.25	120	1.626	1.383	0.256	0.053
		Mean =	2.42						
	Stand. Dev. =		0.63						
Combined			**Mean**	2.44	**Stand. Dev =**	0.65			

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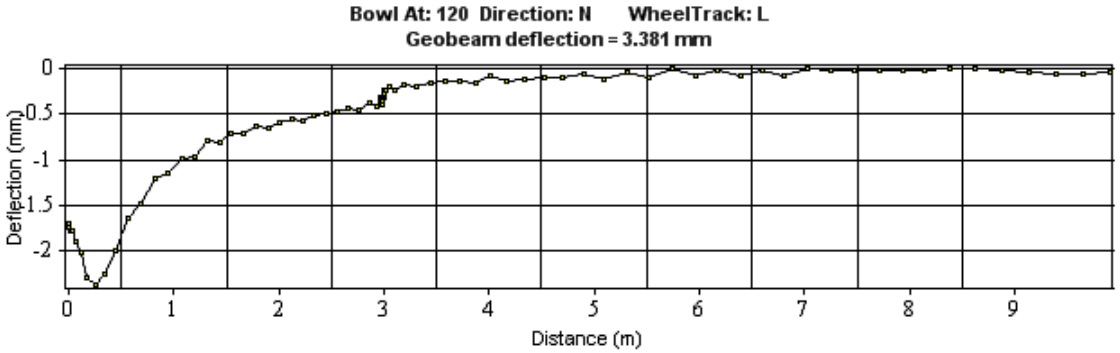


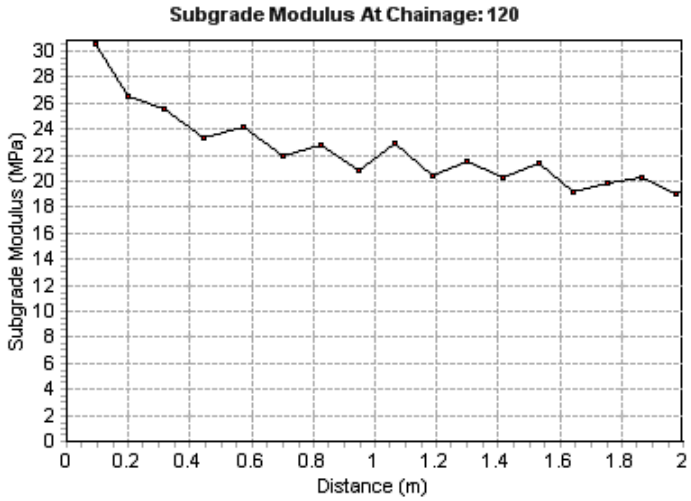


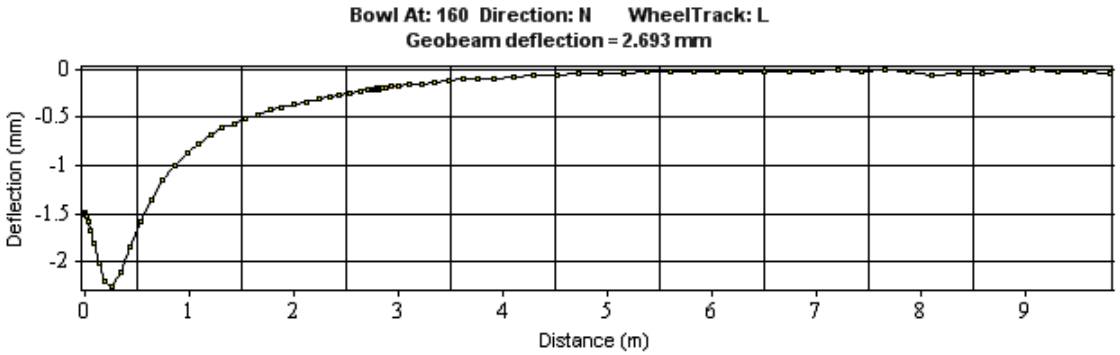


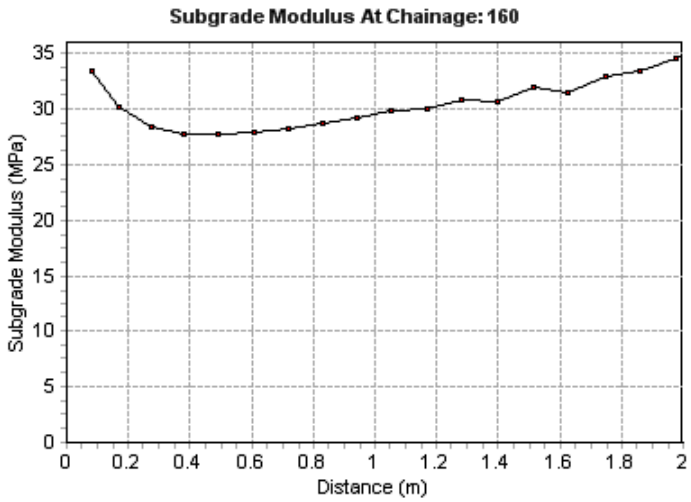


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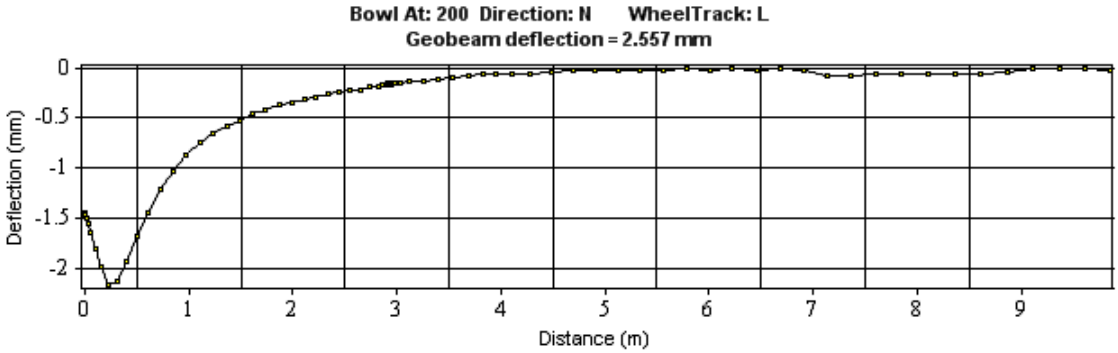


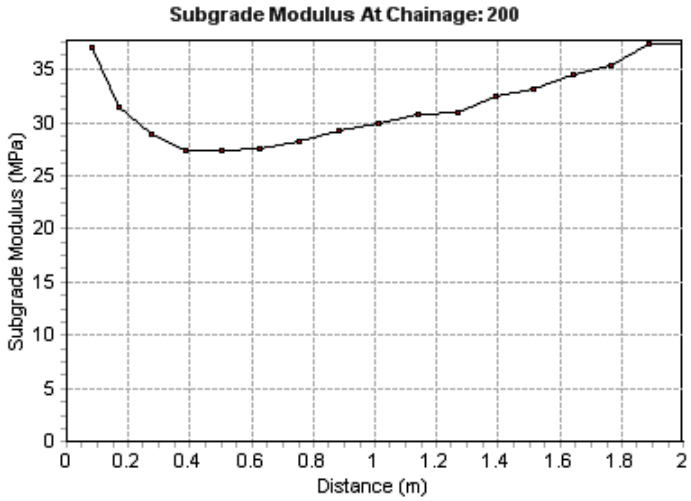


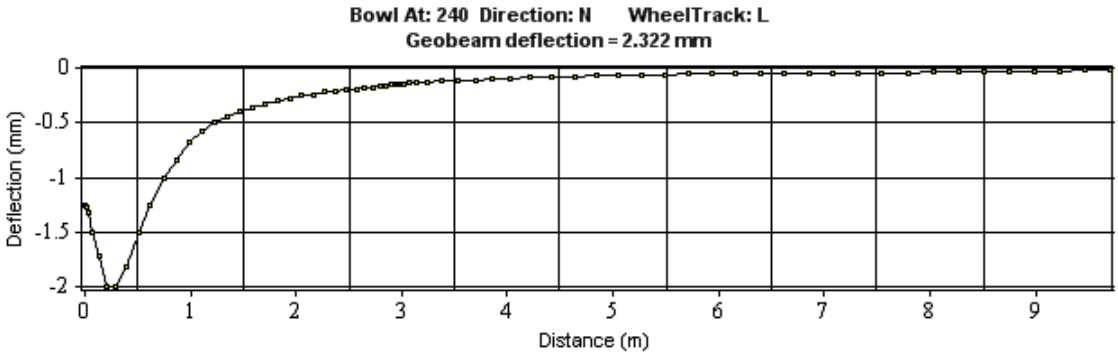


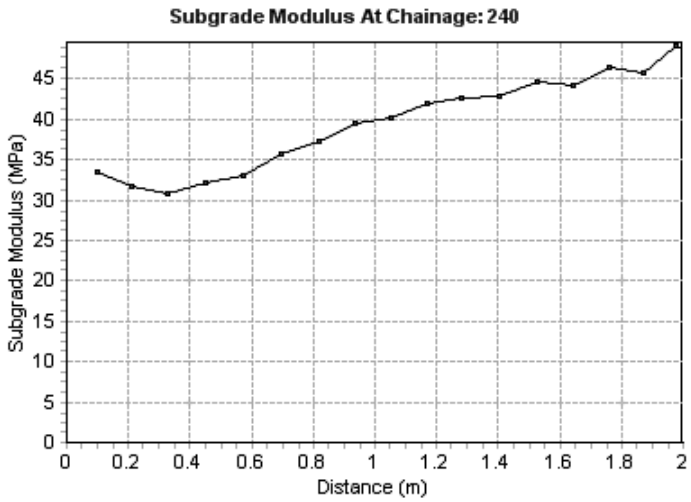


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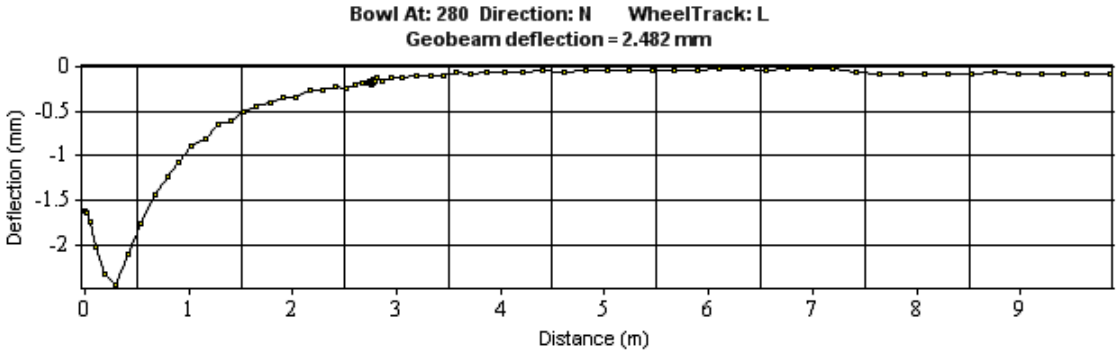


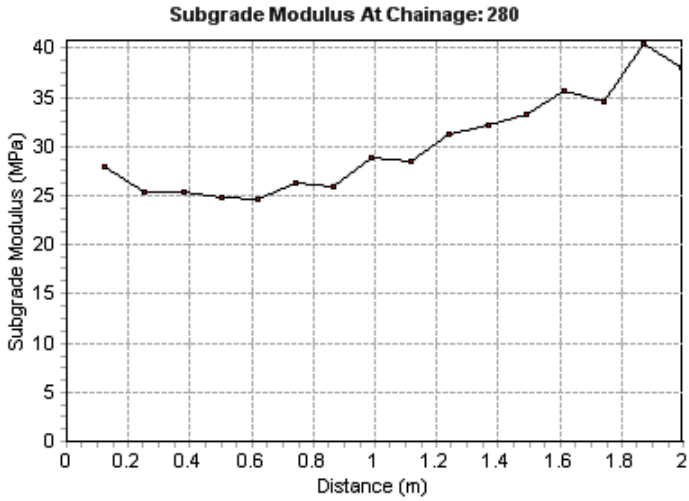




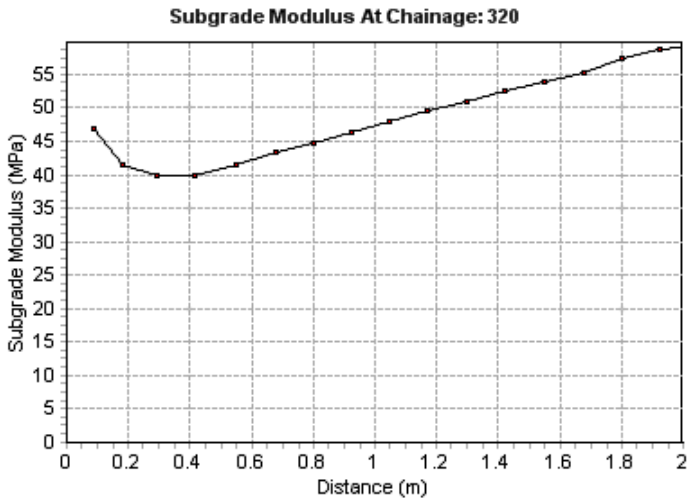


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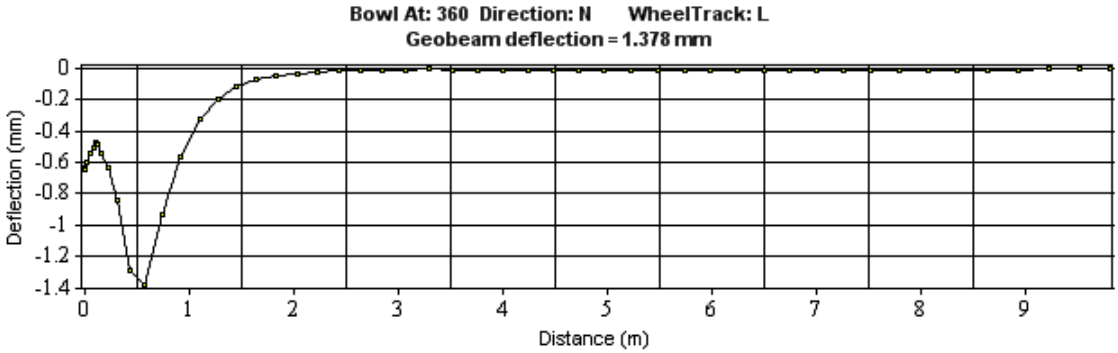


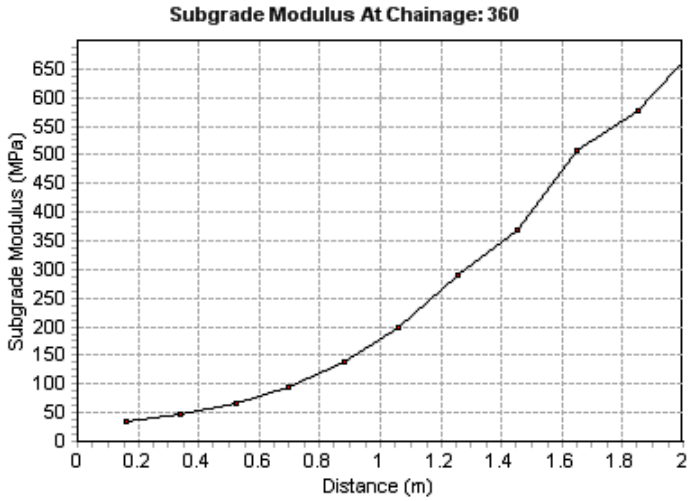


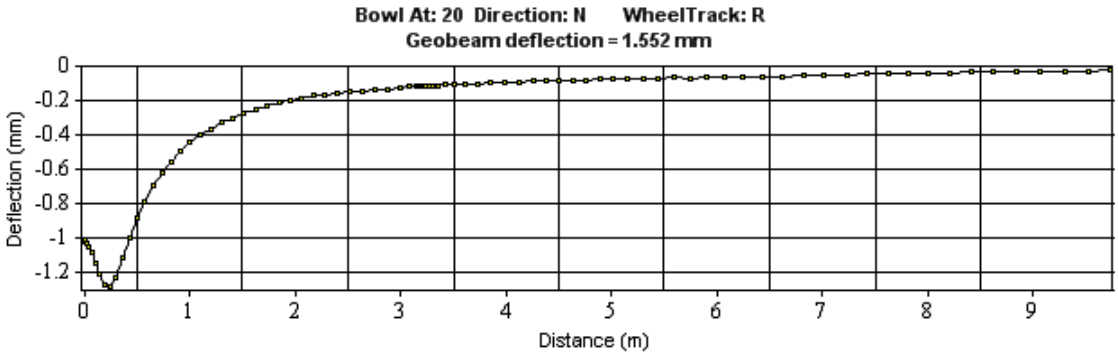


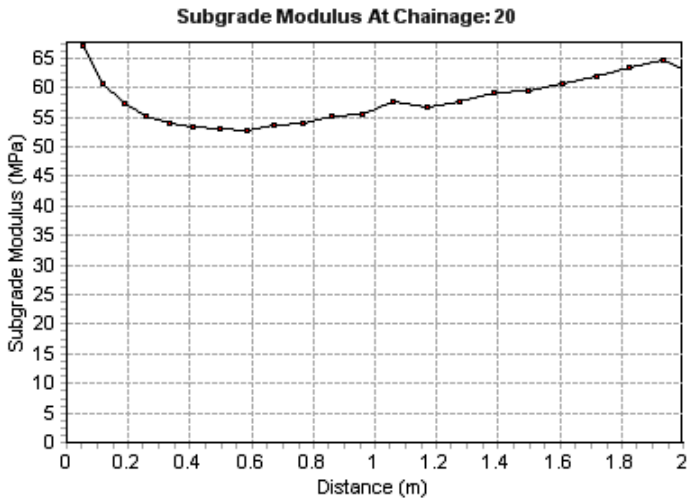


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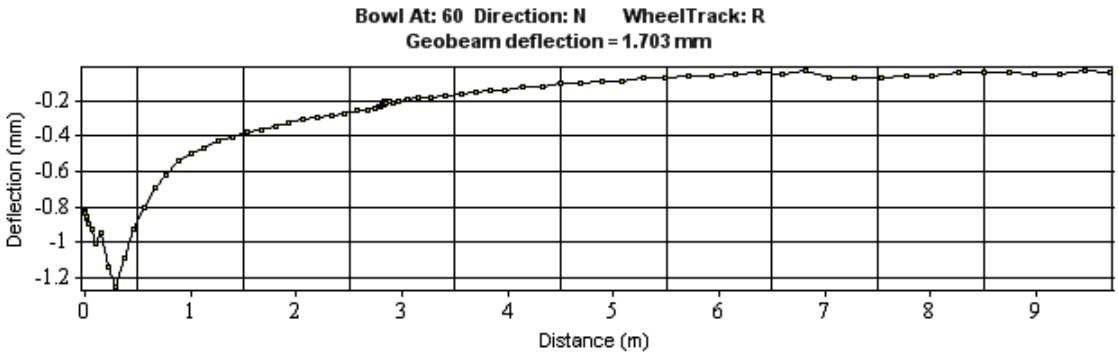


