22 November 2017 Ref No: J00779

Hughes Developments Limited
C/- CivilPlan Consultants Limited
PO Box 97796

Attention: Mr R. Pitkethley

Dear Ryan

RE: Geotechnical Investigation Report for Residential Subdivision at 99 Escotts Road, Tuakau

1 PROJECT BRIEF, SCOPE AND OBJECTIVES

This report has been prepared for Hughes Developments Limited in support of an application to the Waikato District Council for Resource Consent in accordance with the requirements of the Resource Management Act 1991.

Where appropriate, it is in accordance with the recommendations of NZS 4404, Land Development and Subdivision Engineering and related documents.

The scope of this report encompasses the geotechnical suitability and stability of the land having regard for the nature of the development proposals.

Its principal objectives were to assess:

- Existing geomorphological features and their effects on existing and proposed site stability.
- The nature, bearing qualities and relative uniformity of the subsoils to the depths likely to be affected by proposed land development works and future building loads.
- Engineering works required to remediate areas having identified slope stability or groundwater problems.

2 RELATED REPORTS

As part of the preparation of this report we have reviewed the following existing geotechnical reports for the site:

- Ground Consulting Limited, Geotechnical Investigation Report at Escotts Road, Tuakau; Ref R1705-1, dated 28 November 2014.
- Ground Consulting Limited, Geotechnical Investigation Report (Addendum Report) at Escotts Road, Tuakau; Ref R1705-2, dated 8 June 2015.

These investigation reports were for a previous residential subdivision layout for the site comprising of 92 residential lots with a similar layout. It is unknown whether these reports were ever submitted to Council for any previous consent application(s) or subdivision scheme.

As part of their investigations, 23 no. hand auger boreholes were drilled to depths up to 4m and we have appended these borehole logs as supplementary information (Appendix 4).

The main findings of these reports were as follows:

- A geotechnical ultimate bearing capacity of 300kPa should apply for all lots contained within the subdivision.
- The soils were assessed to be Class M (moderately expansive) in terms of AS 2870.
- Computer slope stability assessments undertaken showed that some portions of the stream bank edge along the eastern boundary of the site returned factors of safety below required minimums. Building restriction zones, regrading of sections of slopes and subsoil drainage were recommended within areas of concern.

3 SITE DESCRIPTION

The study area (99 Escotts Road) is located off the eastern end of Escotts Road and this site is described as follows from the Ground Consulting Limited Geotechnical Investigation Report. We concur with this assessment and reiterate as follows:

Site Topography

The subdivision is located on two predominant landforms as follows:

Gently Sloping Terrace: The majority of the subdivision is located on an extensive gently sloping terrace with measured slope angles of less than 10^{o} to the horizontal. The terrace slopes gently down from a high point at ~RL 41m which is located close to the existing end of Escotts Road.

Kairoa Stream Bank: The eastern extent of the gently sloping terrace is marked by a break of slope which delineates the upper portion of a bank which extends down to the Kairoa Stream. The Kairoa Stream is located on or close to the eastern subdivision boundary. The bank is between 5m and 10m high and consists of a series of moderately steep to steep slopes and gullies with intermediary gently sloping topography.

The steeper portions of the bank within the southern portion of the subdivision have been terraced as part of an abandoned orchard.

A tributary of the Kairoa Stream extends onto the south-western portion of the subdivision. This forms a small, moderately steep gully which extends down to existing ponds located to the south-west of the subdivision.

Site Features

The gently sloping terrace and gently sloping portions of the Kairoa Stream bank are presently utilized as a kiwifruit orchard. The orchard consists of series of timber posts, rails and wires which are accessed via. grassed tracks.

The steeper portions of the stream bank are covered in exotics, regenerating bush and fruit trees.

A dwelling is located near the intersection of proposed Roads 1 and 2. The dwelling is accessed via a driveway off Escotts Road.

The subdivision contains no other features of note.

Slope Instability Features

The gently sloping terrace which extends across the majority of the subdivision does not contain any slope instability features.

The steeper portions of the stream bank showed signs of shallow seated slumping typically where slope grades are 1(v) on 3(h) or steeper. The slope instability consisted typically of shallow regolith type failures forming creep terracettes and hummocky ground.

Some of the slopes near the stream edge have been terraced as part of an abandoned orchard. It is likely that the terracing has removed pre-existing slope creep.

4 DEVELOPMENT PROPOSALS

The attached Civil Plan Consultants Limited plan set (Appendix 1) presents the development proposals for the site and show the following:

- Subdivision into 94 new residential lots.
- Associated road, stormwater and sanitary sewer infrastructure.
- 3 new stormwater control ponds.
- 1 retaining wall up to 2.9m high along the eastern boundary of several lots within the eastern portion of site.

Bulk earthworks for the above proposals will comprise cuts of up to 4m deep and fills up to 3.5m deep.

5 FIELDWORK

We have relied on the Ground Consulting Limited field investigation data (attached in Appendix 4 as supplementary information) as part of the preparation of this report. Their field investigation included the drilling of 23 no. boreholes to depths up to 4m.

In addition, we visited site on 30 October 2017 and drilled 6 no. additional hand auger boreholes to depths up to 5m within proposed stormwater ponds and along the retaining wall alignment. Our borehole logs are attached in Appendix 3.

A summary of findings is as follows:

6 SUMMARY OF GROUND CONDITIONS

6.1 Published Geology

The Geological Map of New Zealand, Sheet 3, at a scale of 1:250,000 maps the subdivision as being underlain by the South Auckland Volcanic Field. The South Auckland Volcanic Field consists of basalt flows, scoria, tuff and ash deposits.

Within the vicinity of stream along the eastern boundary, the presence of Holocene age alluvial deposits overlying the above South Auckland Volcanic Field deposits is expected.

6.2 Previous Fieldwork Findings

6.2.1 Ground Consulting Limited Fieldwork Findings

Below is a summary of ground condition findings from the Ground Consulting Limited Geotechnical Investigation Report. We concur with their assessments and reiterate as follows:

Topsoil

Topsoil mantles the grassed and orchard portions of the subdivision to a measured depth of between 0.1m and 0.4m with an average topsoil depth of ~0.2m.

Slope Colluvium

Colluvial soil associated with regolith type slope instability features has developed on the steeper portions of the stream bank. The colluvium consists of disturbed weathered volcanic ash to an observed depth of up to 2.0m but typically less than 0.5m thick.

Weathered Volcanic Ash

A thick weathered volcanic ash layer underlies the subdivision. The weathered volcanic ash typically consists of clayey SILT with some sand which is very stiff to hard, moist, moderately plastic & insensitive.

Shear strength testing undertaken provided an undrained shear strength of between 142kPa and >199kPa with the majority of readings >199kPa.

Volcanic Tuff

Hand auger bore refusal was met within tests HA113, 118, 121 at a depth of between 2.1m and 3.0m. Refusal was typically on very dense silty fine SAND which typically forms the upper portion of weathered tuff deposits.

The hand auger bores are located close to the base of the stream bank. As such it is likely that the stream has eroded down to competent tuff deposits. The tuff deposits likely also underlie the subdivision at depth.

Groundwater

Groundwater was not encountered within any of the hand auger bores undertaken indicating a coherent groundwater table depth of at least 2.0m in the vicinity of the subdivision.

6.3 Lander Geotechnical Fieldwork Findings

6.3.1 HA1, HA2 and HA4

These boreholes were drilled along the proposed retaining wall alignment.

Ground conditions encountered below the topsoil comprised of orange/ brown, stiff to hard silty clay and clayey silt (ash) with sand and gravel inclusions and banding. Termination on inferred basalt boulders/ gravel was encountered and 1.7m, 2.2m and 4.9m respectively.

Scala penetrometer testing within the base of boreholes HA1 and HA2 encountered effective refusal (i.e. hammer bouncing) within 300mm.

Groundwater was encountered within HA2 only, with a standing water level at the completion of the borehole measured at 2.1m.

6.3.2 HA3, HA5 and HA6

These boreholes were drilling within proposed stormwater pond areas. Ground conditions encountered below the topsoil were as follows:

- HA3: orange/ brown, very stiff to hard silty clay (ash) with sand and gravel inclusions. Termination on inferred basalt boulders/ gravel at 1m. Scala penetrometer testing within borehole base encountered effective refusal (i.e. hammer bouncing). Standing groundwater level encountered at 0.9m.
- HA5: orange/ brown/ black, stiff to hard silty clay and clayey silt (ash and tuff) with some sand. Standing groundwater level encountered at 3.8m.
- HA6: orange/ grey, firm to hard silty clay (alluvium). Termination on dense materials at 2.5m. Scala penetrometer testing within borehole base encountered effective refusal (i.e. hammer bouncing). Standing groundwater level encountered at 0.2m.

7 SLOPE STABILITY

7.1 Approach to Slope Stability Analyses

A total of eight cross sections were provided to us by Civilplan Consultants Ltd (as appended) and seven of these cross-sections were used for computer slope stability analysis via SlopeW 2012 version 8 software using the Morgenstern-Price method for circular slips, which is considered to be the governing mode of failure for the geotechnical site model (based on geomorphology, as discussed in section 3).

The degree of stability of a slope is expressed as the factor of safety, which is the ratio of the forces resisting failure to the driving forces causing instability. Theoretical failure of a slope is possible when the factor is 1.0, while increasing values above 1.0 indicate improving stability. General industry standards require slopes within residential subdivisions to have minimum factors of safety of 1.5 and 1.3 under normal and worst credible groundwater conditions respectively. The worst credible groundwater level is based on the Ground Consulting Limited assessment of 2m above assumed existing groundwater level. We concur with this and have adopted the same transient groundwater level for our analyses.

Stability risks on this site were assessed by worst case scenario techniques. Worst case scenarios involve the assessment of the theoretically worst groundwater levels for an existing slope and then using assumed realistic parameters to establish the lowest factor of safety for these conditions. Seismic event (1 in 150 year event, as is usual industry standard for residential subdivision[1]) analysis was also undertaken using effective stress (pseudostatic) and also undrained shear strength parameters with a minimum factor of safety of 1.2 generally acceptable in this scenario.

For our analyses, the following table of conservative effective stress soil parameters were selected. These parameters have been selected based on our experience within similar geologies, and are no less conservative than the industry norm[1].

Footnote 1: Based on Auckland Council Code of Practice for Land Development and Subdivision, Section 2, Version 1.6, Dated 24 September 2013

Table 1: Effective Stress Parameters

Description	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (degrees)
Alluvium/ Recent Colluvium	16	3	28
Volcanic Ash	17	5	30
Weathered Volcanic Tuff	18	7	32
Engineer Certified Fill	18.5	5	32

Existing groundwater, elevated groundwater (2m above existing groundwater) and seismic cases were analysed for each cross section in order to assess the existing (pre development) and post development slope stability, results of which are appended. A summary of critical cases is presented in the following table:

Table 2: Minimum Factors of Safety

Case No.	Conditions of Analysis	Factor of Safety (F.O.S)	Meets F.O.S Criteria? (Y/N)
A.1	Section A – Existing Slope – Existing Groundwater	1.532	Y
A.2	Section A – Existing Slope – Elevated Groundwater	1.166	**N (<1.3)**
A.3	Section A – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.251	Y
A.4	Section A – Proposed Slope – Existing Groundwater	1.854	Y
A.5	Section A – Proposed Slope – Elevated Groundwater	1.317	Y
A.6	Section A – Proposed Slope – Existing Groundwater – Seismic 1/150yr	1.520	Y
B.1	Section B – Existing Slope – Existing Groundwater	2.187	Y
B.2	Section B – Existing Slope – Elevated Groundwater	1.749	Y
B.3	Section B – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.670	Y
B.4	Section B – Proposed Slope – Existing Groundwater	1.978	Y
B.5	Section B – Proposed Slope – Elevated Groundwater	1.627	Y
B.6	Section B – Proposed Slope – Existing Groundwater – Seismic 1/150yr	1.522	Y
C.1	Section C – Existing Slope – Existing Groundwater	4.350	Y
C.2	Section C – Existing Slope – Elevated Groundwater	3.383	Y
C.3	Section C – Existing Slope – Existing Groundwater – Seismic 1/150yr	2.817	Y
C.7	Section C – Remediated Slope (Retaining Wall) – Existing Groundwater	1.595	Y
C.8	Section C – Remediated Slope (Retaining Wall) – Elevated Groundwater	1.352	Y

Case No.	Conditions of Analysis	Factor of Safety (F.O.S)	Meets F.O.S Criteria? (Y/N)
C.9	Section C – Remediated Slope (Retaining Wall) – Existing Groundwater – Seismic 1/150yr	1.343	Y
E.1	Section E – Existing Slope – Existing Groundwater	1.317	**N (<1.5)**
E.2	Section E – Existing Slope – Elevated Groundwater	0.919	**N (<1.3)**
E.3	Section E – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.119	**N (<1.2)**
E.7	Section E – Remediated Slope (3m Deep Counterfort Drains & Retaining Wall) – Existing Groundwater	1.636	Y
E.8	Section E – Remediated Slope (3m Deep Counterfort Drains & Retaining Wall) – Elevated Groundwater	1.572	Y
E.9	Section E – Remediated Slope (3m Deep Counterfort Drains & Retaining Wall) – Existing Groundwater – Seismic 1/150yr	1.341	Y
F.1	Section F – Existing Slope – Existing Groundwater	1.500	Y
F.2	Section F – Existing Slope – Elevated Groundwater	1.241	**N (<1.3)**
F.3	Section F – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.230	Y
F.4	Section F – Proposed Slope – Existing Groundwater	1.700	Y
F.5	Section F – Proposed Slope – Elevated Groundwater	1.451	Y
F.6	Section F – Proposed Slope – Existing Groundwater – Seismic 1/150yr	1.389	Y
G.1	Section G – Existing Slope – Existing Groundwater	1.900	Y
G.2	Section G – Existing Slope – Elevated Groundwater	1.609	Y
G.3	Section G – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.449	Y
G.4	Section G – Proposed Slope – Existing Groundwater	1.876	Y
G.5	Section G – Proposed Slope – Elevated Groundwater	1.526	Y
G.6	Section G – Proposed Slope – Existing Groundwater – Seismic 1/150yr	1.588	Y
H.1	Section H – Existing Slope – Existing Groundwater	2.186	Y
H.2	Section H – Existing Slope – Elevated Groundwater	1.743	Y
H.3	Section H – Existing Slope – Existing Groundwater – Seismic 1/150yr	1.800	Y
H.4	Section H – Proposed Slope – Existing Groundwater	2.218	Y
H.5	Section H – Proposed Slope – Elevated Groundwater	2.201	Y
H.6	Section H – Proposed Slope – Existing Groundwater – Seismic 1/150yr	1.713	Y

7.2 Discussion on Stability Analyses

As can be seen from the above results, the proposed land modification works generally improves the current slope stability factors of safety through easing slope gradients (i.e. removing driving force), filling of the toe of slopes and installation of retaining walls (i.e. increasing resisting force).

However, our stability analyses found that to achieve satisfactory factors of safety post development below the proposed retaining wall within the vicinity of cross-section E-E, a series of 3m deep counterfort drains will be required to control groundwater levels and achieve a satisfactory factor of under worst case scenario elevated ground water conditions (i.e. engineering remediation is required here).

It should be noted however that on slopes steeper than 1(v) in 4(h) shallow soil creep can also occur in the surficial soils and this cannot be modelled accurately using the computer slope stability software. This phenomenon occurs slowly generally due to seasonal fluctuations in moisture content and the expansive nature of the soils, coupled with gravity. Implications associated with this are presented later in the report, and in our experience are normally dealt with by the end user commensurate with the nature of a building development proposal (i.e. at Building Consent).

8 PROJECT EVALUATION AND RECOMMENDATIONS

8.1 General

Our review of existing geotechnical reports and recent field investigations have confirmed that the site is generally suitable for the proposed earthworks, subject to the comments and recommendations contained herein.

The undertaking of earthworks construction and drainage works in accordance with NZS 4404, "Code of Practice for Urban Land Subdivision" and related documents should ensure that the completed development is generally suitable for conventional light timber framed dwellings constructed in accordance with the requirements of NZS 3604. However, AS 2870 expansive Site Class provisions will apply.

The results of our computer analyses show that the bulk earthworks should generally improve the long-term factors of safety under both elevated and existing ground conditions. However, cross-section E-E' found that below the proposed retaining wall a series of 3m deep counterfort drains will be required to ensure satisfactory factors of safety are maintained.

8.2 Site Gradients Steeper Than 1(v) in 4(h)

As discussed in section 7.2, where gradients slope steeper than 1(v) in 4(h) soil creep can occur. Building and earthworks restrictions will therefore be imposed on lots where finished slope gradients are steeper than 1(v) in 4(h). This building line restriction will mainly affect the lots along the eastern boundary of the site and portions of the southern boundary of the site, where lots flank gullies and/or proposed ponds.

The extent of any building line restrictions within lots will be imposed as part of the geotechnical completion report. The likely restriction will state that any building development and/or earthworks within the vicinity of areas where slope gradients are 1(v) in 4(h) or steeper will be subject to specific geotechnical site investigation and foundation design, with a view to retaining walls or leading edge foundation piles to mitigate the long term effects of soil creep.

8.3 Geotechnical Drainage

8.3.1 Counterfort Drainage

As discussed in section 7.2 and 8.1, counterfort drainage will be required below the proposed retaining wall within the vicinity of cross-section E-E'. The attached geotechnical engineering plan (Figure 02) shows the proposed location of these drains (4no. in total spaced at approximately 12m centres), the exact location of these drains should be confirmed on site by the certifying geotechnical engineer prior to construction, and will need to ensure they do not conflict with future retaining wall foundations and/or public service lines.

Details on their construction is presented on the attached geotechnical drainage detail plan (Figure 03). This plan shows that the drains should be 450mm to 600mm wide, a 160mm highway grade perforated drain coil should be place within the base of trench and backfill should be with SAP50 scoria (or approved alternative). A 0.5m thick clay capping layer should be placed over the drainage aggregate with non-woven geotextile cloth underlain the cap. The drains should outlet via the detailed outlet structures, just above working stream level.

The counterfort drains will need to be flushed with clean water after their construction to ensure that they will perform as intended. The permanent outlet structure locations for the drains should be positioned above the 100-year stream flood level to prevent debris blockages etc.

Provided the counterfort drains are constructed as specified, outlets are position above the 100-year stream flood level and they are flushed with clean water following construction, the drains are considered robust and will require no specific ongoing maintenance.

8.3.2 Underfill Drainage

The attached geotechnical engineering plan (Figure 02) shows the proposed location of underfill drainage. These drains are to be positioned within the invert of the gully to be filled within the western portion of the site and beneath the proposed fill at the toe of slope within the north-eastern portion of the site. The construction and outlet details for these drains is shown on the geotechnical drainage detail plan (Figure 03).

8.3.3 General

All geotechnical drains and outlets should be carefully recorded on as-built plans by a Registered Surveyor and the details forwarded to us for inclusion in our geotechnical completion report.

8.4 Stormwater Ponds

The CivilPlan Consultants Limited drawings show that three stormwater ponds are proposed. The boreholes drilled within the vicinity of the two eastern most stormwater ponds terminated at depths between 1m and 2.5m (i.e. above the proposed invert depth of the ponds which are up to 4.5m deep) with the possible presence of basalt boulders noted within HA3.

Prior to the construction of these stormwater ponds, further geotechnical investigation should be undertaken (i.e. trial pits) to determine the ground conditions to the invert depth of the proposed ponds and the excavatability of the material.

Assessment of any requirement for pond liners (i.e. clay liners using material source from site) should be made at this time, and re-evaluated throughout the construction of the ponds.

Construction of the pond fill embankments should comprise of undercutting/benching the subgrade down to suitable stiff inorganic natural ground to the satisfaction of the certifying geotechnical engineer. Pond fill embankments should consist of suitable plastic materials sourced from site, the fill testing control criteria for these materials is presented in section 8.9. As is good engineering practice, a seepage key should be provided beneath the centreline of any impoundment fill bunds, approximately 1m deep by 3m wide, and subject to ground conditions observed during construction.

If pond fill or cut batters are proposed steeper than 1(3) in 3(h) then the matter should be referred to us for further stability assessments.

8.5 Retaining Wall

A retaining wall up to 2.9m (wall type to be confirmed) is proposed within the eastern portion of the site. As part of the specific design of this wall during the building consent phase, further investigation is recommended given the depth some of our boreholes terminated at within the vicinity of this wall (i.e. HA1 and HA2 terminated at 1.7m and 2.2m respectively with gravel/ boulders inferred). This may require rotary cored (machine drilled) boreholes or trial pits that are appropriately positioned.

Building foundations and earthworks restrictions within a zone equal to the height of the completed retaining wall will apply and this will be addressed as part of the geotechnical completion report.

8.6 Earthworks

8.6.1 General

The bulk earthworks for this development involves cuts within the central and eastern portions of the site and filling of the gully within the western portion of the site along with the construction of the stormwater ponds and installation of civil services and roads.

8.6.2 Site Preparation

Within areas of the subdivision affected by earthworks, all vegetation should be cleared. Outside the extent of the earthworks, vegetation cover should be disturbed as little as possible and reinstated wherever practical.

Topsoil should be stripped from all cut and fill areas, stripping operations being planned to extend well beyond cut and fill lines to avoid peripheral fill contamination. Stockpiles of topsoil and unsuitable materials should be sited well clear of the works on suitable areas of natural ground.

8.6.3 Material Suitability

Earthworks operations involving borrow materials should be relatively straightforward. Generally, we envisage these earthworks will involve inorganic, clayey silts and silty clays that should be suitable, with conditioning, for handling and compaction by conventional earthmoving plant.

It is likely that optimum water contents will be lower than the range of natural water contents and accordingly it might be necessary for some drying to take place before compaction. Conversely, the ash materials on this site likely contain the presence of allophanic soils. Allophanic soils show marked irreversible changes in their physical properties when dried below the natural water content. This is attributed to the collapse of the allophanic gel-like structure and aggregation into much coarser grain sizes. Therefore, there may be a risk that the soils may become problematic if over dried. Careful management of the borrow fill materials will therefore be necessary by the Contractor.

It is recommended that standard compaction curve testing and solid density testing is undertaken from representative borrow areas once the contractors digger has established and prior to bulk cut to fill commencing.

In addition, as stated in section 8.4, the boreholes drilled within the vicinity of the two eastern most stormwater ponds terminated at depths between 1m and 2.5m (i.e. above the proposed invert depth of the ponds which are up to 4.5m deep) with the possible presence of basalt boulders noted within HA3. Prior to the construction of these stormwater ponds, further geotechnical investigation should be undertaken (i.e. trial pits) to determine the ground conditions to the invert depth of the proposed ponds, the excavatability of the material and its suitability for re-use as Engineered fill.

8.6.4 Benching of Slopes

All benching of slopes prior to the placement and compaction of filling should be in accordance with the normal requirements of NZS 4404 and related documents and should be the subject of Engineering inspections prior to the placement of any drainage works or filling.

8.6.5 Unsuitables

Any identifiable deposits of unsuitable materials, including existing uncertified filling and organic alluvial deposits, that are considered unfit for reworking should be undercut and disposed of off the site or on topsoil stockpiles if appropriate.

8.7 Foundations for Buildings

8.7.1 Bearing Capacity and Settlement Potential

A geotechnical ultimate bearing capacity of 300 kPa should generally be available for all shallow strip and pad foundations constructed on certified filling and on the stiff to hard natural ground.

However, within the areas of deeper cut, a value of less than 300 kPa may be specified subject to ground conditions exposed near finished subgrade level.

These issues will be re-addressed in our geotechnical completion report at which time it is recommended that a series of additional hand auger boreholes are undertaken within lots in cut ground.

8.7.2 Expansive Site Class

Based on the assessments made in the previous Ground Consulting Limited geotechnical reports (refer Section 2 above), the preliminary AS 2870 expansive Site Class for the subdivision is M (Moderate) where characteristic surface movement (y_s) up to 40mm can be expected.

However, this preliminary assessment will need to be re-assessed with laboratory testing at the completion of the subdivision, and in our experience of ground conditions within the Tuakau area (i.e. volcanic ashes) expansive site classes can typically range from M (moderate) to H1 (high).

Where Site Class M applies (subject to the aforementioned laboratory testing as part of the geotechnical completion report), foundation design may be carried out in accordance with AS 2870 or in accordance with NZS 3604 provided that in this latter case the minimum foundation depth below cleared ground level following topsoil removal and benching of building platform areas is 600mm, and for Class H1 this would increase to 900mm.

8.8 Roading and Services

8.8.1 Roading

We recommend that a programme of penetration resistance testing is carried out along the proposed Road to assess design CBR values once it is cut to subgrade level.

However, based on our past experience and review of vane shear strengths in the borehole logs, we anticipate that CBR values are likely to range from 3 to 5%. It should be noted that experience on previous subdivisions in the area showed that penetrometers may return unrealistically low values in subgrades where the volcanic soils are sensitive to disturbance. In these instances, additional testing of the subgrade by Benkelman Beam and design precedence set on other developments within the area may prove useful in determining a pragmatic approach to dealing with such areas less conservatively than usual mechanistic CBR design approaches. In our experience, undercutting of areas displaying weak CBR subgrade is an economical approach. Chemical stabilisation (e.g. using lime/cement additives) will be subject to reactivity testing on the volcanic soils.

8.8.2 Trench Excavation

Some of the hand auger boreholes did not reach target depth (i.e. the boreholes drilled within the vicinity of the two eastern most stormwater ponds terminated at depths between 1m and 2.5m with the possible presence of basalt boulders noted within HA3). The excavatability of the deeper stormwater and sanitary lines (i.e. beyond the reach of the boreholes drilled to date) may therefore require determining prior to construction, the drain laying contractor should be made aware of the contents of this report in this regard.

8.8.3 Trench Backfill

The attached CivilPlan Consultants Limited drainage reticulation plan shows the proposed location of proposed stormwater and sanitary sewer lines.

Were trenches run parallel to contours, backfilling should be to the highest attainable and where possible the pipe bedding should contain a Novaflo drain coil that is either connected into a stormwater manhole (if possible) or outletted down slope into the stream reserve area. This is to help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

These recommendations should especially apply to **sewer line trenches A/3 to A/7 and B/4 to B/6**. The subdivision drainlaying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place, **and we recommend the 'For Construction' drawings highlight this requirement.**

8.8.4 Groundwater Problems

Construction of the stormwater and sanitary sewage reticulation during the winter months could involve raised groundwater levels and could cause problems with the stability of trench sides, leading to a need for additional subsoil drainage and/or dewatering, especially in areas where deep lines are required.

8.9 Compaction Control

Our preliminary recommendation for control criteria are as follows:

Minimum Shear Strength and Maximum Air Voids Method

(a) Air Voids Percentage

(As defined in NZS 4402)

General Fill	
Average value less than	10%
Maximum single value	12%
Within 500mm of carriageway subgrade	
Average value less than	8%
Maximum single value	10%
Stormwater Pond Embankment	
Average value less than	6%
Maximum value	8%

(b) Undrained Shear Strength

(Measured by Pilcon shear vane - calibrated using NZGS 2001 method)

General fill	
Average value not less than	**140 kPa**
Minimum single value	**110 kPa**
Within 500mm of carriage subgrade	
Average value not less than	**150 kPa**
Minimum single value	**120 kPa**
Stormwater Pond Embankment	
Average value not less than	**140 kPa**
Minimum single value	**110 kPa**

Note: The average value shall be determined over any ten consecutive tests

8.10 Fill Induced Settlements

Provided the recommendations of this report (i.e. geotechnical drainage, gully muckouts) are followed and given the presence of very stiff subsoils within the site in general, it is expected that any consolidation settlement will have abated by the time bulk earthworks have been completed (which are likely take a minimum of 3 months).

8.11 Plan Review and Further Work

If significant changes are proposed to be made to the earthworks plans reviewed to date, we reserve the right to revisit our evaluations and recommendations when they come to hand. Prior to bulk earthworks commencing, standard compaction curve testing is recommended to confirm the compaction control criteria.

It should be noted that it was not possible to cover all proposed building lots during the site investigation works carried out to date. Accordingly, it may be necessary at the time of preparation of our Geotechnical Completion report to undertake specific site investigation work on any previously uninvestigated lots that have either been cut or not affected by the earthworks.

In addition, as discussed in sections 8.4 and 8.5, additional geotechnical investigation is recommended prior to the construction of the stormwater ponds and to aid in the specific design of the proposed retaining wall in due course (i.e. as part of the building consent process).

8.12 Inspections

It is important that we are given the opportunity to examine the site during construction, so that the nature and quality of the exposed subsoils can be related to the report assumptions. In all circumstances however, if variations in the subsoils occur from those described or assumed to exist then the matter should be referred back to us immediately.

Following satisfactory completion of the works we should be in a position to issue a geotechnical completion report (and PS4's for retaining walls inspected by us).

9 LIMITATIONS

This report has been prepared solely for the use of our client, Hughes Developments Limited, their professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. 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.

The opinions, recommendations and comments given in this report result from the application of normal methods of site investigation. As factual evidence has been obtained solely from boreholes which by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report.

If variations in the subsoils occur from those described or assumed to exist then the matter should be referred back to us immediately.

For and on behalf of Lander Geotechnical Consultants Limited

Prepared By:

Chris Edwards
Senior Engineering Geologist
MEngNZ.

Reviewed/ Authorised By:

Shane Lander
Principal Geotechnical Engineer
CMEngNZ, CPEng

Attachments:

Appendix 1: CivilPlan Consultants Limited Plan Set

Appendix 2: Lander Geotechnical Consultants Limited Figures 1 to 3

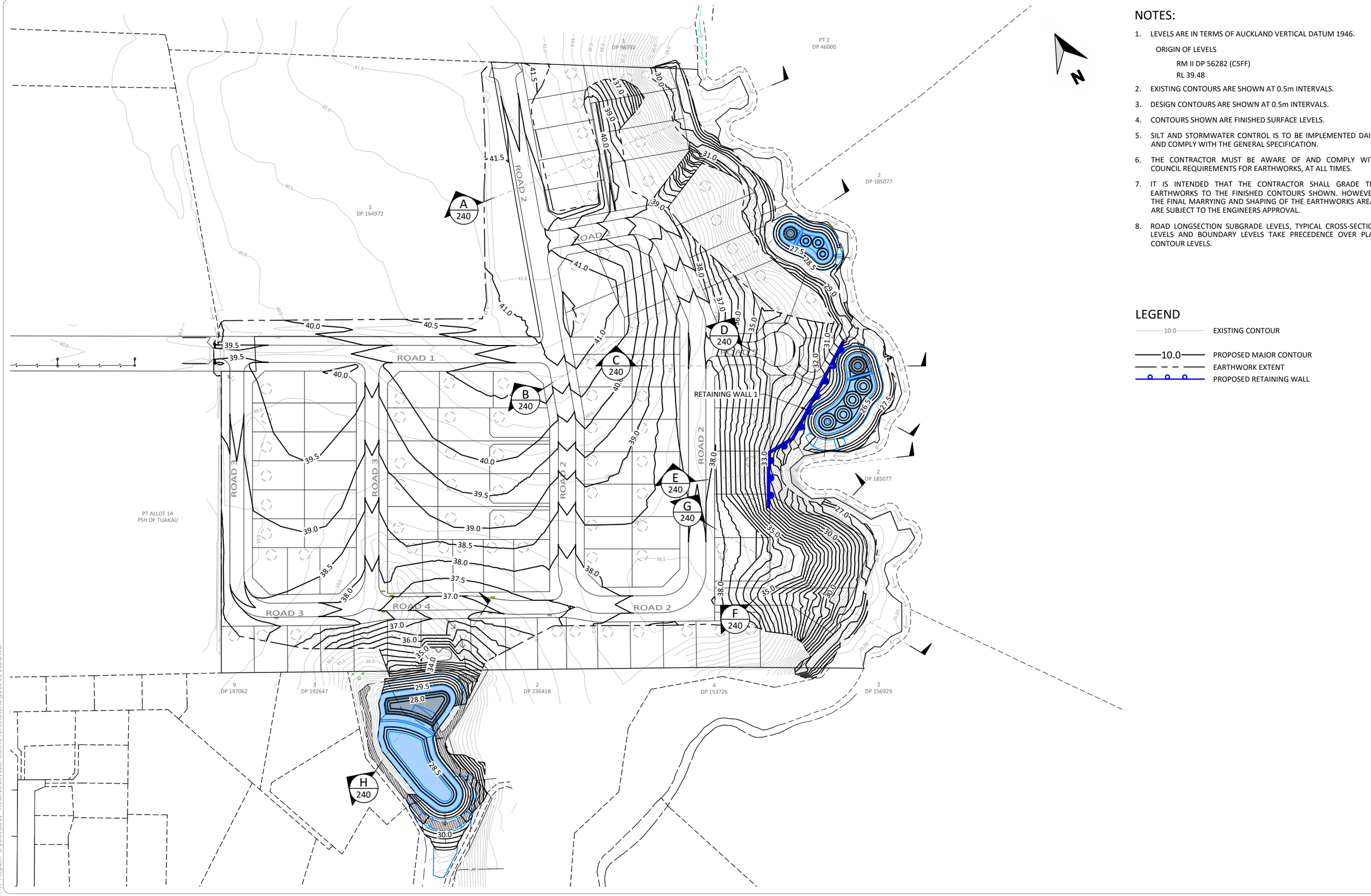
Appendix 3: Lander Geotechnical Field Investigation Data

Appendix 4: Ground Consulting Limited Field Investigation Data (Supplementary Data)

Appendix 5: Slope Stability Analysis Results

Appendix 1

CivilPlan Consultants Limited Plan Set



NOTES:

1. LEVELS ARE IN TERMS OF AUCKLAND VERTICAL DATUM 1946.

   ORIGIN OF LEVELS

   RM II DP 56282 (C5FF)

   RL 39.48
2. EXISTING CONTOURS ARE SHOWN AT 0.5m INTERVALS.
3. DESIGN CONTOURS ARE SHOWN AT 0.5m INTERVALS.
4. CONTOURS SHOWN ARE FINISHED SURFACE LEVELS.
5. SILT AND STORMWATER CONTROL IS TO BE IMPLEMENTED DAILY AND COMPLY WITH THE GENERAL SPECIFICATION.
6. THE CONTRACTOR MUST BE AWARE OF AND COMPLY WITH COUNCIL REQUIREMENTS FOR EARTHWORKS, AT ALL TIMES.
7. IT IS INTENDED THAT THE CONTRACTOR SHALL GRADE THE EARTHWORKS TO THE FINISHED CONTOURS SHOWN. HOWEVER, THE FINAL MARRYING AND SHAPING OF THE EARTHWORKS AREAS ARE SUBJECT TO THE ENGINEERS APPROVAL.
8. ROAD LONGSECTION SUBGRADE LEVELS, TYPICAL CROSS-SECTION LEVELS AND BOUNDARY LEVELS TAKE PRECEDENCE OVER PLAN CONTOUR LEVELS.

LEGEND

- 10.0 — EXISTING CONTOUR
- 10.0 — PROPOSED MAJOR CONTOUR
- EARTHWORK EXTENT
- PROPOSED RETAINING WALL

REV	REVISION DETAILS	BY	DATE
-	-	XXX	XX.XX.XX

DRAWN: GDS DATE: 09.2017
CHECKED: RJP DATE: XX.XX.XX
APPROVED: RJP DATE: XX.XXXX

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

SHEET TITLE:
FINISHED CONTOURS PLAN

ISSUE STATUS: DRAFT@03.11.17
SCALE: (A1/A3) 1:1000 / 1:2000
SCALE BAR 1:2000@A3 0 20 40 60 80 100m
DRAWING NUMBER: 2011-01-200 REV: -

Printed by: GLEN@03.11.17 // Filepath: S:\JOBS\2011 - HUGHES DEVELOPMENTS TUAKAU\CAD\2011-01-200.DWG

NOTES:

1. PROPOSED ISOPACHS ARE SHOWN AT 0.5m INTERVALS.
2. ALL WORKS AND MATERIALS ARE TO COMPLY WITH RELEVANT COUNCIL ENGINEERING STANDARDS .
3. ALL TOPSOIL TO BE STRIPPED AND STOCKPILED CLEAR OF THE PROPOSED EARTHWORKS IN A LOCATION AGREED WITH THE ENGINEER.
4. ALL EROSION AND SEDIMENT CONTROL DEVICES TO BE INSTALLED, AS-BUILT AND INSPECTED BY THE ENGINEER / COUNCIL REPRESENTATIVE PRIOR TO COMMENCING THE EARTHWORKS ON THE SITE.
5. AREA OF EARTHWORKS = X.XXX ha.
6. EARTHWORK VOLUMES ARE FROM EXISTING SURFACE TO FINISHED SURFACE AND ARE:

   CUT VOLUME= XXXX m^3

   FILL VOLUME= XXXX m^3

LEGEND

10.0 PROPOSED CUT ISOPACH

10.0 PROPOSED FILL ISOPACH

EARTHWORKS ZERO CUT/FILL LINE

EARTHWORK EXTENT

CUT PROPOSED CUT

FILL PROPOSED FILL

REV	REVISION DETAILS	BY	DATE
-	-	XXX	XX.XX.XX

DRAWN: GDS DATE: 09.2017
CHECKED: RJP DATE: XX.XX.XX
APPROVED: RJP DATE: XX.XXXX

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

SHEET TITLE:
PROPOSED ISOPACHS PLAN

ISSUE STATUS: DRAFT@03.11.17

SCALE: (A1/A3) 1:1000 / 1:2000

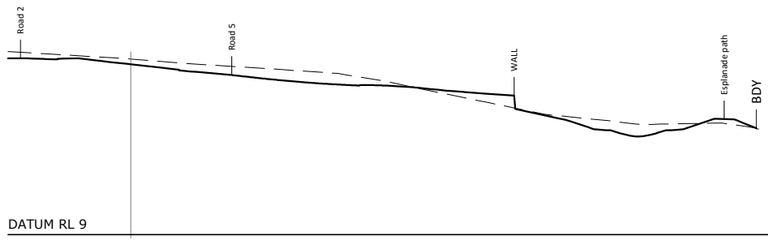
SCALE BAR 1:2000@A3 0 20 40 60 80 100m

DRAWING NUMBER: 2011-01-220 REV: -

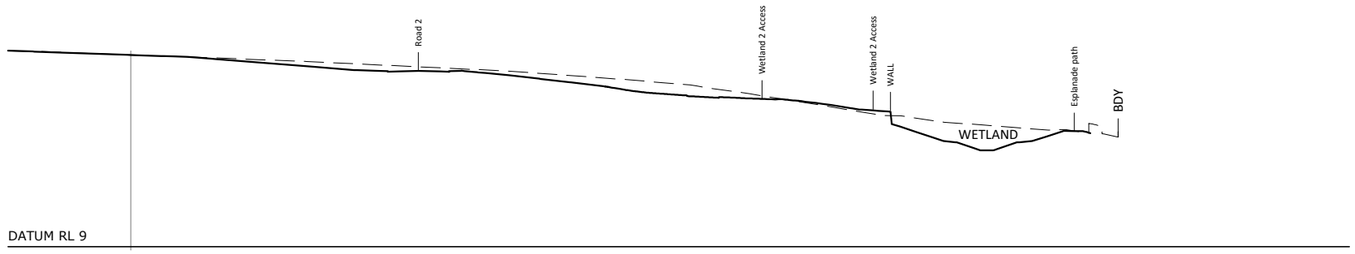
LEGEND

EXISTING GROUND LINE

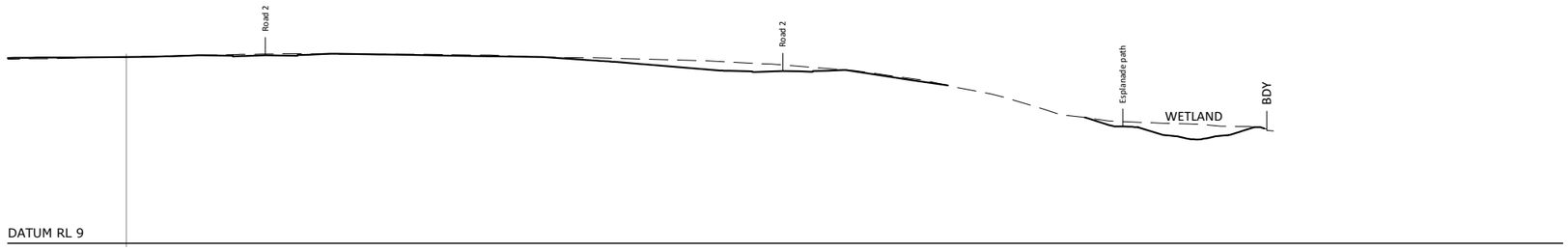
PROPOSED GROUND LINE



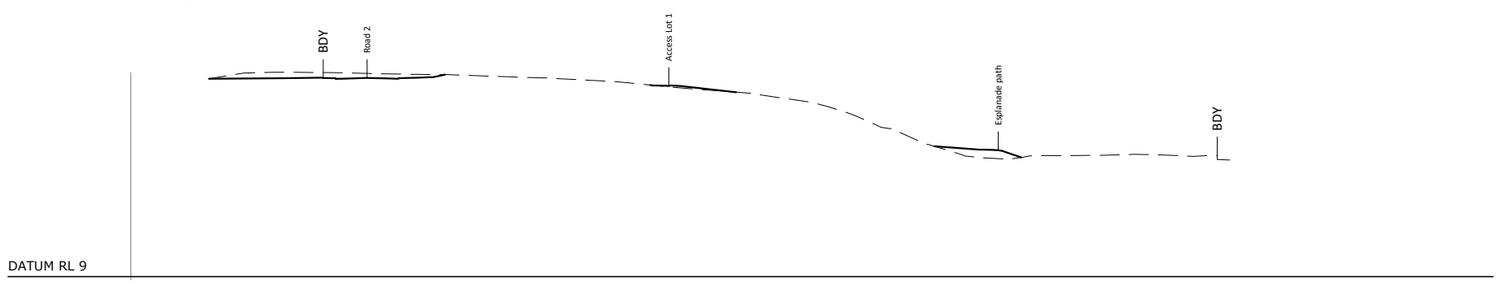
D 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



C 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



B 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



A 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000

REV	REVISION DETAILS	BY	DATE
-	-	-	XX.XX.XX

DRAWN: --- DATE: XX.XXXX
CHECKED: --- DATE: XX.XX.XX
APPROVED: --- DATE: XX.XX.XX

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

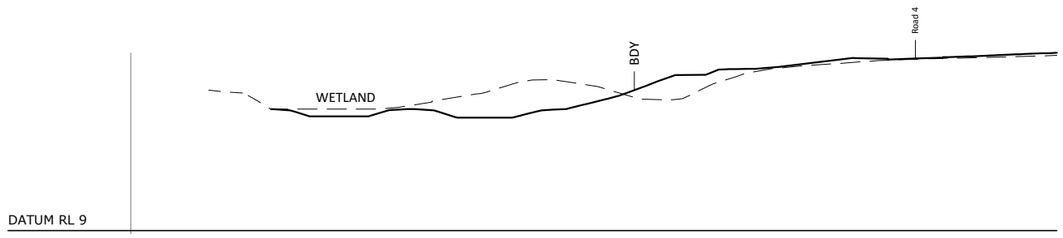
SHEET TITLE:
EARTHWORKS CROSS SECTIONS
SHEET 1

ISSUE STATUS: DRAFT@03.11.17
SCALE: (A1/A3) 1:500 / 1:1000
SCALE BAR 1:1000@A3 0 10 20 30 40 50m
DRAWING NUMBER: 2011-01-240 REV: -

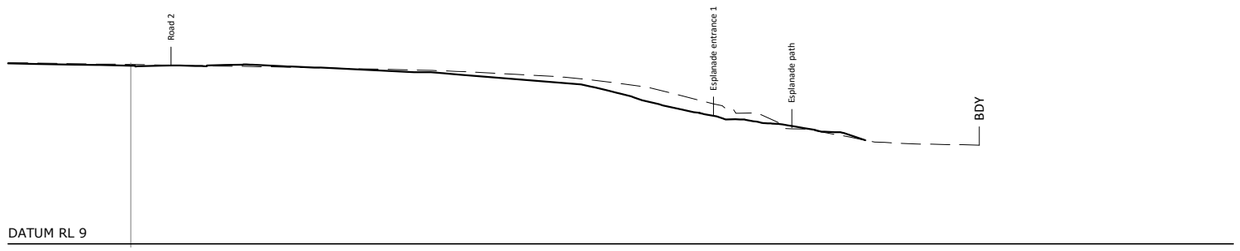
LEGEND

EXISTING GROUND LINE

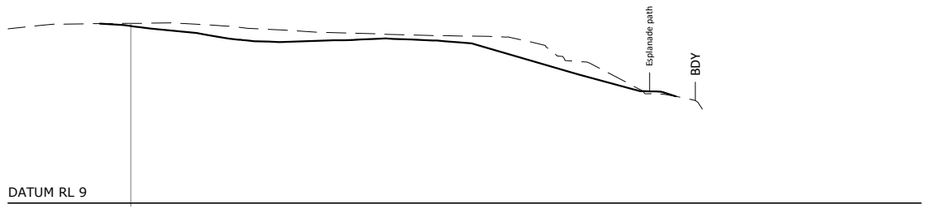
PROPOSED GROUND LINE



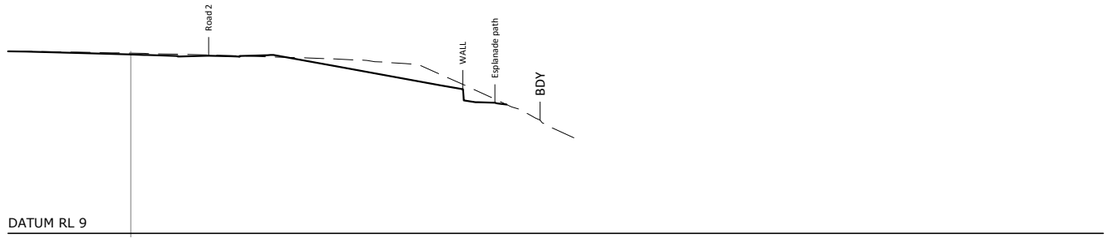
H 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



G 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



F 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000



E 200 SITE CROSS SECTION
SCALE: (A1/A3) 1:500/1:1000

REV	REVISION DETAILS	BY	DATE
-	-	-	XX.XX.XX

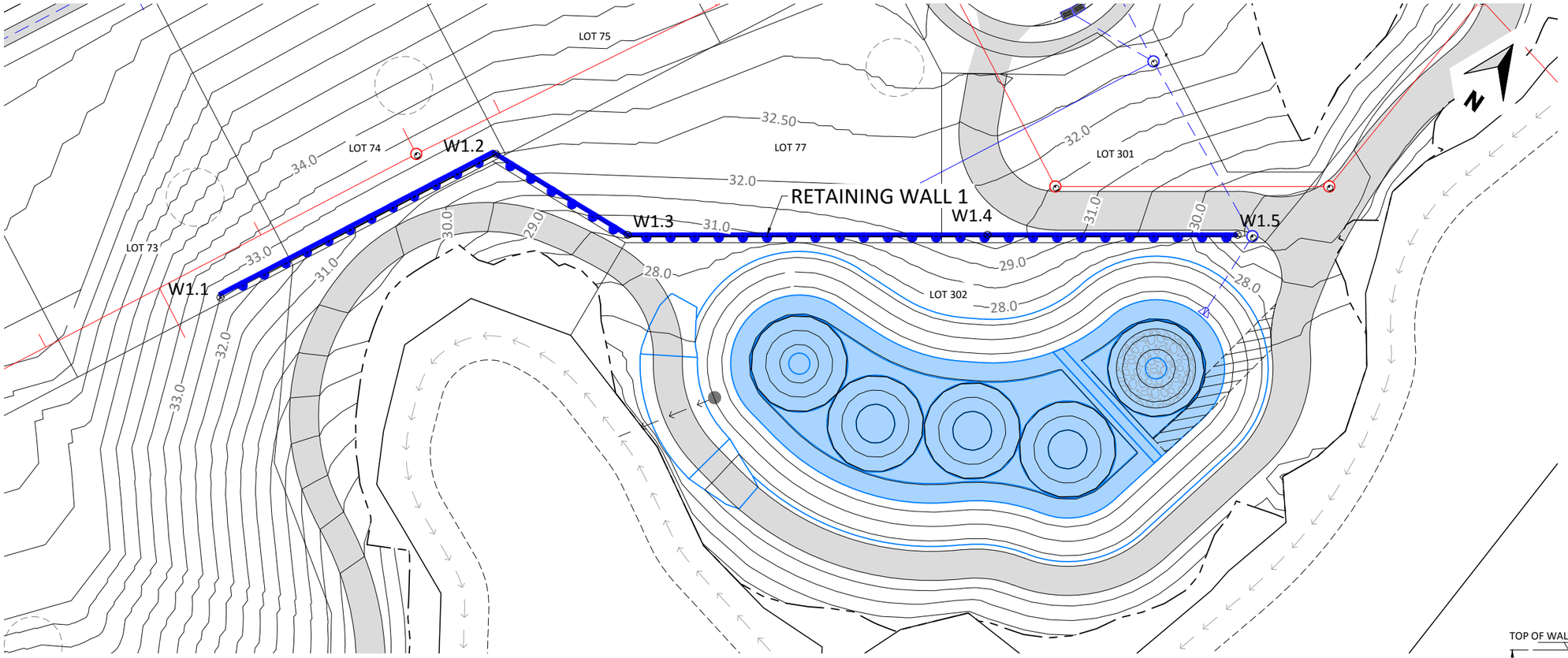
DRAWN: --- DATE: XX.XXXX
CHECKED: --- DATE: XX.XX.XX
APPROVED: --- DATE: XX.XX.XX

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

SHEET TITLE:
EARTHWORKS CROSS SECTIONS
SHEET 2

ISSUE STATUS: DRAFT@03.11.17
SCALE: (A1/A3) 1:500 / 1:1000
SCALE BAR 1:1000@A3 0 10 20 30 40 50m
DRAWING NUMBER: 2011-01-241 REV: -



RETAINING WALL PLAN

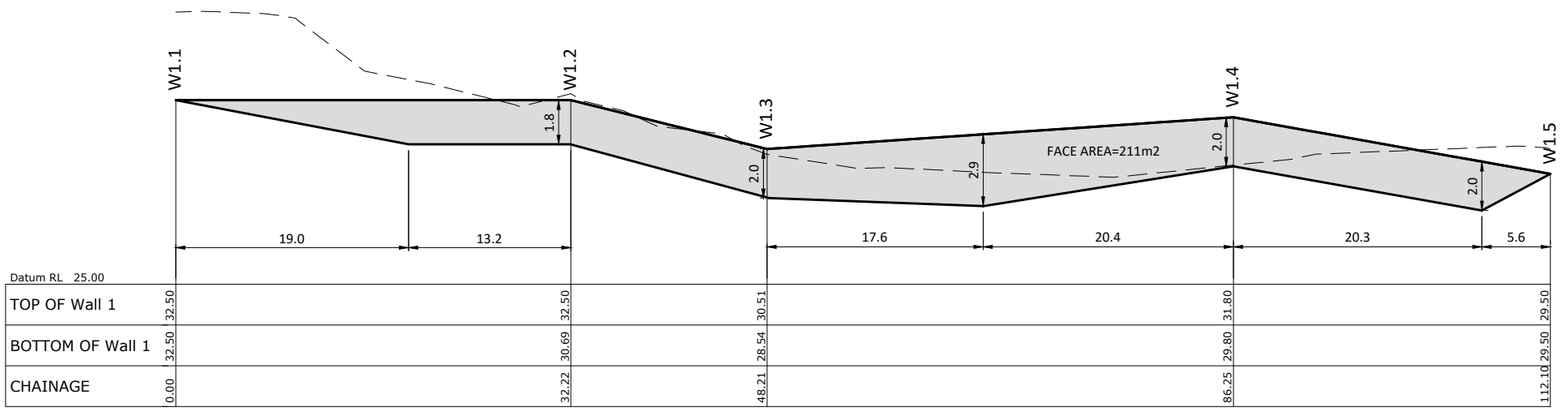
SCALE: (A1/A3) 1:250/1:500

LEGEND

- 10.0 — EXISTING CONTOUR
- PROPOSED MAJOR CONTOUR
- EARTHWORK EXTENT
- PROPOSED RETAINING WALL

NOTES

1. WALL 1 IS A TIMBER POST RETAINING WALL.

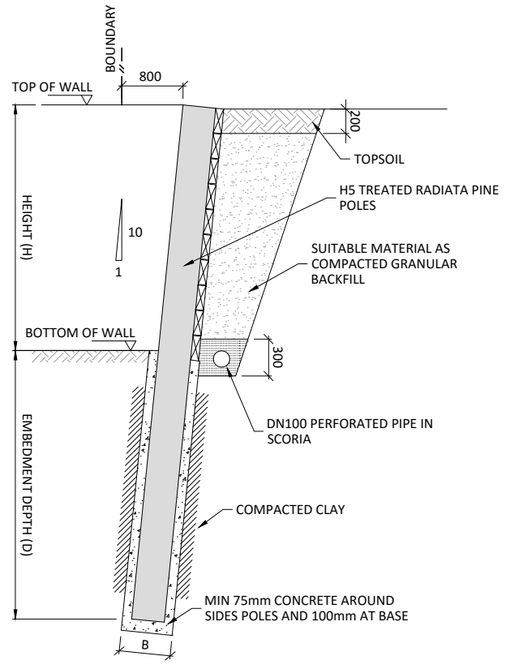


Datum RL 25.00

	W1.1	W1.2	W1.3	W1.4	W1.5
TOP OF Wall 1	32.50	32.50	30.51	31.80	29.50
BOTTOM OF Wall 1	32.50	30.69	28.54	29.80	29.50
CHAINAGE	0.00	32.22	48.21	86.25	112.10

RETAINING WALL 1 LONGITUDINAL SECTION

SCALE: (A1/A3) 1:250H 1:125V / 1:500H 1:250V



RETAINING WALL TYPICAL CROSS SECTION

SCALE: NTS

WALLS ARE INDICATIVE ONLY-BUILDING CONSENT REQUIRED

REV	REVISION DETAILS	BY	DATE
-	-	xxx	xx.xx.xx

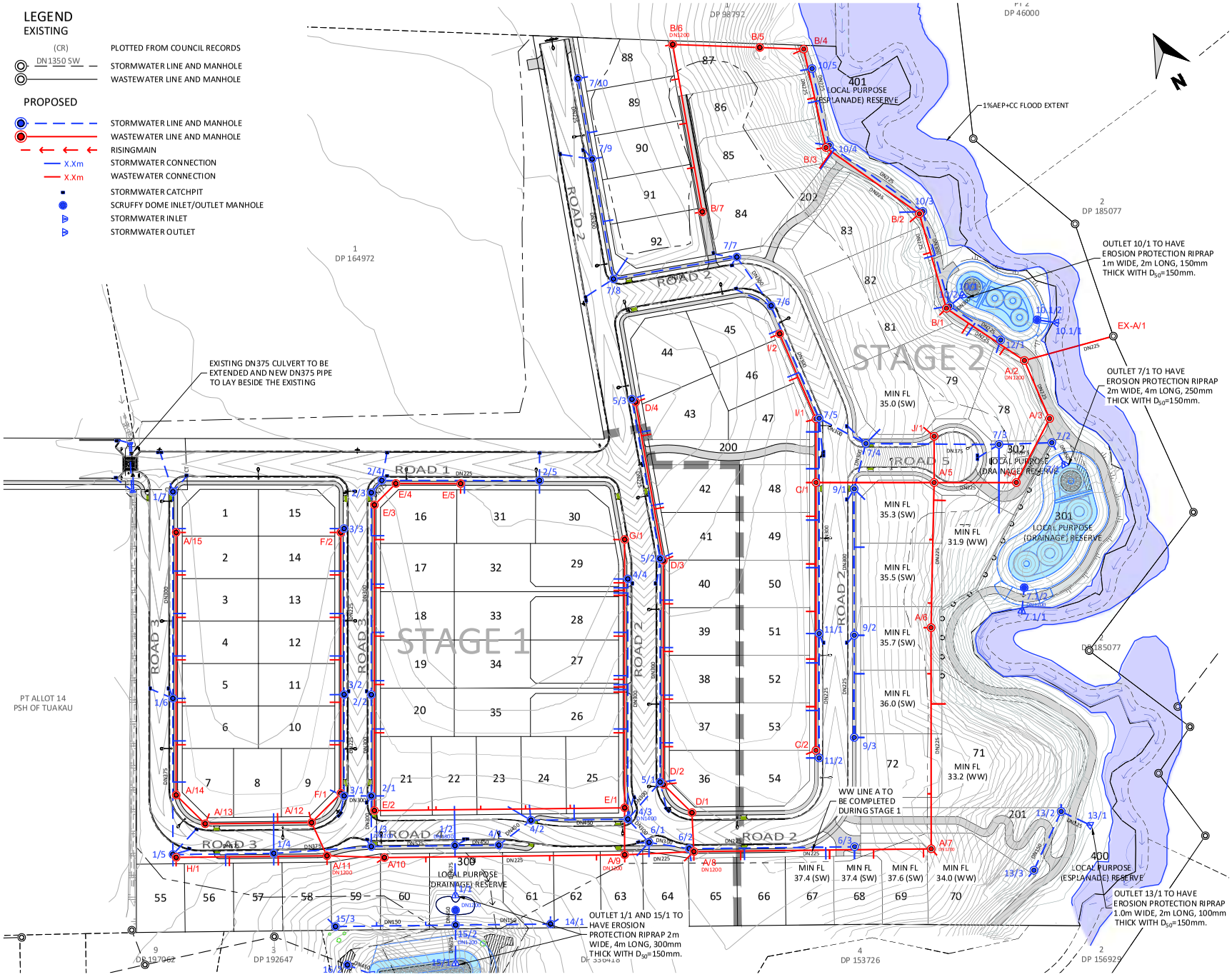
DRAWN: GDS DATE: 09.2017
CHECKED: RJP DATE: xx.xx.xx
APPROVED: RJP DATE: xx.xxxx

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

SHEET TITLE:
RETAINING WALL PLAN AND ELEVATION

ISSUE STATUS: DRAFT@06.11.17
SCALE: (A1/A3) 1:1000 / 1:2000
SCALE BAR 1:2000@A3 0 20 40 60 80 100m
DRAWING NUMBER: 2011-01-270 REV: -



NOTES:

1. ALL WORKS AND MATERIALS ARE TO COMPLY WITH RELEVANT COUNCIL ENGINEERING STANDARDS.
2. ALL WORKS ON EXISTING STORMWATER, WASTEWATER LINES AND WATERMAINS TO BE CARRIED OUT BY AN APPROVED LICENSED CONTRACTOR AT THE DEVELOPERS EXPENSE.
3. CONTRACTOR TO LOCATE / MARK AND CONFIRM ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORK ON SITE AND PROTECTION OF SAME.
4. CONTRACTOR TO CHECK ALL PIPE INVERTS AGAINST PIPE CLASHES BEFORE LAYING.
5. ALL WASTEWATER LINES SHALL BE DN150 uPVC DWV SN16 AS/NZ 1260, UNLESS SHOWN OTHERWISE.
6. ALL DN 100 & DN 150 STORMWATER LINES SHALL BE uPVC DWV SN16 AS/NZ 1260, UNLESS SHOWN OTHERWISE.
7. ALL DN225 AND ABOVE STORMWATER LINES SHALL BE CLASS 2 REINFORCED CONCRETE RUBBER RING JOINTED (RCRRJ) UNLESS SHOWN OTHERWISE.
8. ALL PROPOSED CONNECTIONS SHALL BE DN100, UNLESS SHOWN OTHERWISE AND ARE DIMENSIONED FROM THE CENTRE OF THE DOWNSTREAM MANHOLE.
9. ALL PROPOSED CONNECTIONS SHOULD TERMINATE 1m FROM THE FINISH GRADE LEVEL.
10. MAINTAIN 1m DISTANCE BETWEEN CONNECTION AND BOUNDARY.
11. ALL SINGLE CATCHPIT LEADS SHALL BE DN 225 RCRRJ CLASS 4 PIPE, UNLESS SHOWN OTHERWISE.
12. ALL DOUBLE CATCHPIT LEADS SHALL BE DN 300 RCRRJ CLASS 4 PIPE, UNLESS SHOWN OTHERWISE.
13. ALL CATCHPITS TO BE CONSTRUCTED WITH A STANDARD 675x450 CAST IRON GRATING & FRAME AS PER STD DETAILS RD034 & RD035.
14. PIPE LENGTH ON LONGITUDINAL SECTIONS IS LENGTH OF PIPE HORIZONTALLY BETWEEN CENTRE OF MANHOLES.
15. FOR PIPE GRADES BETWEEN 10% - 20%, CEMENT STABILISED BEDDING IS REQUIRED.
16. RETAINING WALL NOVACOIL DRAINAGE TO BE CONNECTED TO CATCHPITS. NOVACOIL UNDER PAVED AREAS TO BE SOLID WALL AND HARDFILL BACK FILLED.
17. ALL MANHOLES SHALL BE DN1050 RC WITH MIN. 600mm OPENING, CAST IRON COVERS. HEAVY DUTY CONCRETE LIDS TO BE USED IN PAVEMENT AREAS, UNLESS SHOWN OTHERWISE.
18. WASTEWATER MANHOLES TO HAVE 25mm EXTRA SACRIFICIAL WALL THICKNESS AND SHALL BE FITTED WITH A STAINLESS STEEL SAFETY GRILLE SUPPORTED BY THE MANHOLE FRAME AND CAPABLE OF CARRYING A 100kg POINT LOAD ANYWHERE. THE GRILLE SHALL HAVE A PATTERN WITH OPENINGS THAT WILL NOT PASS A 150mm DIAMETER SPHERE.
19. BEDDING TO COMPLY WITH RELEVANT COUNCIL DETAILS.
20. HARDFILL BACKFILL ALL PIPE CROSSINGS BELOW CARRIAGEWAY / TRAFFIC AREAS 1.0m BEYOND LIMIT OF CARRIAGEWAY.
21. HARDFILL BACKFILL 1.0m EITHER SIDE OF PIPE CROSSOVERS.
22. WHERE CLEARANCE BETWEEN PIPELINE CROSSOVERS IS LESS THAN 100mm THE GAP IS TO BE POLYSTYRENE PACKED IN ADDITION TO HARDFILLING OF CROSSOVERS.
23. ADJUSTMENT OF ANY INVERT LEVELS IS AT CONTRACTORS OWN RISK DUE TO TIGHT TOLERANCE AT PIPE CROSSINGS.
24. ANY WORK DEEMED BY THE ENGINEER AS BEING SUBSTANDARD WORK SHALL BE RECTIFIED AT THE CONTRACTORS EXPENSE.
25. REFER TO SHEETS 2011-01-460/461/462/463 FOR WETLAND DETAILING.

DRAFT

REV	REVISION DETAILS	BY	DATE
-	-	XXX	XX.XX.XX

DRAWN: GDS DATE: 09.2017
CHECKED: RJP DATE: XX.XX.XX
APPROVED: RJP DATE: XX.XXXX

CIVILPLAN CONSULTANTS
Level 3, 3 Osterley Way, Manukau, Auckland. Phone: 09 222 2445

PROJECT TITLE:
HUGHES DEVELOPMENTS LIMITED
99 ESCOTTS ROAD
TUAKAU

SHEET TITLE:
DRAINAGE RETICULATION PLAN
OVERALL LAYOUT

ISSUE STATUS: DRAFT@10.11.17
SCALE: (A1/A3) 1:750 / 1:1500
SCALE BAR 1:1500 @A3 0 15 30 45 60 75m
DRAWING NUMBER: 2011-01-400 REV: -

Printed by: RYAN@10.11.17 // Filepath: S:\JOBS\2011 - HUGHES DEVELOPMENTS TUAKAU\CAD\2011-01-400.DWG

Appendix 2

Lander Geotechnical Consultants Limited Figures 1 to 3

1. LEVELS ARE IN TERMS OF AUCKLAND VERTICAL DATI

   ORIGIN OF LEVELS

   RM II DP56282
   757089.231mN
   415881.197mE
   RL 39.48

2. EXISTING CONTOURS ARE SHOWN AT 0.5m INTERVA
3. DESIGN CONTOURS ARE SHOWN AT 0.5m INTERVAL
4. CONTOURS SHOWN ARE FINISHED SURFACE LEVELS.
5. SILT AND STORMWATER CONTROL IS TO BE IMPLI AND COMPLY WITH THE GENERAL SPECIFICATION.
6. THE CONTRACTOR MUST BE AWARE OF AND AUCKLAND COUNCIL REQUIREMENTS FOR EARTH TIMES.
7. IT IS INTENDED THAT THE CONTRACTOR SHA EARTHWORKS TO THE FINISHED CONTOURS SHO THE FINAL MARRYING AND SHAPING OF THE EART ARE SUBJECT TO THE ENGINEERS APPROVAL.
8. ROAD LONGSECTION SUBGRADE LEVELS, TYPICAL LEVELS AND BOUNDARY LEVELS TAKE PRECEDEN CONTOUR LEVELS.