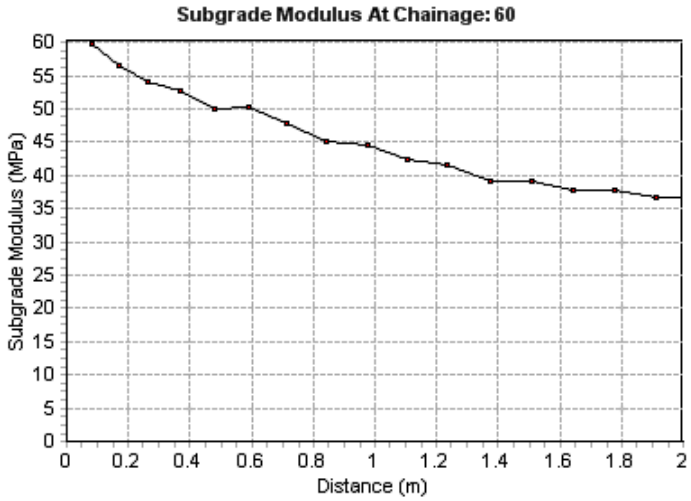


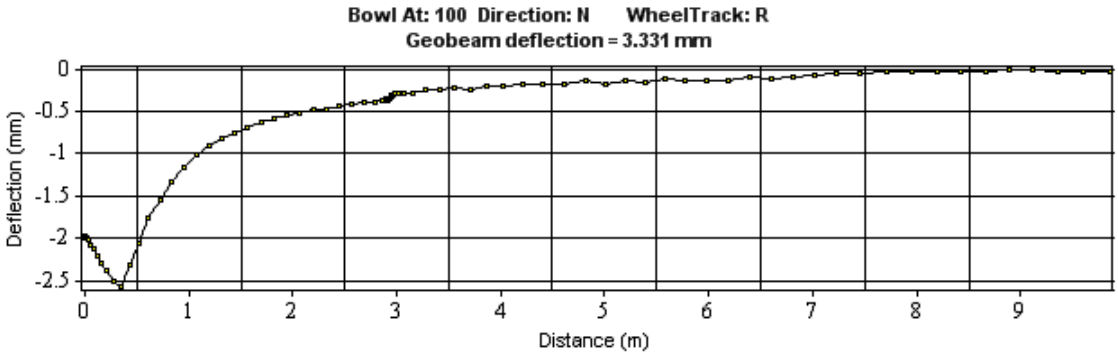


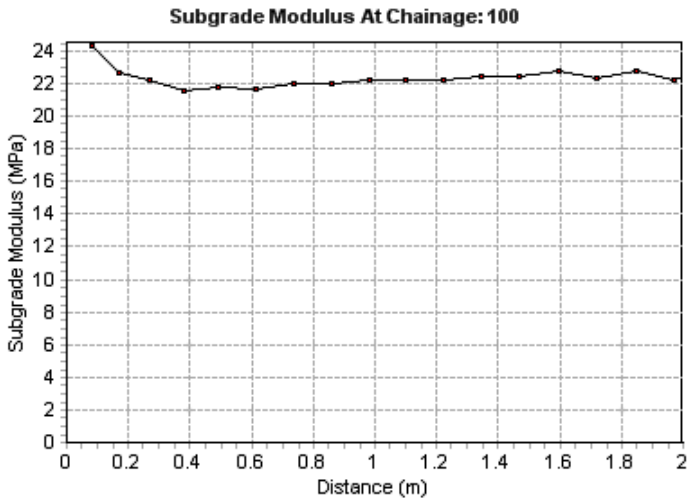


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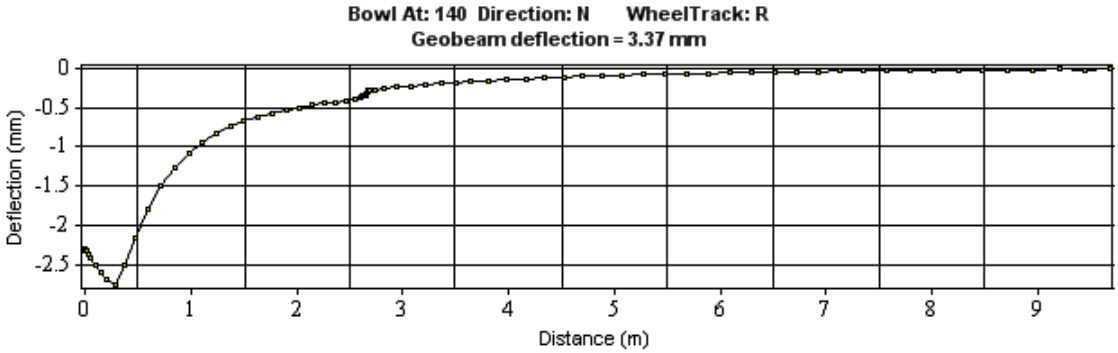


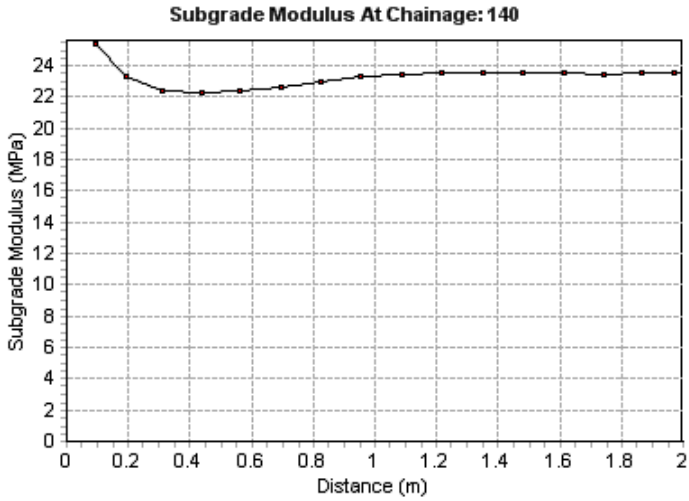


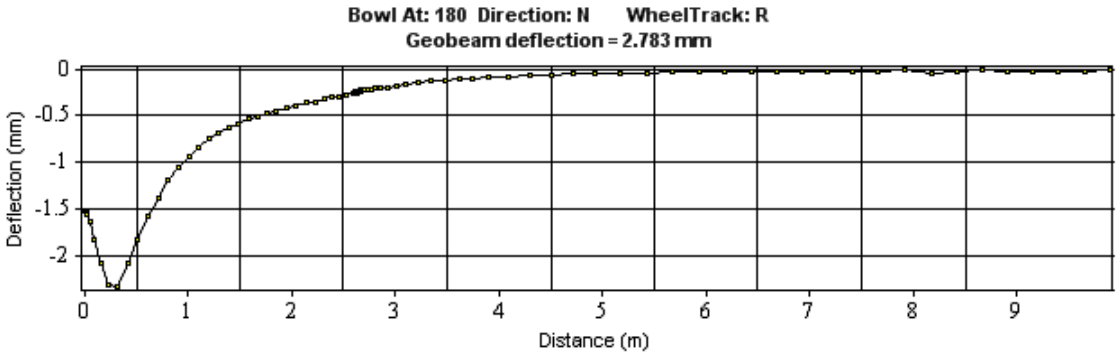


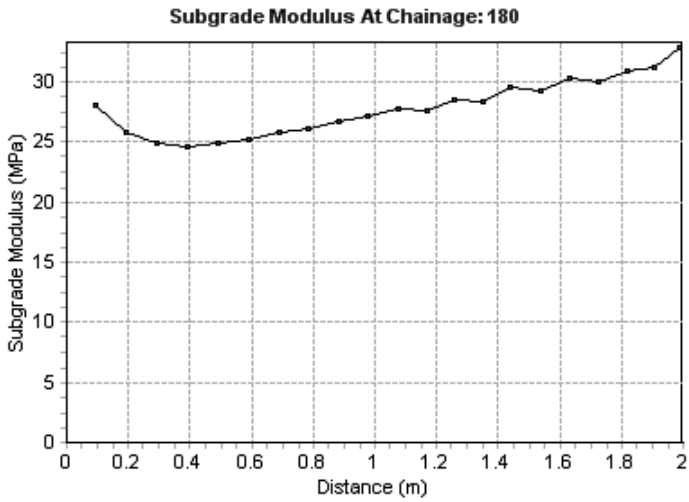


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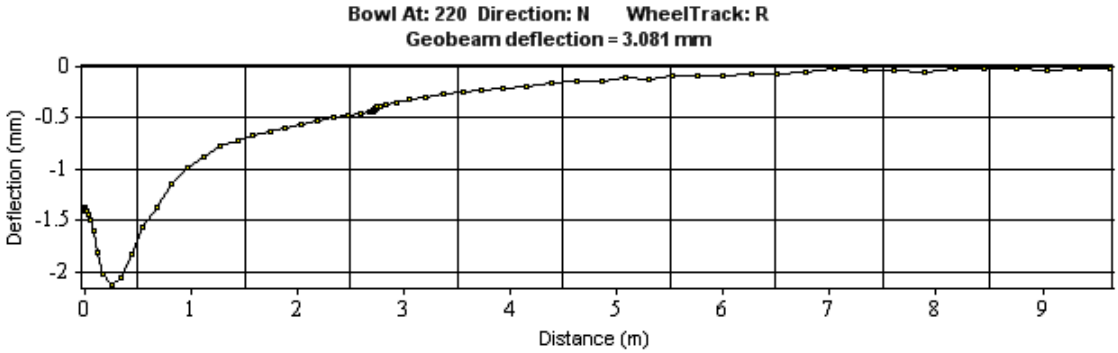


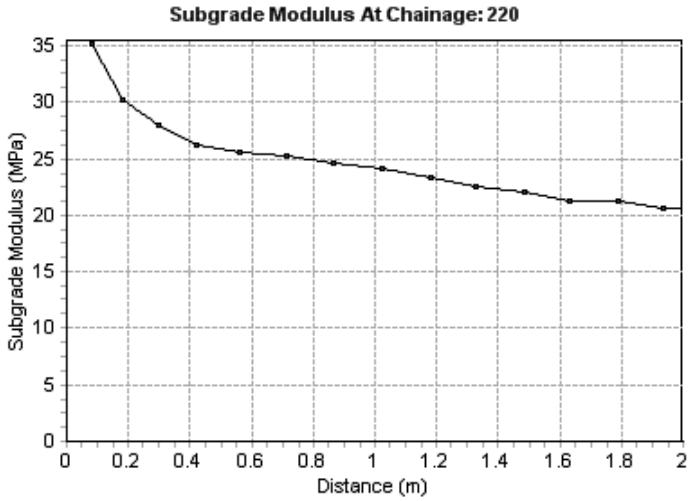


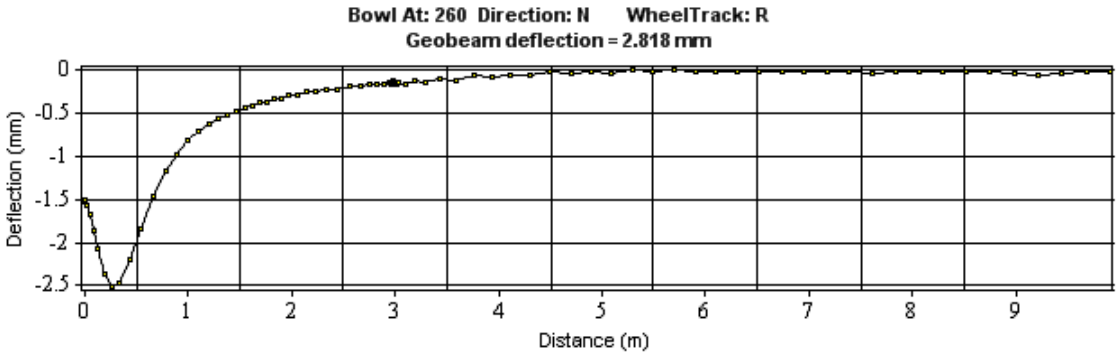


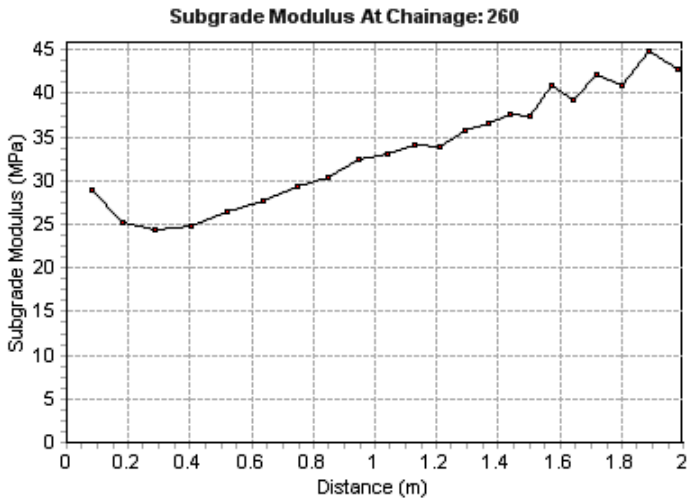


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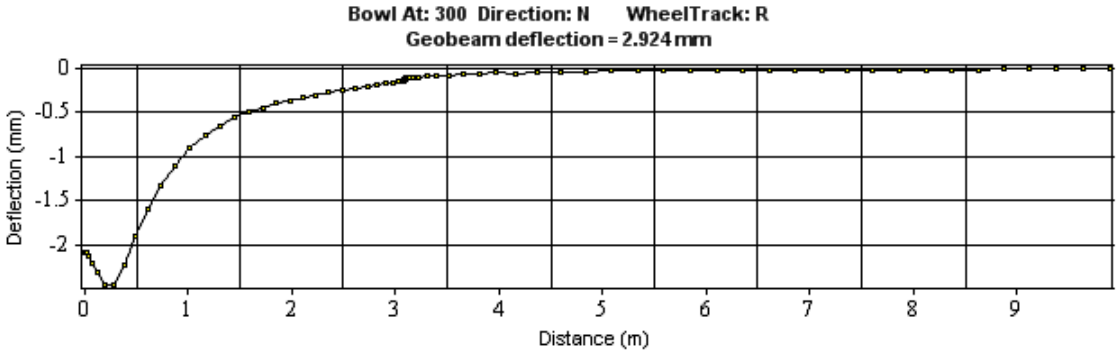


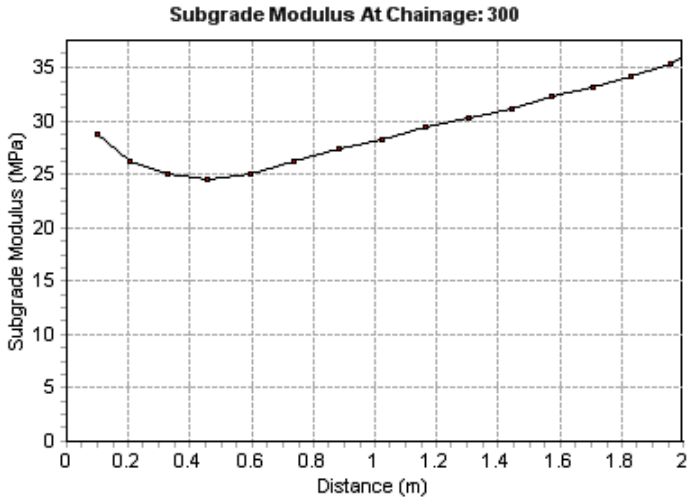


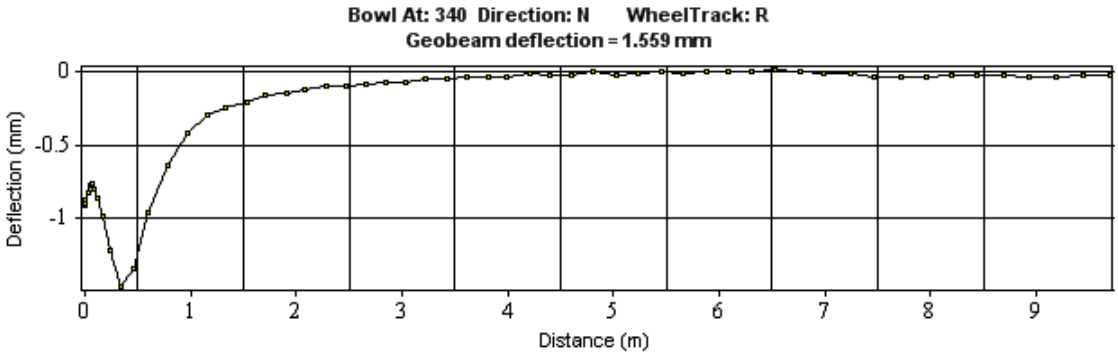


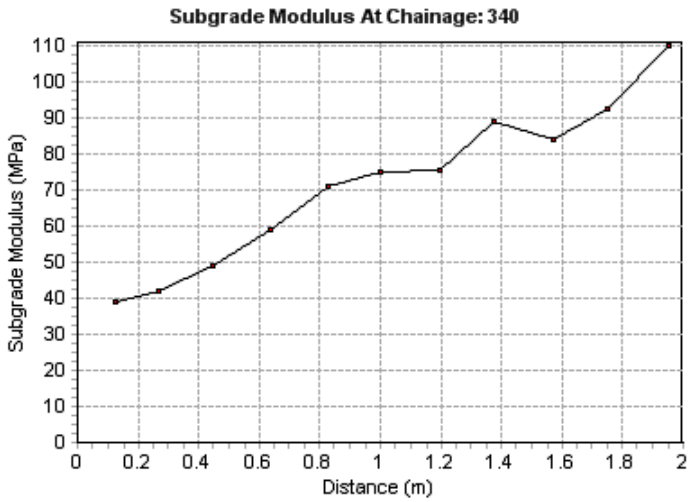


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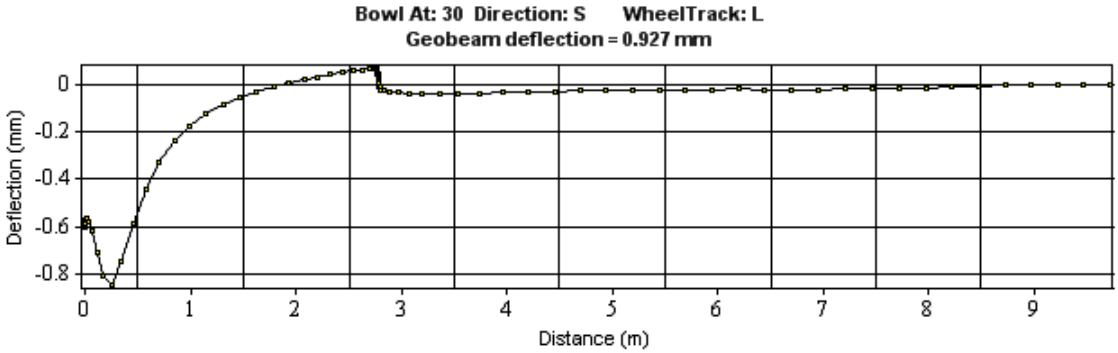