LEGEND

- 10.0 — EXISTING CONTOUR
- 10.0 — PROPOSED MAJOR CONTOUR
- EARTHWORK EXTENT
- PROPOSED RETAINING WALL
- LANDER GEOTECHNICAL HAND AUGER BOREHOLE (OCTOBER 2017)
- GROUND CONSULTING HAND AUGER BOREHOLE (NOVEMBER 2014)

Source drawing: CivilPlan Consultants Limited, Dwg No. 2011-01-200, dated 03.11.17

revision	description	drawn	approved	date

0 30.0 60.0 90.0 120.0
Horizontal Scale (metres)
0 30.0 60.0 90.0 120.0
Vertical Scale (metres)

drawn	MPC
approved	CE
date	9.11.17
scale	1:2000
original size	A3

LANDER geotechnical

client:	HUGHES DEVELOPMENTS LTD
project:	99 ESCOTTS ROAD, TUAKAU
title:	SITE INVESTIGATION PLAN
project no:	J 00779
figure no:	01

Template revision: 1:2000 (10/12/14)

1. PROPOSED ISOPACHS ARE SHOWN AT 0.5m INTERV/
2. ALL WORKS AND MATERIALS ARE TO COMPLY WITH COUNCIL ENGINEERING STANDARDS .
3. ALL TOPSOIL TO BE STRIPPED AND STOCKPILED PROPOSED EARTHWORKS IN A LOCATION AGR ENGINEER.
4. ALL EROSION AND SEDIMENT CONTROL DEVICES T(AS-BUILT AND INSPECTED BY THE ENGINEE REPRESENTATIVE PRIOR TO COMMENCING THE E/ THE SITE.
5. AREA OF EARTHWORKS = X.XXX ha.
6. EARTHWORK VOLUMES ARE FROM EXISTING SURFA SURFACE AND ARE:

CUT VOLUME= XXXX m^3
FILL VOLUME= XXXX m^3

LEGEND

10.0 PROPOSED CUT ISOPACH
10.0 PROPOSED FILL ISOPACH
EARTHWORKS ZERO CUT/FILL LINE
EARTHWORK EXTENT

CUT PROPOSED CUT
FILL PROPOSED FILL

GEOTECHNICAL DRAINAGE LEGEND
(SEE FIGURE 03 FOR CONSTRUCTION DETAILS)

INDICATIVE ALIGNMENT OF UNDERFILL DRAINAGE. (TO BE CONFIRMED ON SITE DURING CONSTRUCTION)

INDICATIVE ALIGNMENT OF 3M DEEP COUNTERFORT DRAINAGE (12M SPACINGS). RETAINING WALL DRAINAGE TO CONNECT INTO COUNTERFORT DRAINAGE LINES (TO BE CONFIRMED ON SITE DURING CONSTRUCTION)

INDICATIVE POSITION OF ENGINEER APPROVED OUTLET STRUCTURE (TO BE CONFIRMED ON SITE DURING CONSTRUCTION)

Underfill drain to outlet into pond - to be confirmed on site during construction

Source drawing: CivilPlan Consultants Limited, Dwg No. 2011-01-220, dated 03.11.17

revision	description	drawn	approved	date

0 30.0 60.0 90.0 120.0
Horizontal Scale (metres)
0 30.0 60.0 90.0 120.0
Vertical Scale (metres)

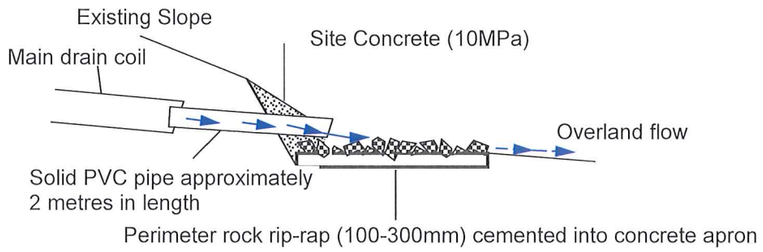
drawn	MPC
approved	CE
date	9.11.17
scale	1:2000
original size	A3

LANDER geotechnical

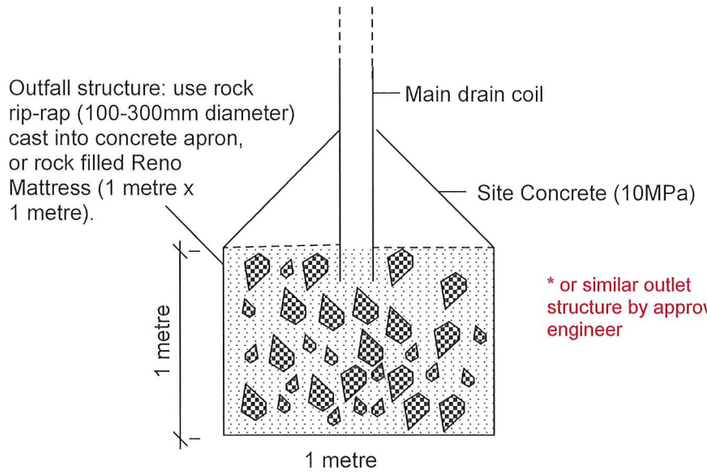
client: HUGHES DEVELOPMENTS LTD
project: 99 ESCOTTS ROAD, TUAKAU
title: GEOTECHNICAL ENGINEERING PLAN
project no: J 00779
figure no: 02

Template revision: 1:2000 (10/12/14)

OUTLET STRUCTURE* - CROSS SECTION VIEW

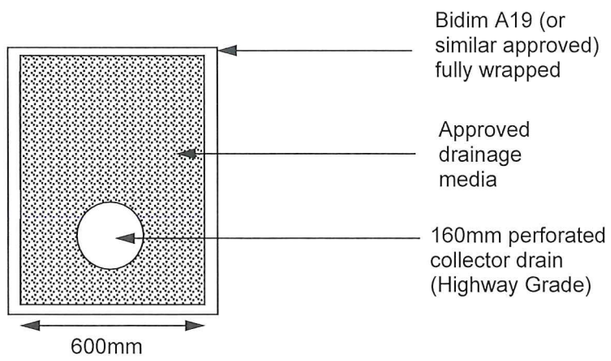


OUTLET STRUCTURE* - PLAN VIEW

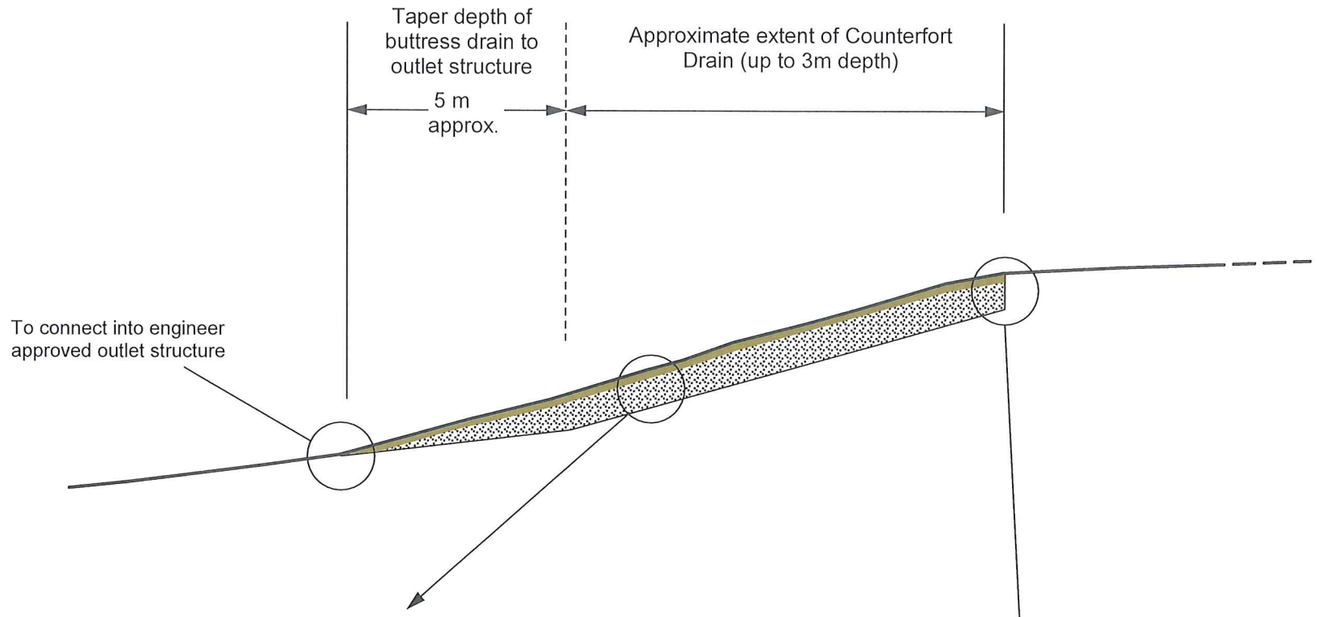


* or similar outlet structure by approved engineer

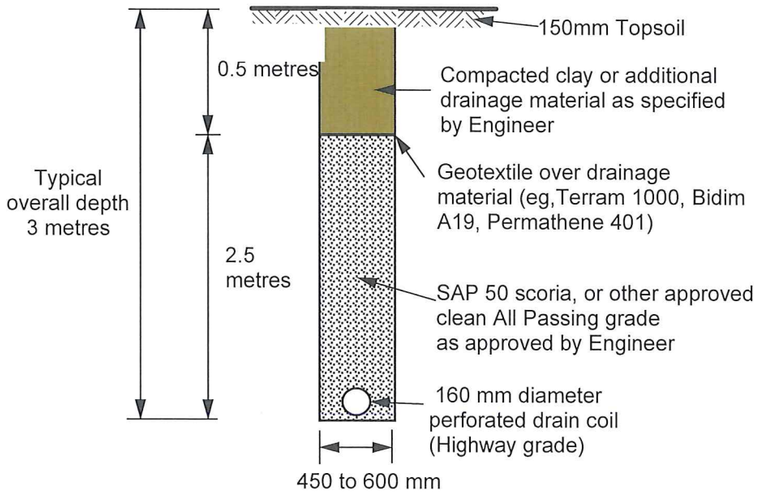
TYPICAL UNDERFILL DRAIN DETAIL - END VIEW

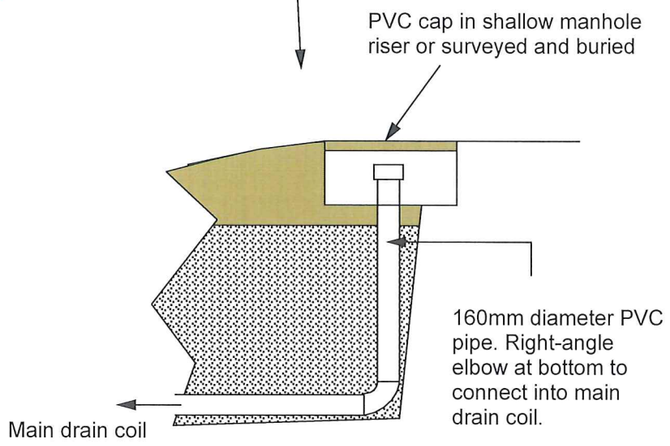


COUNTERFORT DRAINAGE DETAIL - CROSS SECTION VIEW



COUNTERFORT DRAINAGE DETAIL - END VIEW





FLUSHING PORT DETAILS - CROSS SECTION VIEW

revision	description	drawn	approved	date

drawn	MPC
approved	CE
date	9.11.17
scale	NTS
original size	A3

LANDER geotechnical

client: HUGHES DEVELOPMENTS LTD

project: 99 ESCOTTS ROAD, TUAKAU

title: GEOTECHNICAL DRAINAGE DETAIL

project no: J 00779

figure no: 03

Appendix 3

Lander Geotechnical Field Investigation Data

Client : HUGHES DEVELOPMENTS LTD

Project Location : 99 ESCOTTS ROAD, TUAKAU

Job Number: J00779

Auger Borehole No. HA01

Sheet 1 of 6

Vane Head:	Logged By:	Processor :	Date:
946	JL	LJ	30.10.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, orange/brown. Very stiff, moist, medium plasticity [ASH]					
becoming high plasticity	0.5		186+		
becoming insensitive	1.0		155/106	1.5	
clayey SILT with minor fine sand, orange/brown. Very stiff, moist, low to medium plasticity, moderately sensitive, with occasional fine gravel sized inclusions					Scala Penetrometer Test (blows/100mm)
with some fine sand, with minor fine gravel sized inclusion	1.5		163/61	2.7	
			UTP		
EOB at 1.7m. Too hard to auger further. Inferred boulder inclusion. Scala penetrometer test commenced and found effective refusal at 2.0m.					16 12 20+ (ER) ER = Effective Refusal
	2.0				
	2.5				
	3.0				
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic
Fill	Gravel	Siltstone	No Core
Clay	Organic	Limestone	
Silt	Pumice	Volcanic	

Client : HUGHES DEVELOPMENTS LTD

Project Location : 99 ESCOTTS ROAD, TUAKAU

Job Number: J00779

Auger Borehole No. HA02

Sheet 2 of 6

Vane Head:	Logged By:	Processor :	Date:
946	JL	LJ	30.10.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY with trace fine sand, orange/brown. Very stiff, moist, medium plasticity, moderately sensitive, with occasional course sand to fine gravel sized inclusions [ASH]		0.5		131/45	2.9	
		1.0		184/70	2.6	
		1.5		186+		
becoming saturated, insensitive, with some fine sand, with minor course sand to fine gravel sized inclusions		2.0	▽	139/75 UTP	1.9	Scala Penetrometer Test (blows/100mm) 20+ (ER) ER = Effective Refusal
EOB at 2.2m. Too hard to auger further. Inferred boulder inclusion. Scala penetrometer test commenced and found effective refusal immediately.		2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0				

LANDER geotechnical

Comments:
Groundwater encountered 2.0m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic				
Fill	Gravel	Siltstone	No Core				
Clay	Organic	Limestone					
Silt	Pumice	Volcanic					

Client : HUGHES DEVELOPMENTS LTD

Project Location : 99 ESCOTTS ROAD, TUAKAU

Job Number: J00779

Auger Borehole No. HA03

Sheet 3 of 6

Vane Head:	Logged By:	Processor :	Date:
946	JL	LJ	30.10.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY with trace fine sand, orange/brown. Very stiff, moist, medium plasticity, moderately sensitive [ASH]						
becoming wet, with occasional course sand to fine gravel sized inclusions		0.5		152/70	2.2	Scala Penetrometer Test (blows/100mm)
becoming saturated			▽			
EOB at 1.0m. Too hard to auger further. Inferred boulder inclusion. Scala penetrometer test commenced and found effective refusal immediately.		1.0		UTP		20+ (ER) ER = Effective Refusal
		1.5				
		2.0				
		2.5				
		3.0				
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater encountered 0.9m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked:

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : HUGHES DEVELOPMENTS LTD

Project Location : 99 ESCOTTS ROAD, TUAKAU

Job Number: J00779

Auger Borehole No. HA04

Sheet 4 of 6

Vane Head:	Logged By:	Processor :	Date:
946	JL	LJ	30.10.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, orange/brown. Very stiff, moist, medium plasticity [ASH]	0.5		UTP		
becoming very stiff, insensitive	1.0		178/106	1.7	
with some course sand to fine gravel sized inclusions					
with trace course sand to fine gravel sized inclusions	1.5		UTP		
becoming high plasticity					
becoming yellow/brown, with minor course sand to fine gravel sized inclusions	2.0		117/65	1.8	
becoming moderately sensitive	2.5		107/41	2.6	
becoming stiff, wet	3.0		69/35	2.0	
at 3.2m, with intermixed white, high plasticity clay					
clayey SILT, orange. Very stiff, wet, medium plasticity, moderately sensitive	3.5		140/65	2.2	
	4.0		156/67	2.3	
clayey SILT, orange streaked light yellow/brown. Stiff, wet, low to medium plasticity, insensitive	4.5		86/45	1.9	
fine GRAVEL, black. Loose, saturated, no plasticity			UTP		
EOB at 4.9m. Too hard to auger further. Inferred boulder inclusion.	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	HUGHES DEVELOPMENTS LTD	**Auger Borehole No.**	HA05
Project Location :	99 ESCOTTS ROAD, TUAKAU		Sheet 5 of 6
Job Number:	J00779	Vane Head: 2153 / Logged By: CE / Processor : LJ / Date: 30.10.17	

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
silty CLAY, orange. Hard, moist, medium plasticity [ASH]		0.5		UTP		
clayey SILT, orange. Hard, moist, medium plasticity		1.0		UTP		
		1.5		UTP		
		2.0		UTP		
becoming very stiff, moderately sensitive		2.5		101/39	2.6	
clayey SILT with fine sand, orange/brown. Stiff, moist, medium plasticity, insensitive, with some black streaks [TUFF]		3.0		91/49	1.9	
with moderately thin bed of fine gravel inclusions, and some limonite staining						
becoming very stiff		3.5	▽	196+		
becoming sensitive		4.0		156/35	4.5	
becoming brown, with black speckles, with some fine sand		4.5		UTP		
		5.0		UTP		
EOB at 5.0m. Target Depth.		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater encountered 4.0m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : HUGHES DEVELOPMENTS LTD

Project Location : 99 ESCOTTS ROAD, TUAKAU

Job Number: J00779

Auger Borehole No. HA06

Sheet 6 of 6

Vane Head:	Logged By:	Processor :	Date:
2153	CE	LJ	30.10.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL		▽			
silty CLAY, orange. Stiff, moist, high plasticity, insensitive [ALLUVIUM]	0.5		70/39	1.8	
becoming firm, wet, sensitive, push probed to 2.0m	1.0		28/7	4.0	
becoming light grey, stiff					
becoming stiff	1.5		98/17	5.8	
becoming very stiff	2.0		115/28	4.1	Scala Penetrometer Test (blows/100mm)
silty CLAY with trace fine sand, grey. Hard, moist, medium plasticity					
EOB at 2.5m. Too hard to auger further. Scala penetrometer test commenced and found effective refusal immediately.	2.5		UTP		20+ (ER)
	3.0				ER = Effective Refusal
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater encountered 0.8m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Appendix 4

Ground Consulting Limited Field Investigation Data (Supplementary Data)

HAND-AUGER LOG

Bore No.: **HA 101**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa) 100 200	Scala Penetrometer Test (blows/50mm) 2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 102**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.		0			
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>199	
			2		>199	
					>199	
			3		193/108	
	Becoming dark orange/brown.				>199	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 103**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					196/102	
	Becoming orange with pink mottles.		2		>199	
					>199	
	Becoming dark orange/brown.		3		>199	
					159/99	
	EOB @4.0m		4		187/119	
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 104**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
	Becoming orange with pink mottles.				>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 105**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>199	
	Becoming orange with pink mottles.		2		>199	
					193/111	
			3		196/114	
	Becoming dark orange/brown.				>199	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 106**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				159/119	
	Becoming orange with brown mottles.		1		>199	
					>199	
			2		>199	
					>199	
			3		>199	
	Becoming dark orange/brown.				>199	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 107**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming dark orange/brown.		1		>199	
					>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 108**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
	TOPSOIL.					
WEATHERED VOLCANIC ASH	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>!99	
			2		162/91	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 109**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>199	
			2		>199	
					>199	
			3		>199	
	Becoming light orange/brown.				>199	
	EOB @4.0m		4		>199	
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 110**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>199	
			2		>199	
	Becoming pinkish orange with brown mottles.				>199	
			3		>199	
	Becoming dark orange/brown.				>199	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 111**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
	TOPSOIL.					
WEATHERED VOLCANIC ASH	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
	Becoming light orange with light brown mottles.				>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 112**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light orange with brown mottles.		1		>199	
					>199	
	Becoming light brown.		2		>199	
					165/119	
			3		>199	
	Becoming dark reddish brown.				>199	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 113**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
					>!99	
			2		>199	
	Becoming dark brown with red mottles.				>199	
	EOB @3.0m on auger refusal.		3		UTP	
	No groundwater encountered		4			
			5			
			6			

Vane Shear Strength (kPa): 100, 200

Scala Penetrometer Test (blows/50mm): 2, 4, 6, 8, 10

HAND-AUGER LOG

Bore No.: **HA 114**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming light brown with orange mottles.		1		>199	
	Becoming reddish brown.				>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 115**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				196/131	
	Becoming light brown with orange mottles.		1		>199	
	Becoming reddish brown.				>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 116**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				182/136	
	Becoming dark brown with orange mottles.		1		156/108	
	Becoming reddish brown.				>!99	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 117**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				159/105	
	Becoming dark brown with orange mottles.		1		>199	
					193/114	
			2		142/105	
					>199	
			3		156/88	
	Becoming dark orange/brown.				182/111	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 118**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				>199	
	Becoming dark brown with orange mottles.		1		>199	
					>199	
	Very dense, silty SAND at base of auger.		2		190/82	
	EOB @2.5m on auger refusal.				UTP	
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 119**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				193/133	
	Becoming light brown with orange mottles.		1		>199	
	Becoming dark reddish brown.				>199	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 120**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Very stiff to hard, moist, moderate plasticity, insensitive.				196/125	
	Becoming dark brown with orange mottles.		1		>199	
					159/97	
			2		>199	
					>199	
			3		153/94	
	Becoming dark orange with brown mottles.				184/116	
			4		>199	
	EOB @4.0m					
	No groundwater encountered		5			
			6			

HAND-AUGER LOG

Bore No.: **HA 121**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming dark brown with orange mottles.		1		165/111	
					176/114	
	Dense, silty SAND on base of auger.		2		UTP	
	EOB @2.1m on auger refusal.					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

Bore No.: **HA 122**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming dark brown with orange mottles.		1		>199	
	Becoming light reddish brown.				>199	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

HAND-AUGER LOG

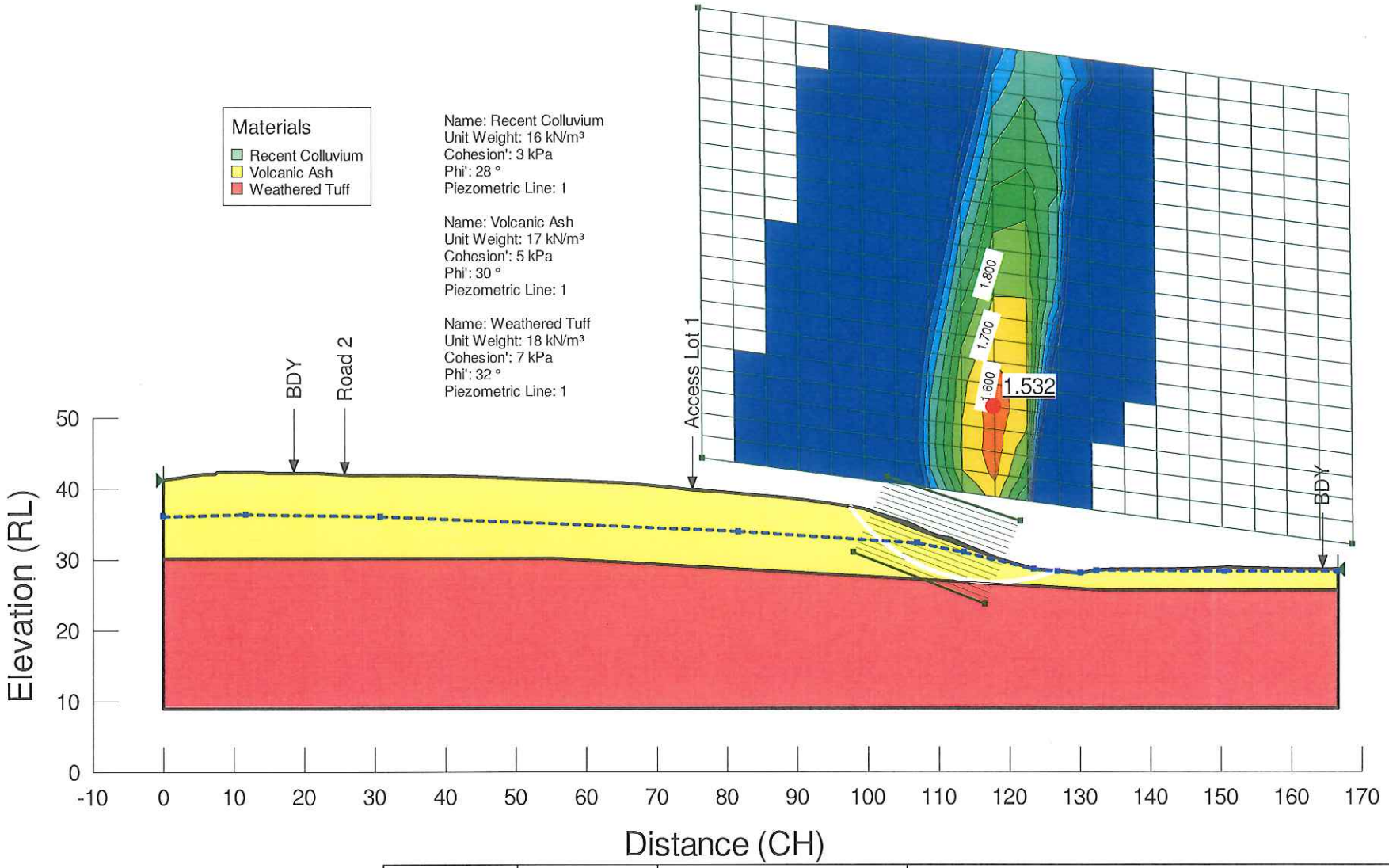
Bore No.: **HA 123**		Project: **Titchmarsh Subdivision. Escotts Rd, Tuakau.**	
Augered by: J.M	Checked by: F.W	Date: 03 November 2014	

Ground CONSULTING LTD

Geology	Soil Description	Soil Symbol	Depth (m)	Water Level	Vane Shear Strength (kPa)	Scala Penetrometer Test (blows/50mm)
					100 200	2 4 6 8 10
WEATHERED VOLCANIC ASH	TOPSOIL.					
	Clayey SILT with some sand; Hard, moist, moderate plasticity, insensitive.				>199	
	Becoming dark brown with orange mottles.		1		>199	
	Becoming light reddish brown.				>199	
			2		>199	
	EOB @2.0m					
	No groundwater encountered		3			
			4			
			5			
			6			

Appendix 5

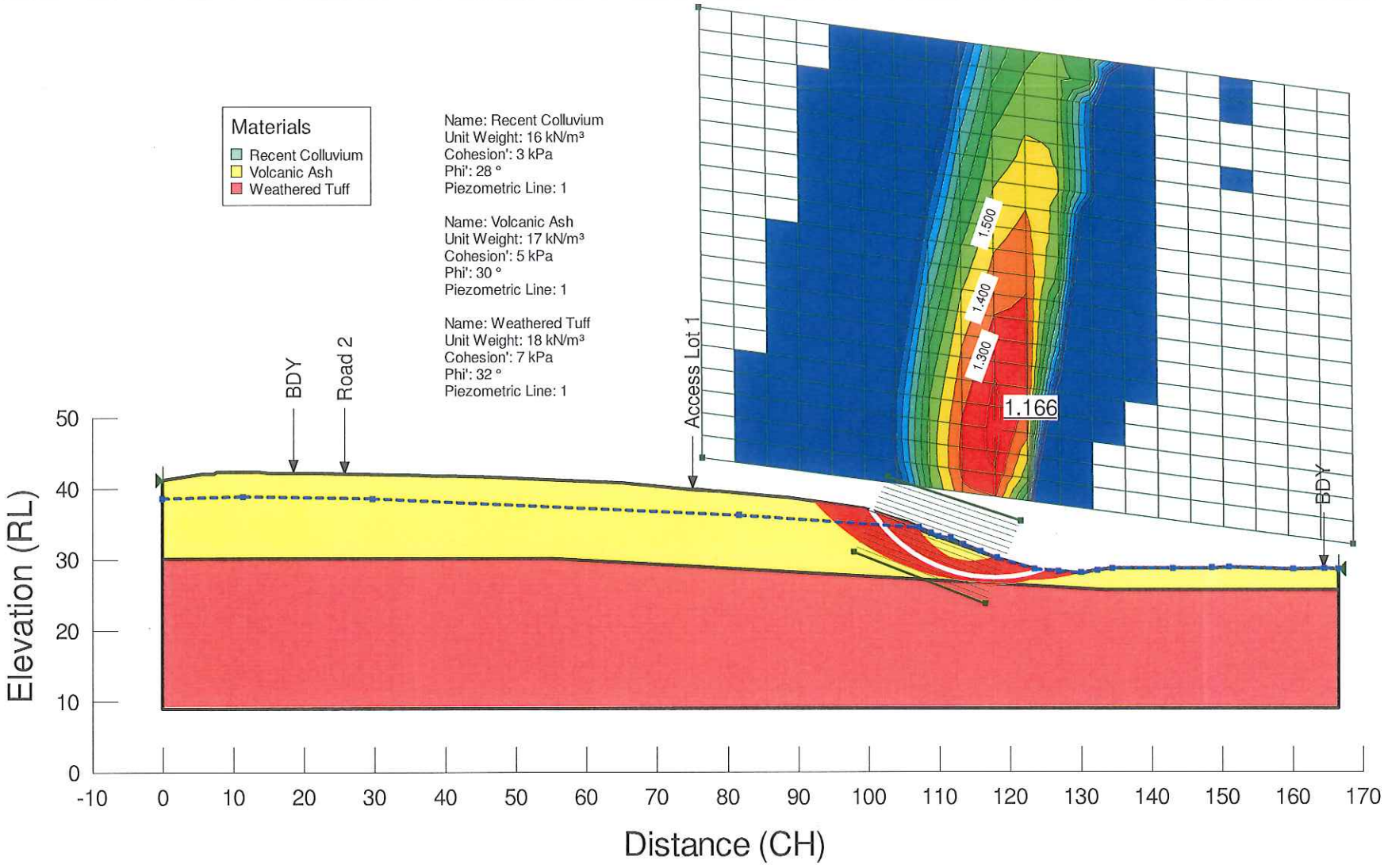
Slope Stability Analysis Results



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

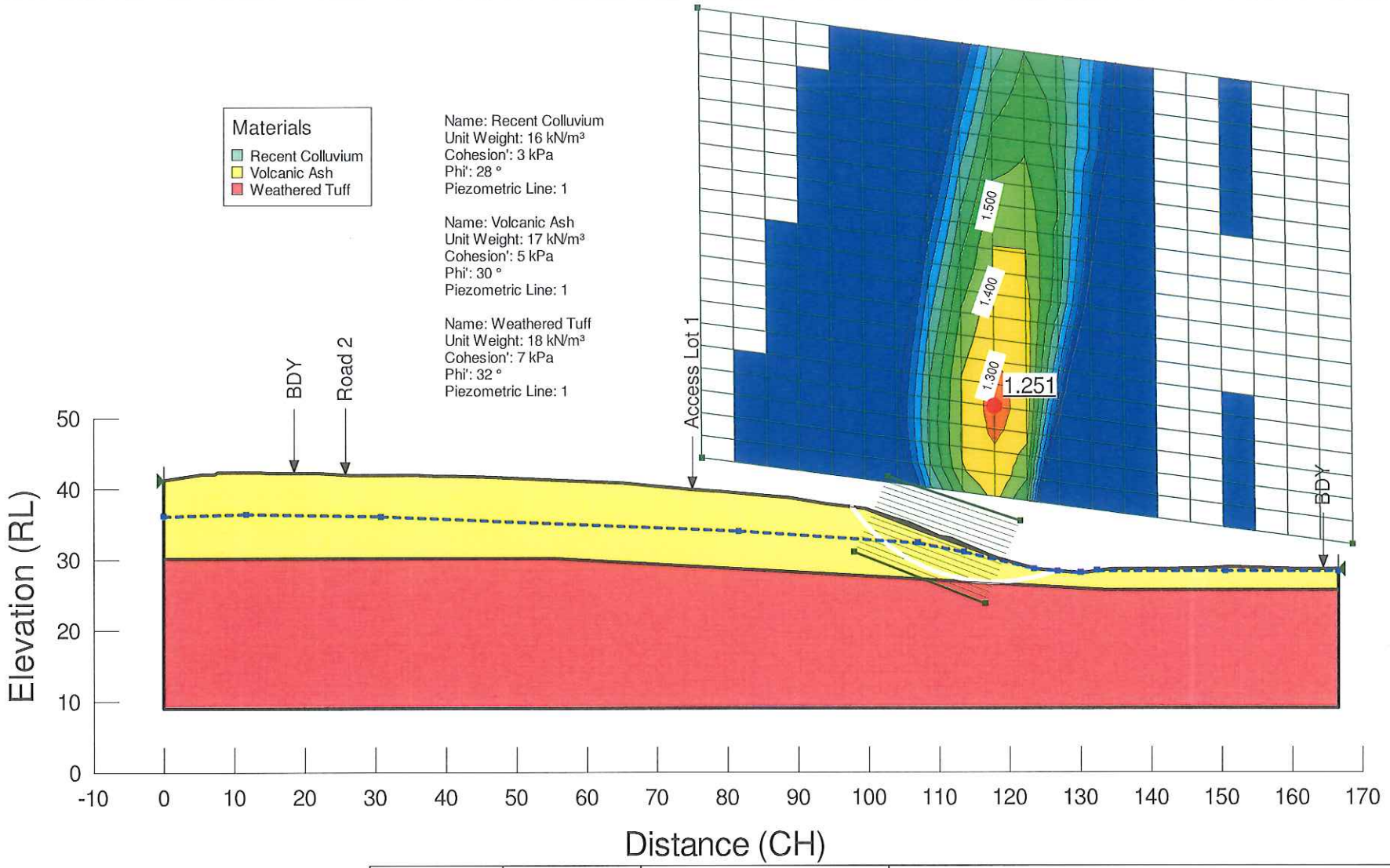
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION A-A': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **A.1**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

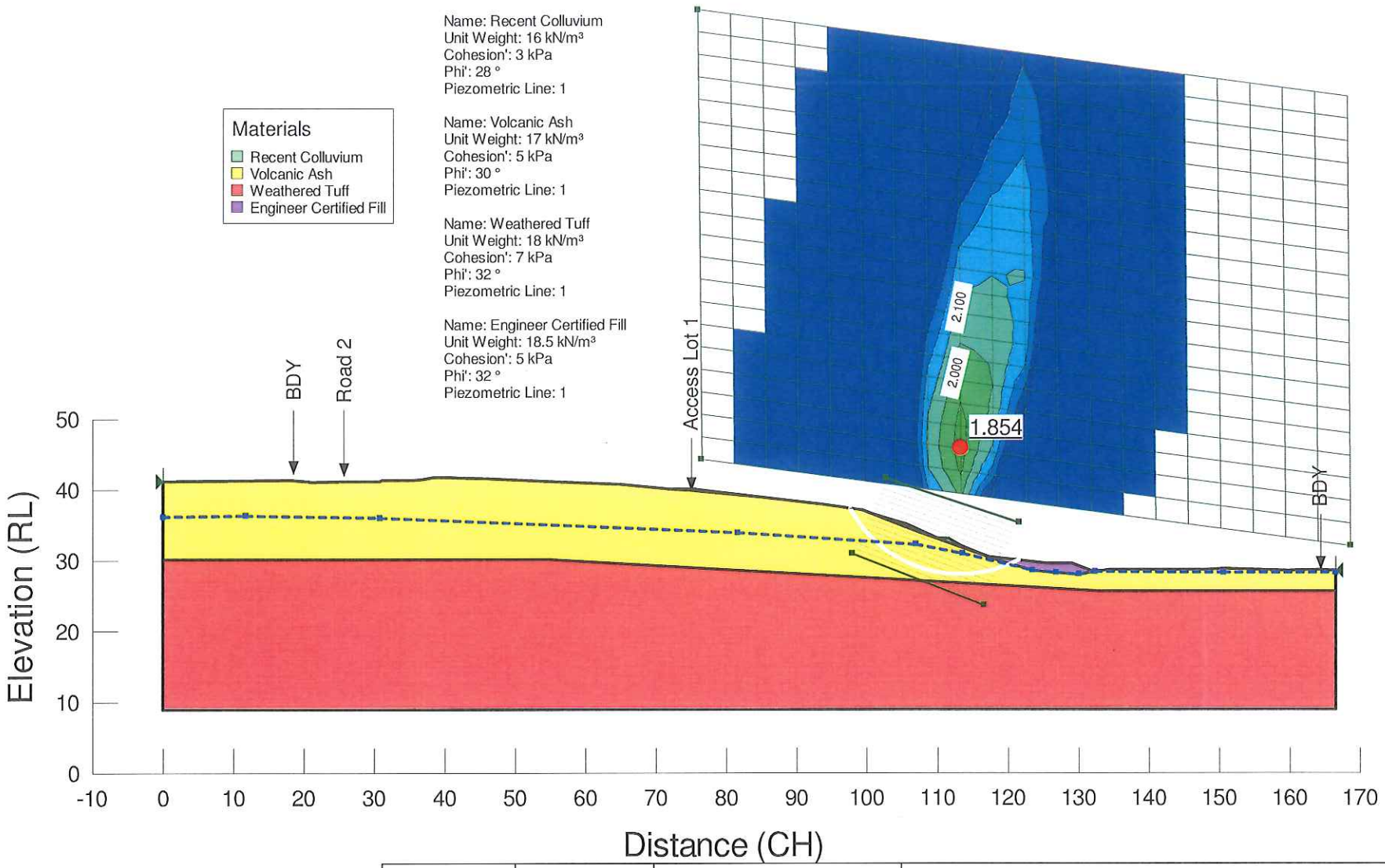
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION A-A': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: A.2



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

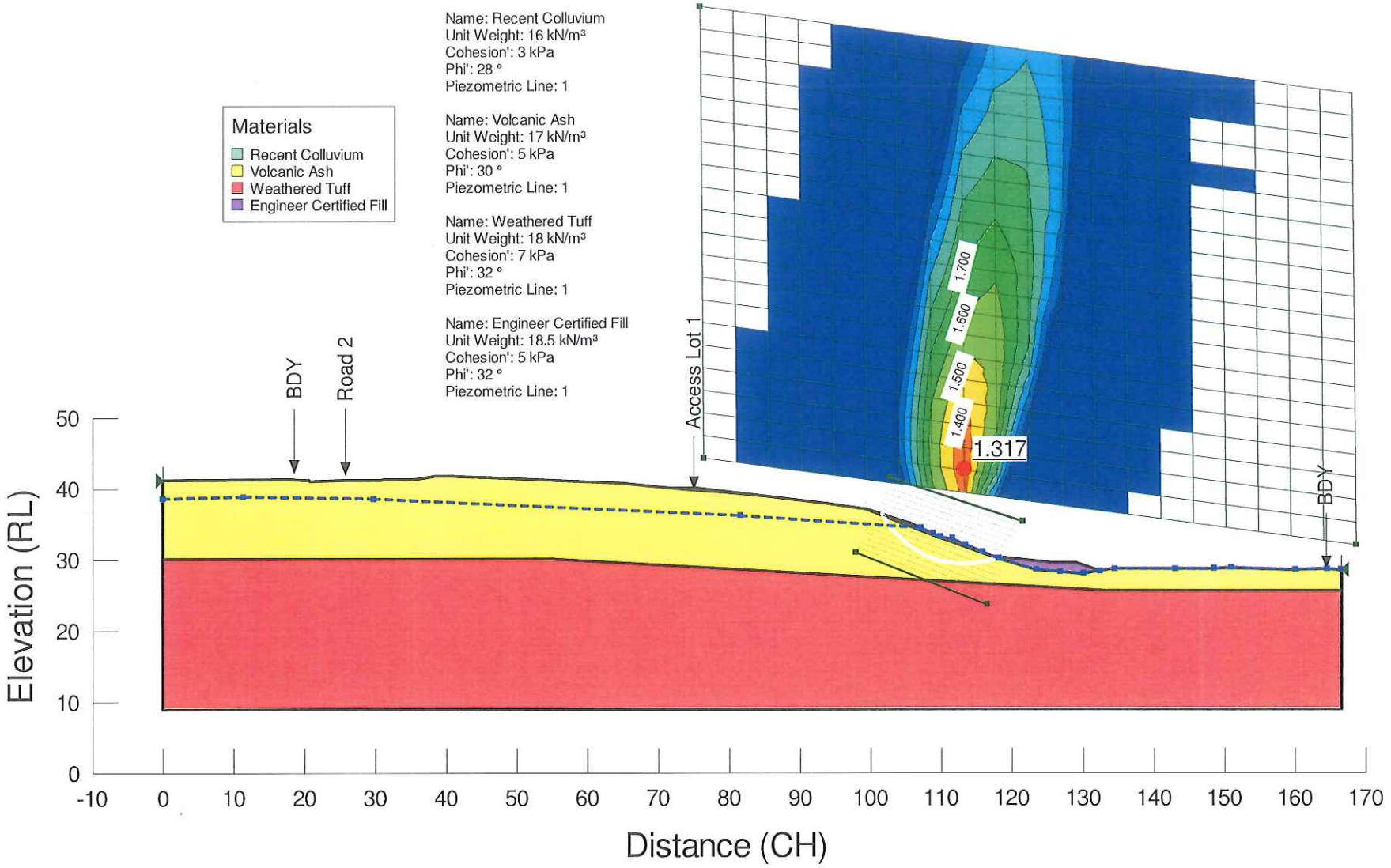
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION A-A': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: A.3



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

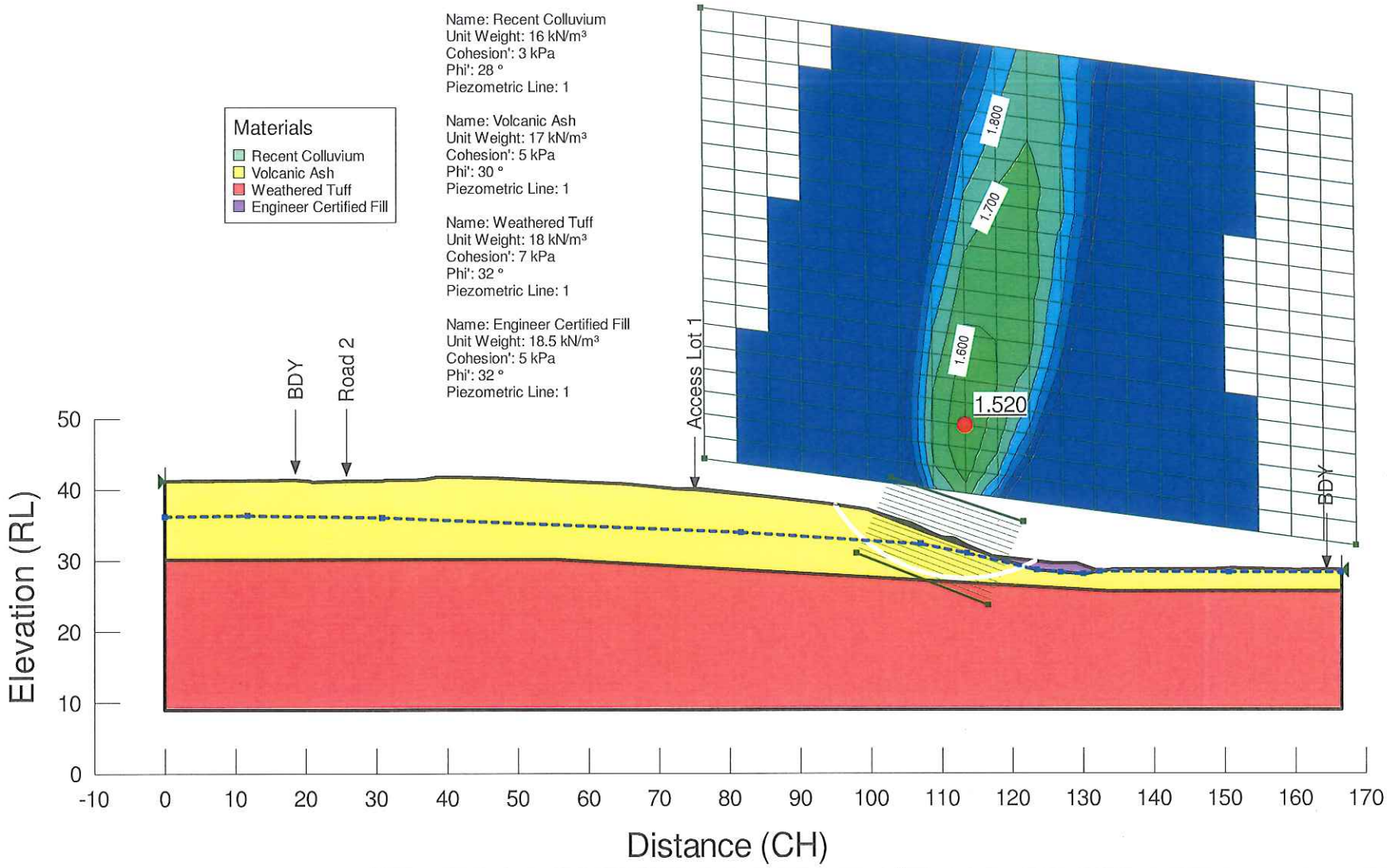
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION A-A': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: A.4



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

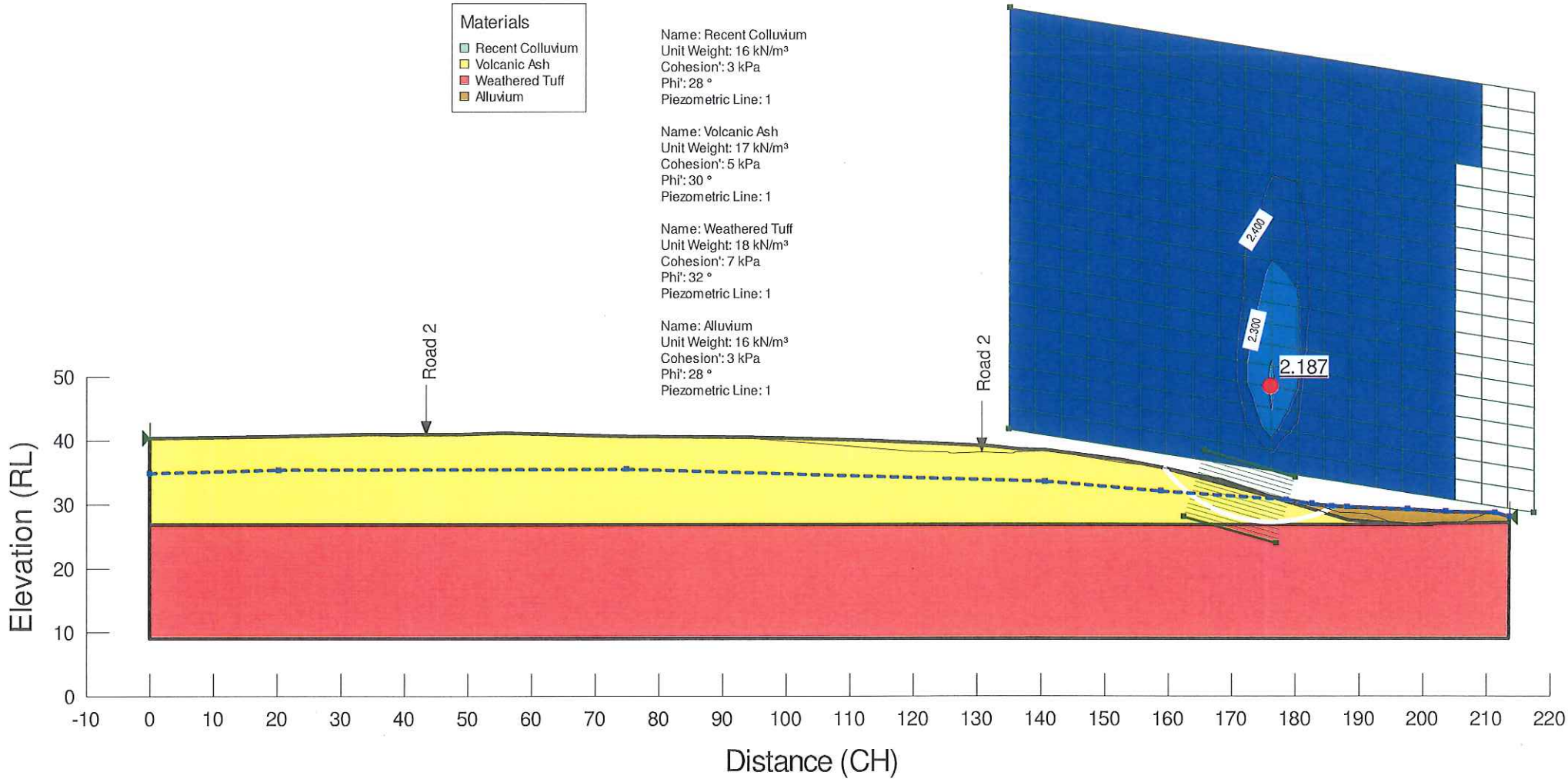
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION A-A': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: A.5



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

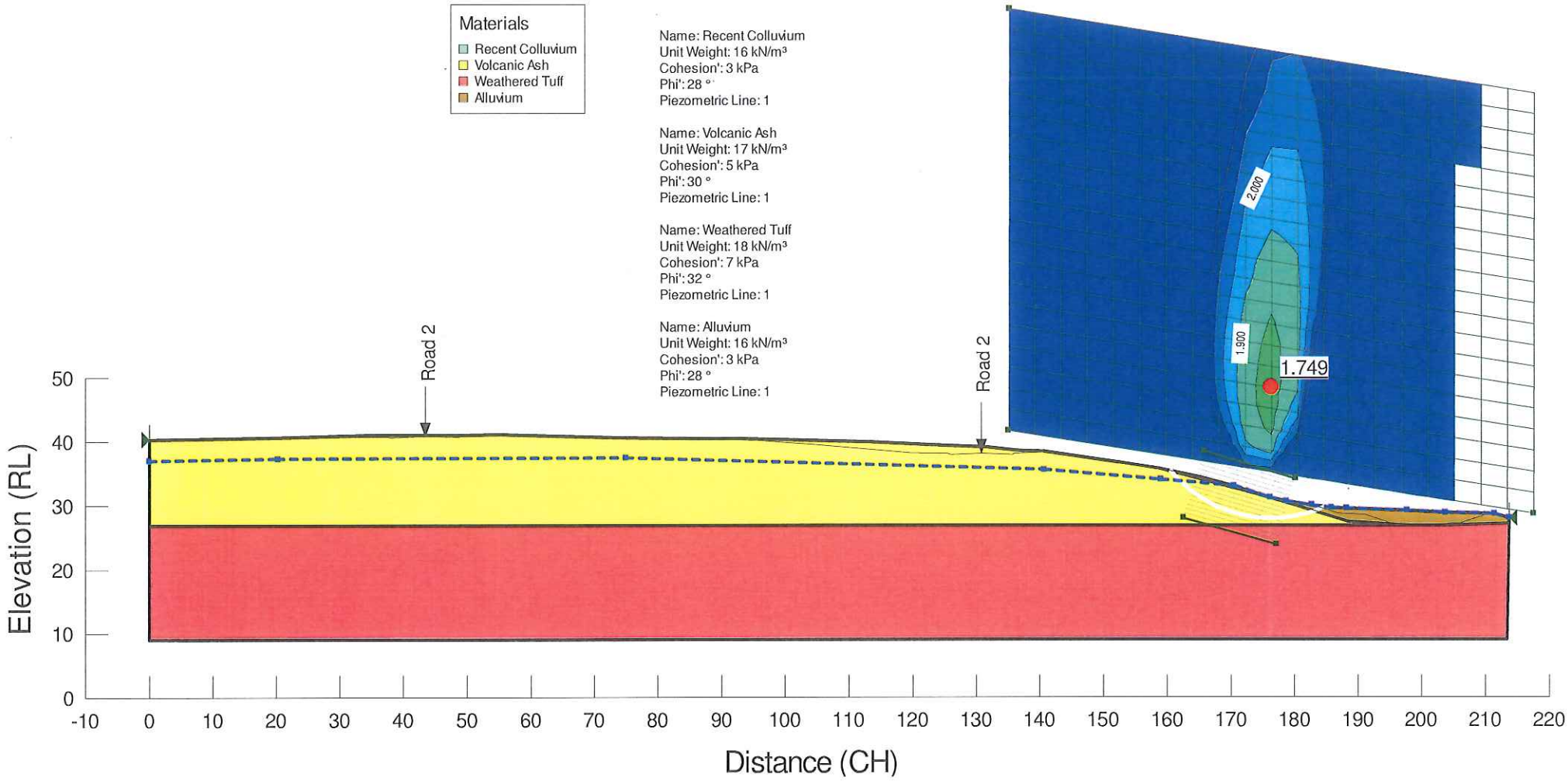
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION A-A': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)**
Job no: **J00779**	Case no: **A.6**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

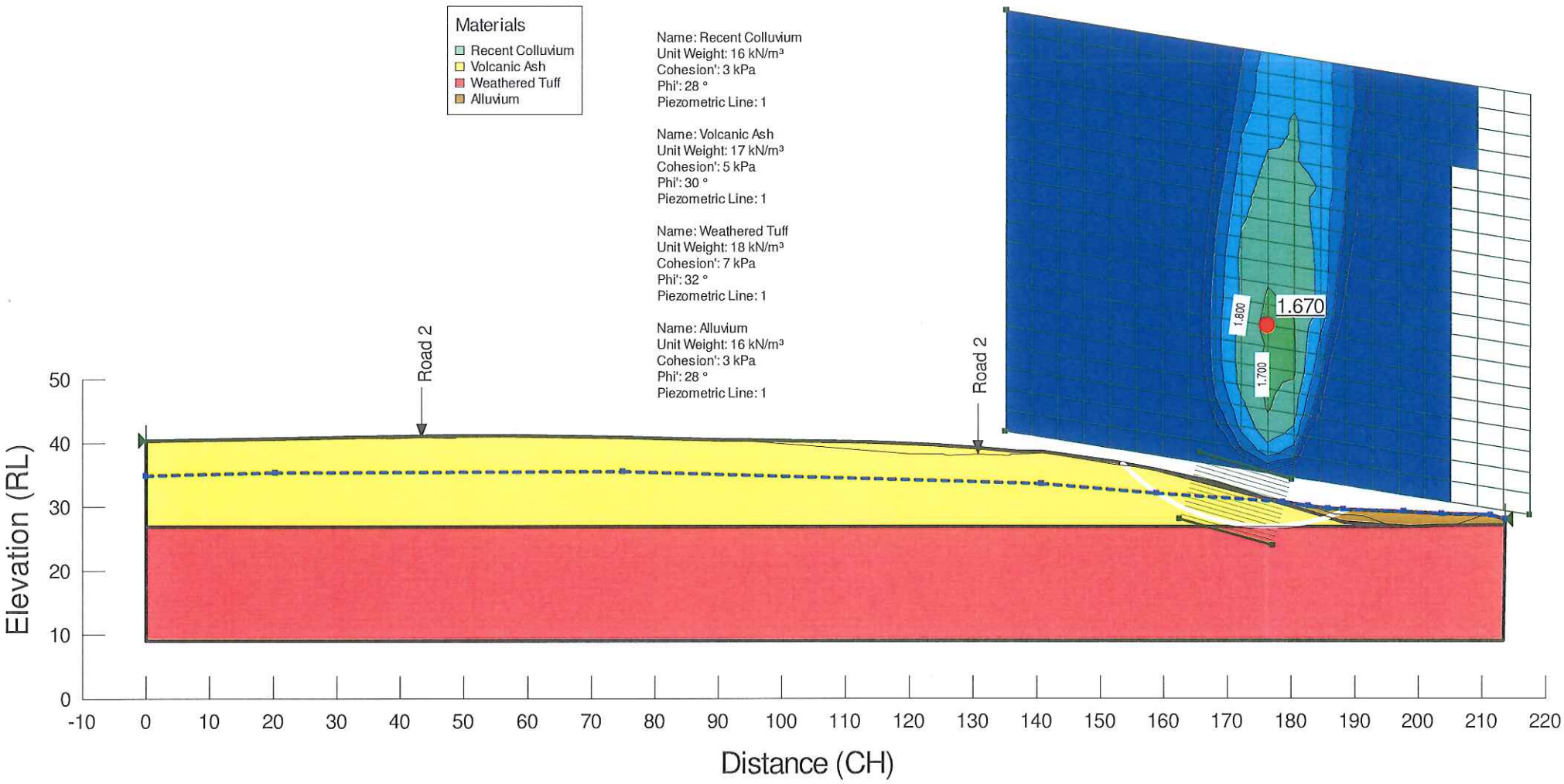
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION B-B': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **B.1**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

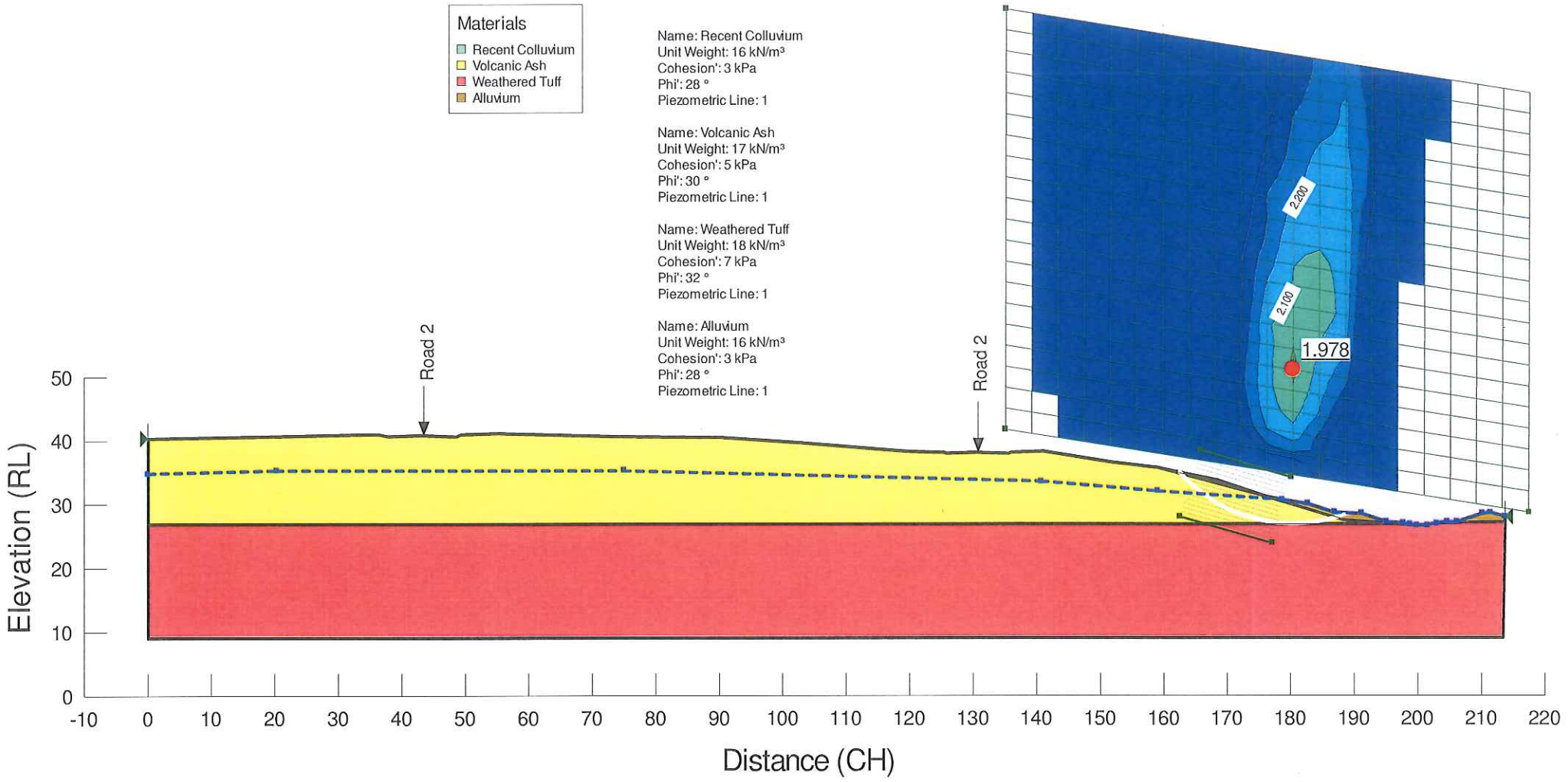
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION B-B': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **B.2**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

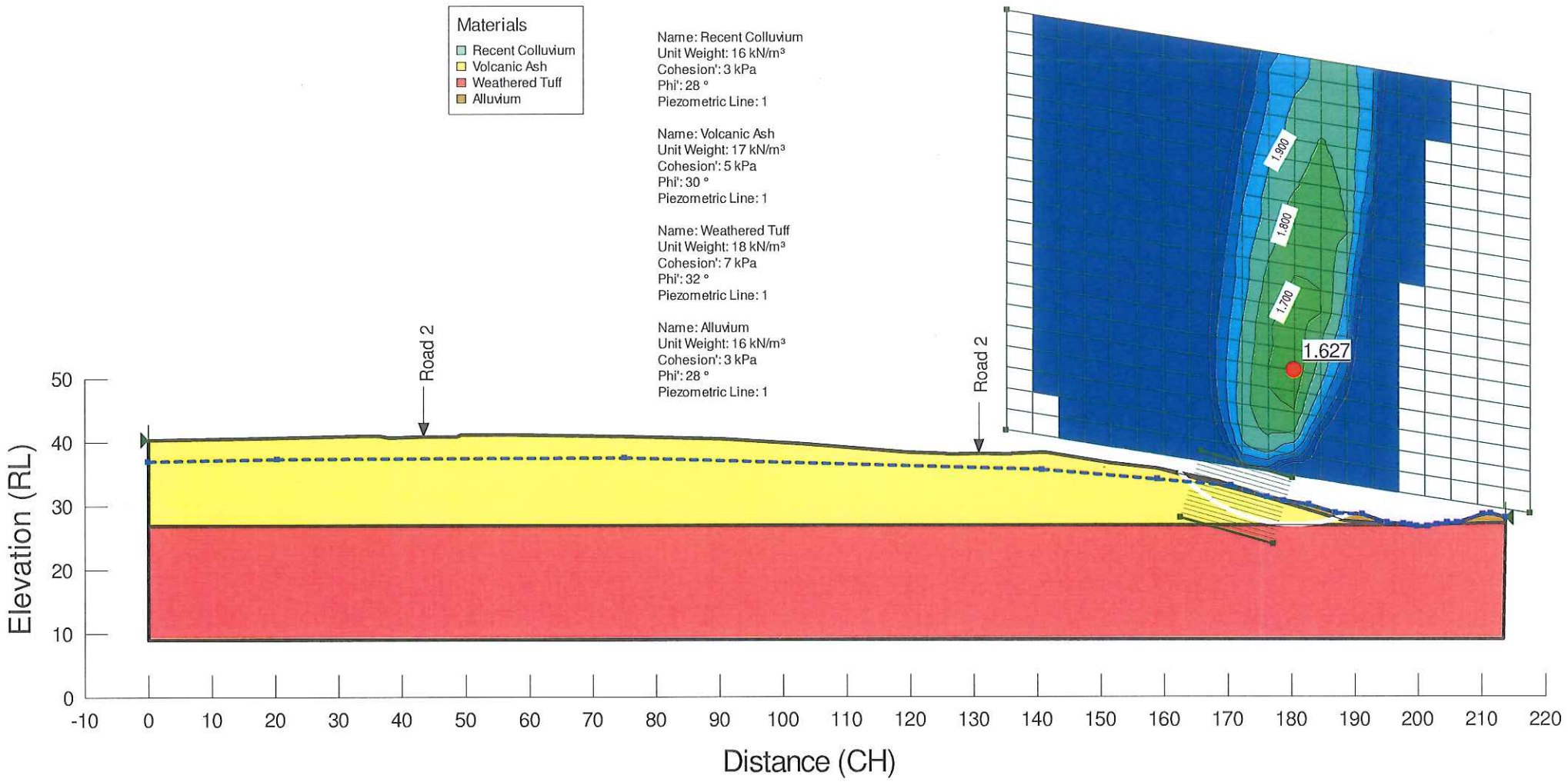
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION B-B': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)**
Job no: **J00779**	Case no: **B.3**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

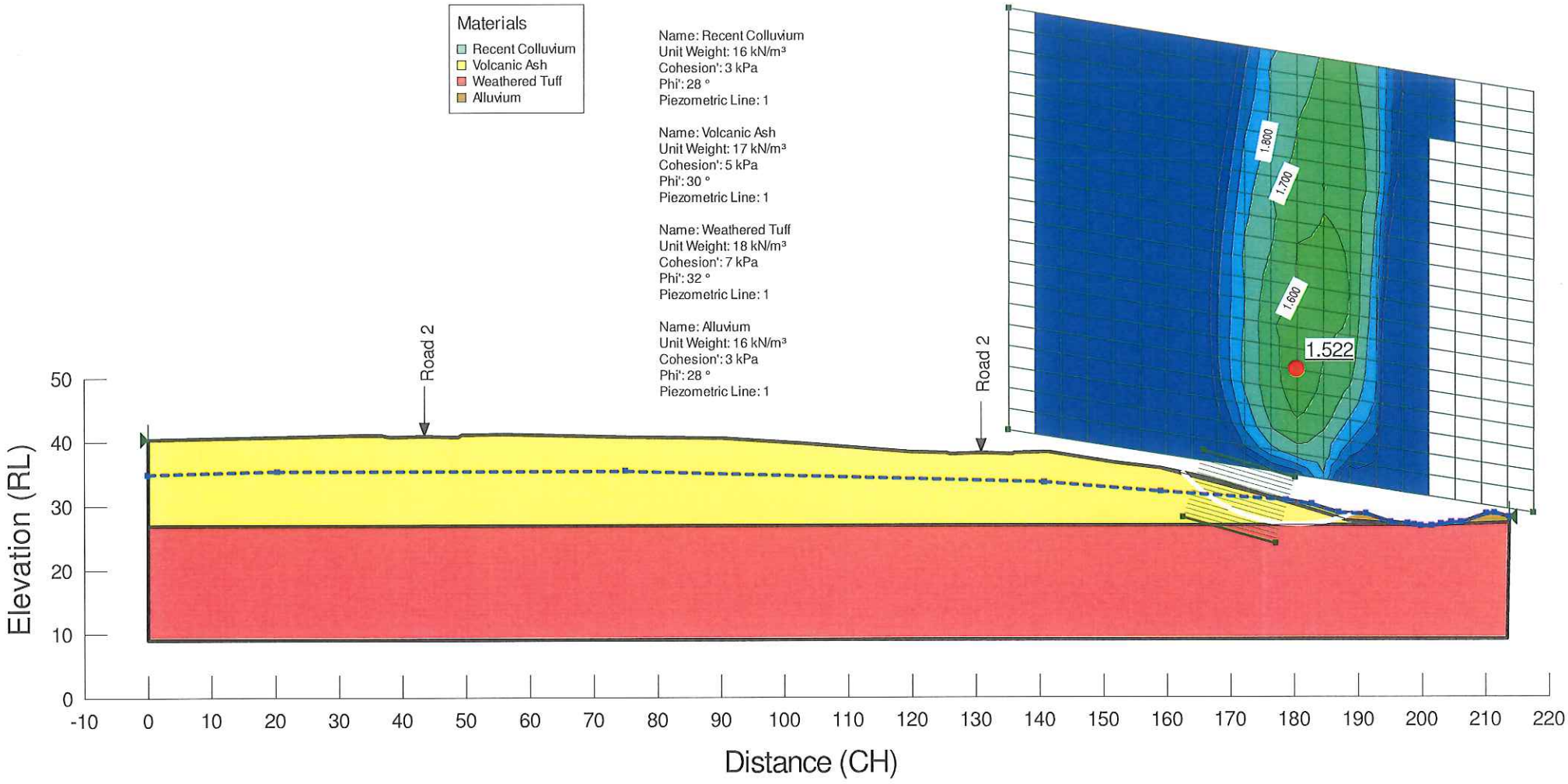
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION B-B': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: B.4



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

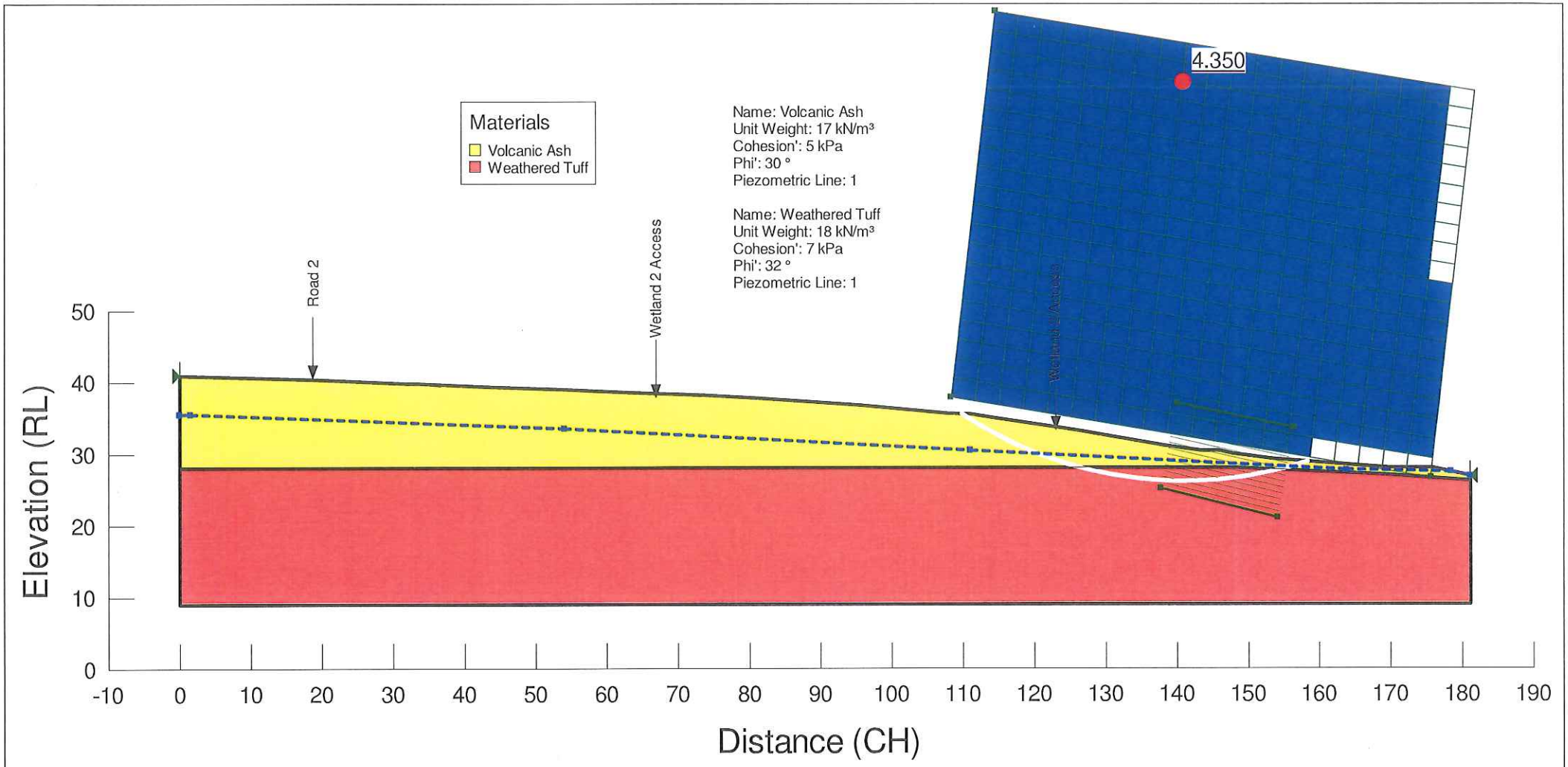
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION B-B': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: B.5