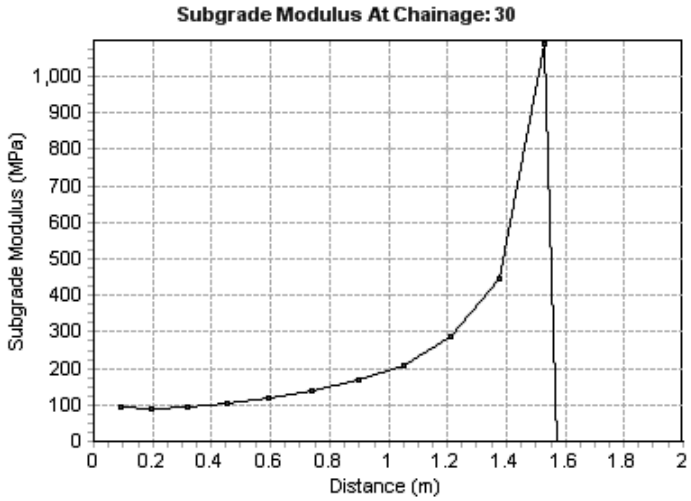


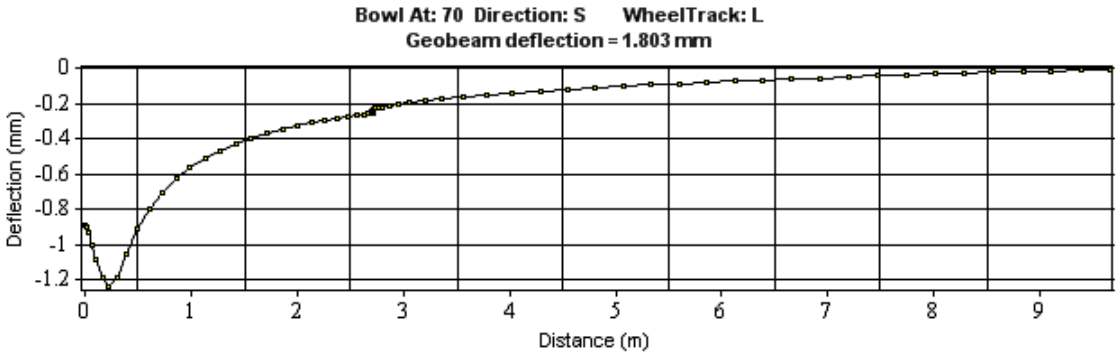


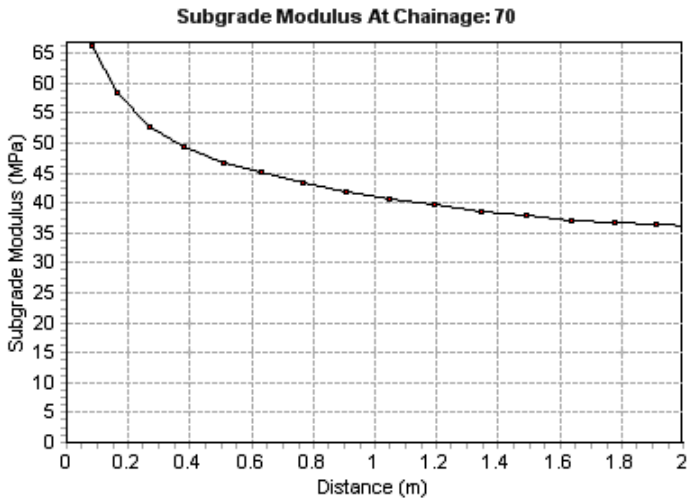


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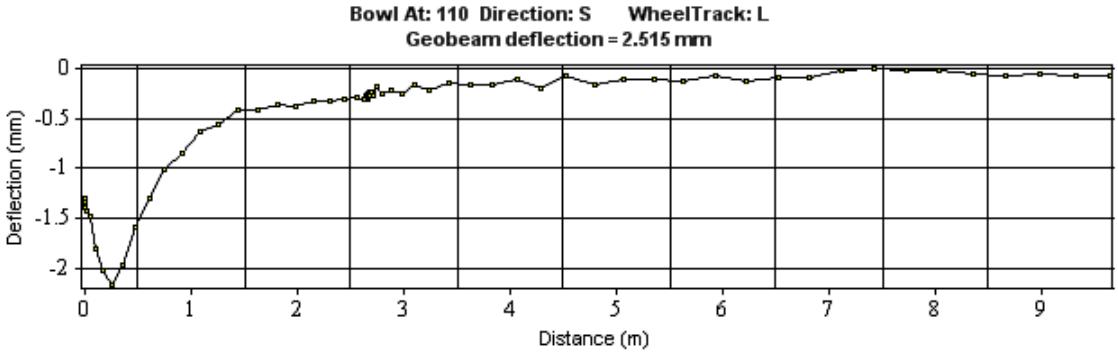


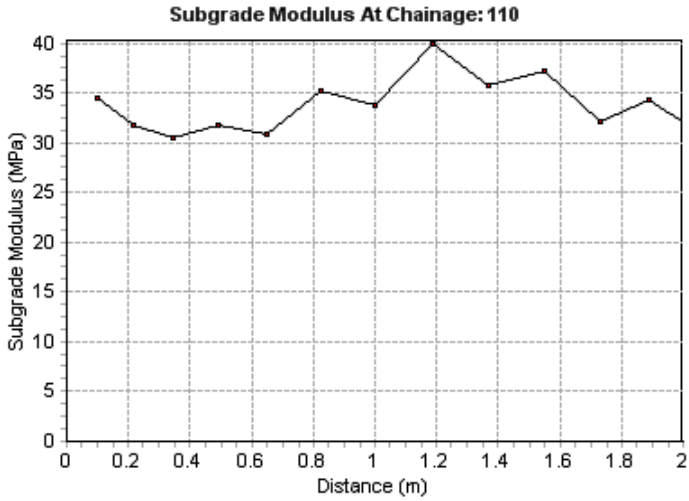


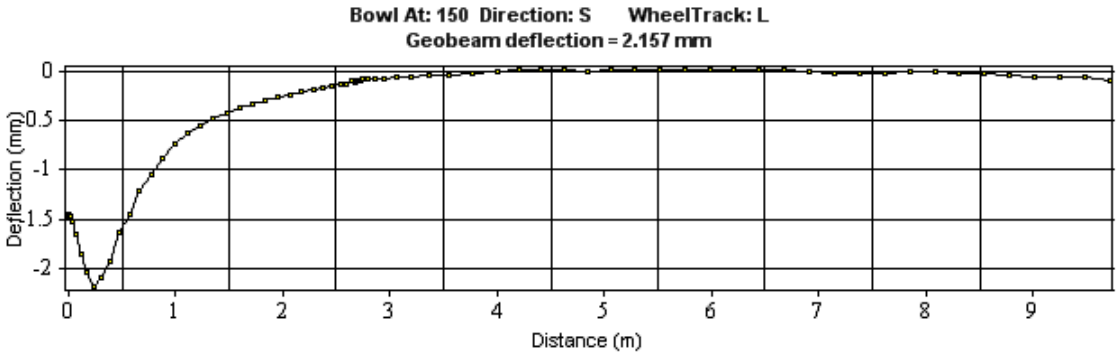


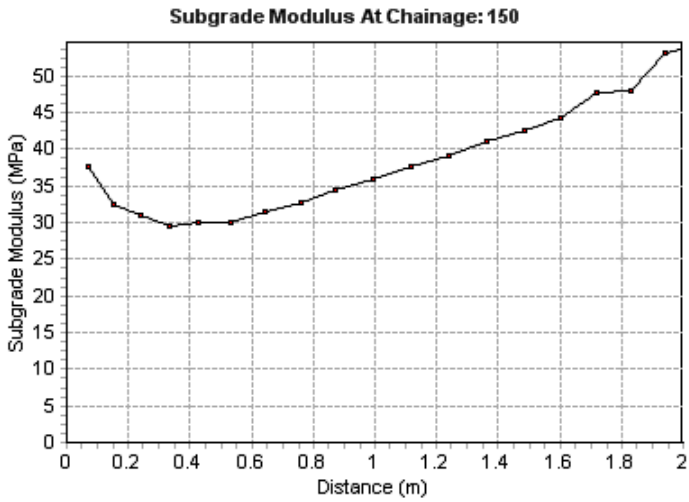


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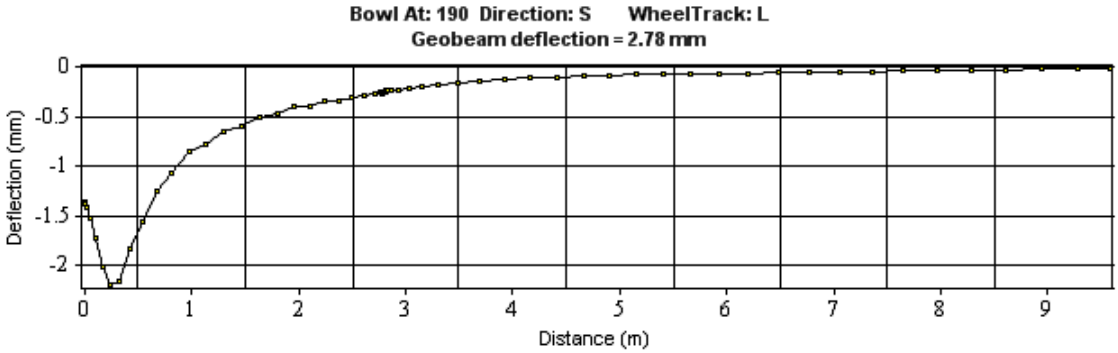


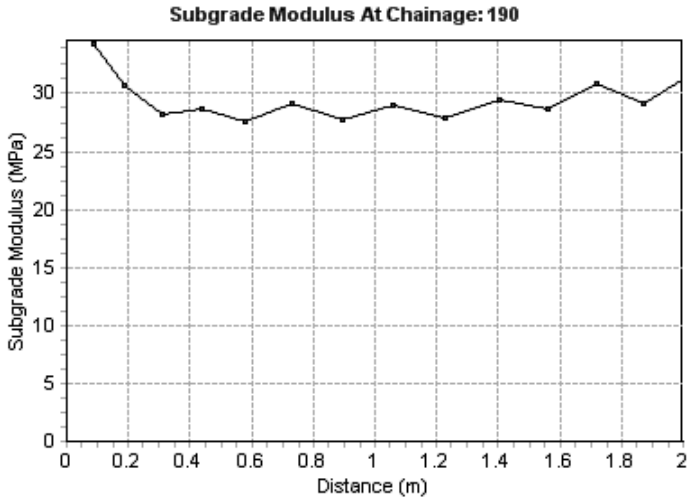


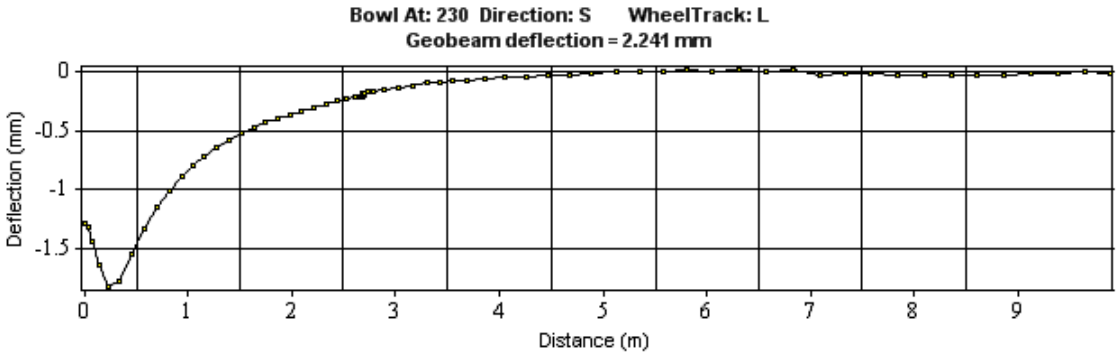


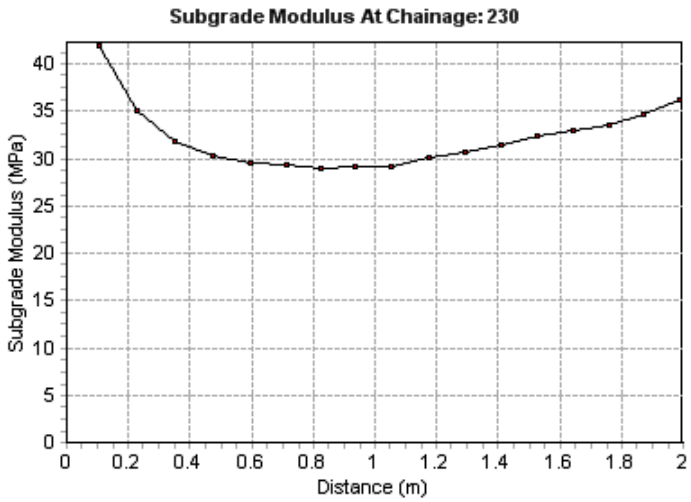


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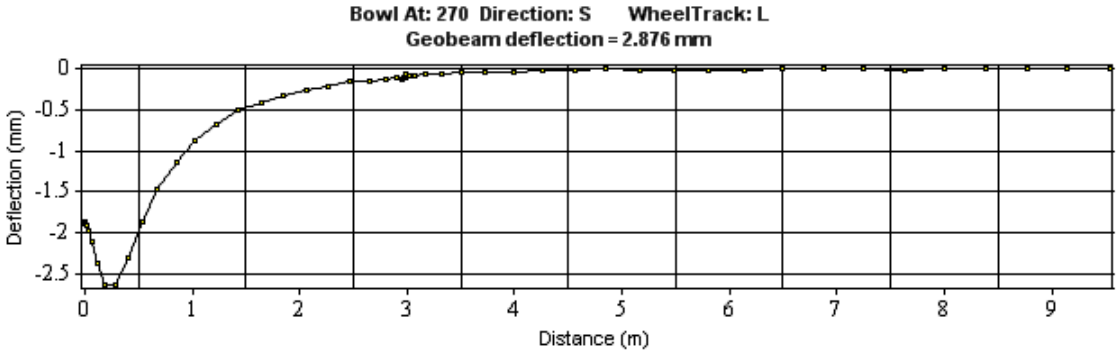


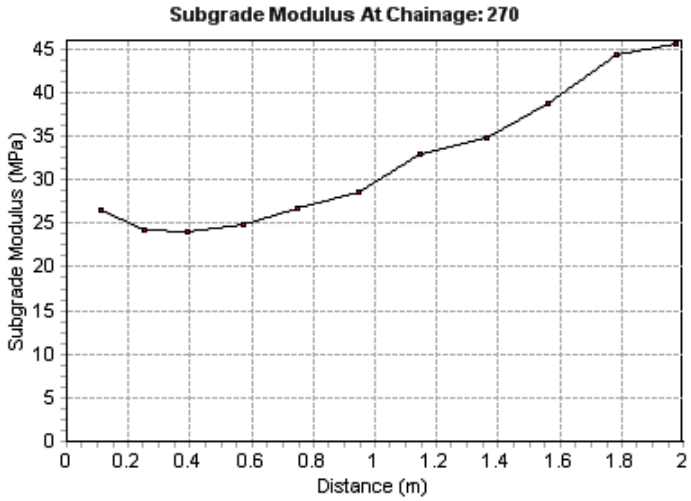


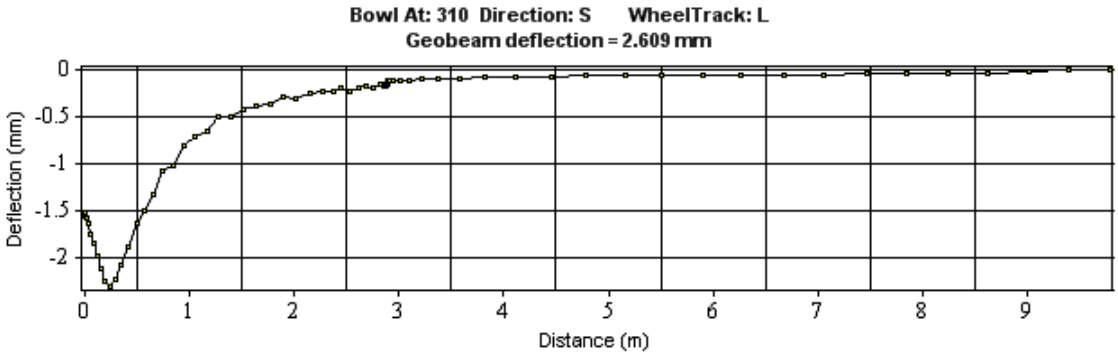


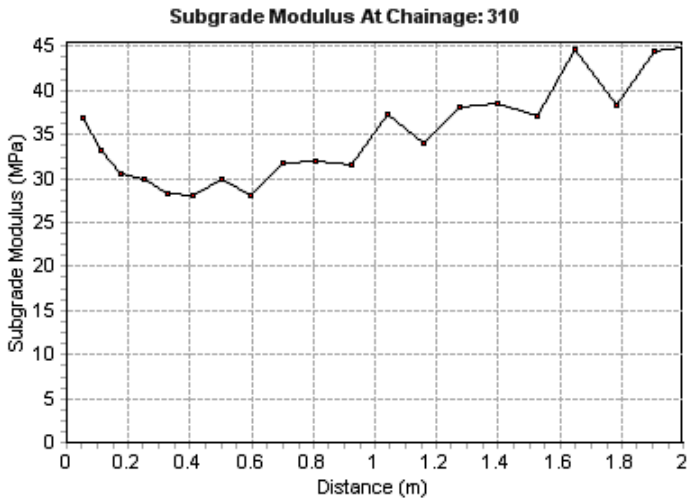


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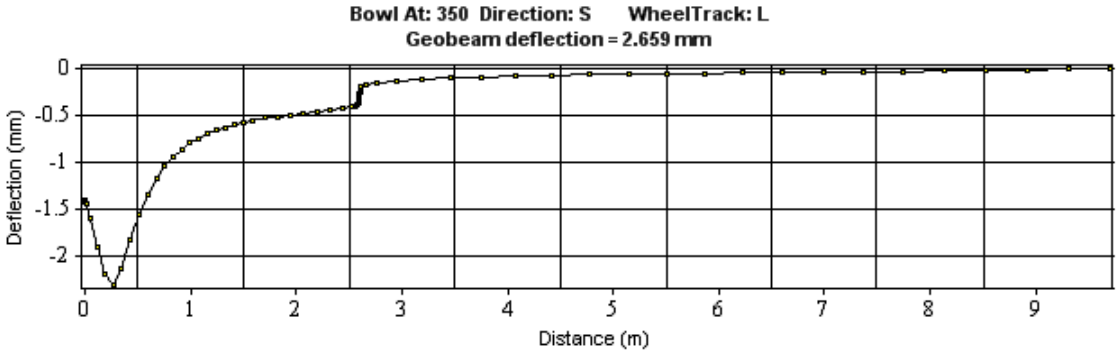