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

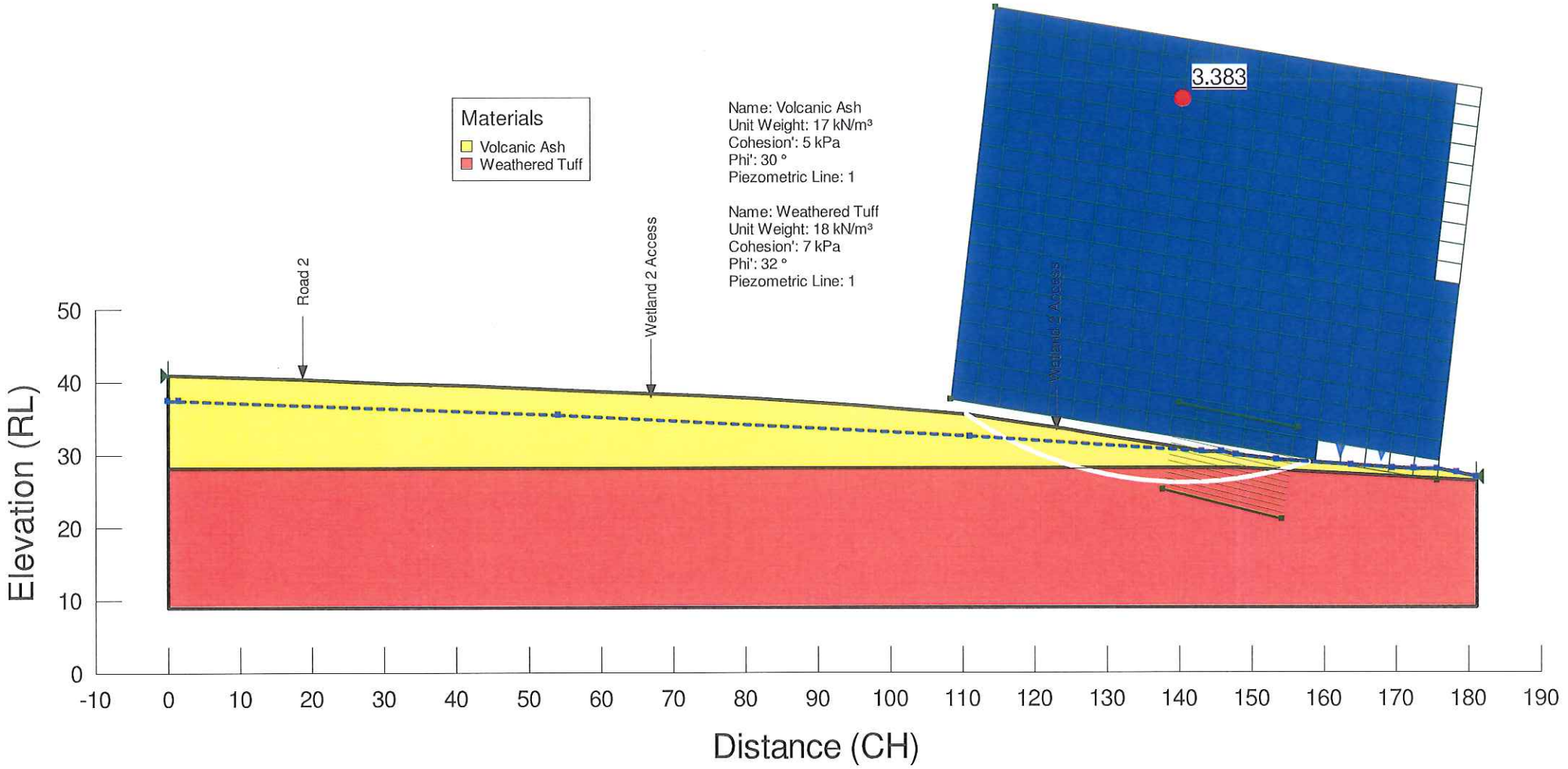
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION B-B': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: B.6



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

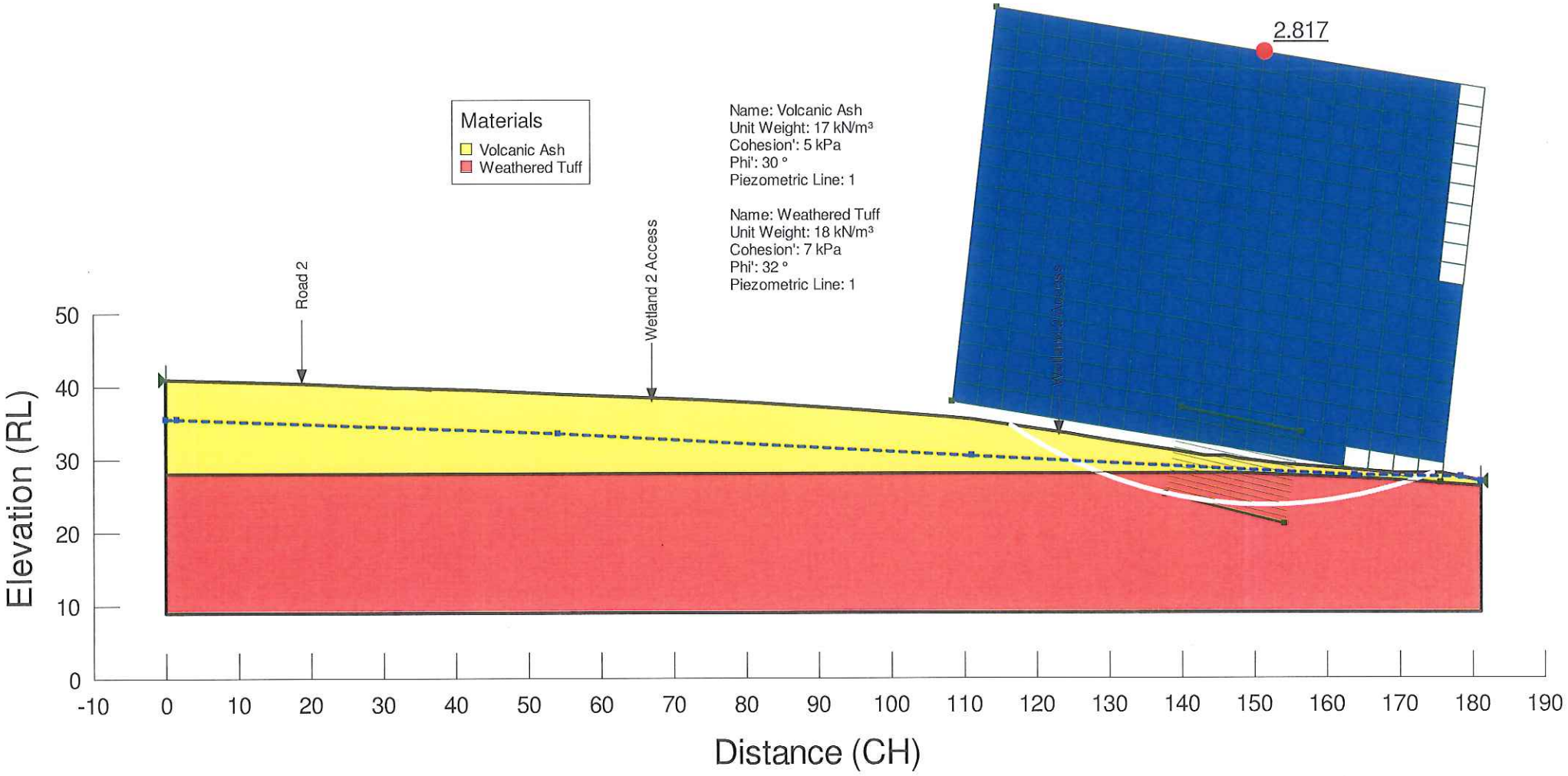
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION C-C': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **C.1**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

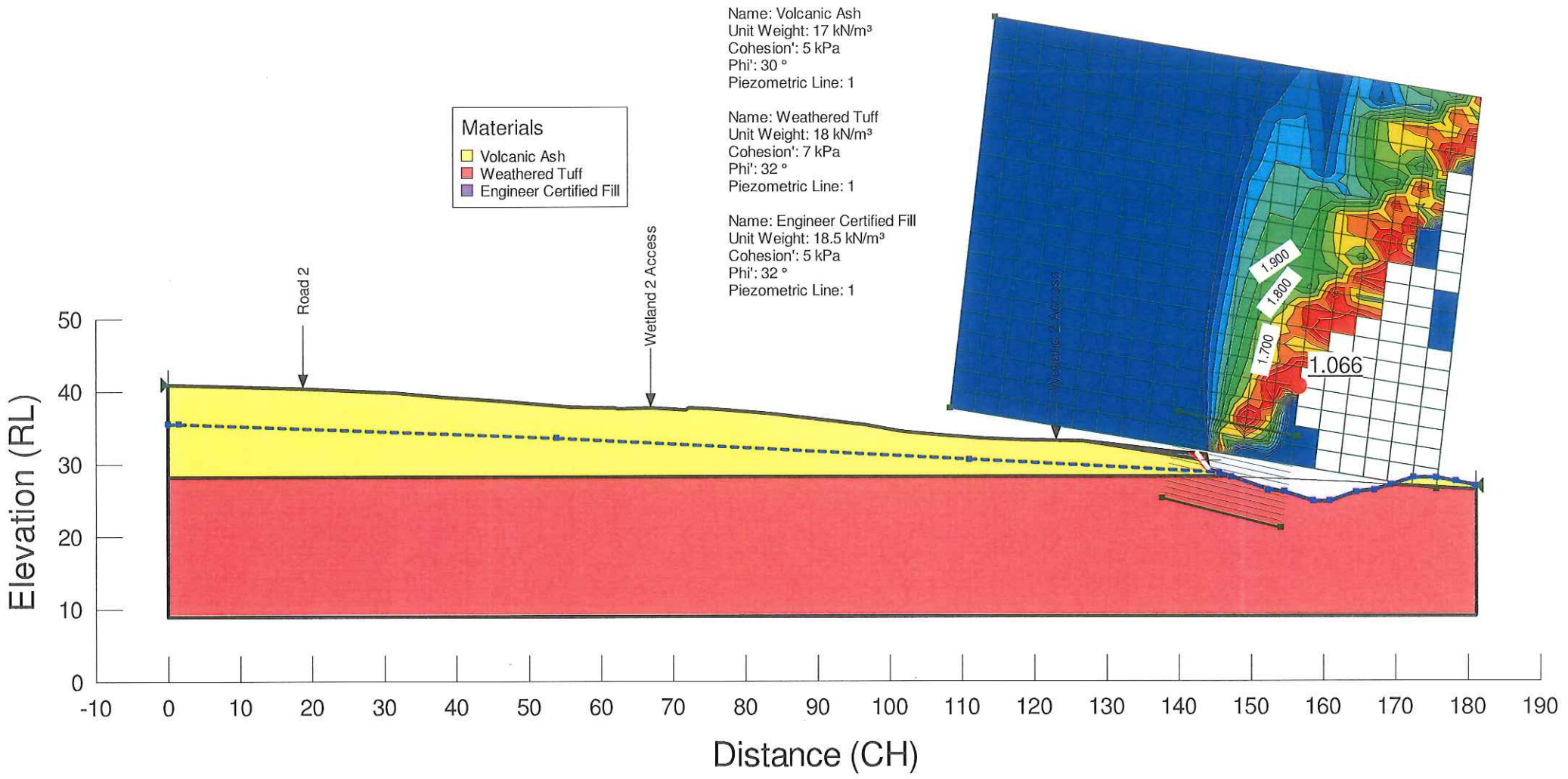
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: C.2



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

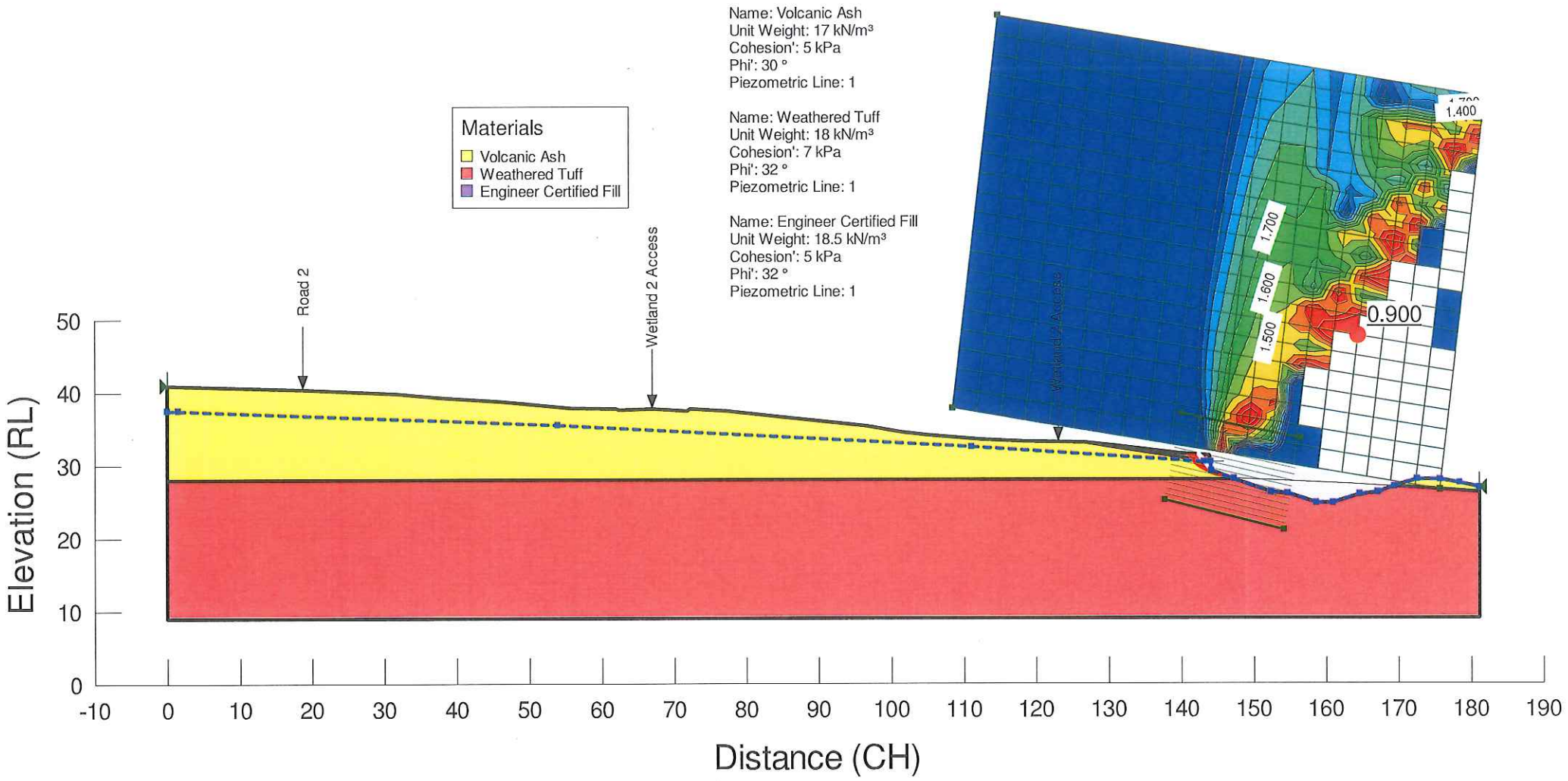
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: C.3



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

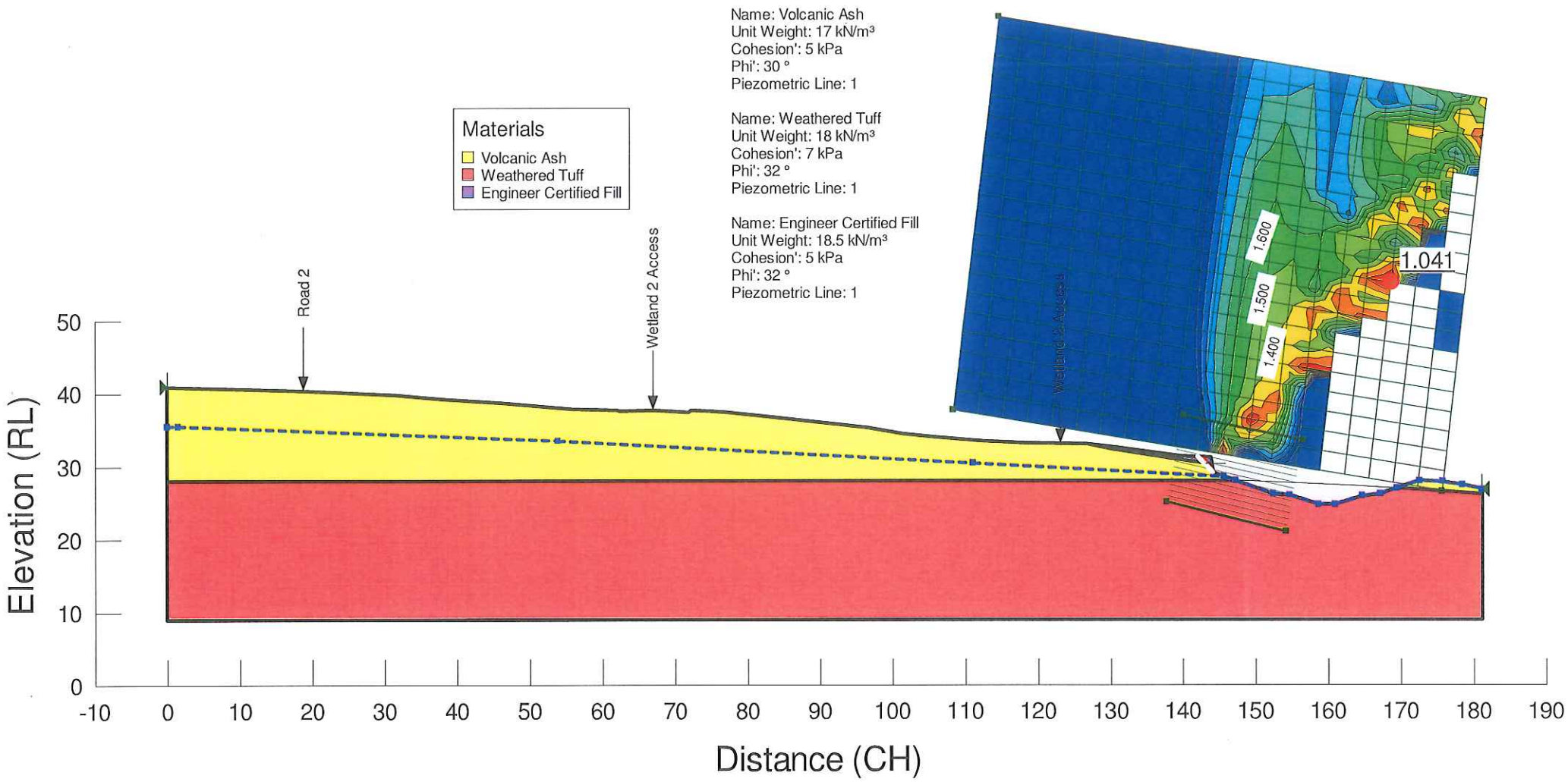
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: C.4



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

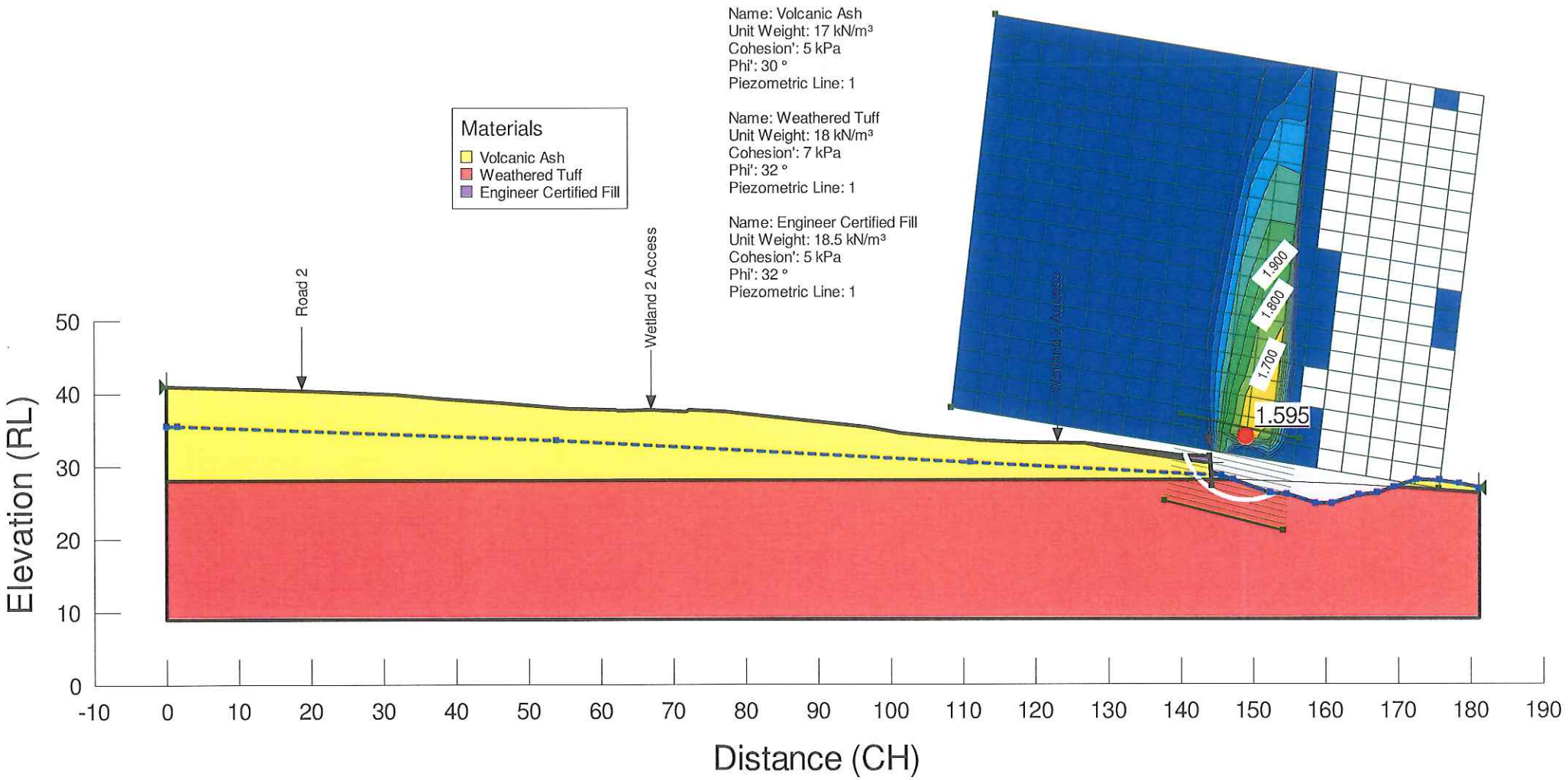
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: C.5



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

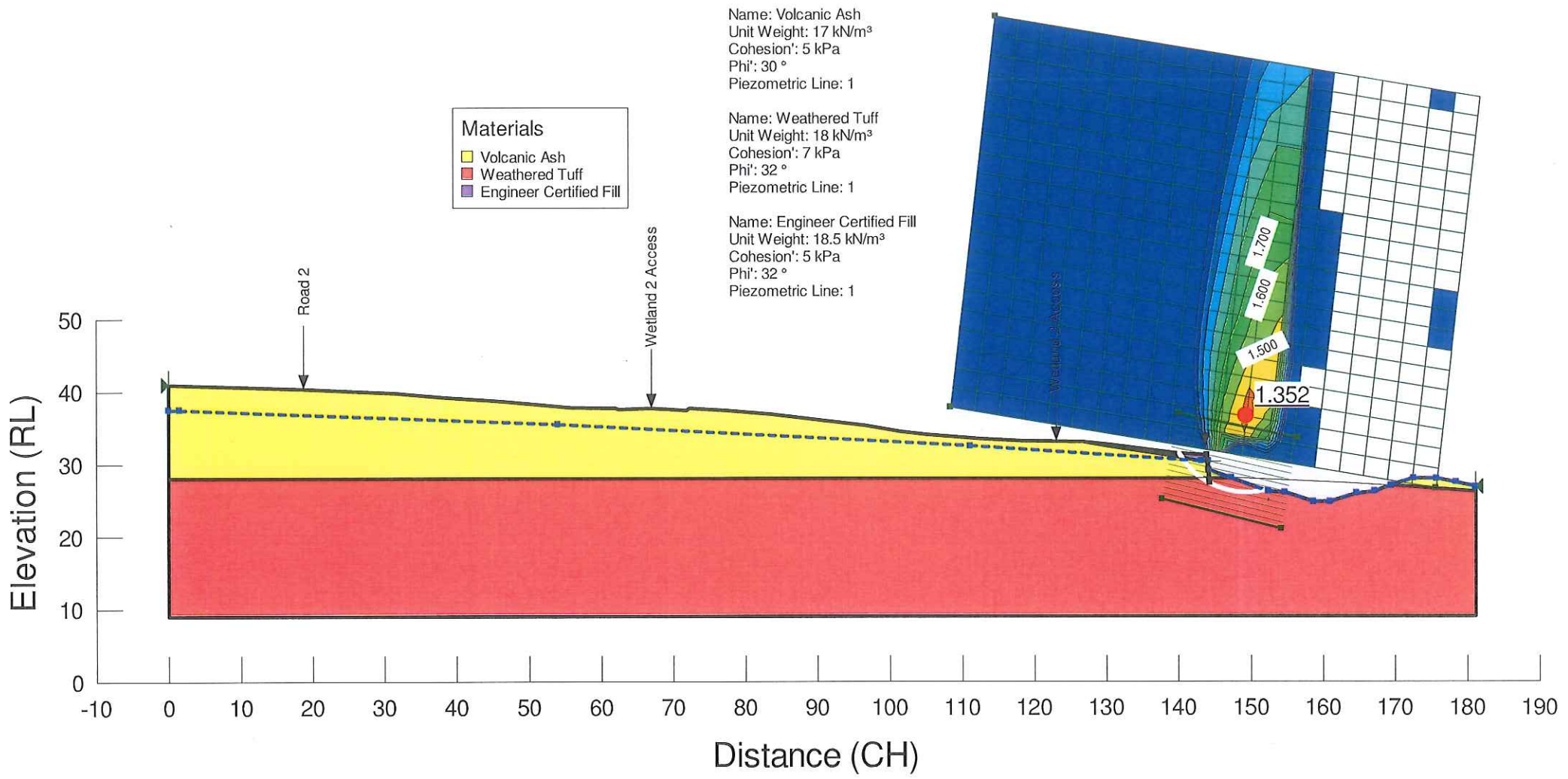
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: C.6



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

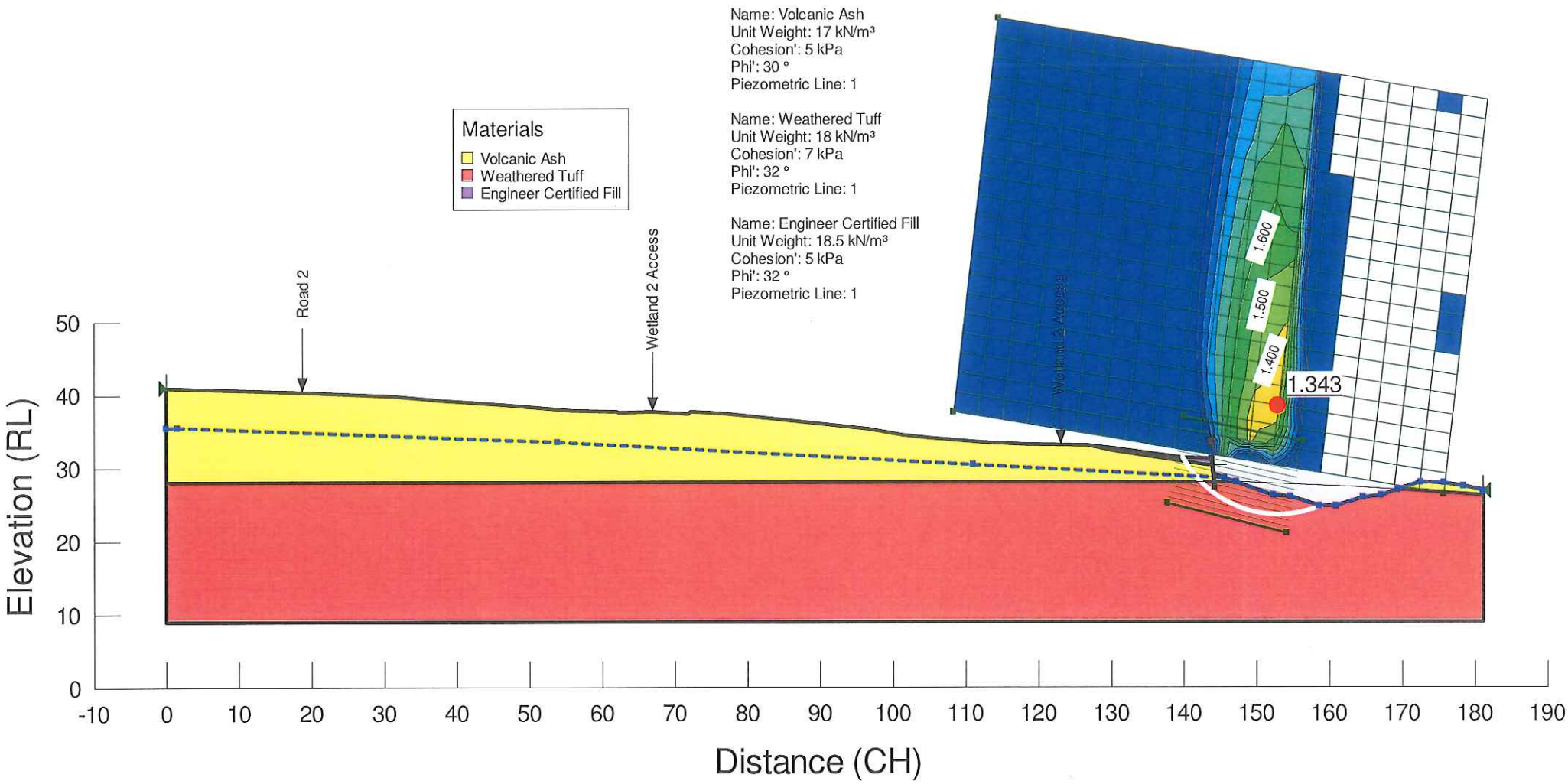
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': REMEDIATED SLOPE (RETAINING WALL) – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: C.7



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

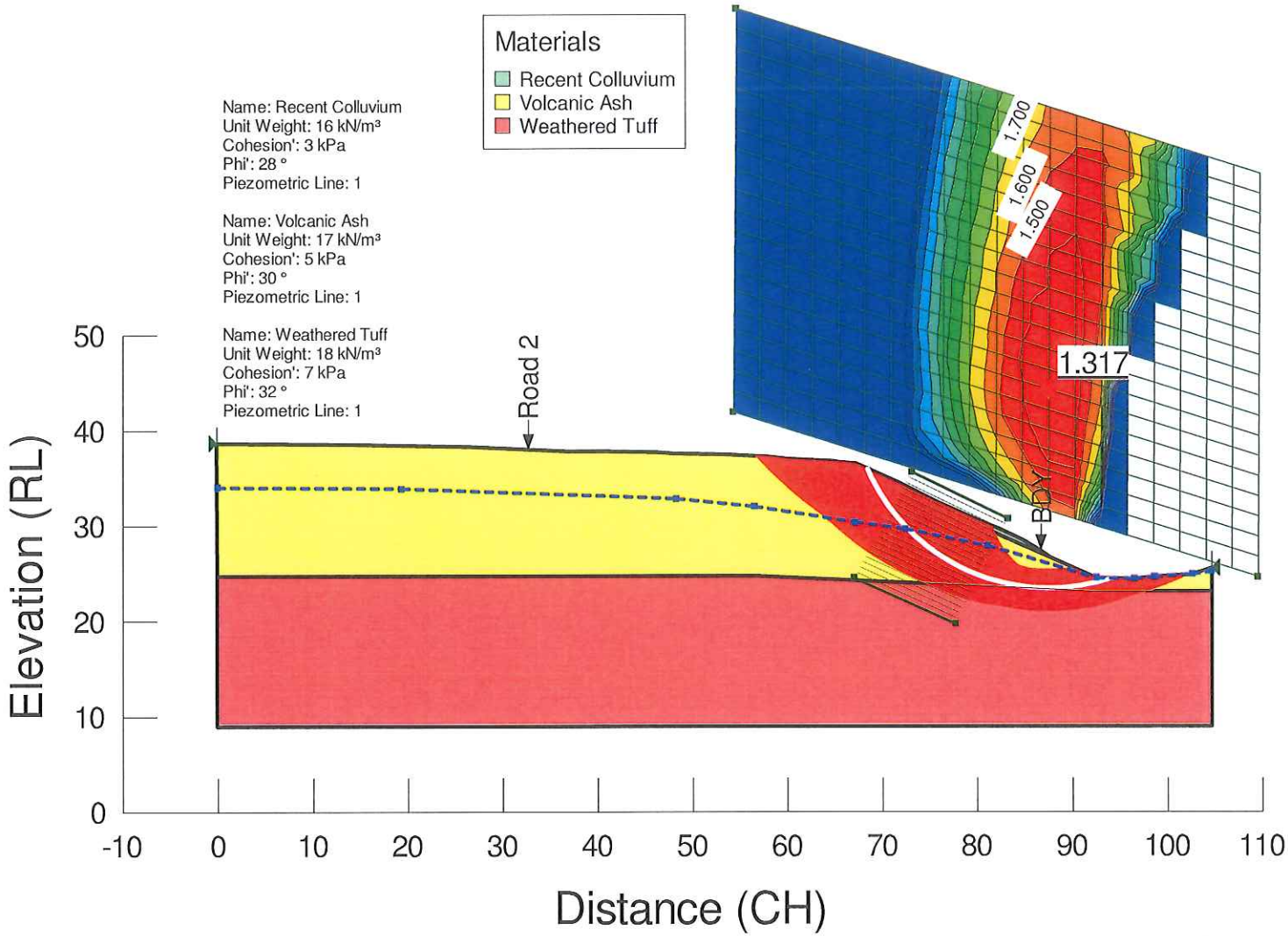
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': REMEDIATED SLOPE (RETAINING WALL) – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: C.8



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

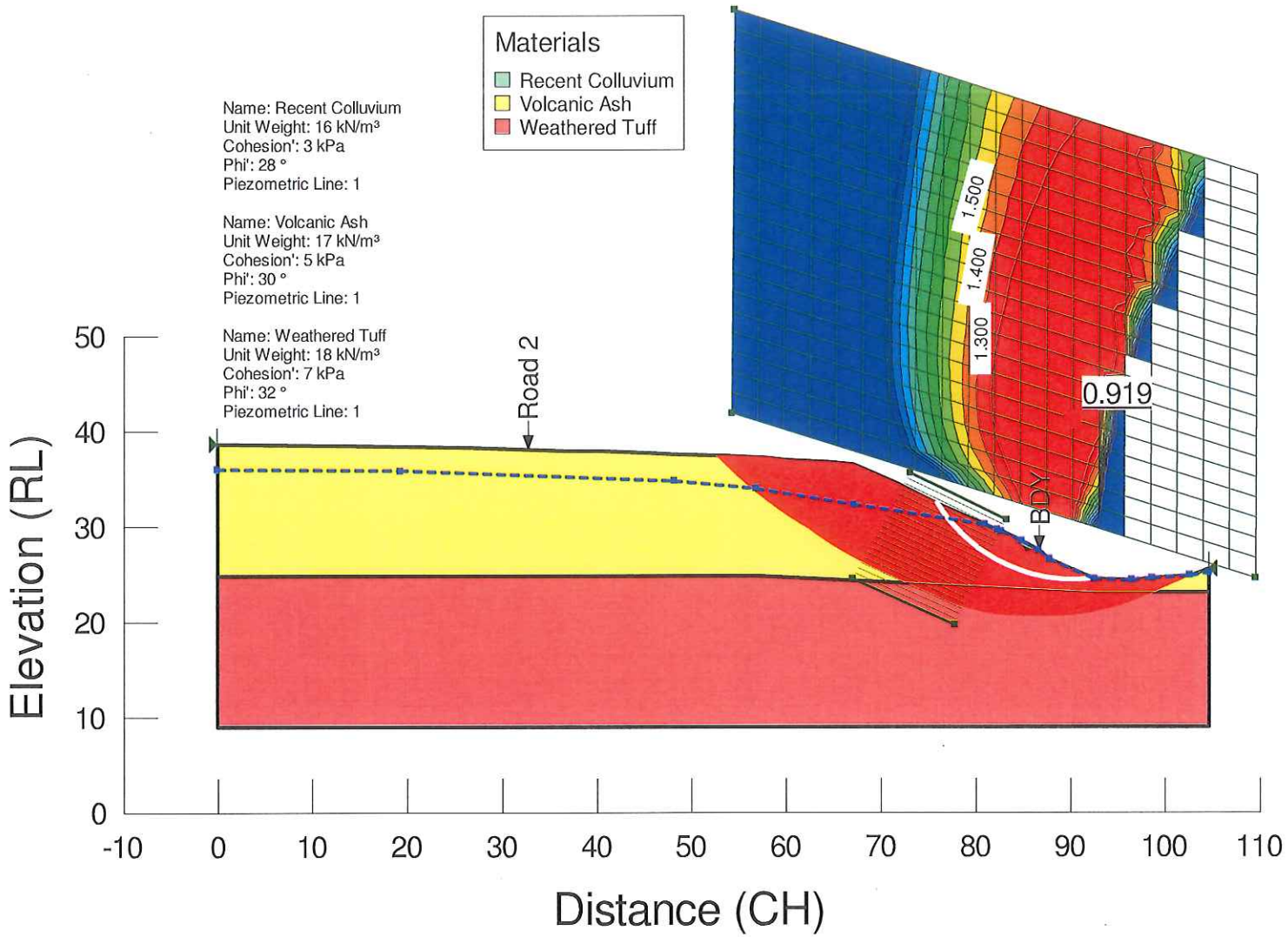
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION C-C': REMEDIATED SLOPE (RETAINING WALL) – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: C.9



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

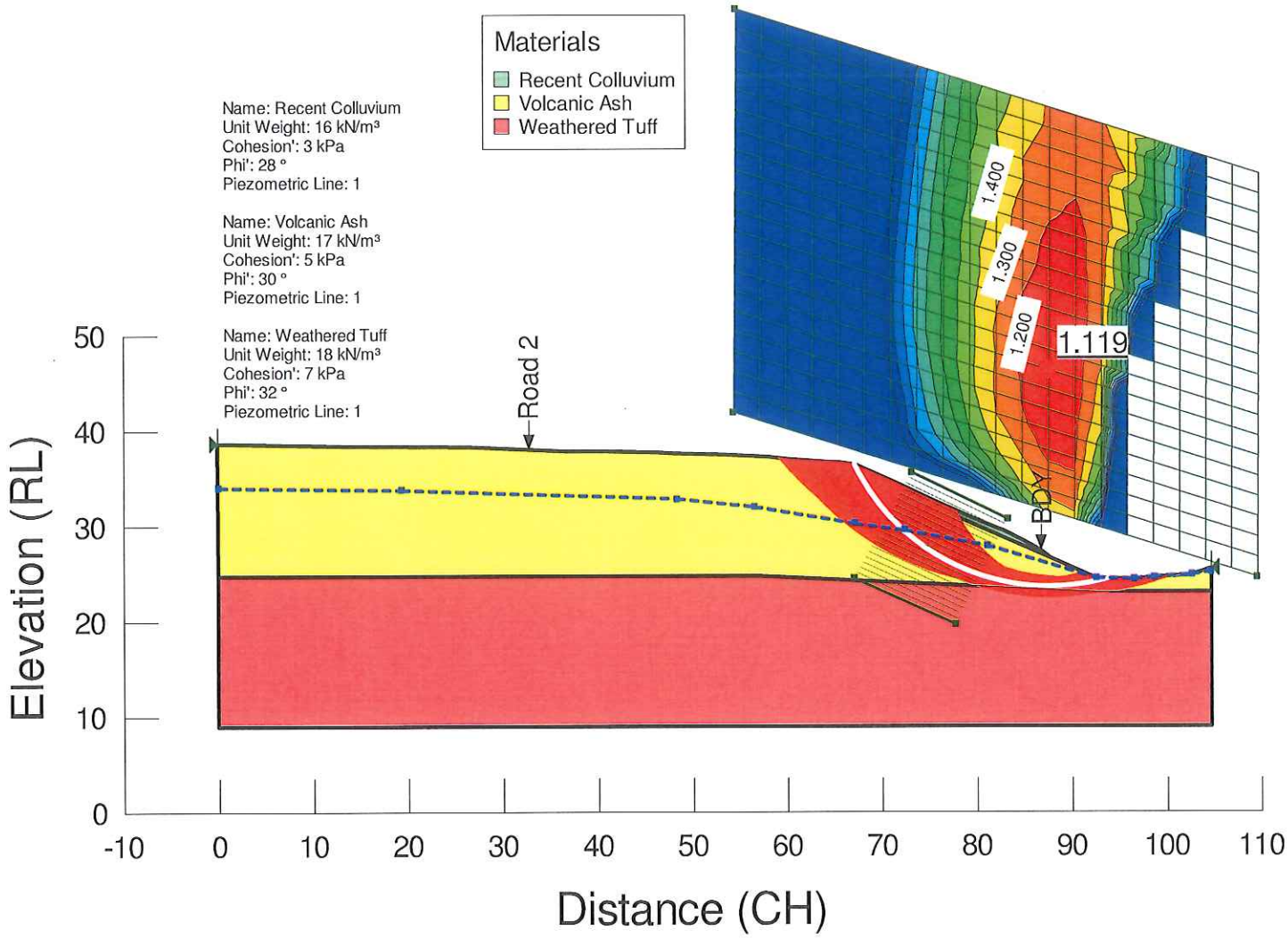
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION E-E': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **E.1**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: E.2



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

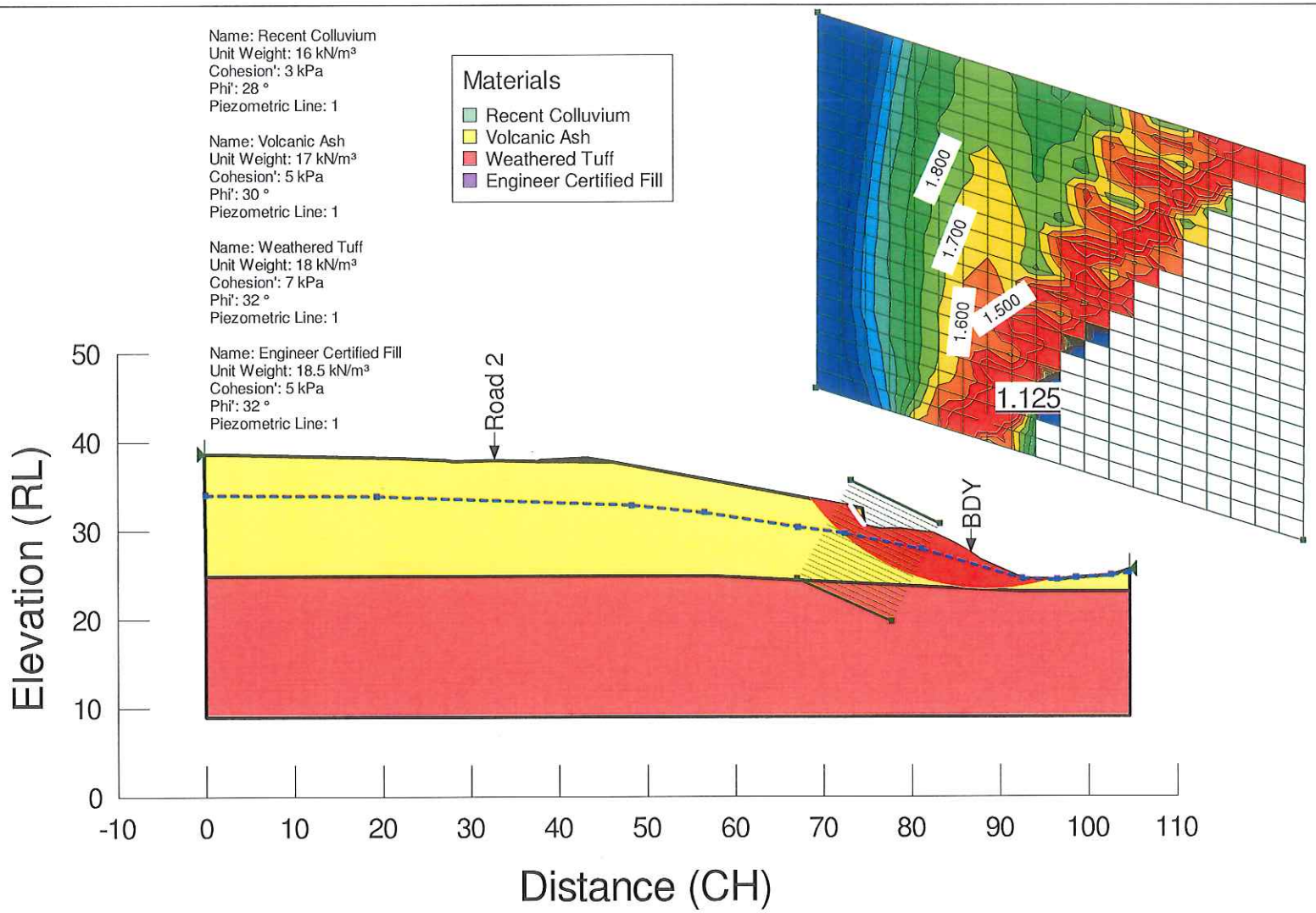
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: E.3

Name: Recent Colluvium
Unit Weight: 16 kN/m³
Cohesion': 3 kPa
Phi': 28 °
Piezometric Line: 1

Name: Volcanic Ash
Unit Weight: 17 kN/m³
Cohesion': 5 kPa
Phi': 30 °
Piezometric Line: 1

Name: Weathered Tuff
Unit Weight: 18 kN/m³
Cohesion': 7 kPa
Phi': 32 °
Piezometric Line: 1

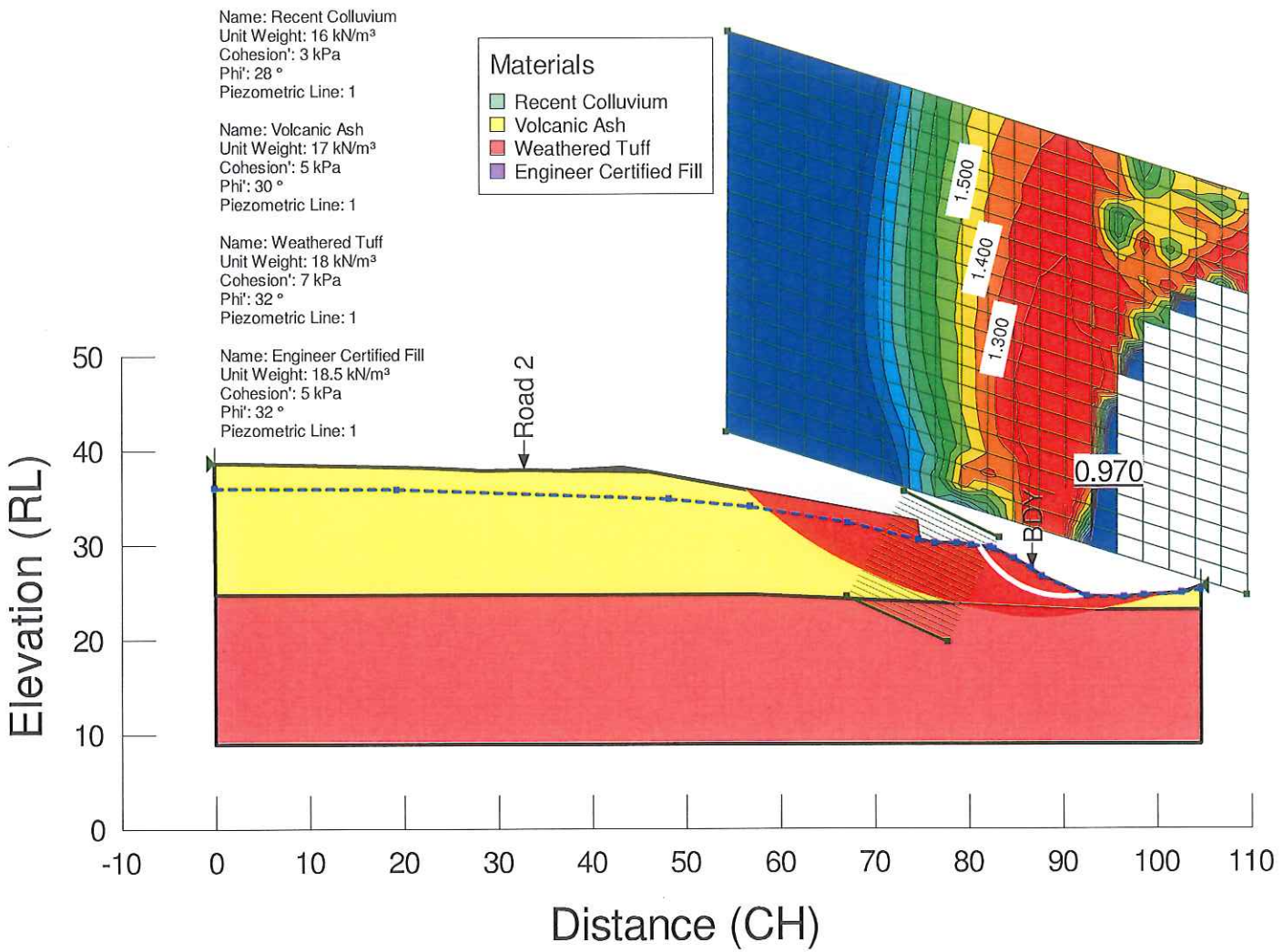
Name: Engineer Certified Fill
Unit Weight: 18.5 kN/m³
Cohesion': 5 kPa
Phi': 32 °
Piezometric Line: 1



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: E.4



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

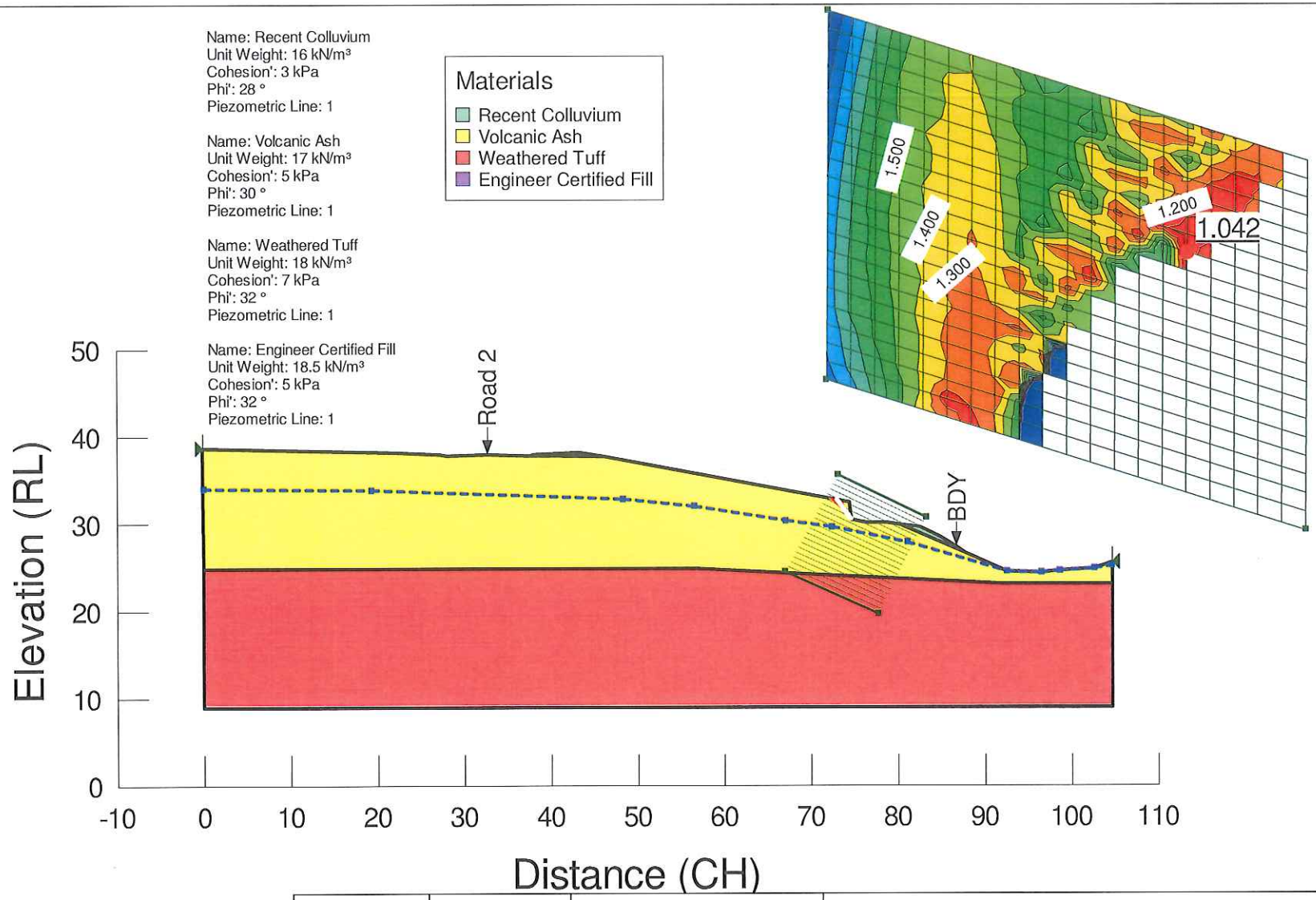
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)
Job no: J00779	Case no: E.5

Name: Recent Colluvium
Unit Weight: 16 kN/m³
Cohesion': 3 kPa
Phi': 28 °
Piezometric Line: 1

Name: Volcanic Ash
Unit Weight: 17 kN/m³
Cohesion': 5 kPa
Phi': 30 °
Piezometric Line: 1

Name: Weathered Tuff
Unit Weight: 18 kN/m³
Cohesion': 7 kPa
Phi': 32 °
Piezometric Line: 1

Name: Engineer Certified Fill
Unit Weight: 18.5 kN/m³
Cohesion': 5 kPa
Phi': 32 °
Piezometric Line: 1



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

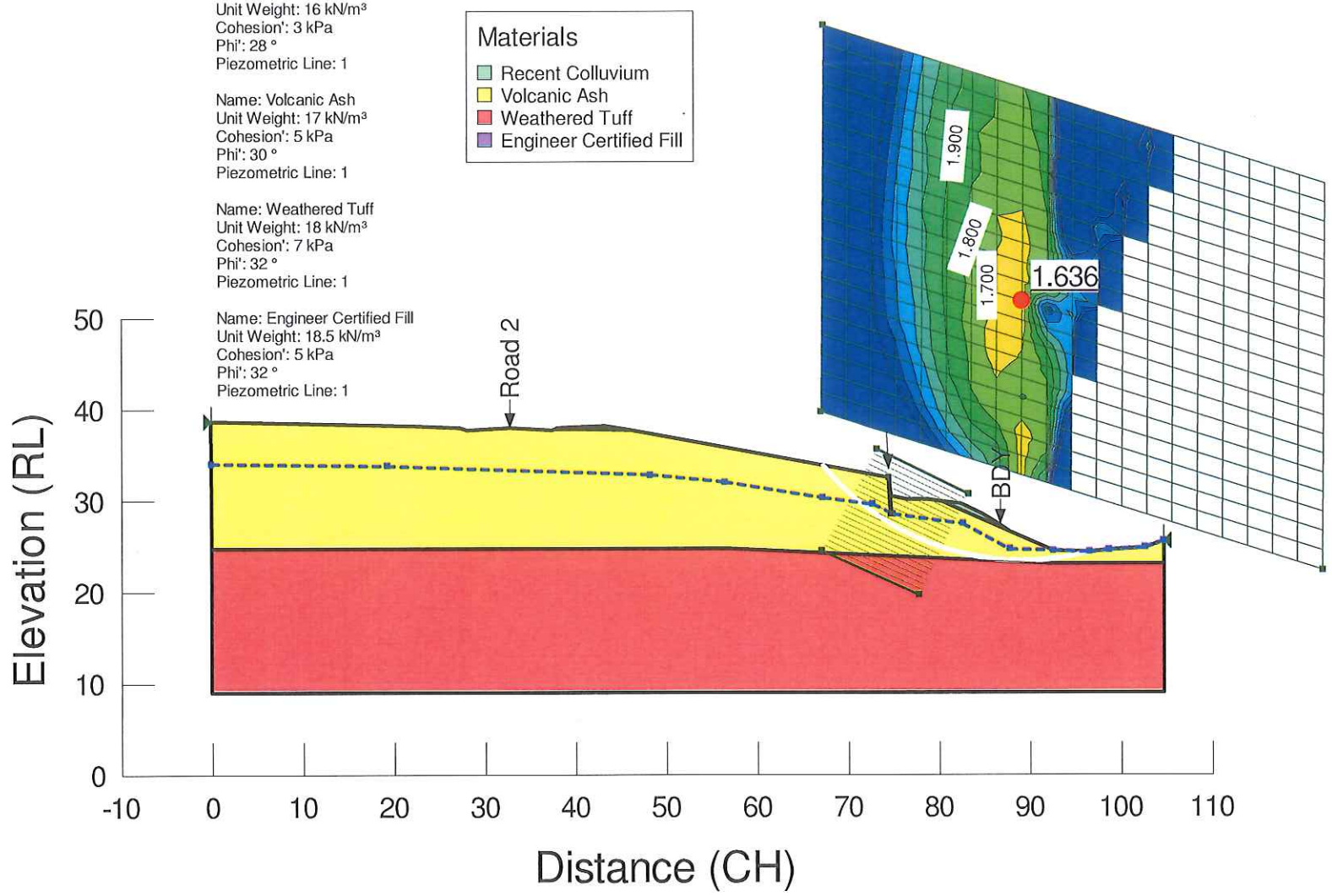
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: E.6

Name: Recent Colluvium
Unit Weight: 16 kN/m³
Cohesion': 3 kPa
Phi': 28 °
Piezometric Line: 1

Name: Volcanic Ash
Unit Weight: 17 kN/m³
Cohesion': 5 kPa
Phi': 30 °
Piezometric Line: 1

Name: Weathered Tuff
Unit Weight: 18 kN/m³
Cohesion': 7 kPa
Phi': 32 °
Piezometric Line: 1

Name: Engineer Certified Fill
Unit Weight: 18.5 kN/m³
Cohesion': 5 kPa
Phi': 32 °
Piezometric Line: 1



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

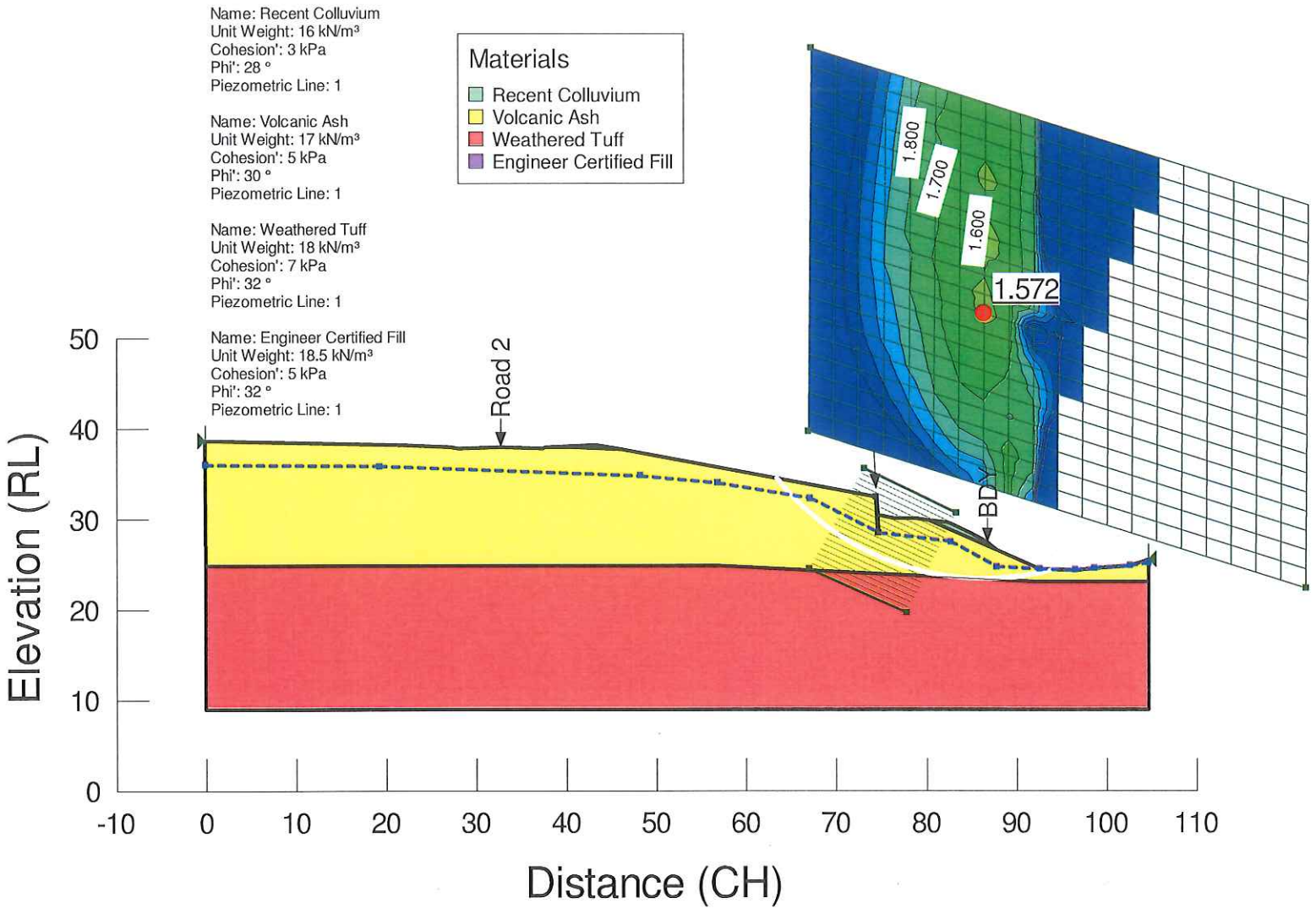
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': REMEDIATED SLOPE (3M DEEP COUNTERFORT DRAINS AND RETAINING WALL) – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: E.7

Name: Recent Colluvium
Unit Weight: 16 kN/m³
Cohesion': 3 kPa
Phi': 28 °
Piezometric Line: 1

Name: Volcanic Ash
Unit Weight: 17 kN/m³
Cohesion': 5 kPa
Phi': 30 °
Piezometric Line: 1

Name: Weathered Tuff
Unit Weight: 18 kN/m³
Cohesion': 7 kPa
Phi': 32 °
Piezometric Line: 1

Name: Engineer Certified Fill
Unit Weight: 18.5 kN/m³
Cohesion': 5 kPa
Phi': 32 °
Piezometric Line: 1



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

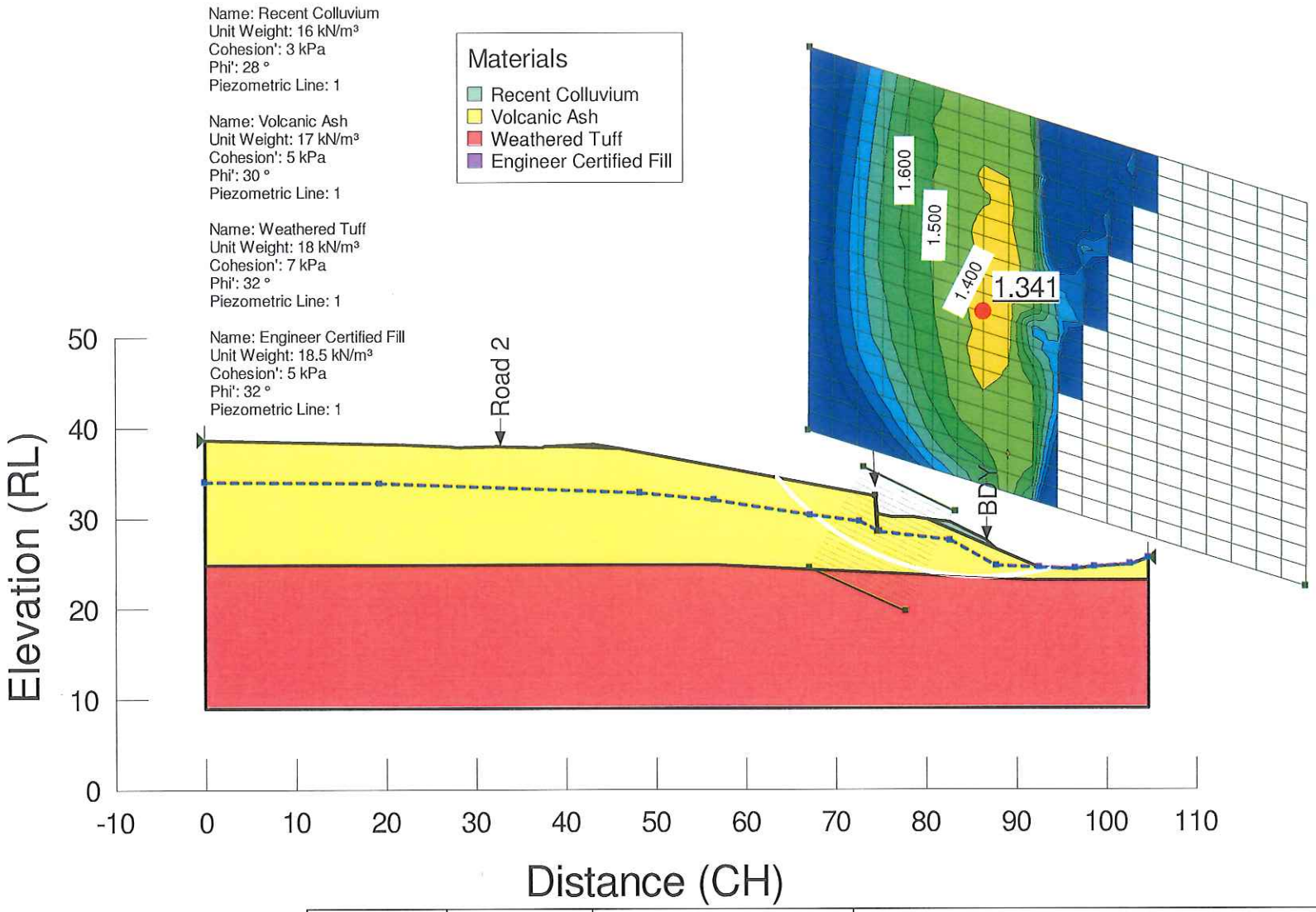
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION E-E': REMEDIATED SLOPE (3M DEEP COUNTERFORT DRAINS AND RETAINING WALL) – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **E.8**

Name: Recent Colluvium
Unit Weight: 16 kN/m³
Cohesion': 3 kPa
Phi': 28 °
Piezometric Line: 1

Name: Volcanic Ash
Unit Weight: 17 kN/m³
Cohesion': 5 kPa
Phi': 30 °
Piezometric Line: 1

Name: Weathered Tuff
Unit Weight: 18 kN/m³
Cohesion': 7 kPa
Phi': 32 °
Piezometric Line: 1