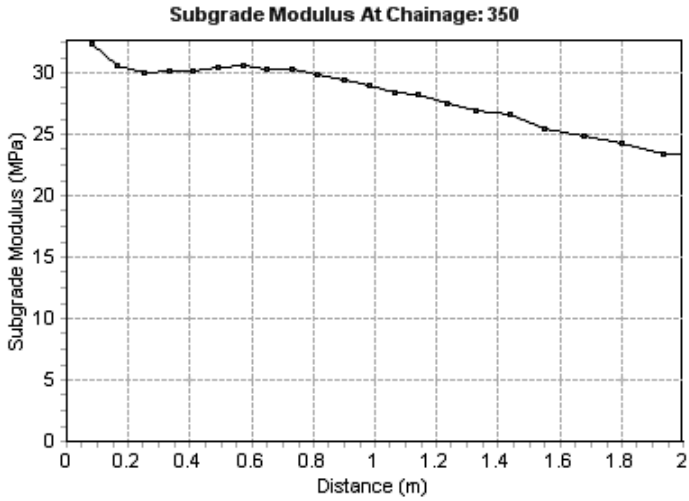


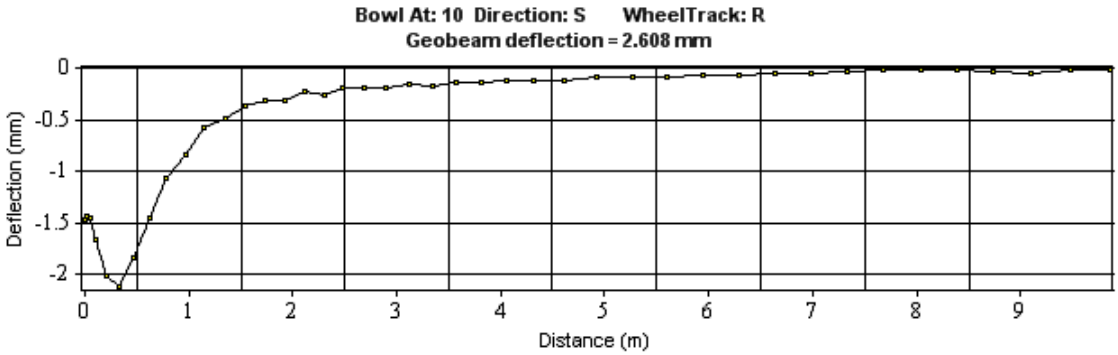


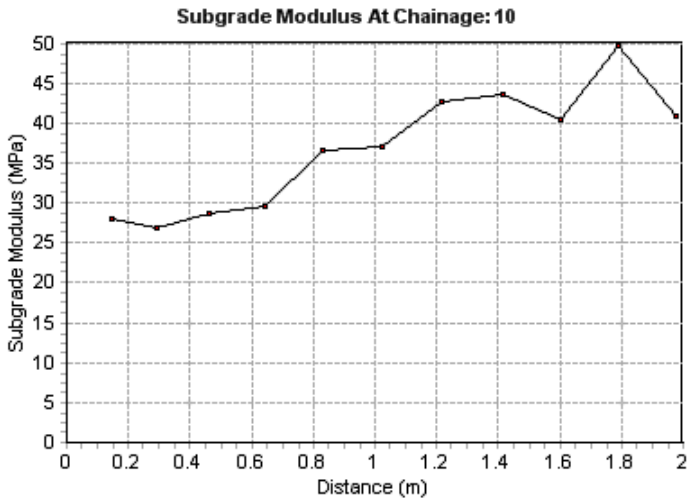


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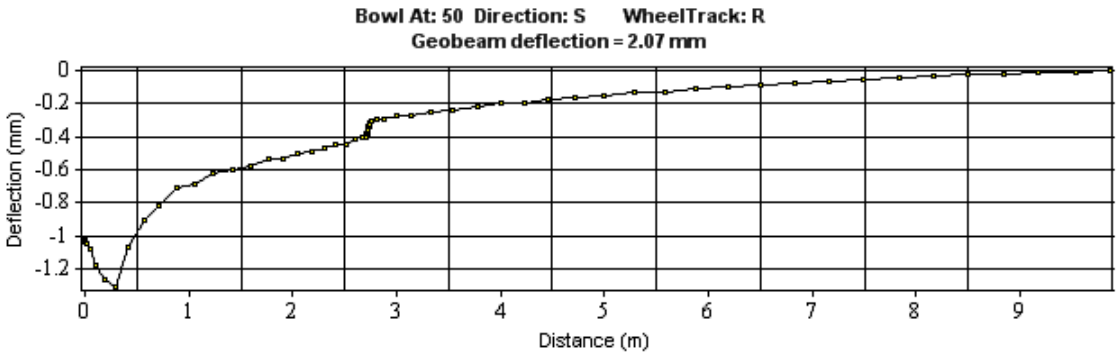


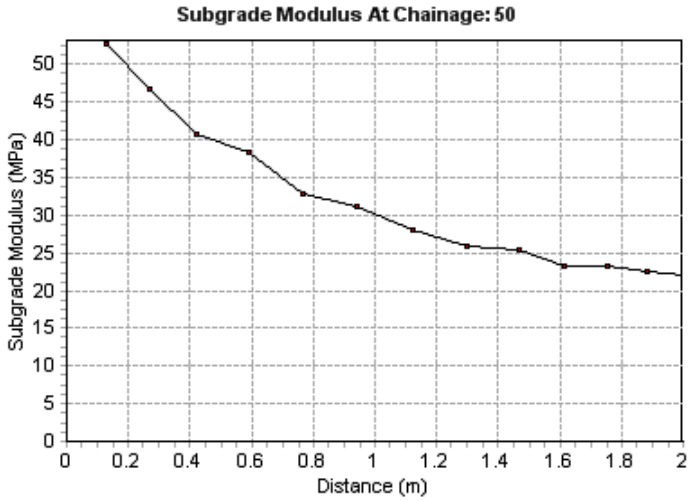


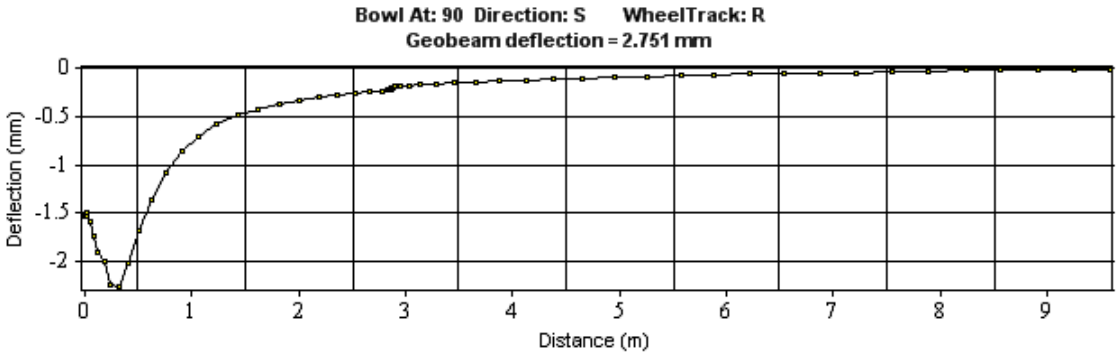


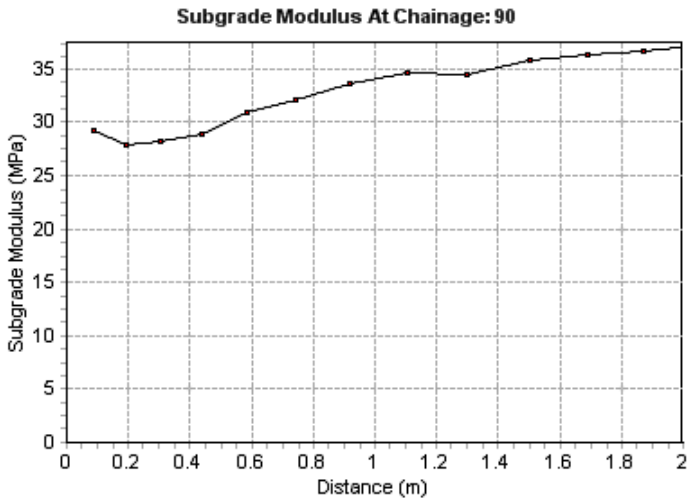


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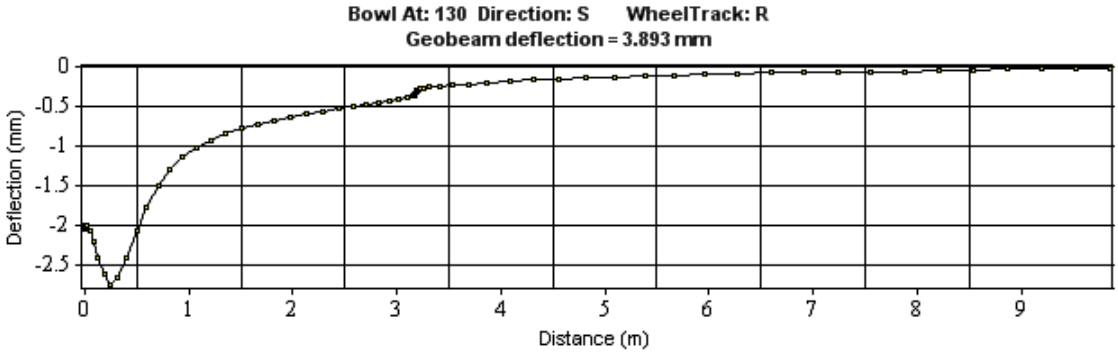


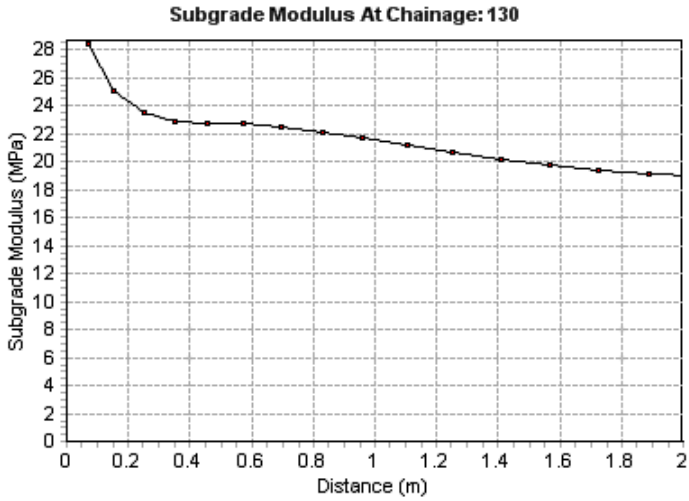


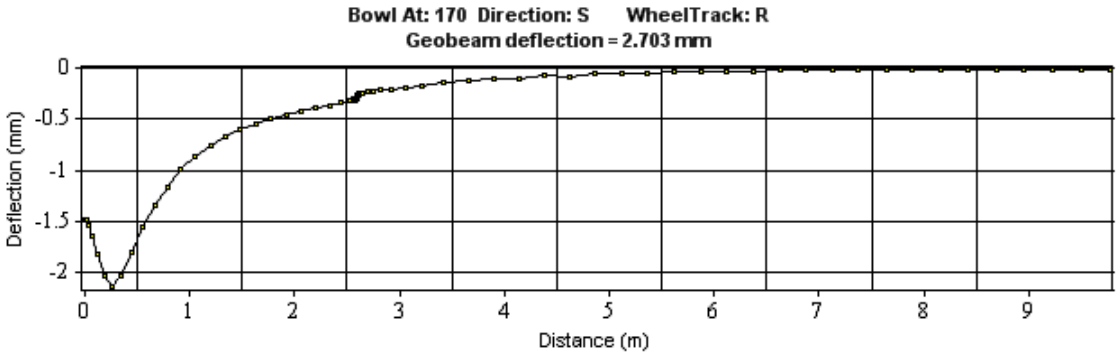


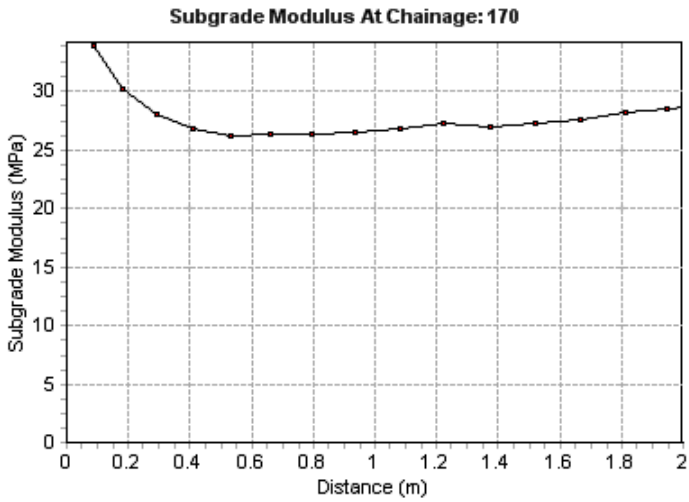


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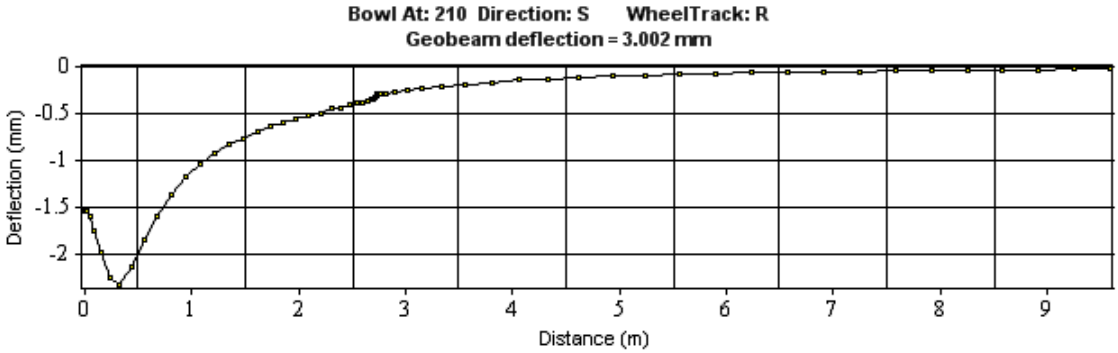


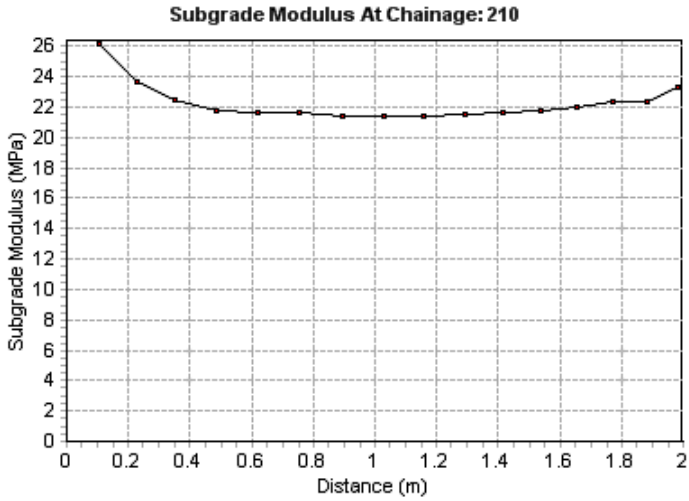


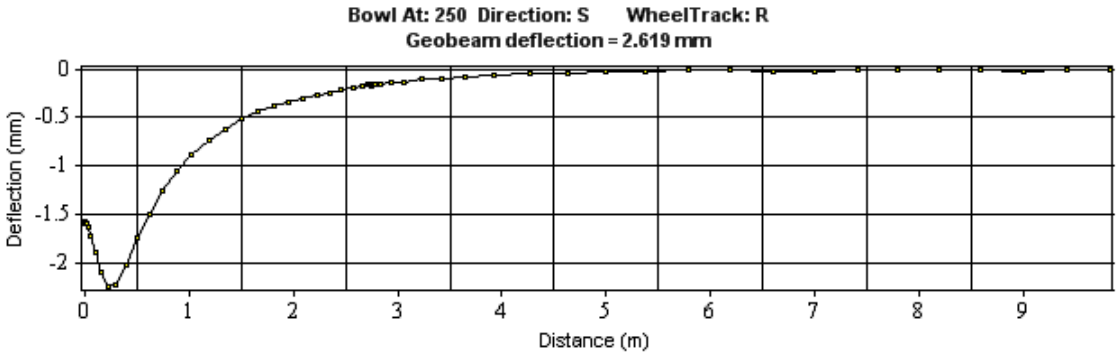


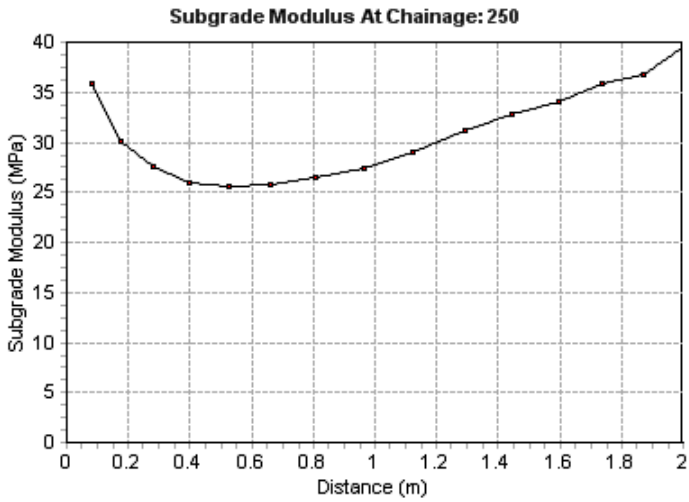


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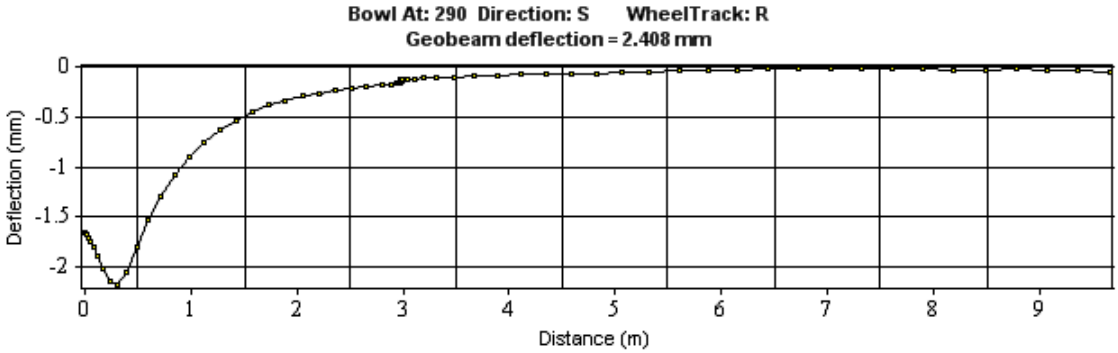


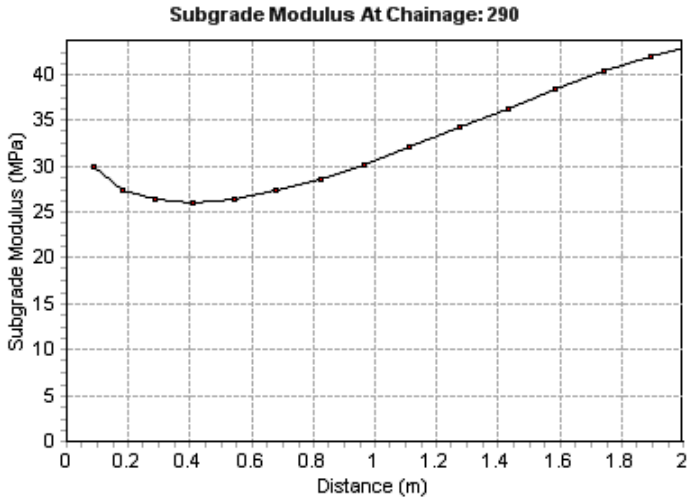


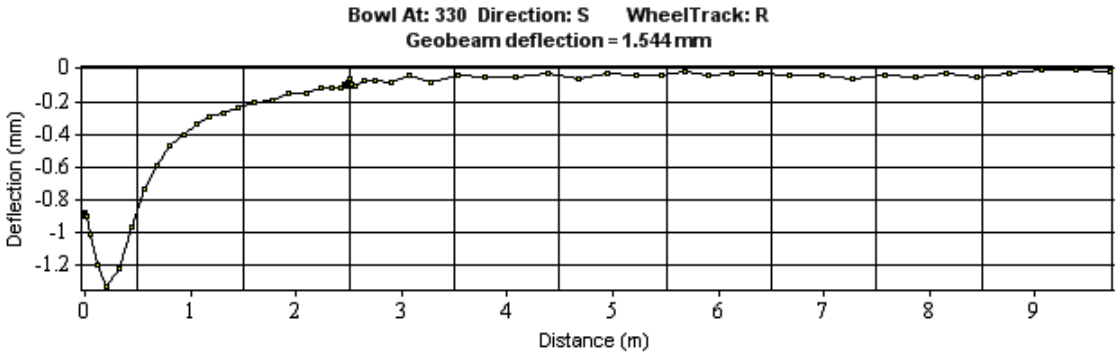


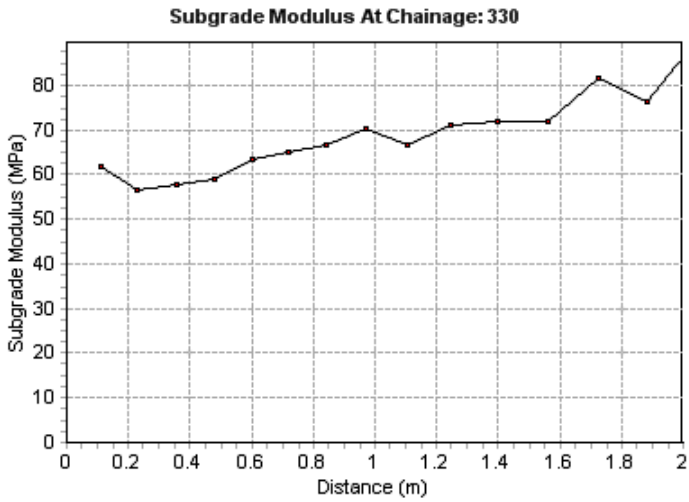


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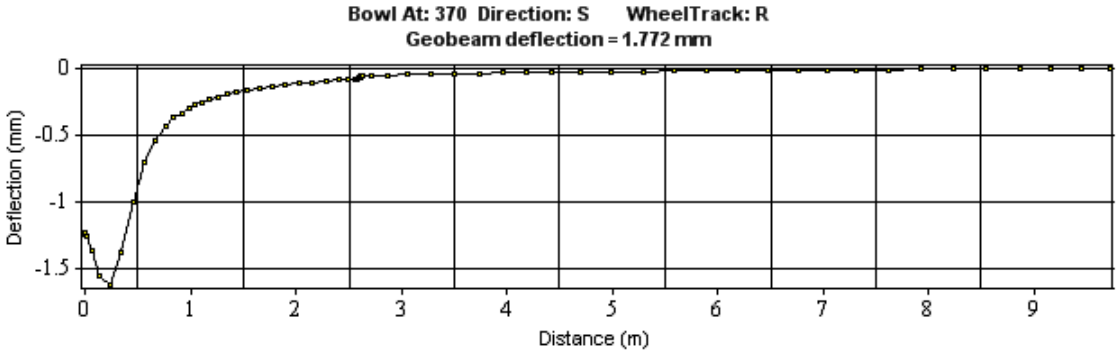


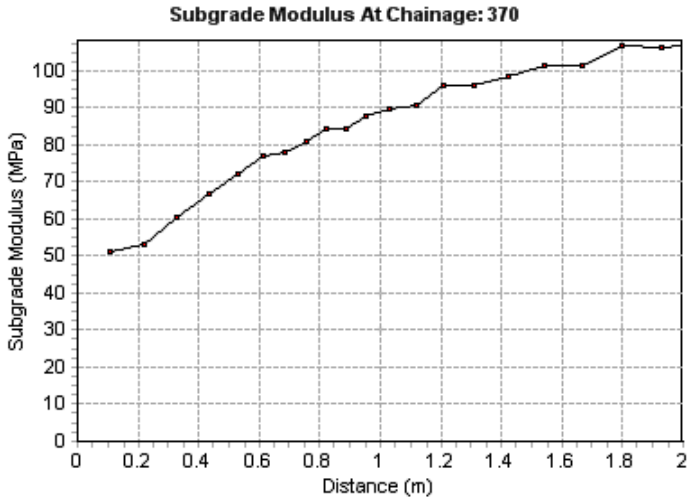






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Geobeam Report

PO Box 9360, Newmarket Auckland 1149
Ph +64 9 356 3510 Fax 64 9 356 3511

Printed: 01-Dec-2008
Geotechnics Job No. 614173.007
Source File: tontayrotorua2.txt

Customer:	Tonkin & Taylor	**Customer Ref:**	n/a	**Radius Loaded Area (m)**	0.15
Site:	Western Road sub-di	**Weather:**	fine	**Rear Axle Load (kN):**	82
Suburb/City:	Rotorua	**Road Temp. C:**	50	**Tyre Pressure (kPa):**	825
Road:	Road 2	**Surface Type:**	Asphalt	**Transducer ID:**	130606
Test Date:	28/11/2008	**RL:**	n/a	**Transducer Plate Dia (mm):**	60
Test Time:	13:27	**Geobeam No:**	1	**Calibration :**	1.27
Operator:	pdj	**Checked:**		**Cable ID:**	1
				Date Checked:	

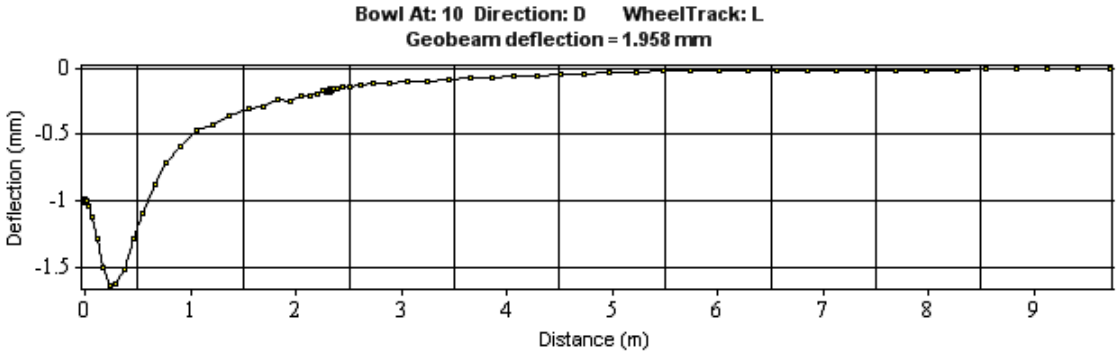
Statistical Data

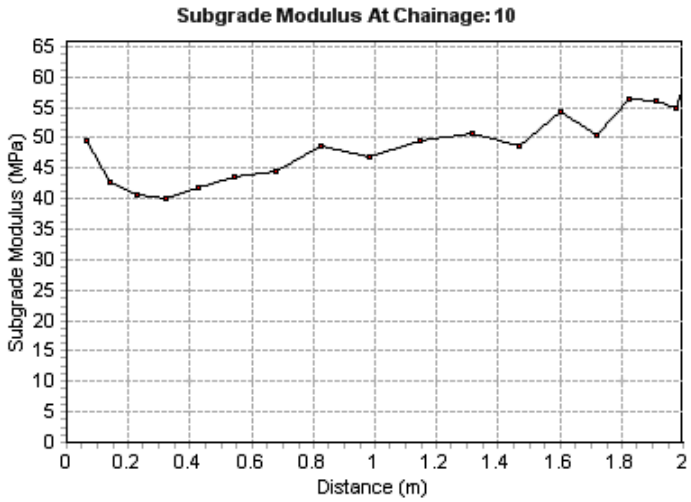
Number of deflection readings	25	
Mean of deflections	2.33	mm
Deflections standard deviation	0.56	mm
Deflections 95th percentile	3.25	mm

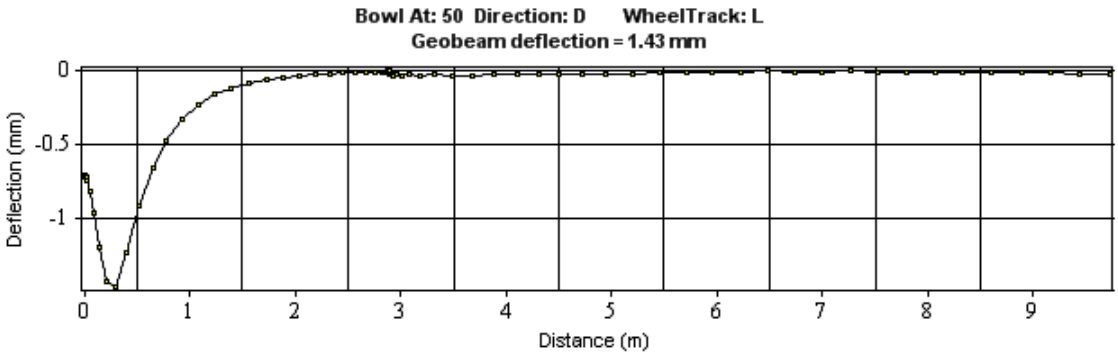
Chainage (m)	Lane	Wheel Track	Geobeam Deflection (mm)	Curvature Function (d0-d200)	Composite Modulus (MPa)	Uncorrected Raw Deflections (mm) 0.0 m	0.2 m	0.9 m	2.7 m
Direction: D									
10	RH	L	1.96	0.14	108	1.643	1.520	0.467	0.110
50	RH	L	1.43	0.23	148	1.460	1.231	0.238	0.028
90	RH	L	1.58	0.09	134	1.337	1.258	0.290	0.094
130	RH	L	2.14	0.29	99	1.897	1.616	0.793	0.092
170	RH	L	1.38	0.25	154	1.008	0.778	0.392	0.175
210	RH	L	2.40	0.31	88	2.088	1.791	0.774	0.143
30	RH	R	1.96	0.35	109	1.784	1.442	0.301	0.072
70	RH	R	2.20	0.28	97	2.047	1.775	0.321	0.057
110	RH	R	2.19	0.26	97	1.916	1.670	0.649	0.114
150	RH	R	2.13	0.27	100	1.690	1.439	0.865	0.162
190	RH	R	2.64	0.30	80	1.969	1.707	0.690	0.258
230	RH	R	2.92	0.32	73	2.269	1.986	0.670	0.247
		Mean =	2.08						
		Stand. Dev. =	0.46						
Direction: I									
40	LH	L	2.94	0.08	72	2.058	2.019	0.605	0.322
80	LH	L	2.47	0.49	86	2.148	1.676	0.435	0.140
120	LH	L	2.18	0.32	98	1.939	1.629	0.432	0.093
160	LH	L	3.45	0.65	61	3.266	2.623	0.938	0.087
200	LH	L	3.09	0.20	69	2.637	2.459	1.370	0.169
240	LH	L	2.45	0.17	87	2.070	1.914	0.922	0.152
20	LH	R	1.57	0.18	135	1.292	1.123	0.410	0.111
60	LH	R	2.43	0.50	87	2.244	1.757	0.360	0.076
100	LH	R	2.43	0.27	87	2.183	1.923	0.425	0.102
140	LH	R	1.94	0.20	109	1.775	1.588	0.581	0.063
180	LH	R	2.20	0.35	97	1.759	1.431	0.745	0.185
220	LH	R	2.58	0.20	82	2.421	2.227	1.052	0.082
260	LH	R	3.52	0.08	60	2.761	2.718	1.135	0.283
		Mean =	2.56						
		Stand. Dev. =	0.57						

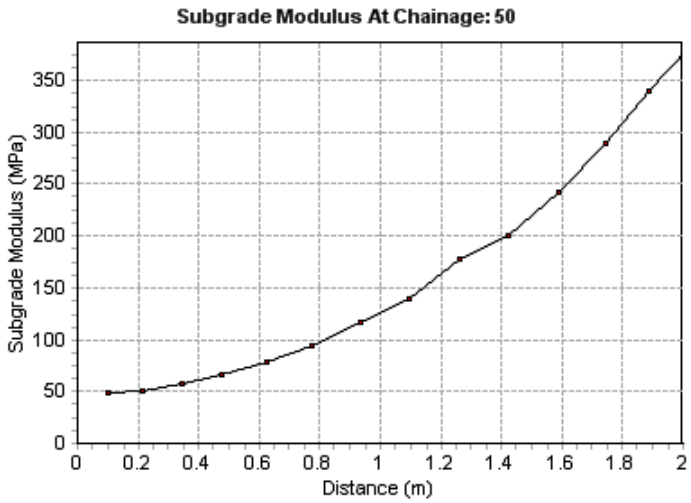
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Combined		**Mean**	2.33	**Stand. Dev =**	0.56

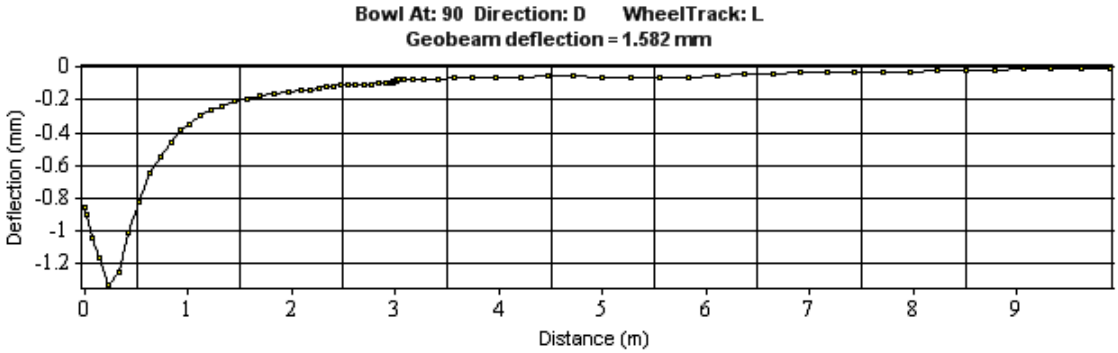


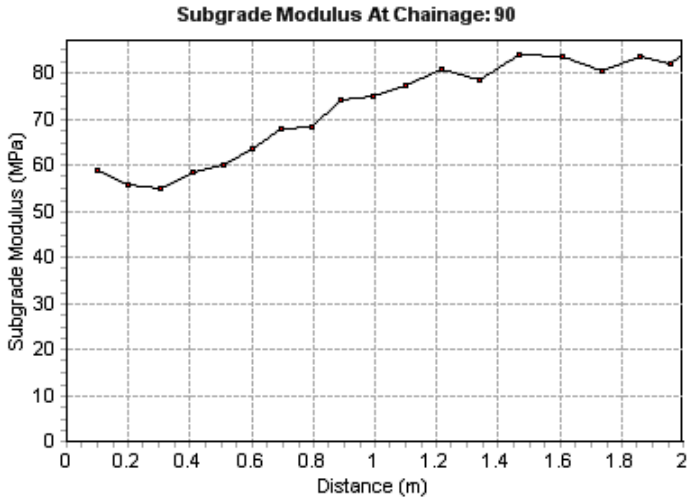


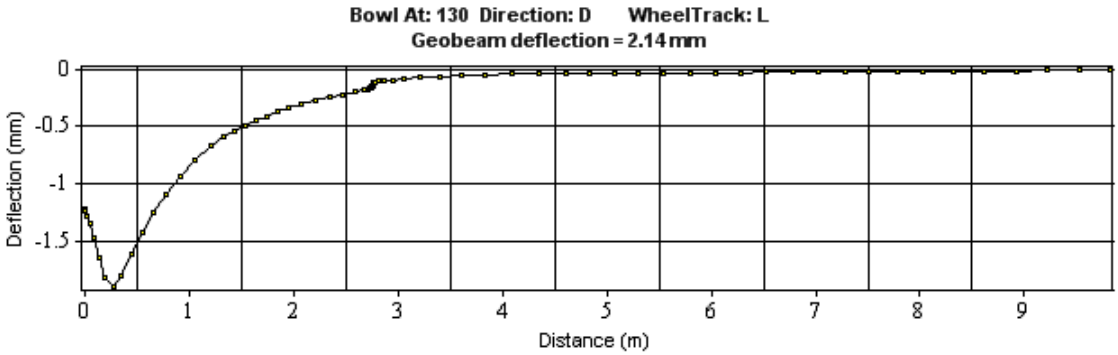


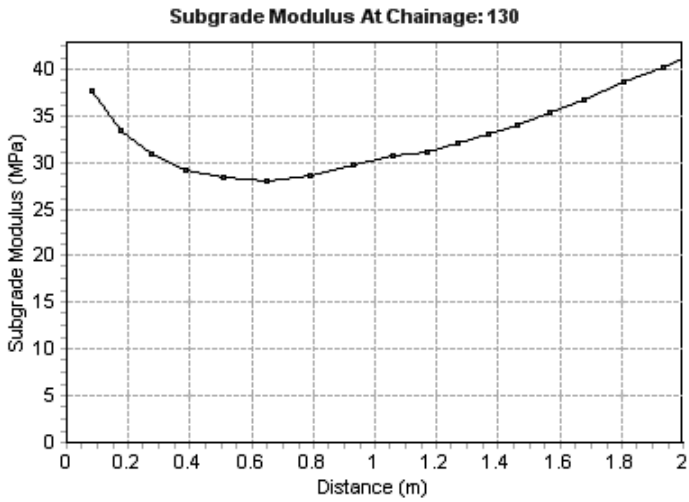


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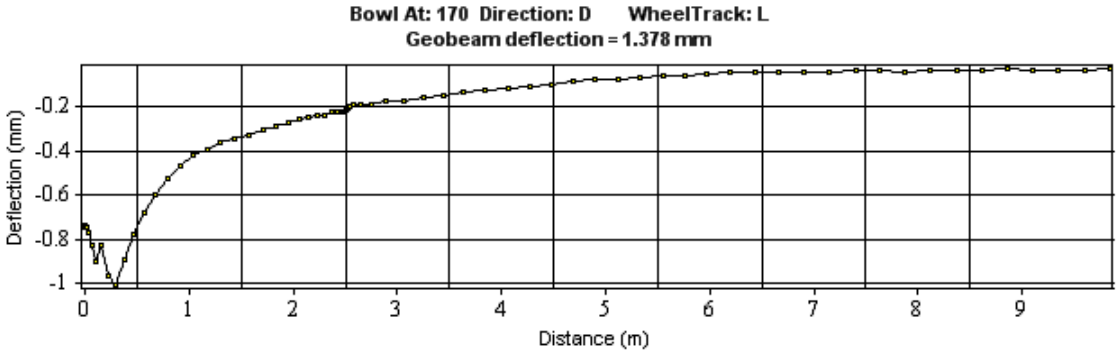