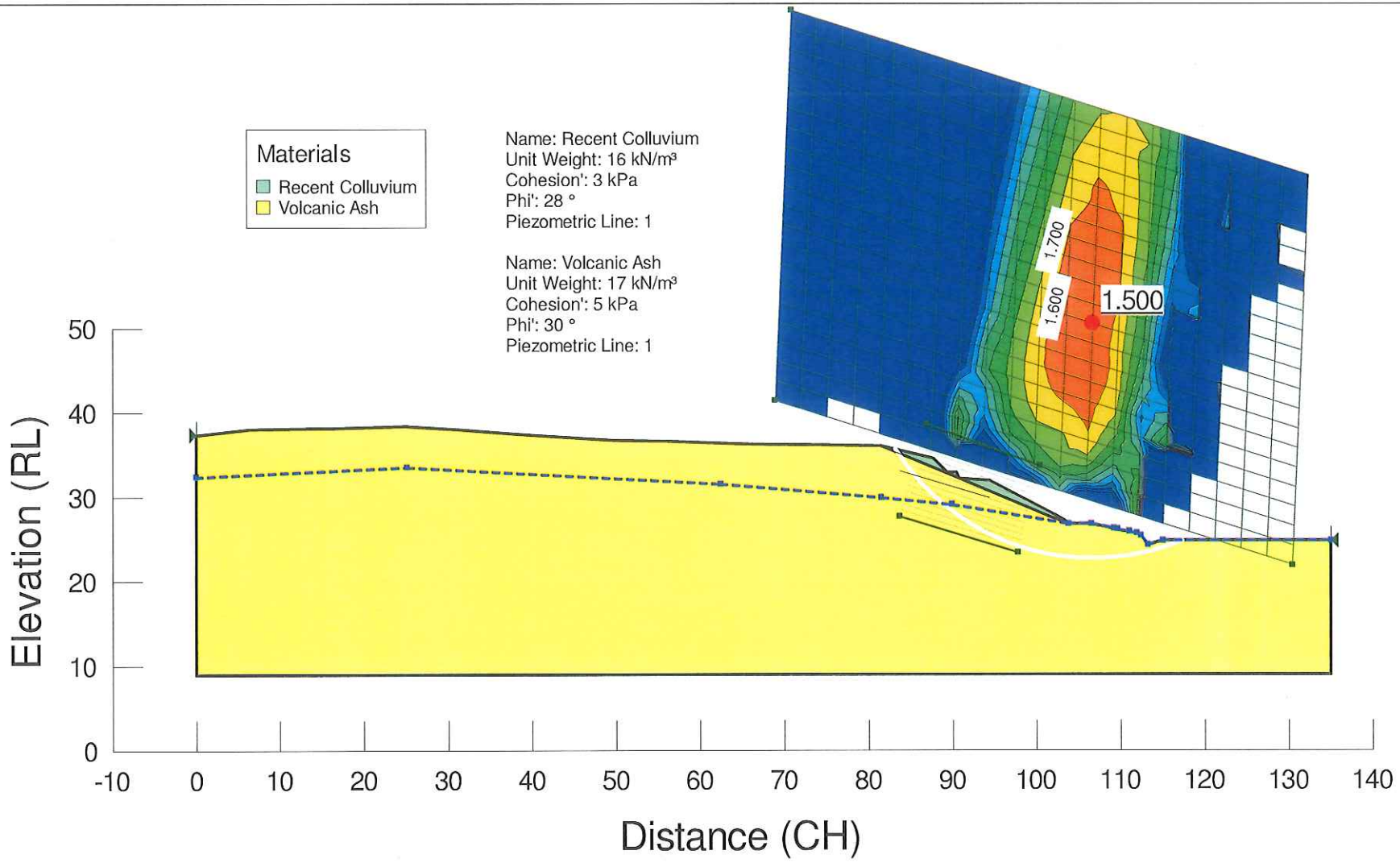
Name: Engineer Certified Fill
Unit Weight: 18.5 kN/m³
Cohesion': 5 kPa
Phi': 32 °
Piezometric Line: 1



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

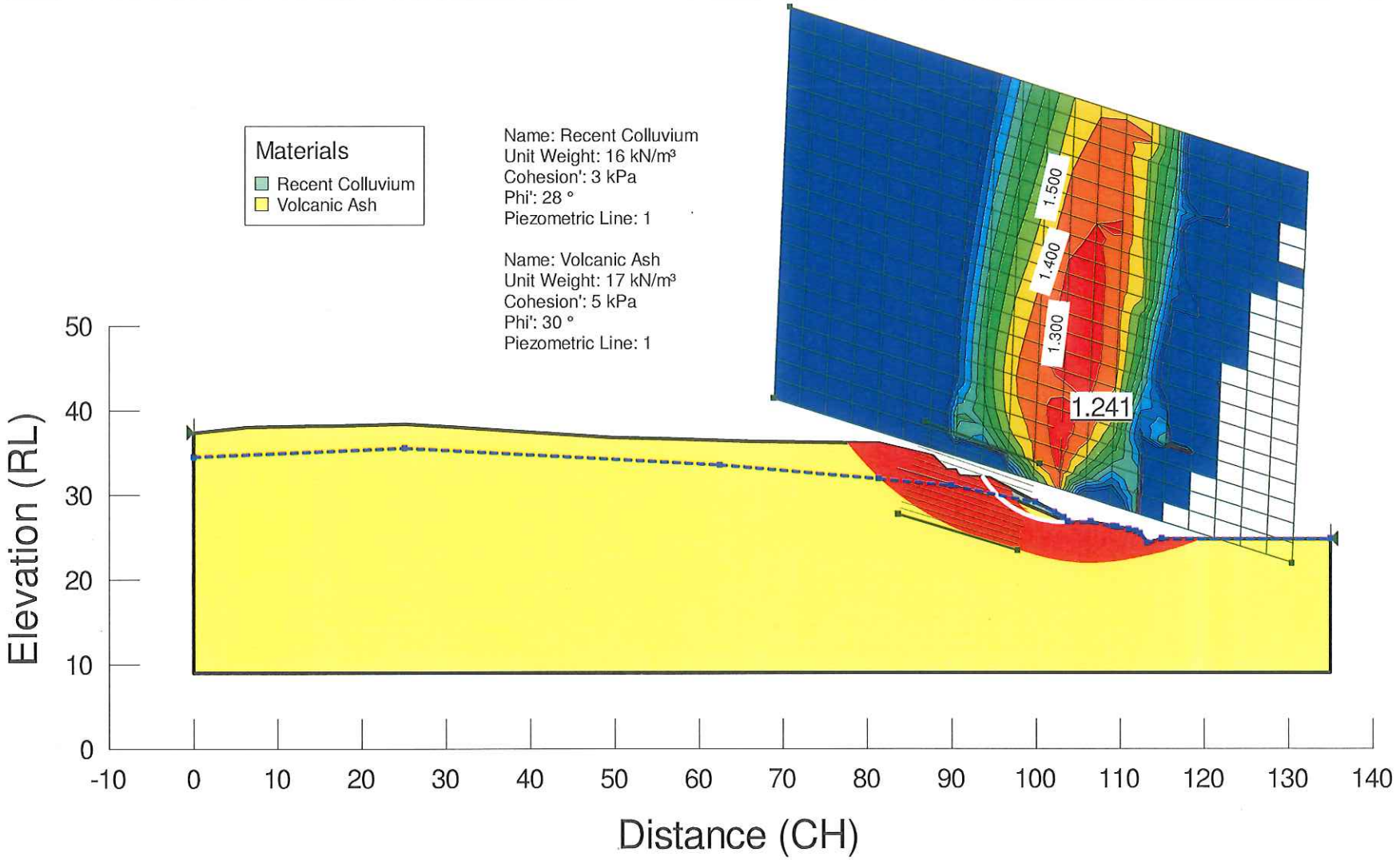
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION E-E': REMEDIATED SLOPE (3M DEEP COUNTERFORT DRAINS AND RETAINING WALL) – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: E.9



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

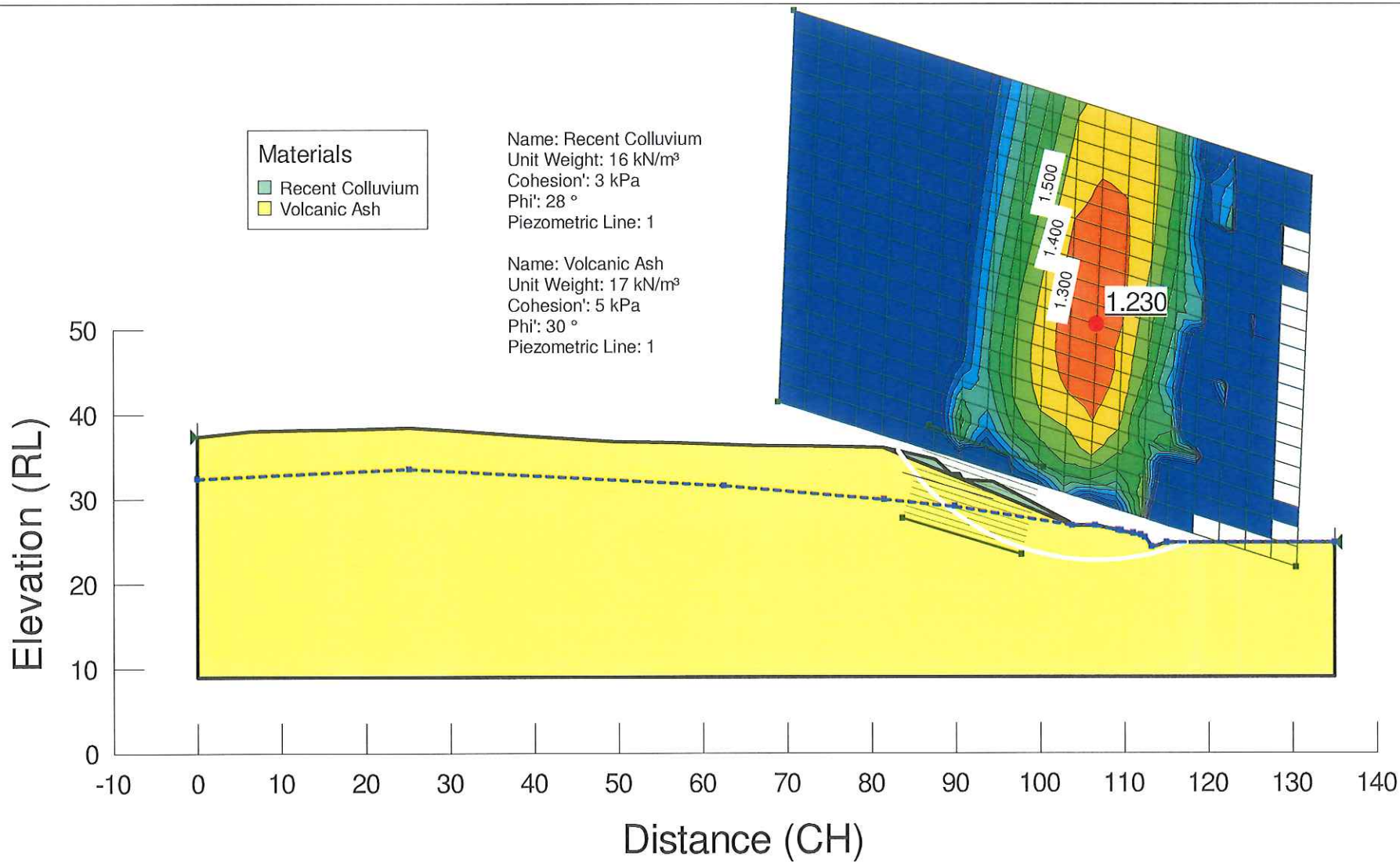
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION F-F': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)
Job no: J00779	Case no: F.1



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

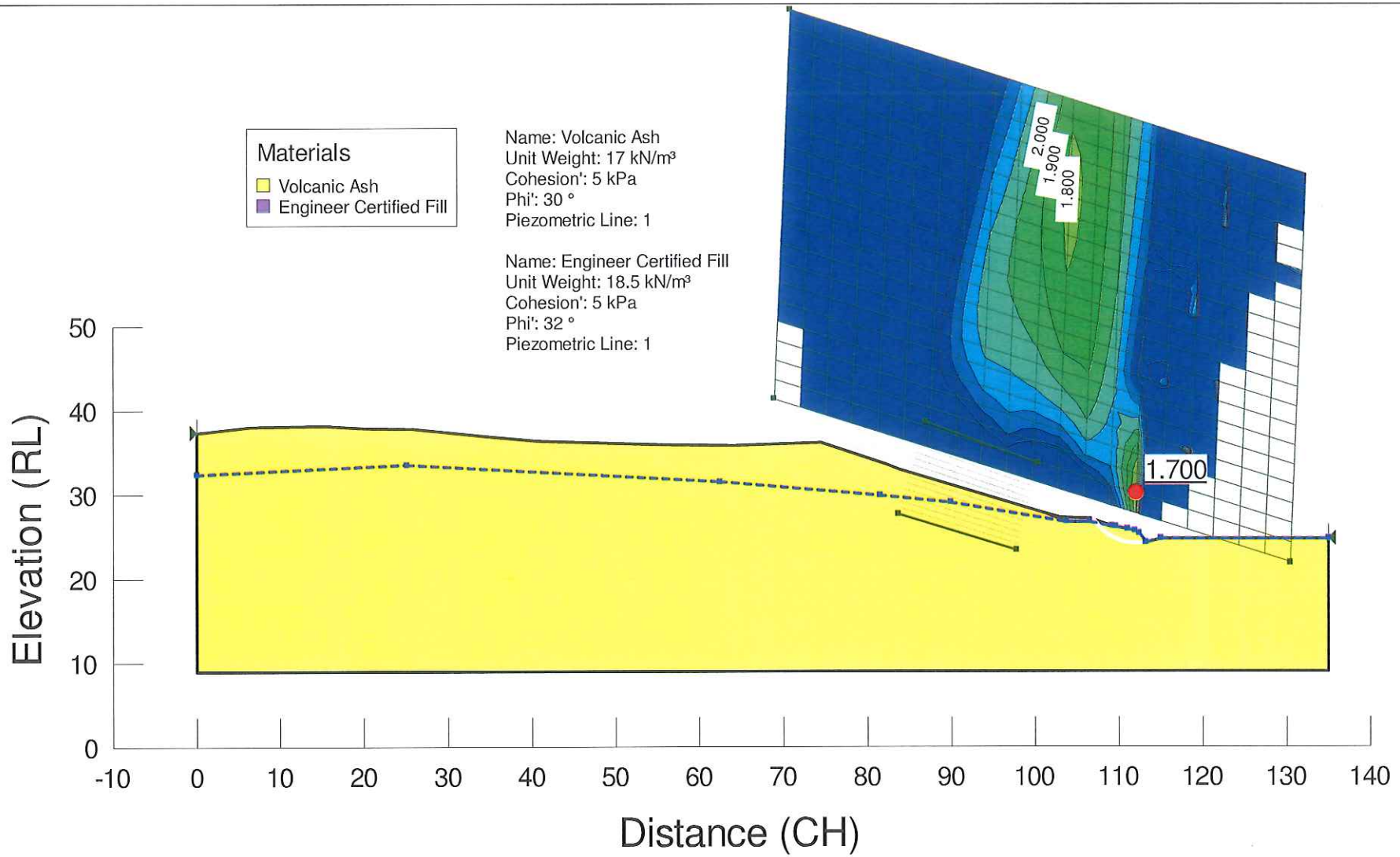
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION F-F': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **F.2**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

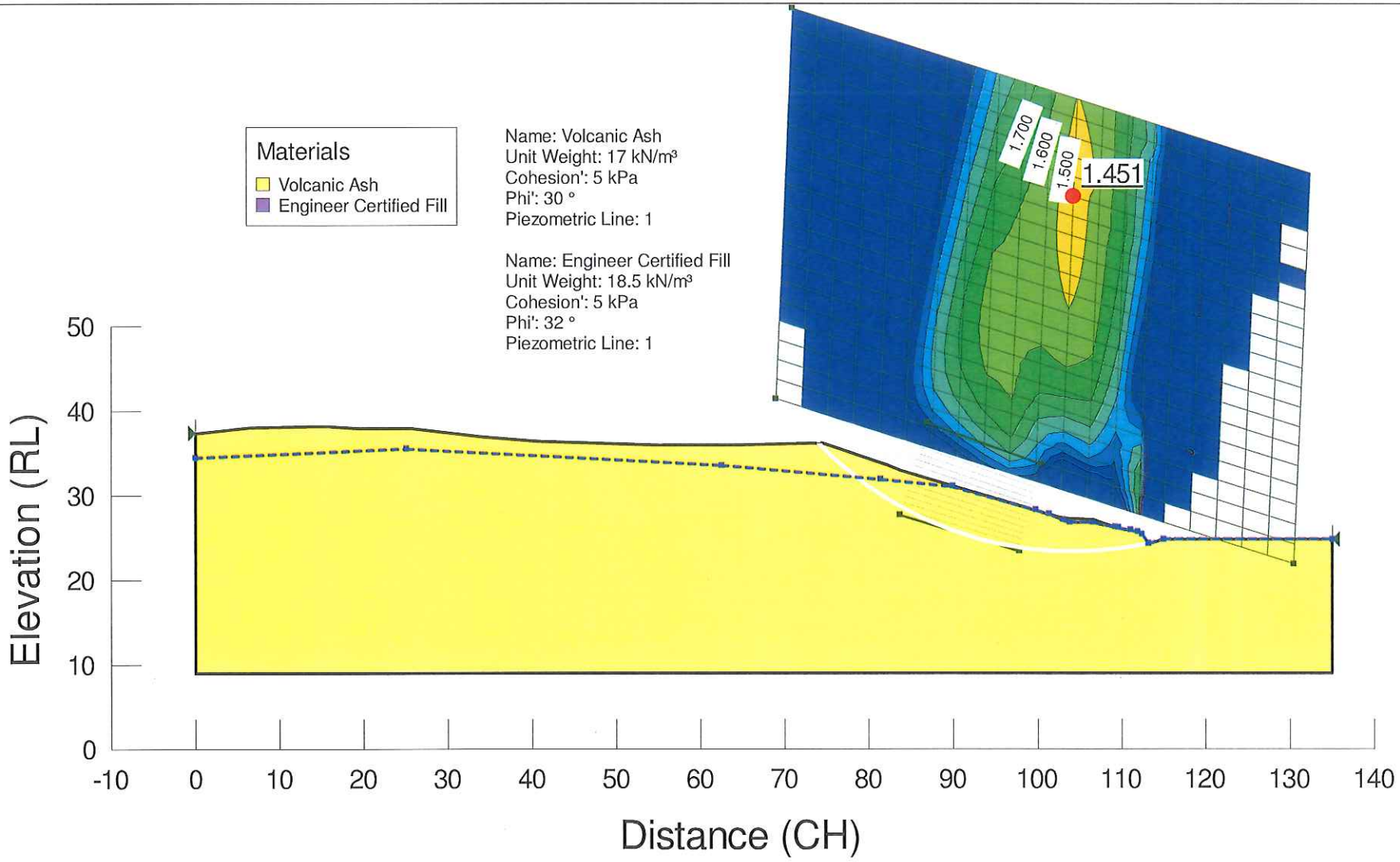
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION F-F': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: F.3



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

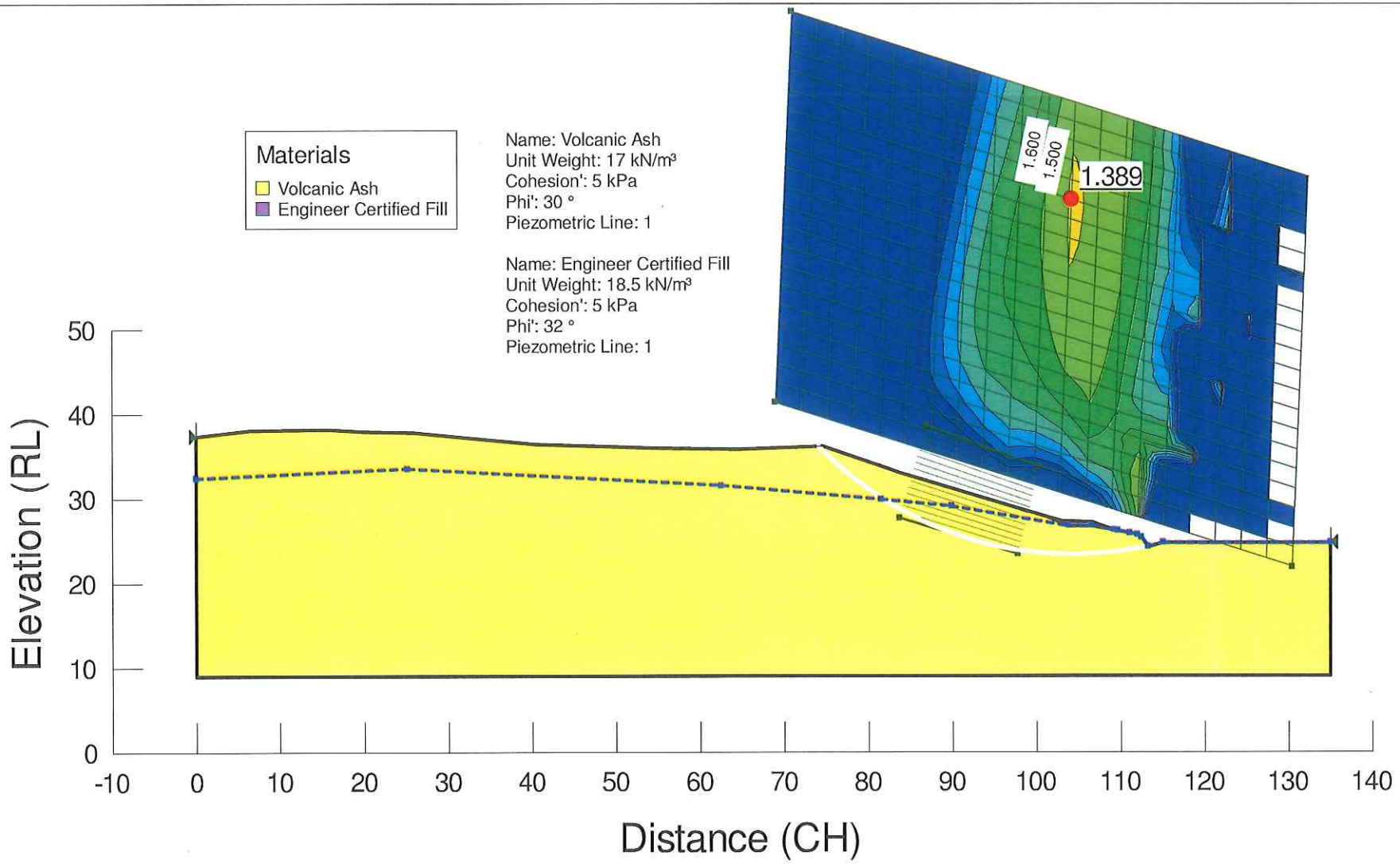
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION F-F': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **F.4**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

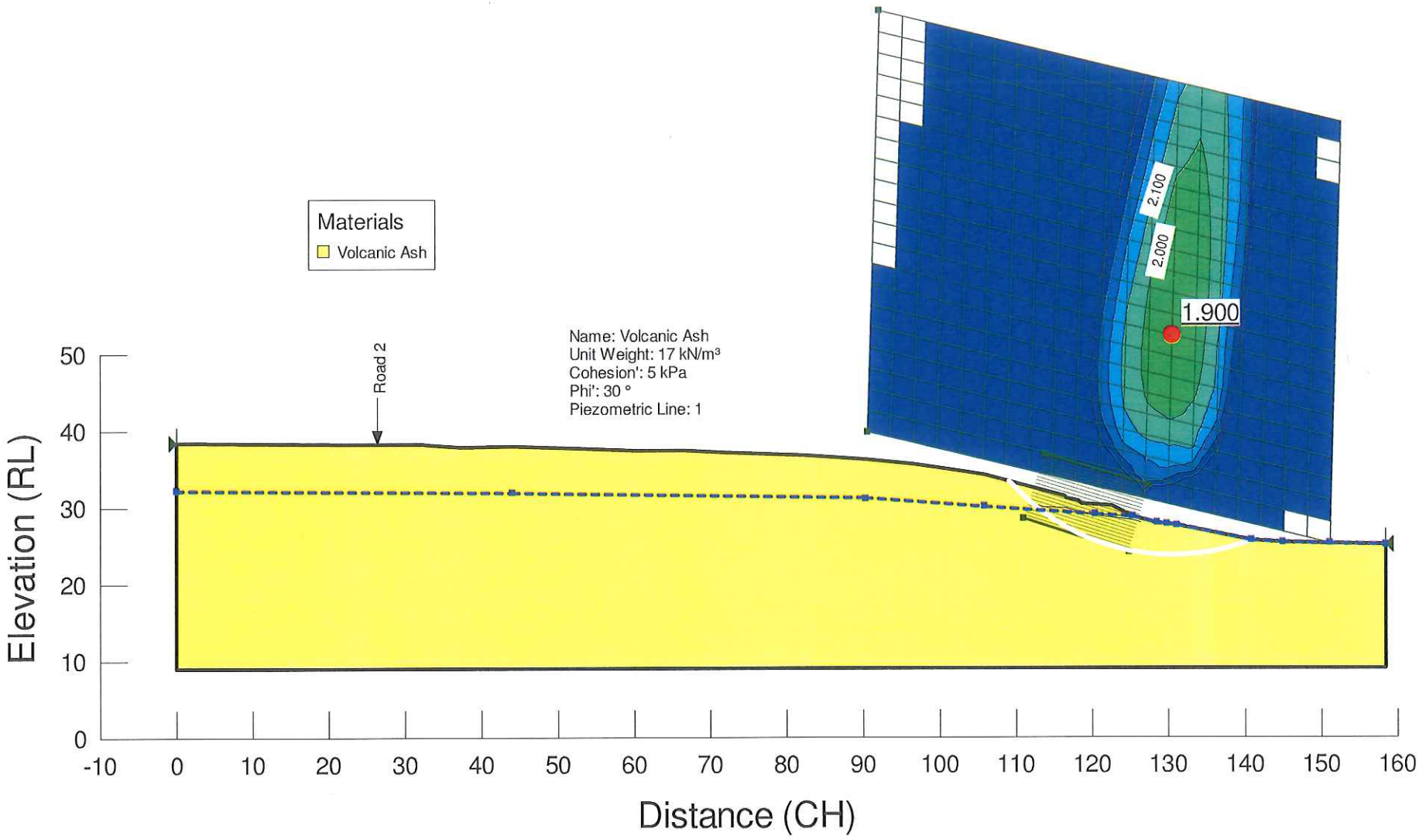
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION F-F': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **F.5**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

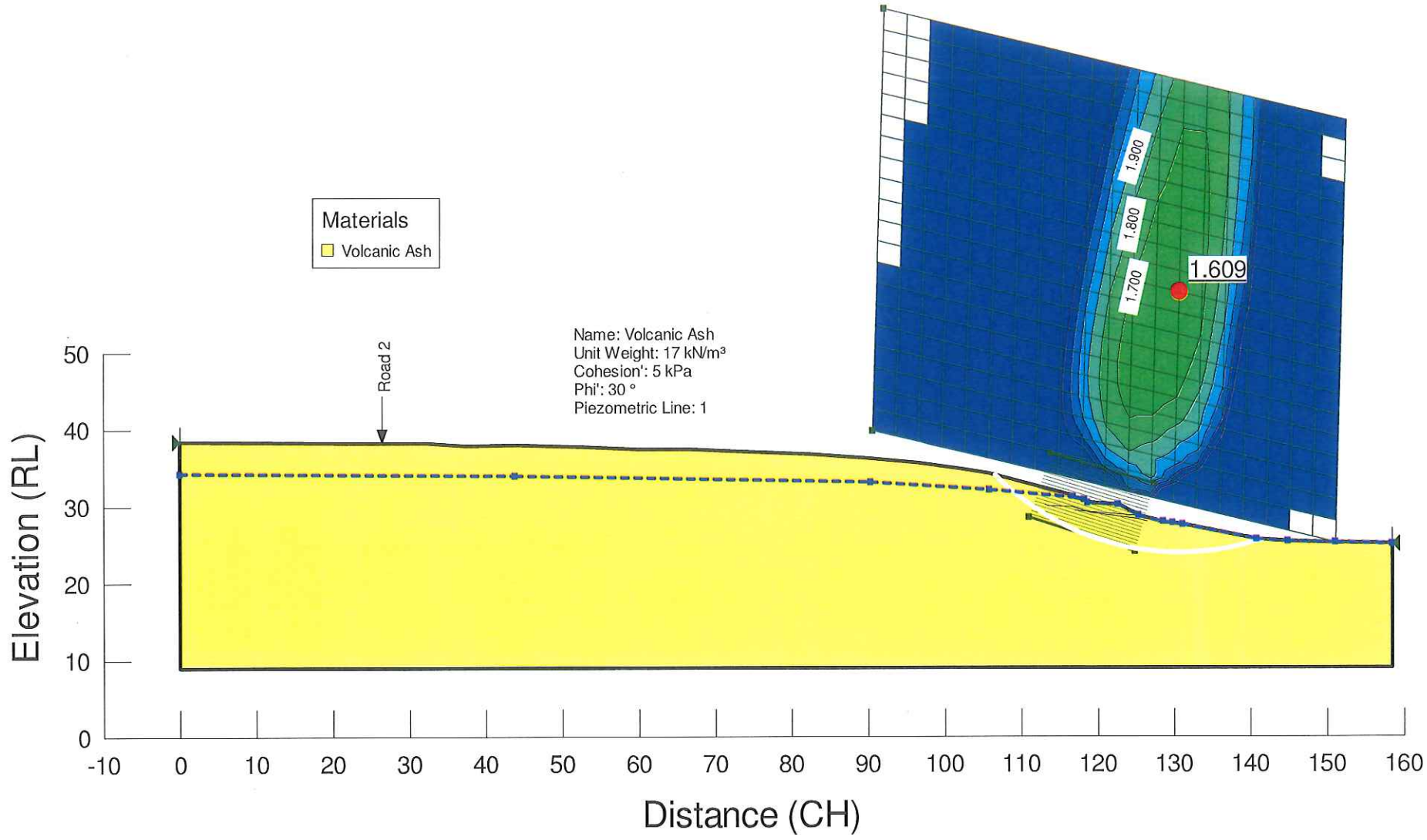
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION F-F': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: F.6



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

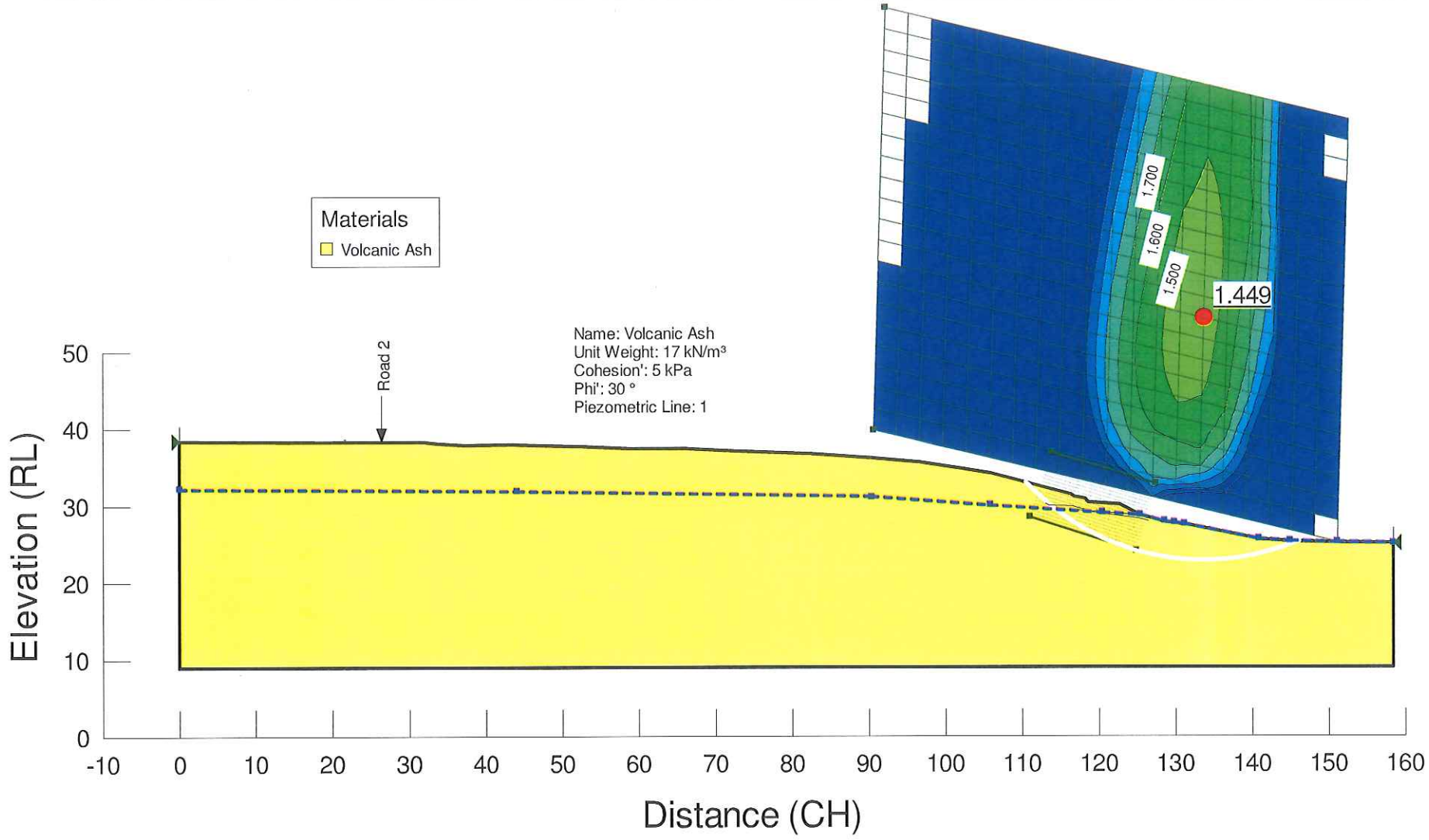
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION G-G': EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **G.1**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