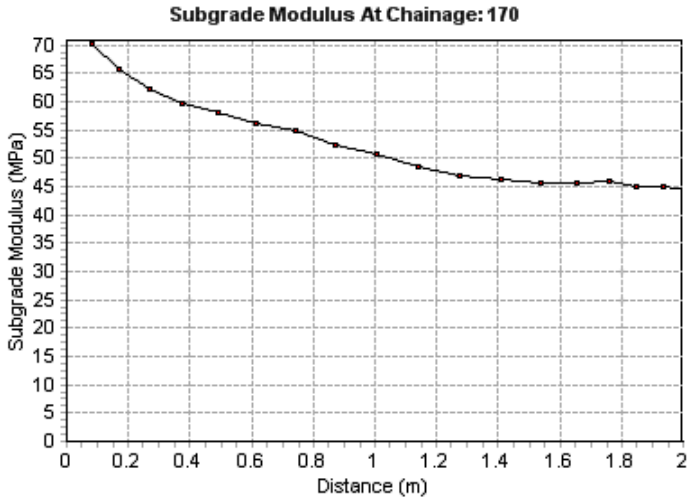


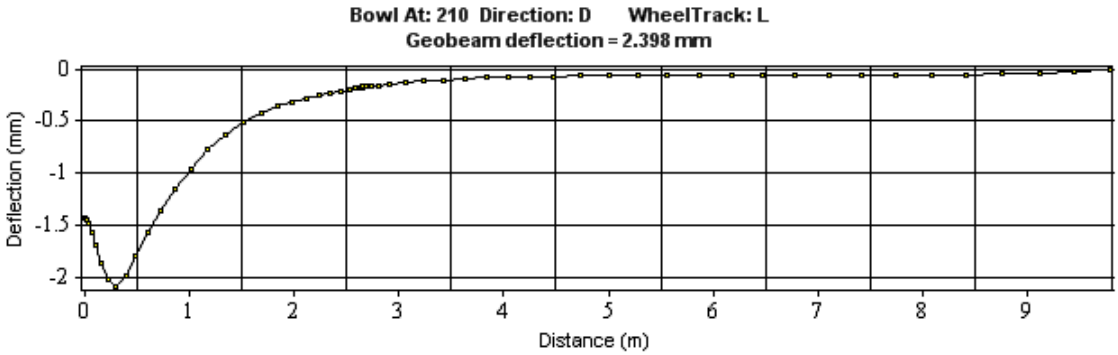


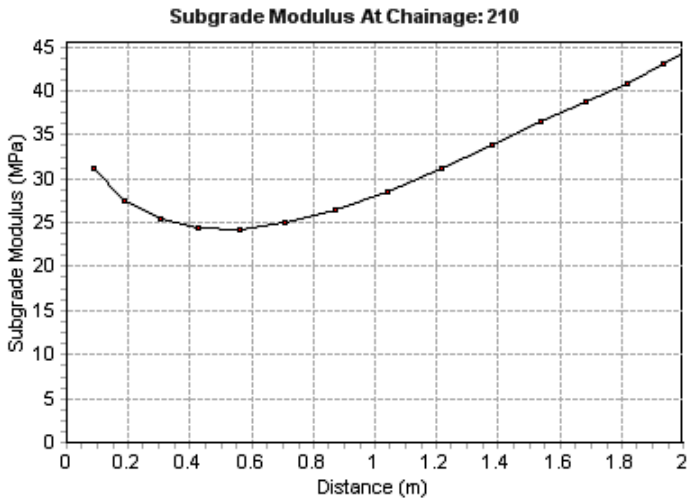


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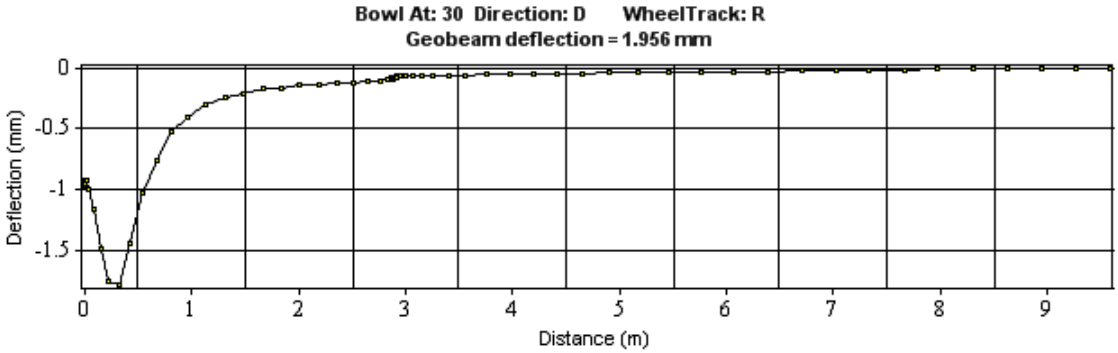


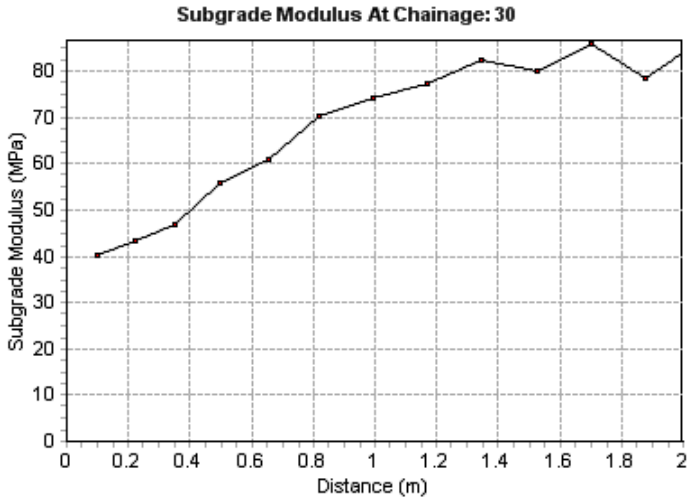


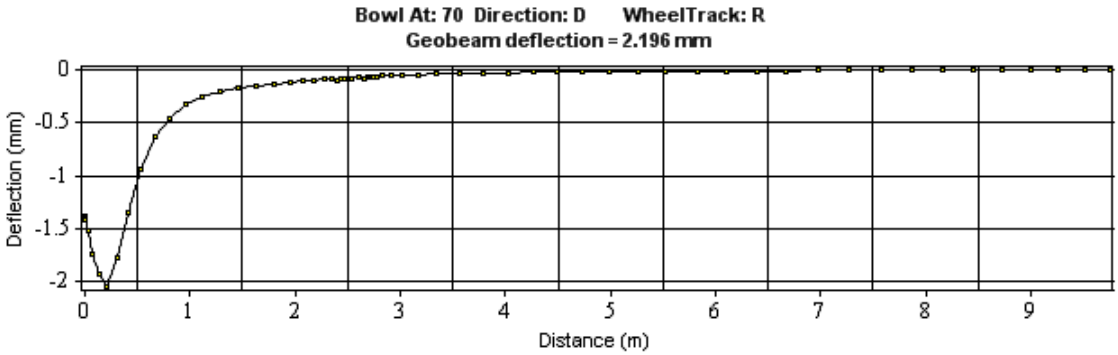


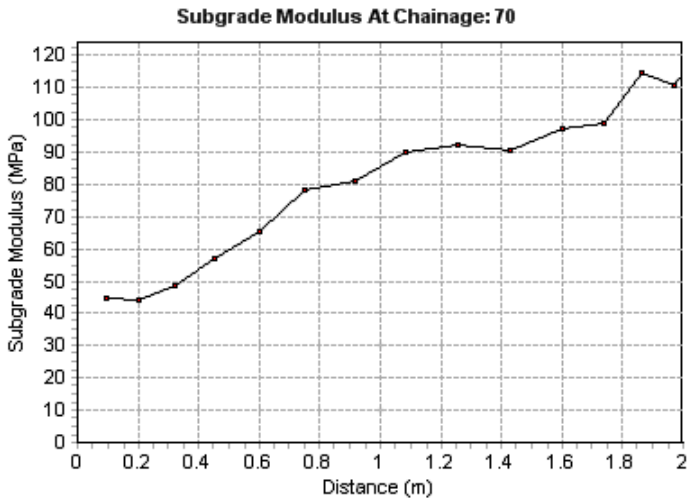


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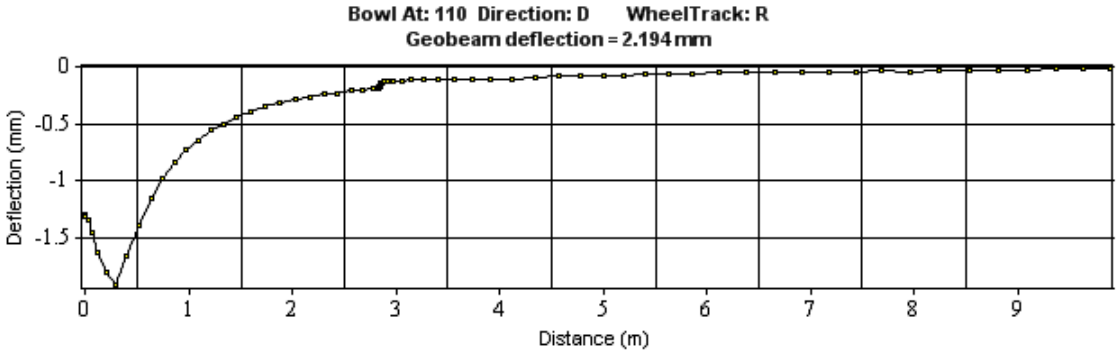


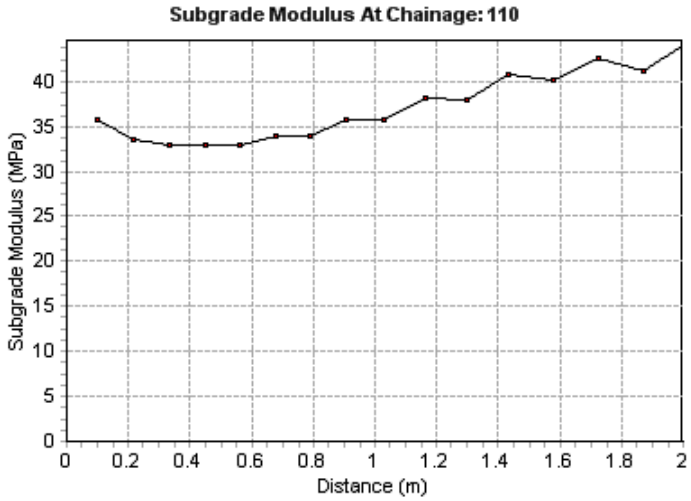


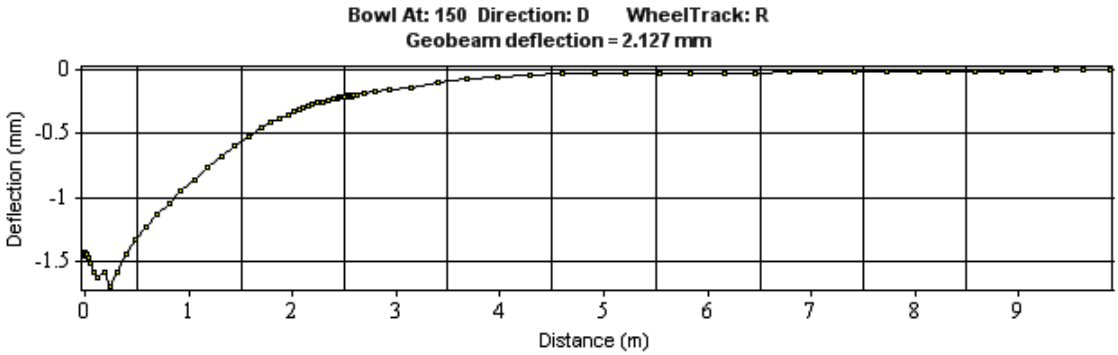


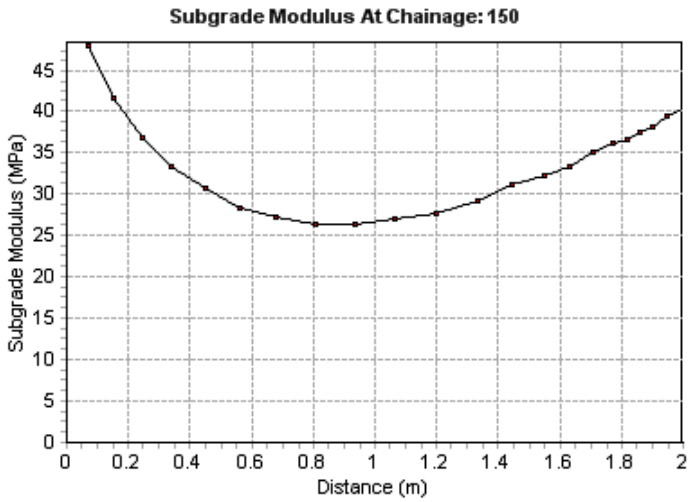


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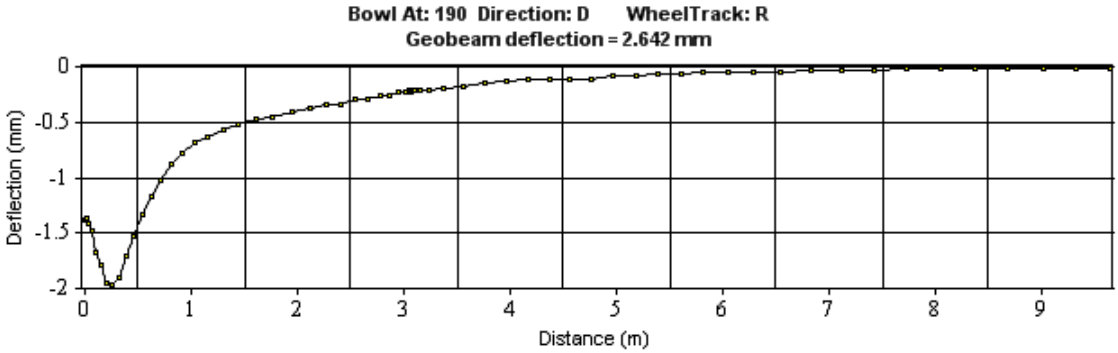


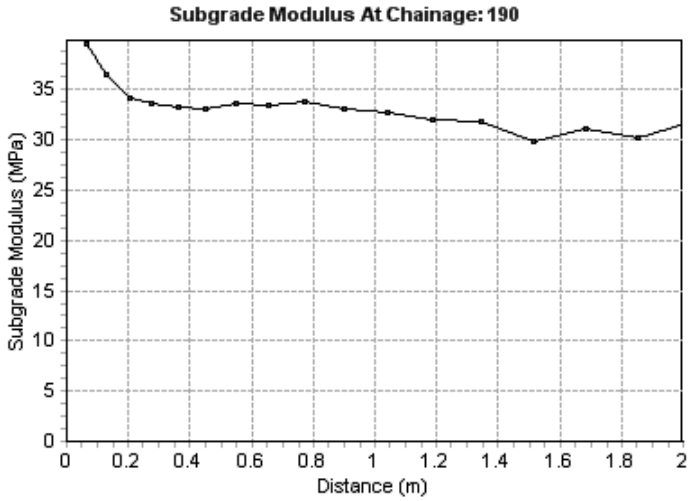


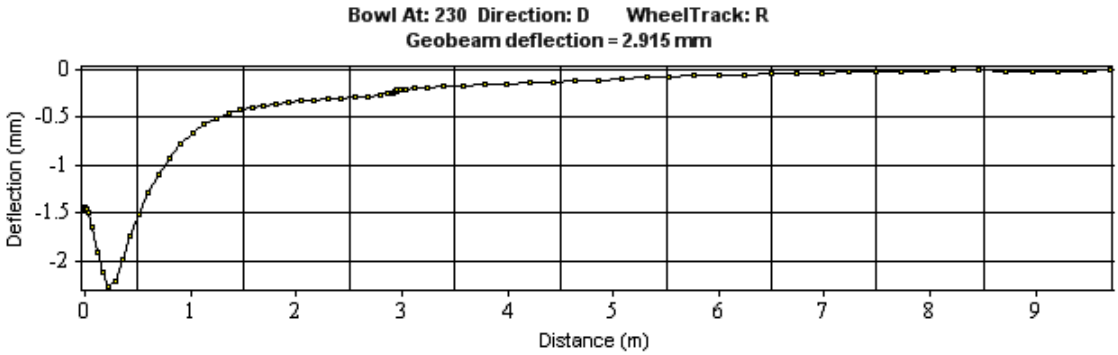


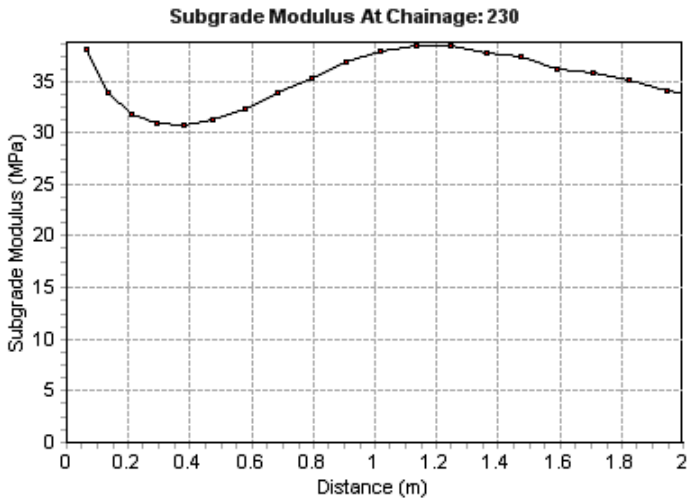


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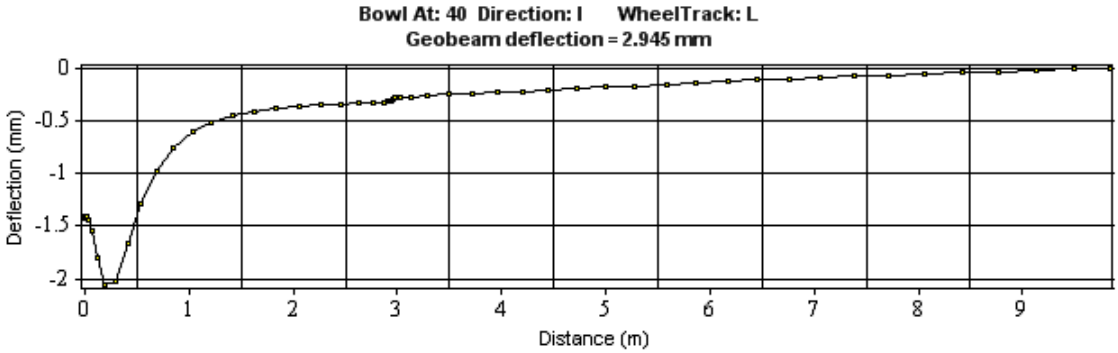


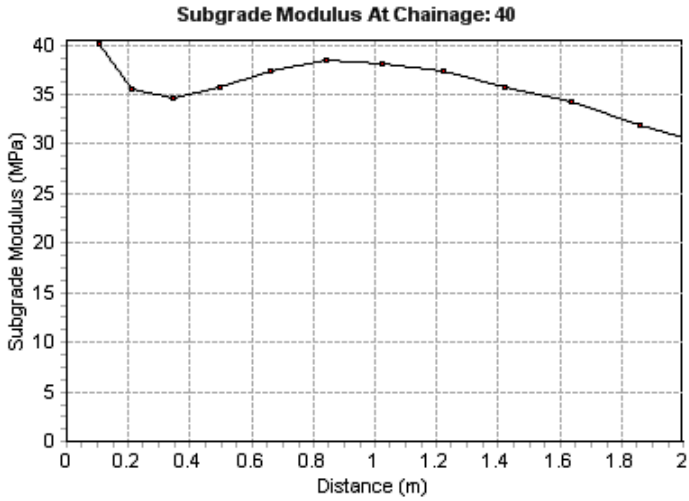


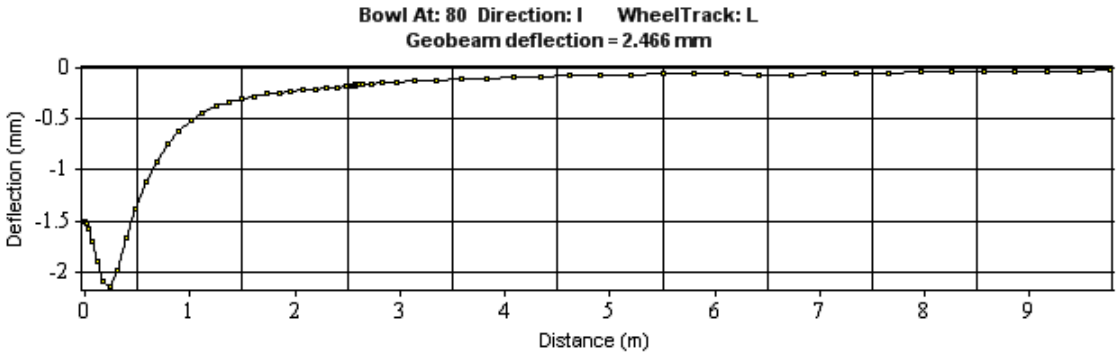


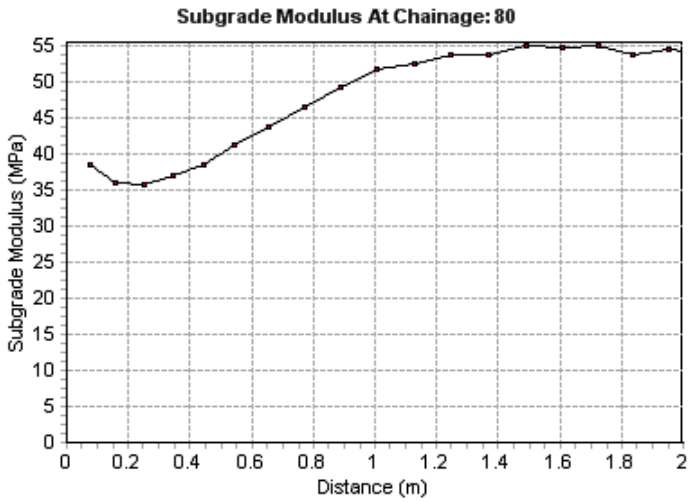


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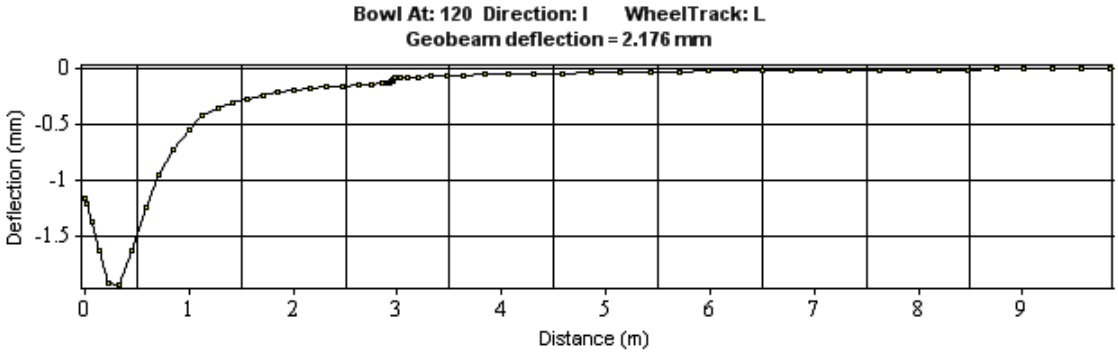


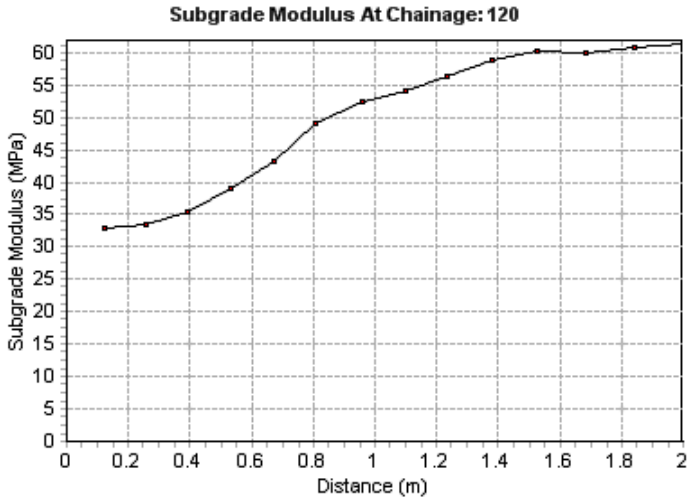


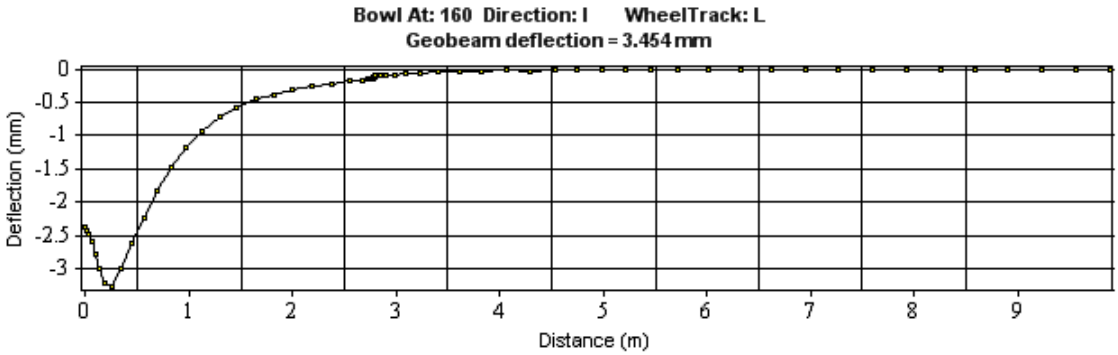


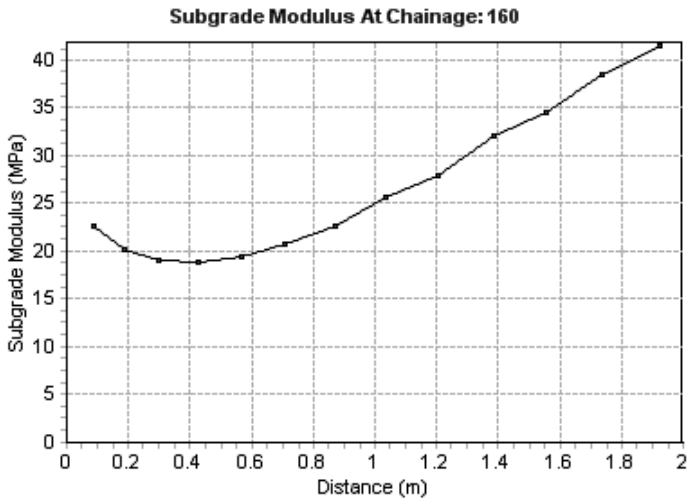


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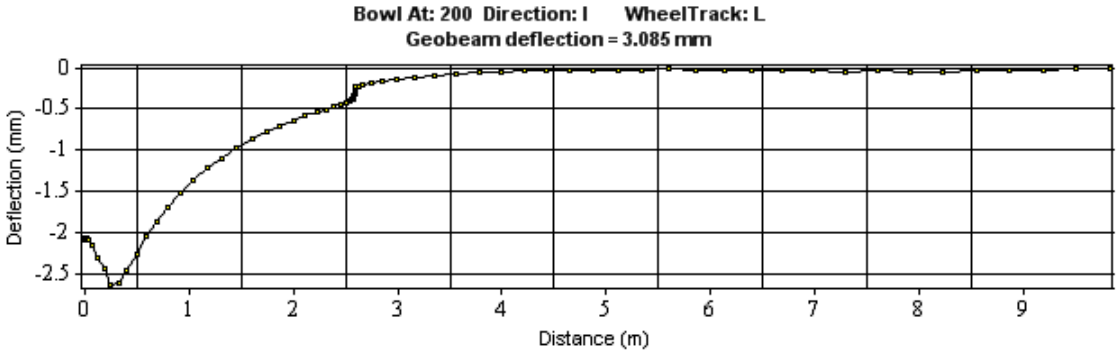


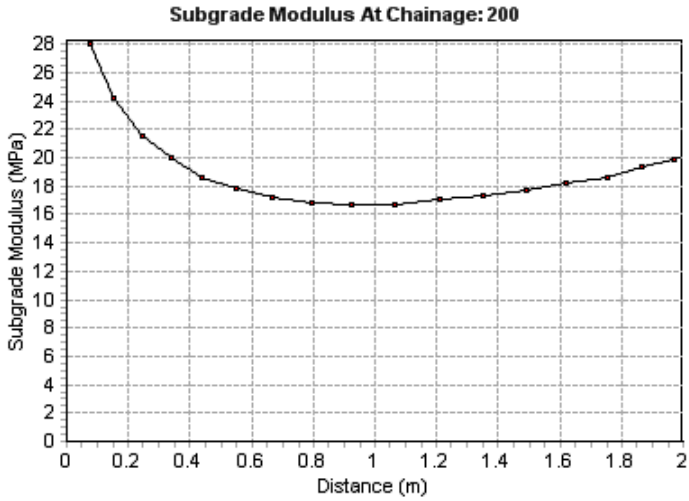


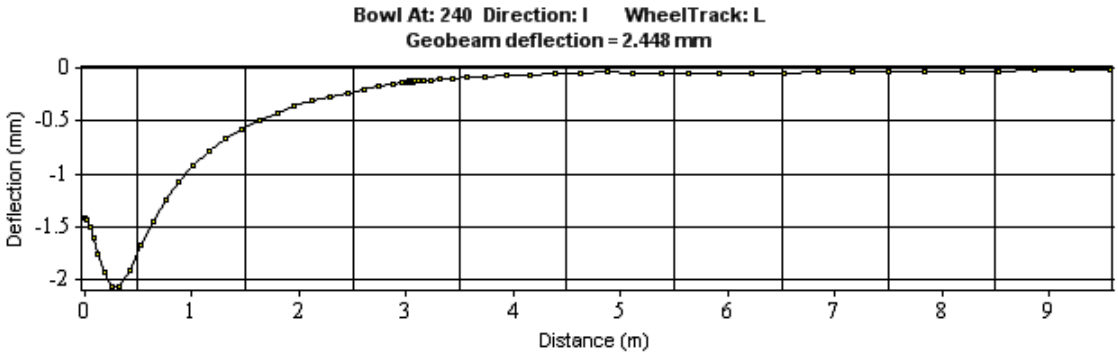


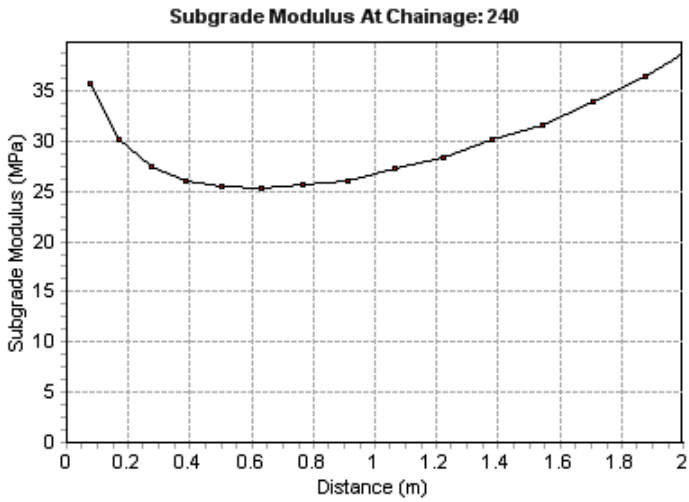


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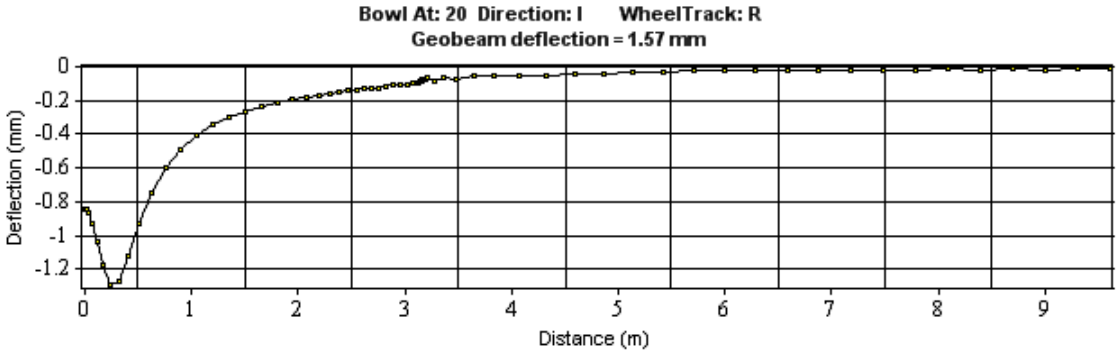


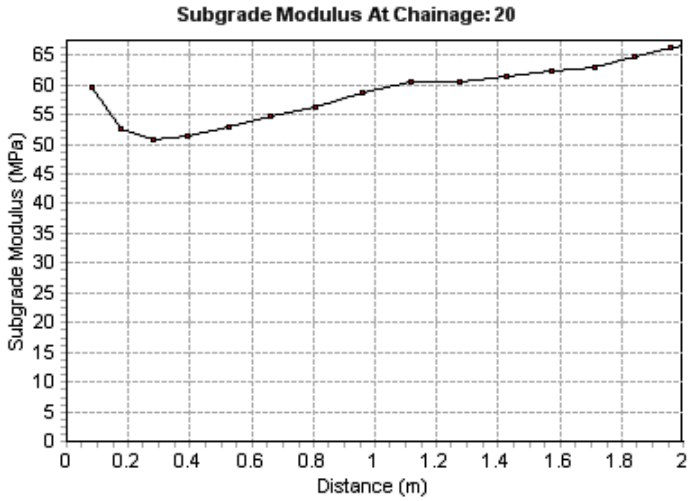


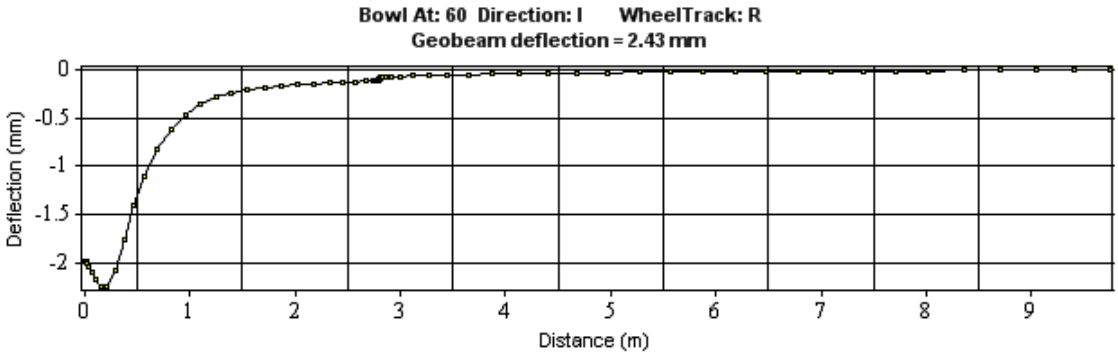


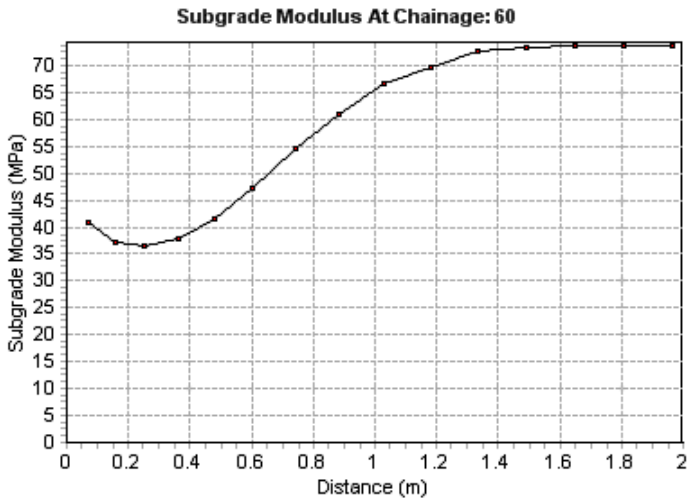


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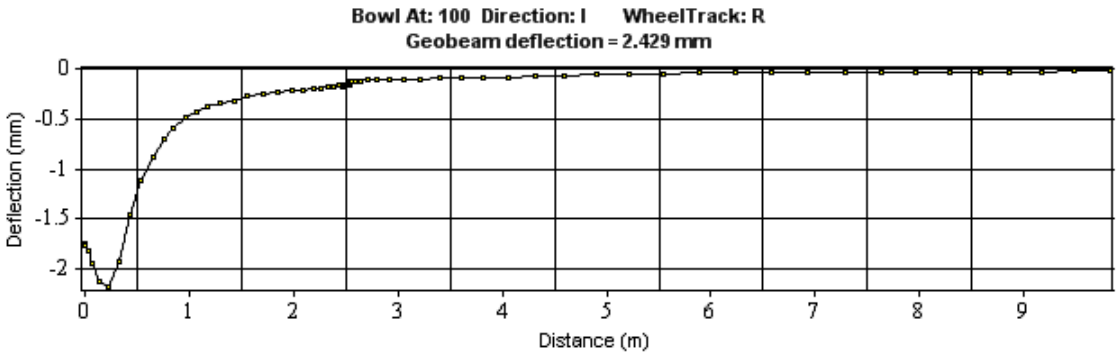