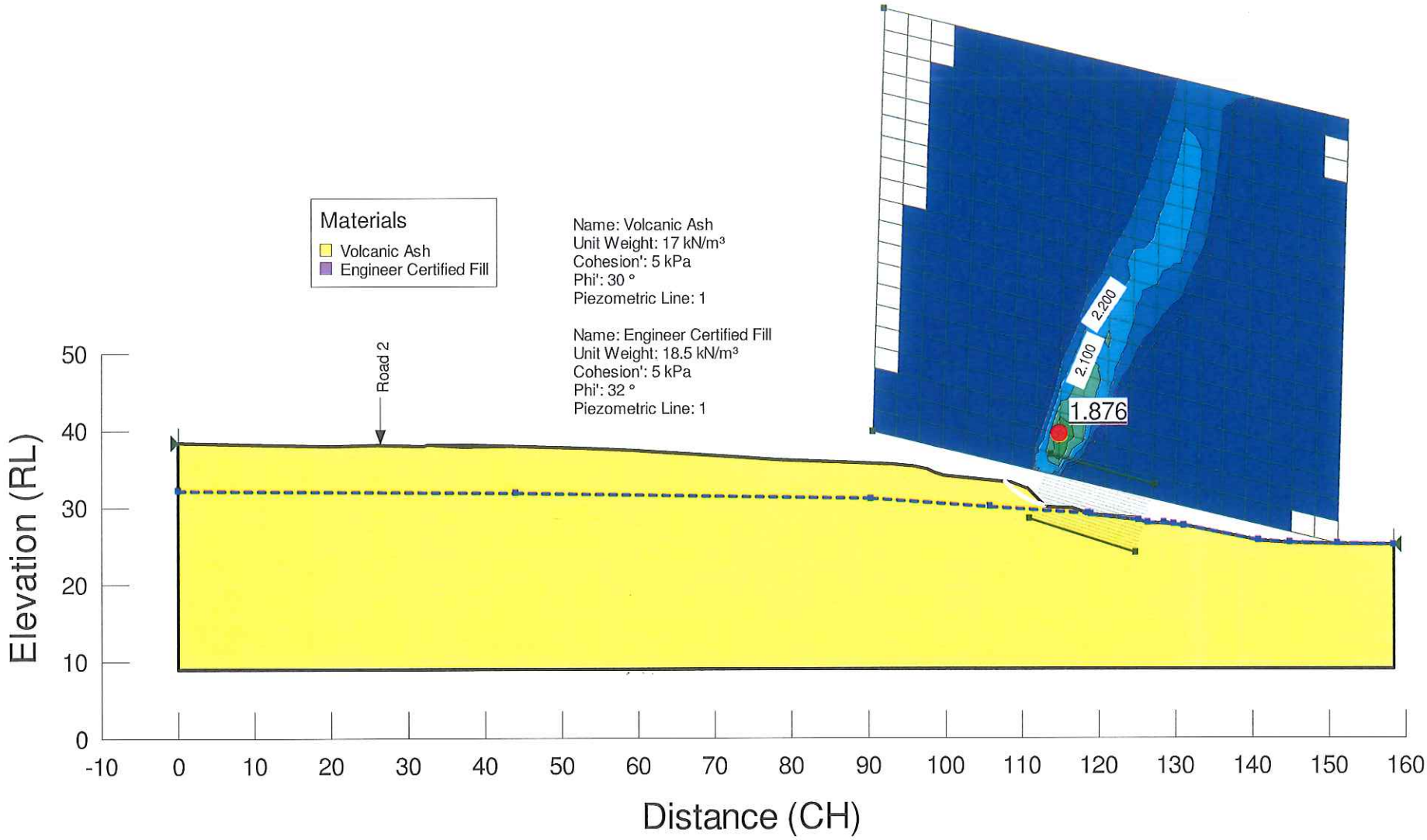
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION G-G': EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **G.2**



Drawn	MPC
Approved	CE
Date	8/11/17
Scale	Not to scale
Original Size	A4

LANDER geotechnical

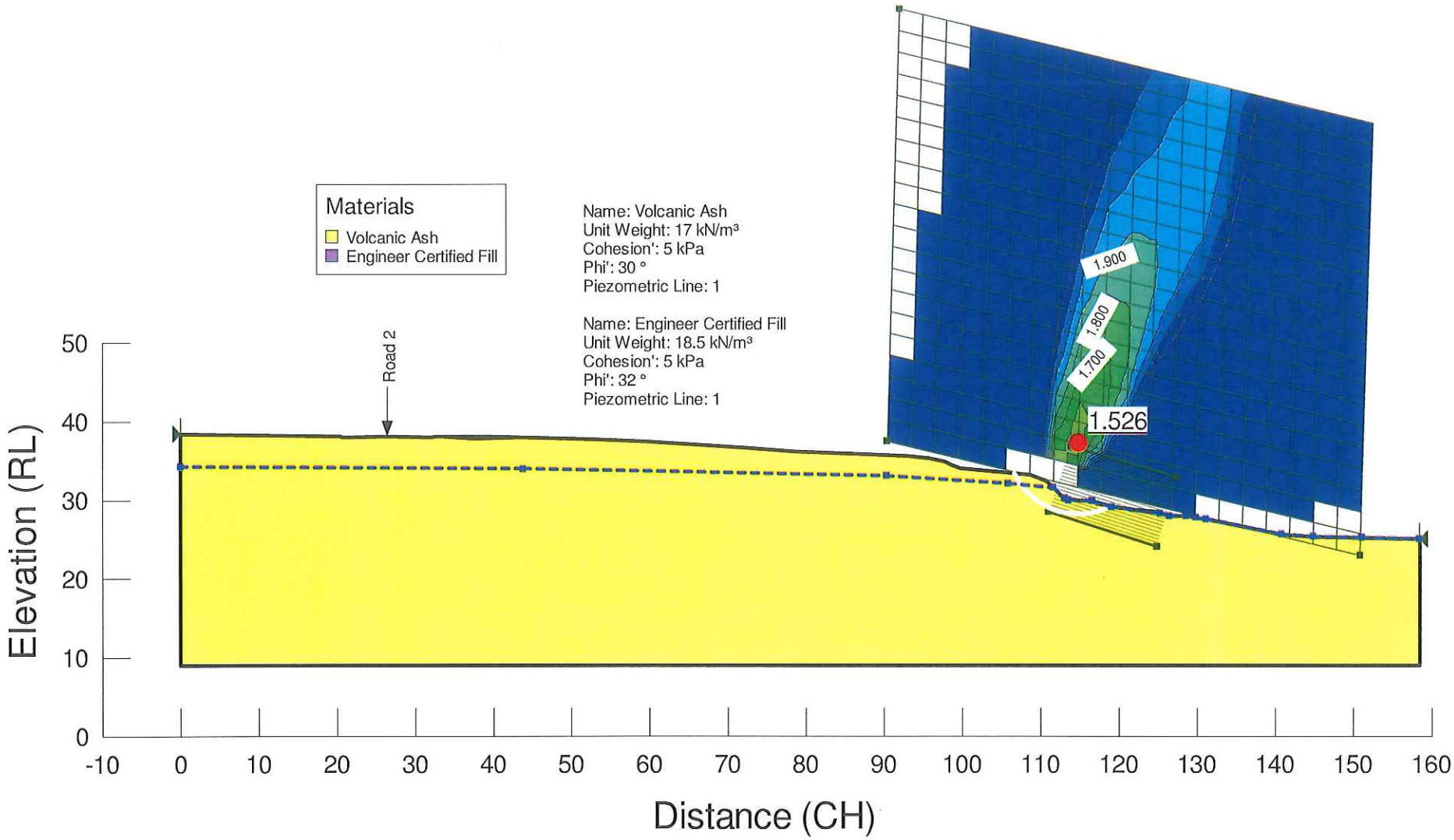
Client:	HUGHES DEVELOPMENTS LIMITED
Project:	99 ESCOTTS ROAD, TUAKAU
Title:	CROSS SECTION G-G': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)
Job no: J00779	Case no: G.3



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

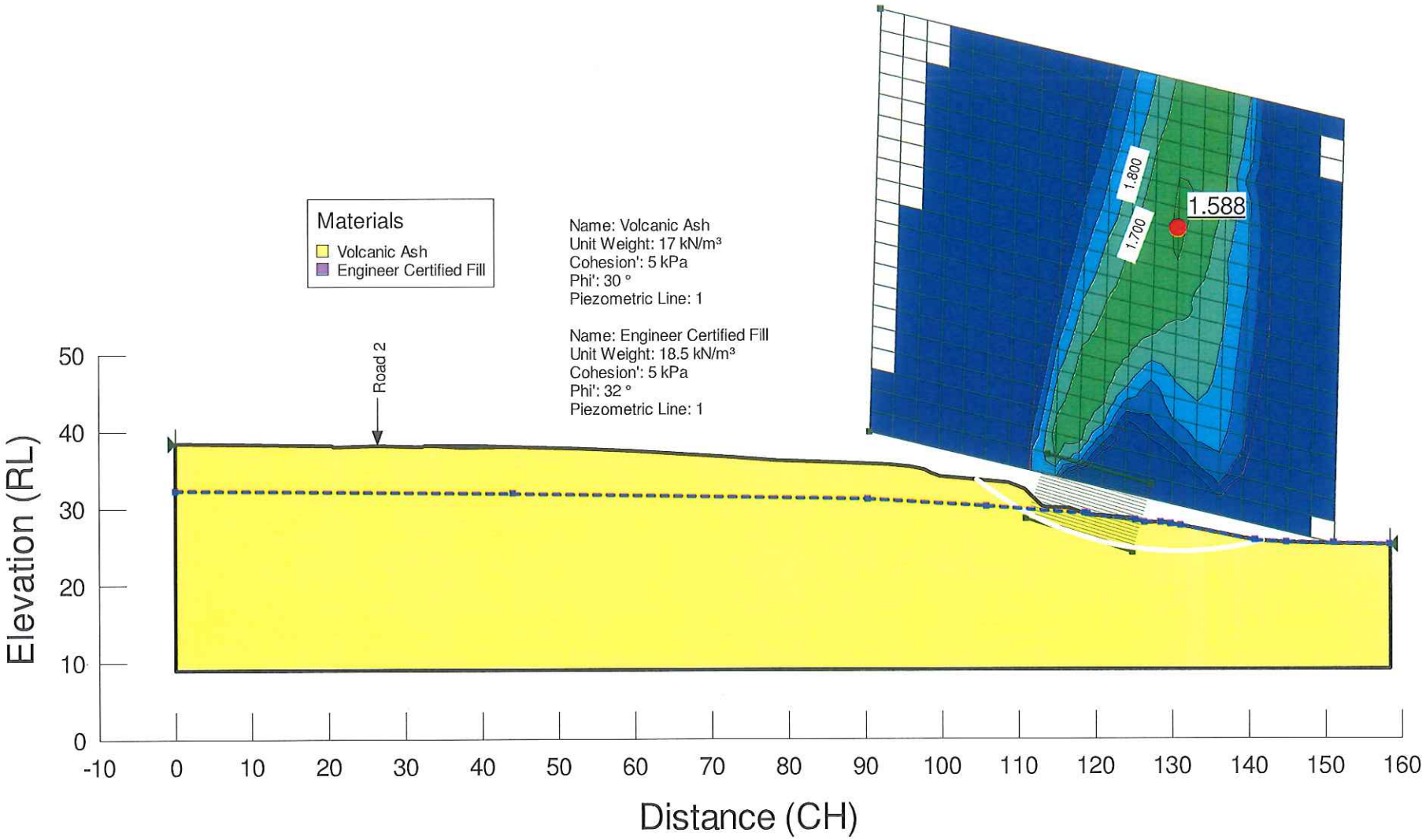
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION G-G': PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **G.4**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

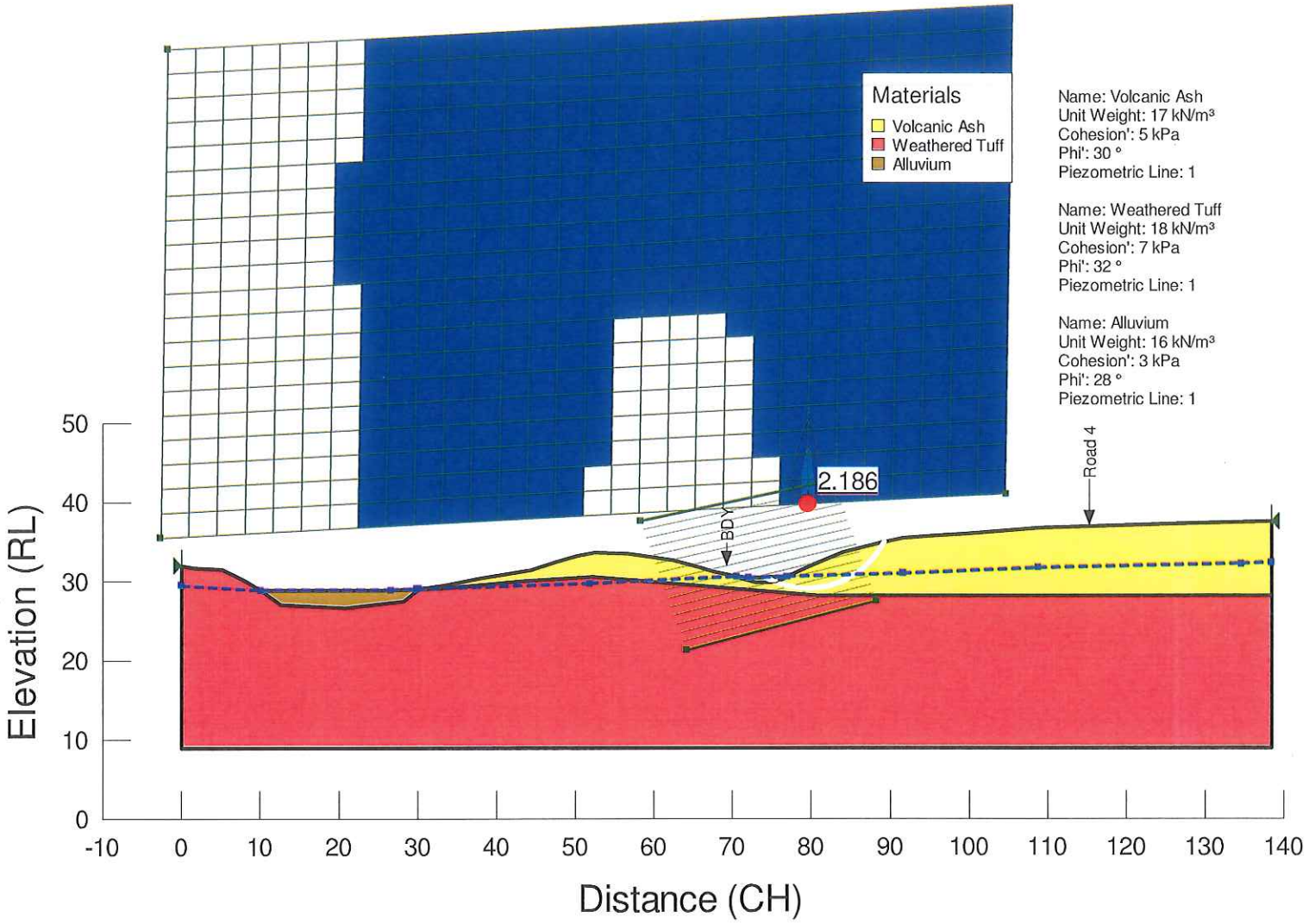
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION G-G': PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **G.5**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

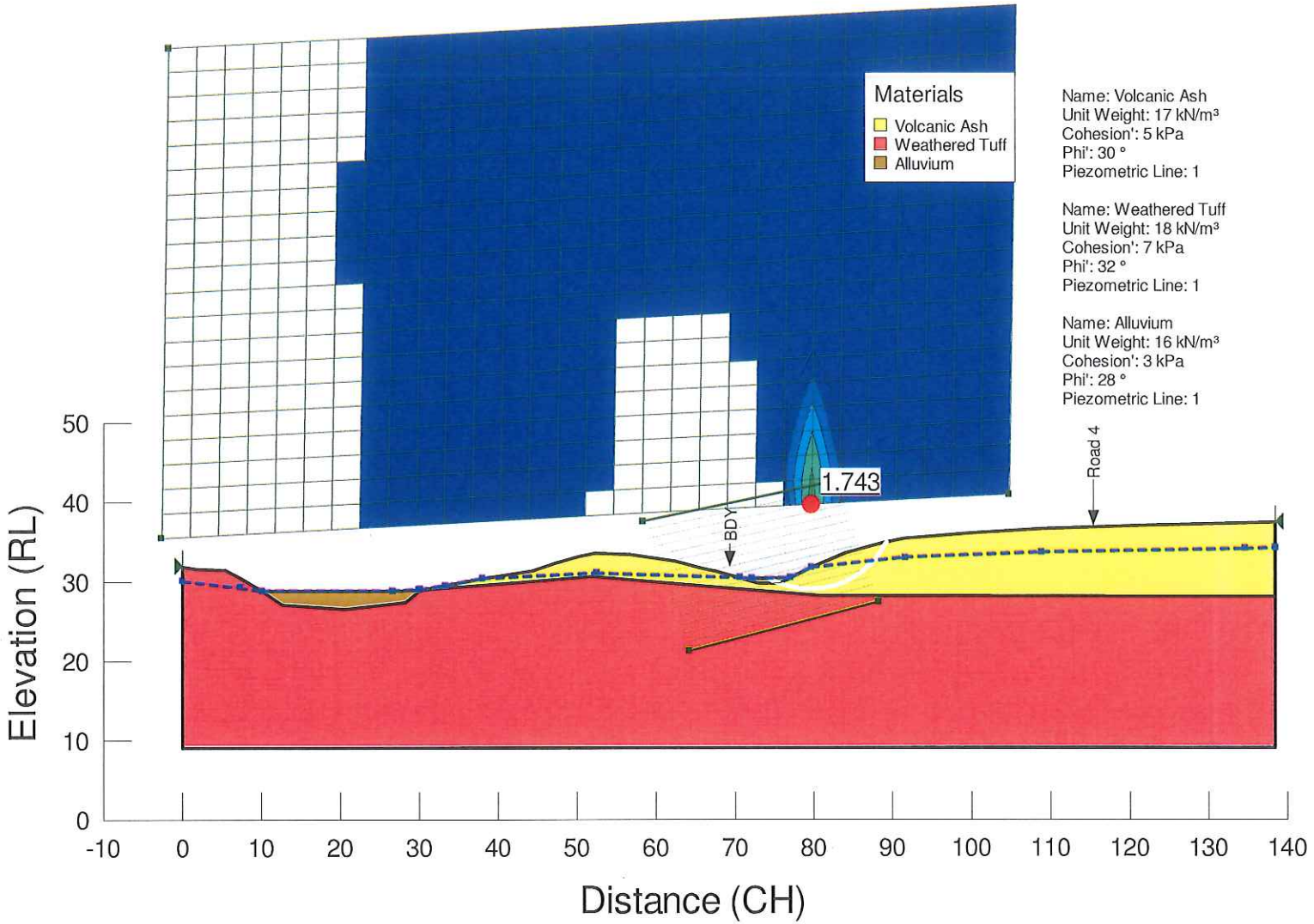
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION G-G': EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)**
Job no: **J00779**	Case no: **G.6**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

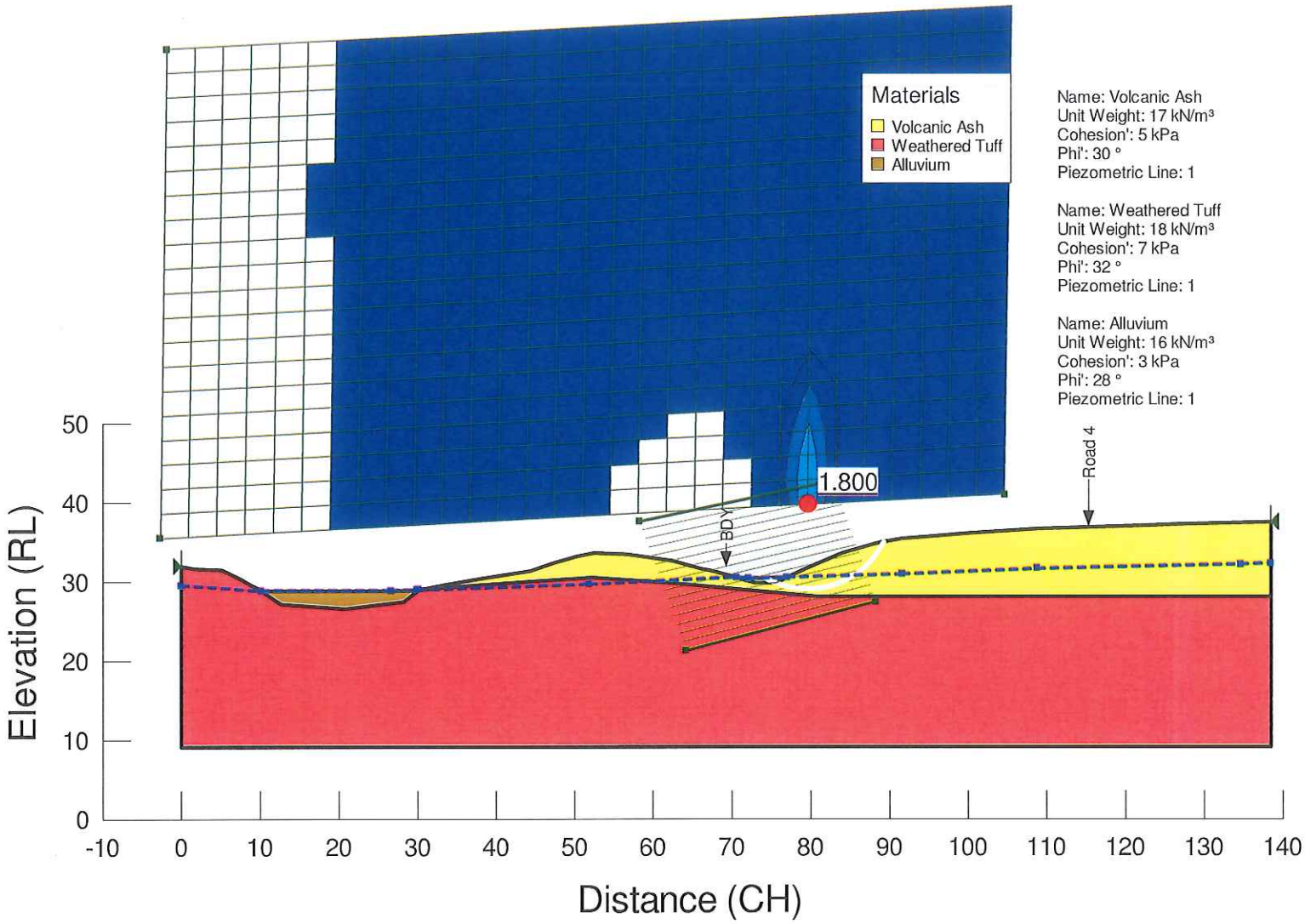
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: EXISTING SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **H.1**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

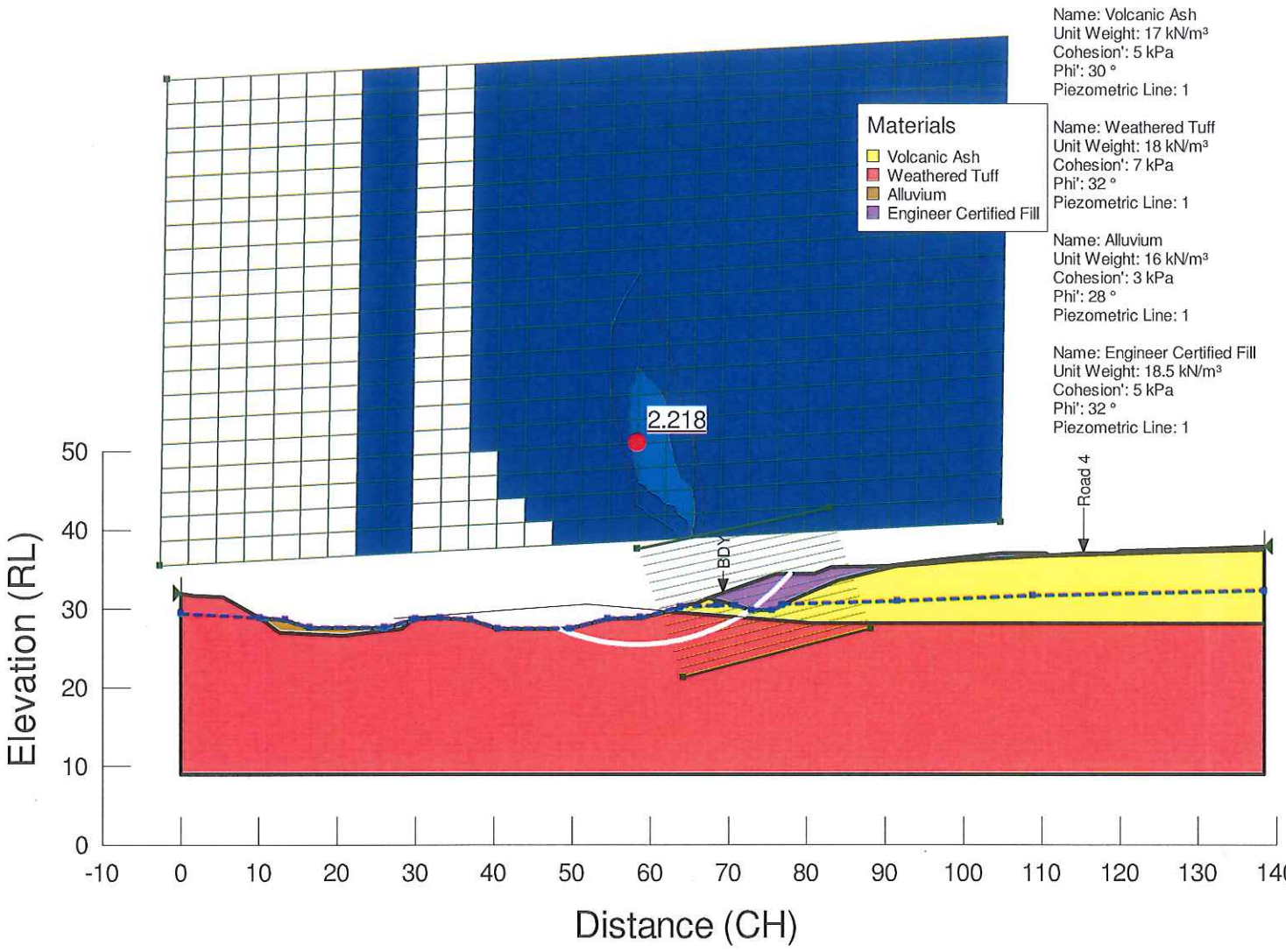
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: EXISTING SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **H.2**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

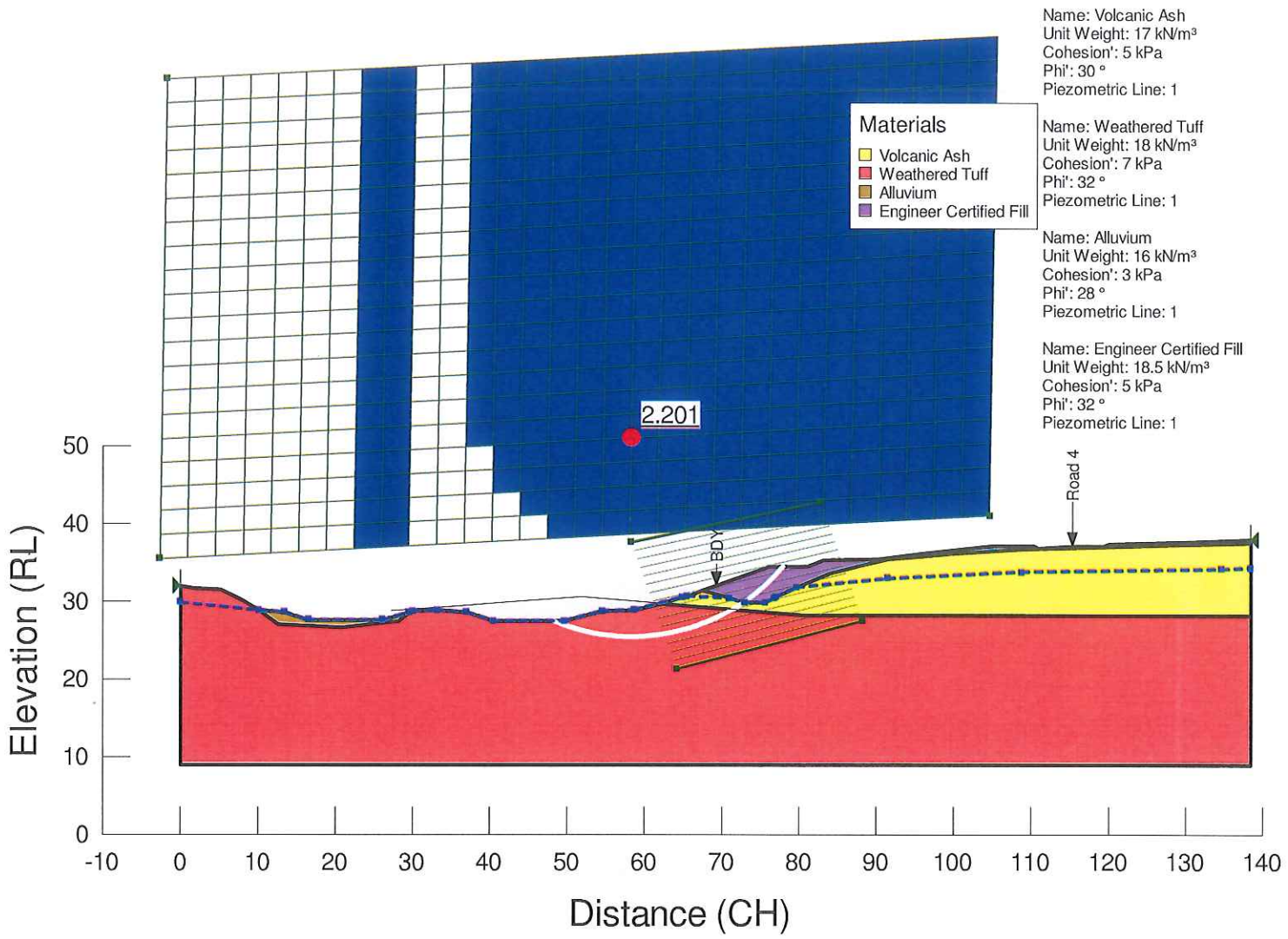
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)**
Job no: **J00779**	Case no: **H.3**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

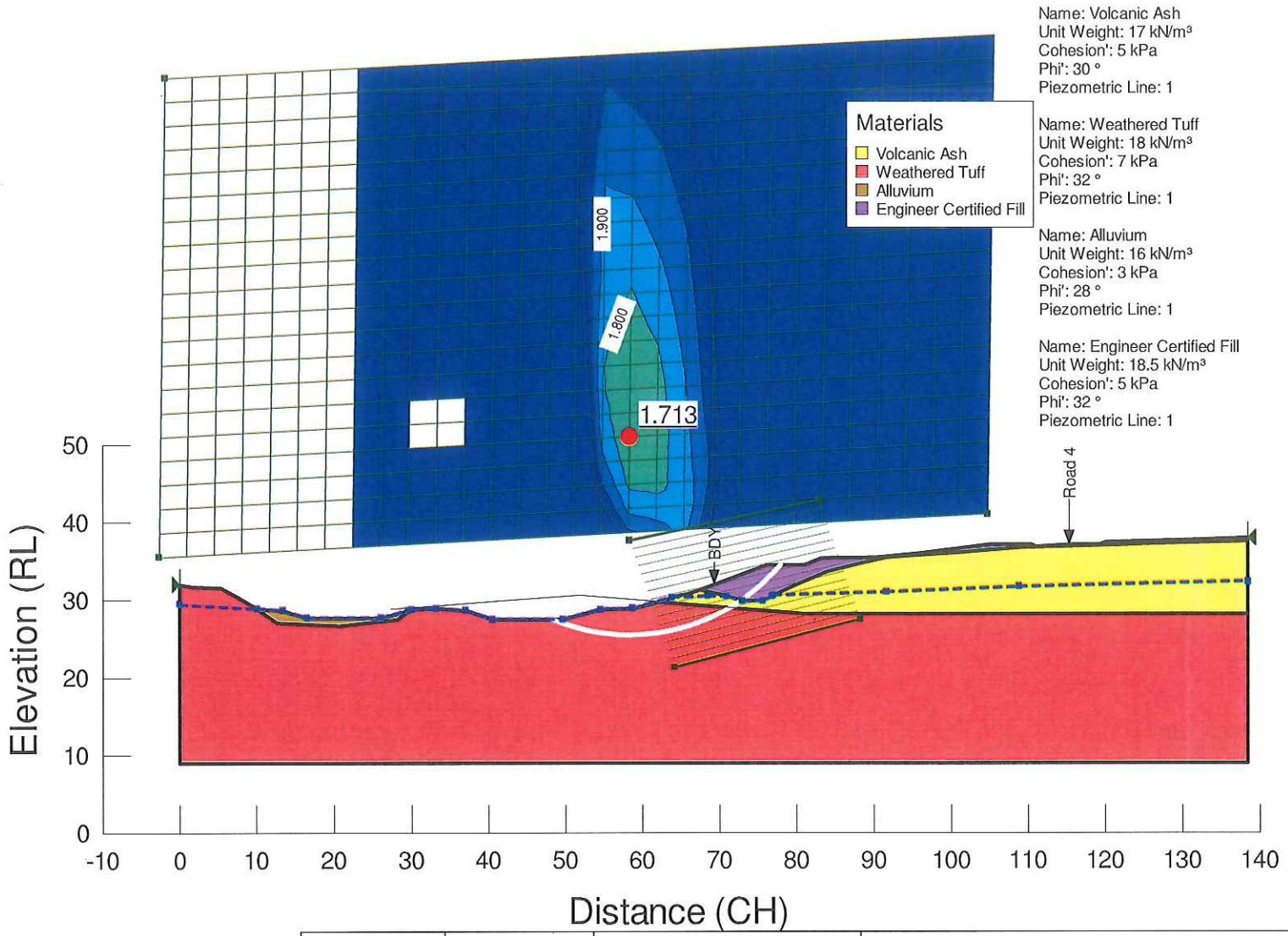
Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: PROPOSED SLOPE – EXISTING GROUNDWATER (F.O.S <1.5)**
Job no: **J00779**	Case no: **H.4**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: PROPOSED SLOPE – ELEVATED GROUNDWATER (F.O.S <1.3)**
Job no: **J00779**	Case no: **H.5**



Drawn	**MPC**
Approved	**CE**
Date	**8/11/17**
Scale	**Not to scale**
Original Size	**A4**

LANDER geotechnical

Client:	**HUGHES DEVELOPMENTS LIMITED**
Project:	**99 ESCOTTS ROAD, TUAKAU**
Title:	**CROSS SECTION H-H: EXISTING SLOPE – EXISTING GROUNDWATER – SEISMIC 1/150yr (F.O.S <1.2)**
Job no: **J00779**	Case no: **H.6**