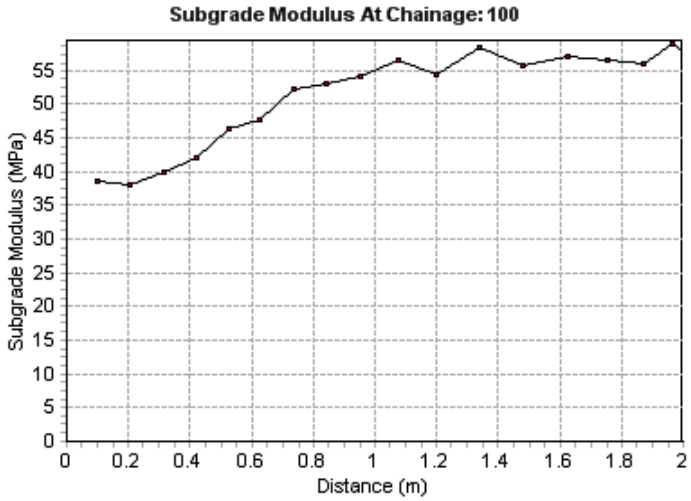


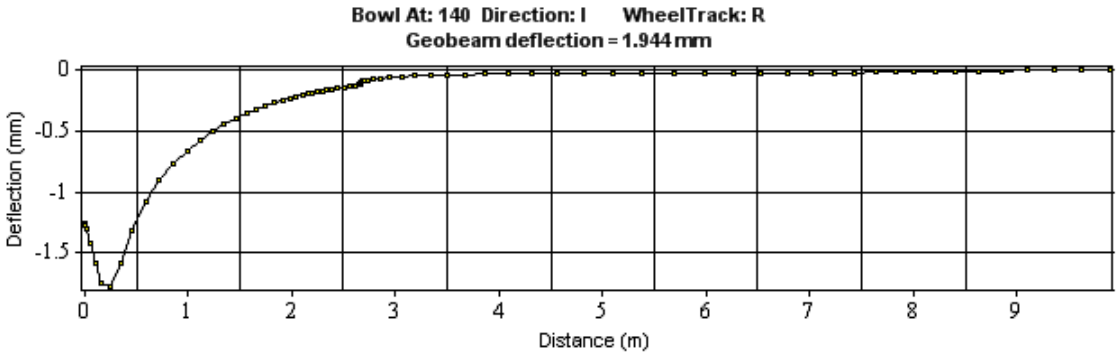


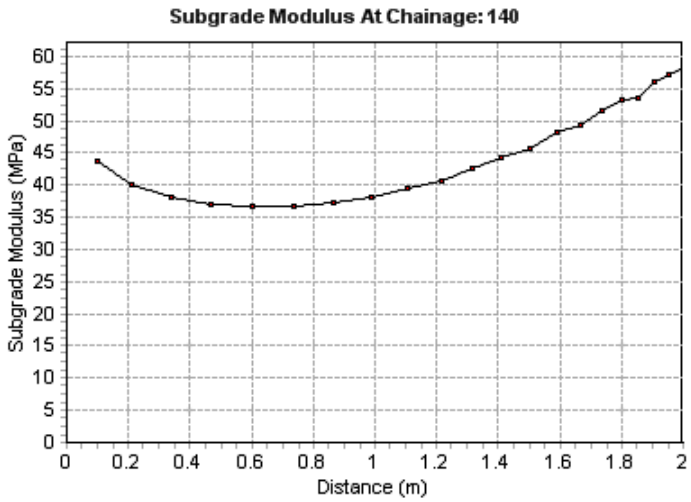


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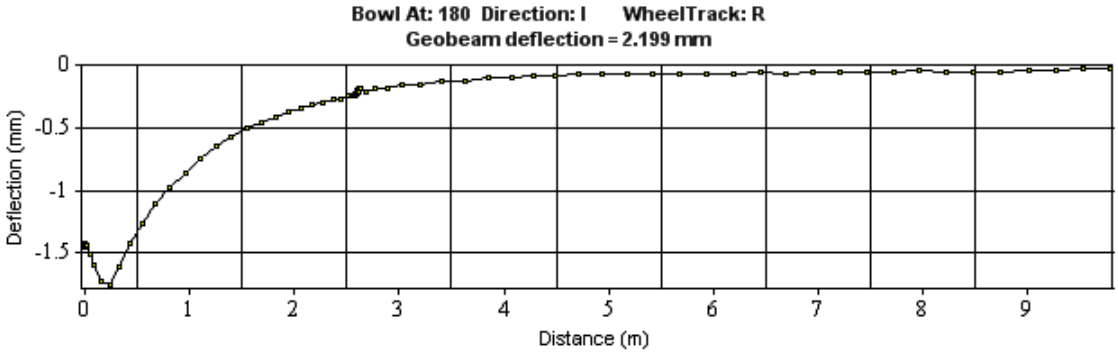


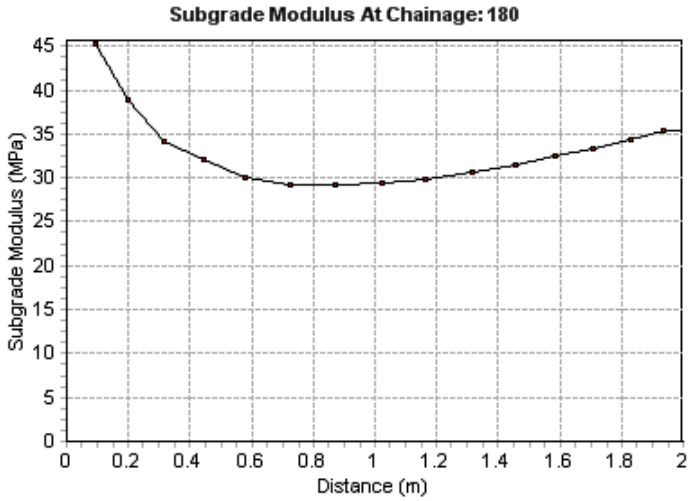


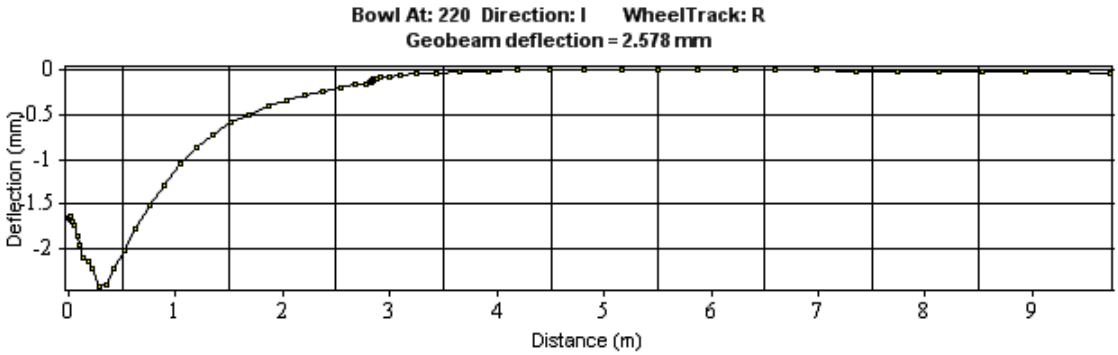


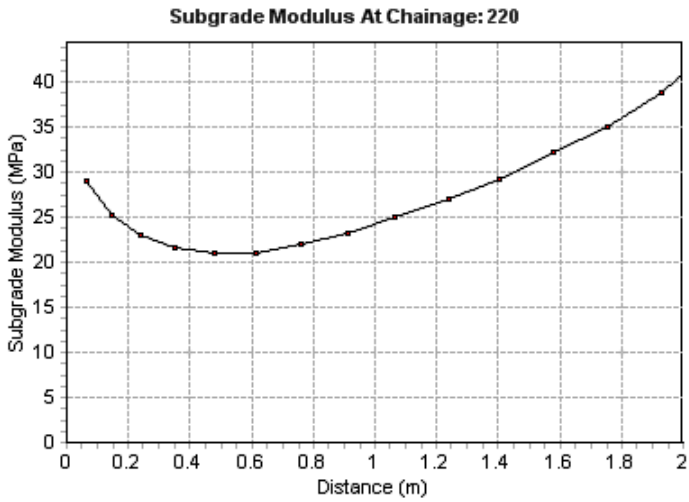


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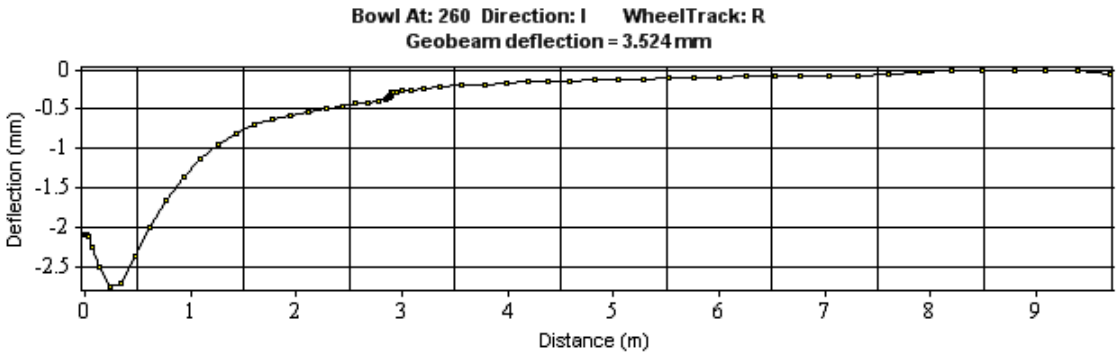


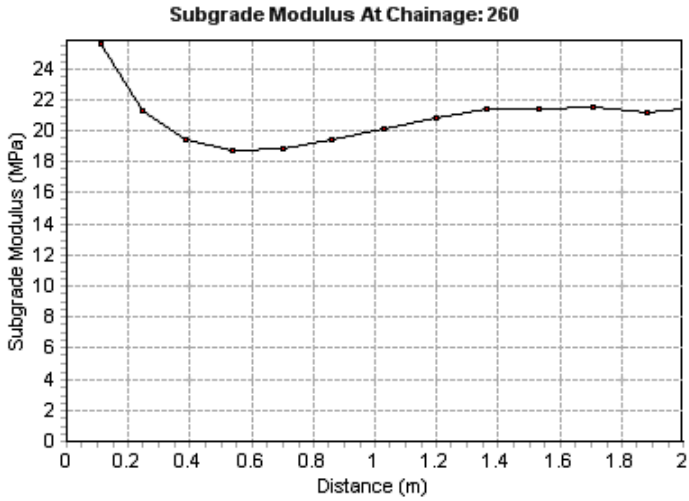






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Geobeam Report

PO Box 9360, Newmarket Auckland 1149
Ph +64 9 356 3510 Fax 64 9 356 3511

Printed: 01-Dec-2008
Geotechnics Job No. 614173.007
Source File: tontayrotorua3.txt

Customer:	Tonkin & Taylor	**Customer Ref:**	n/a	**Radius Loaded Area (m)**	0.15
Site:	Western Road	**Weather:**	Overcast	**Rear Axle Load (kN):**	82
Suburb/City:	Rotorua	**Road Temp. C:**	45	**Tyre Pressure (kPa):**	825
Road:	ROW	**Surface Type:**	Asphalt	**Transducer ID:**	130606
Test Date:	28/11/2008	**RL:**	n/a	**Transducer Plate Dia (mm):**	60
Test Time:	14:30	**Geobeam No:**	1	**Calibration :**	1.27
Operator:	pdj	**Checked:**		**Cable ID:**	1
				Date Checked:	

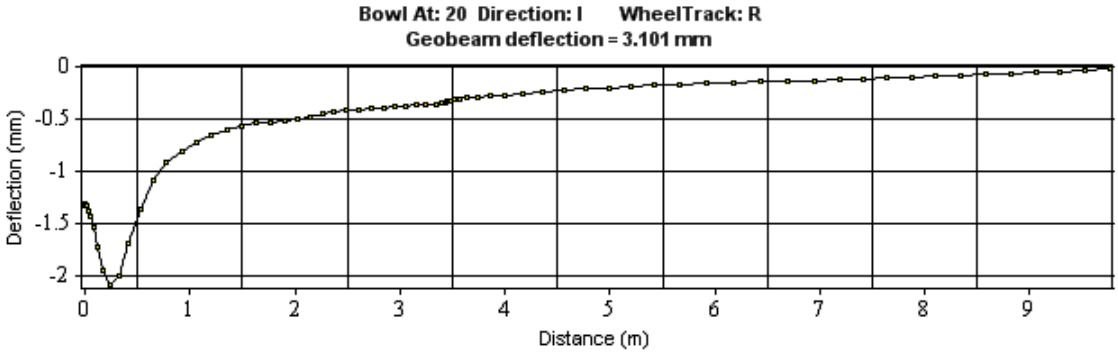
Statistical Data

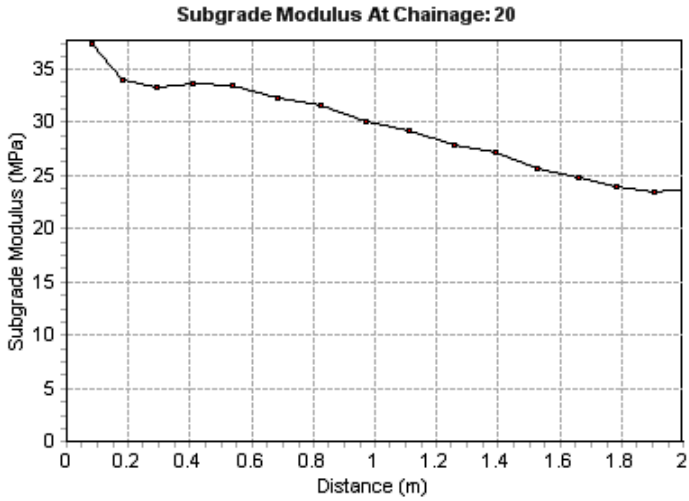
Number of deflection readings	4	
Mean of deflections	3.14	mm
Deflections standard deviation	0.48	mm
Deflections 95th percentile	3.93	mm

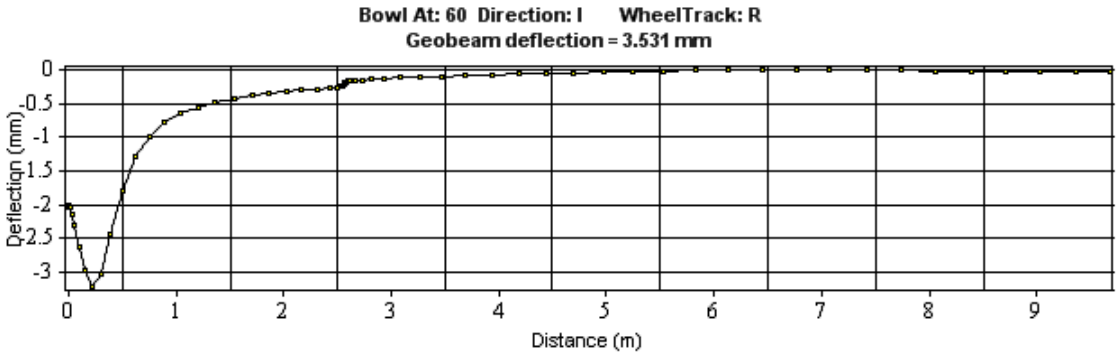
Chainage (m)	Lane	Wheel Track	Geobeam Deflection (mm)	Curvature Function (d0-d200)	Composite Modulus (MPa)	Uncorrected Raw Deflections (mm) 0.0 m	0.2 m	0.9 m	2.7 m
Direction: I									
20	n/a	R	3.10	0.45	68	2.095	1.696	0.719	0.389
60	n/a	R	3.53	0.79	60	3.220	2.447	0.646	0.138
100	n/a	R	3.46	0.56	61	2.656	2.136	0.883	0.306
140	n/a	R	2.48	0.50	86	2.122	1.638	0.469	0.144
		Mean =	3.14						
		Stand. Dev. =	0.48						

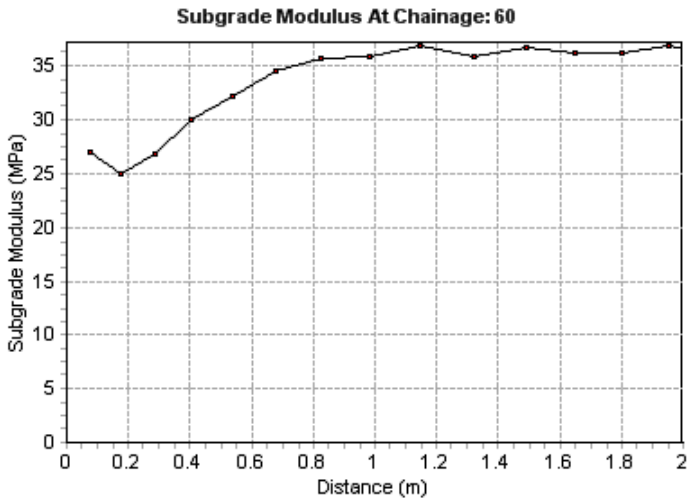
Combined **Mean** 3.14 **Stand. Dev =** 0.48

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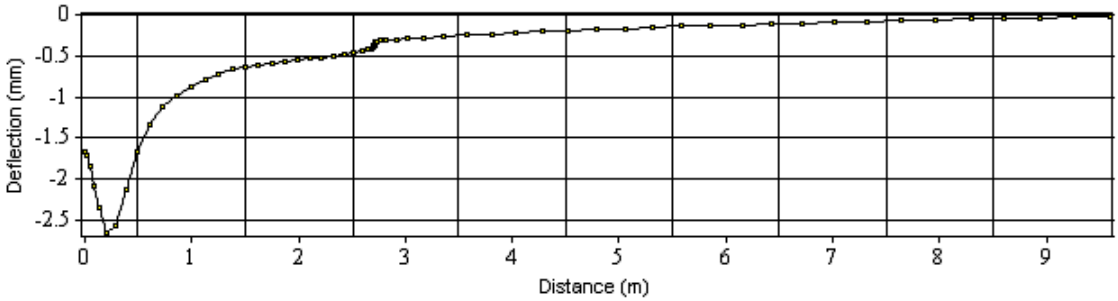




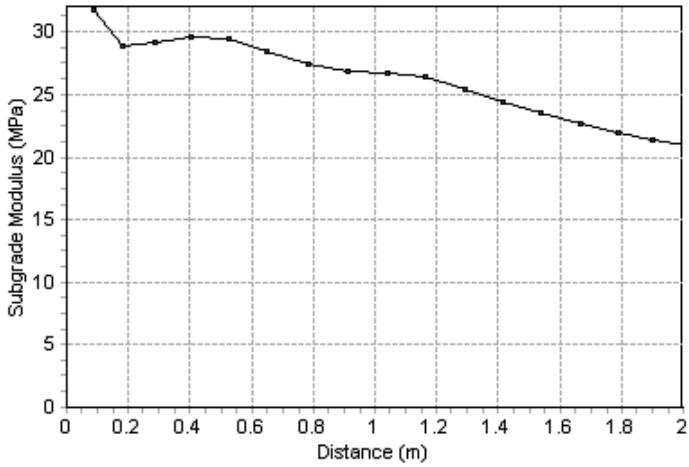


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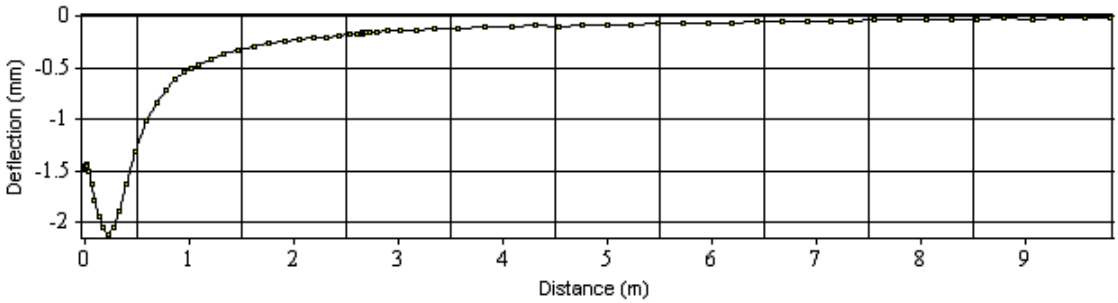
Bowl At: 100 Direction: I WheelTrack: R
Geobeam deflection = 3.462 mm



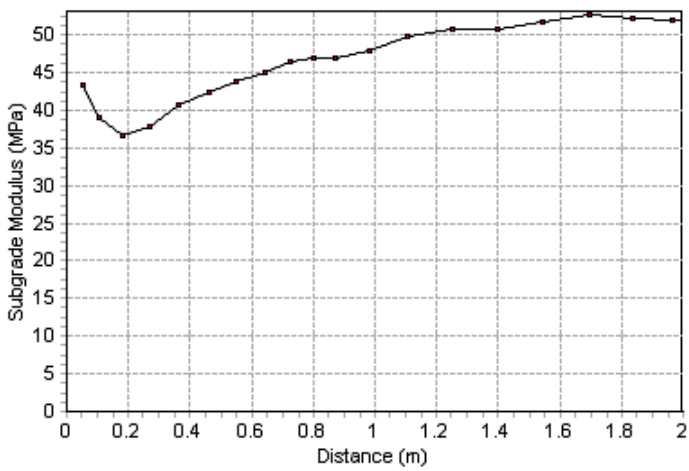
Subgrade Modulus At Chainage: 100



Bowl At: 140 Direction: I WheelTrack: R
Geobeam deflection = 2.476 mm



Subgrade Modulus At Chainage: 140



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