ATTACHMENT 3

GEOTECHNICAL CERTIFICATION

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit 2, 3 Distribution Avenue
Molendinar QLD 4214
Phone (07) 5568 8900

Fraser Property Industrial Constructions Pty Ltd
C/- Gassman Development Perspectives
PO Box 392
BURLEIGH QLD 4207

Project 90520.01
22 January 2019
L.001.DraftA
GS:sj

Attention: Mitchell Gassman

Email: mitchell@gassman.com.au

Geotechnical Advice and Bulk Earthworks Global Stability Analysis
Proposed Industrial Development
Stapylton -Jacobs Well Road, Stapylton

1. Introduction

The report presents the results of a geotechnical assessment carried out by Douglas Partners Pty Ltd (DP) for the proposed industrial development at the above site. The work was carried out at the request of Gassman Development Perspectives (Gassman) (project civil engineer) on behalf of the Fraser Property Industrial Construction Pty Ltd Pty Ltd (FRIC) (project developer) to provide geotechnical advice and global stability assessment of the proposed bulk earthworks associated with the above site. The works were carried out in accordance with DP's fee proposal GLD190342 (Rev 3) dated 21 October 2019 and acceptance from Paul Solomon on 20 November 2019 representing FRIC.

The aim of the assessment was to provide comment on the following:

- Geotechnical assessment of the impact (if any) of the proposed cut batter along the site's northern boundary on adjacent piled structure and carpark;
- Geotechnical advice on the steepness in which the cut batter can be both stood (both unsupported and supported) along the southern embankment of SJW Road for the DTMR upgrade works. This is required as part of the relocation works required for the gas main currently within the bank;
- Global stability assessment for the stage 1 bulk earthworks; and
- Bulk Earthworks Specification (This will be presented as a 'standalone' report).

The following report for a previous geotechnical investigation was provided to DP by Gassman and was reviewed and used as part of this assessment:

- Morrison Geotechnics Pty Ltd – *'Broadscale Geotechnical Assessment, Proposed Industrial Development, Lot 1 on RP6882 and Lot 240 on W31320 Stapylton Jacobs Well Road and Christensen Road, Stapylton'* Job No: GE 11/002 dated 21 February 2011.

This assessment relies on the accuracy of the previous geotechnical report.

2. Geotechnical Assessment

2.1 Bulk Earthworks Global Stability Assessment

It is understood that cuts/fills of up to approximately 9 m and 5 m are expected respectively across the site. Boulder retaining walls up to approximately 4 m vertical height are also proposed.

This report is specific to the assessment of the theoretical factor of safety for global 'deep seated' stability only of the proposed bulk earthworks and proposed retaining systems and does not assess any internal or local stability as parts of the retaining wall design.

The following proposed bulk earthworks drawings, as supplied by Gassman were used to assist in the global stability analysis:

- Drawing No. – 5941 ENG BE1 150 to 160, Rev A, 20/12/2019 (cross sections); and
- Drawing No. – 5941 ENG BE1 050 - 055, Rev A, 20/12/2019 (cut and fill plans).

This report must be read in conjunction with the attached notes *'About this Report'* and the above referenced reports by others.

Global stability analyses was undertaken based on the subsurface conditions encountered during the previous geotechnical investigation, and bulk earthworks and the cross sections provided by Gassman.

A 20 kPa surcharge to model industrial building loads were assumed for the analysis with a setback of 1.5 m from the rear of any batter. A phreatic surface was also included to allow for seepage effects during the wet season.

Where retaining walls are shown (boulder walls) this assessment considers global stability only and does not consider internal, overturning or sliding stability of the walls, which should be considered as part of detailed design and verification by a suitability qualified engineer. Further, it is assumed that footings supporting the boulder walls will be founded at least 1 m below finished level. Where bio retention basins are proposed down slope of cut/fill or retained batters, it is assumed that the bio-retention systems will be design, constructed and certified to adequately drain as required and not affect the integrity of the upslope batters or retaining systems. Measures will need to be implemented to ensure the basin has impermeable walls and floors and will be adequately designed to drain quickly and not allow water to pond.

In the area under assessment, generally the subsurface conditions comprised stiff or stronger clay, medium dense or denser sand or sandstone, described as being extremely low to low strength. The proposed earthworks will require a cut/fill operation where additional fill will be placed to specification requirements. All fill will be placed under Level 1 inspection by DP in accordance with the requirements of AS 3798-2007.

The geotechnical parameters used for our analysis are as listed in Table 1.

Table 1 – Summary of Geotechnical Material Properties

Material	C' (kPa)	Φ' (°)	γ (kN/m^3)
Controlled Fill(i)	5	26	19
Clay – stiff or stronger	5	26	19
Sand – medium dense or denser	0	32	20
Sandstone - extremely low strength or stronger	15	35	21
Boulder Retaining Wall	22	45	22

Note: (i) It is assumed that all fill will be placed in accordance with Level 1 requirements under inspection and testing by DP.

(ii) Assumed parameters to test for global stability models only.

The global stability analyses consisted of external stability checks using the Slope/W 2019 Version 10.1.1.18972 software (Geo-Studio International, Ltd) using the Bishops method for six selected cross sections from the supplied Gassman drawings and were considered typical for the proposed works.

The sections analysed were as follows:

- Section A;
- Section B;
- Section C;
- Section D:
- Section E;
- Section G; and
- Section K.

The results of the analysis of the proposed batters are attached and shown in Table 2, and indicate a FOS against failure of at least 1.5 in each instance as required. Therefore, the outcomes are considered acceptable with regards to long term stability subject to the assumptions made in this report.

Table 2 – Results of Slope Stability Analysis

Figure	Section	Cut/Filling Batters/Retaining Systems	Factor of Safety[(i)]
1	A	Cut Batter	2.6
2	H	Boulder Retaining Wall	1.5
3	C	Cut Batter	1.6
4	G	Cut Batter	2.7
5	C	Boulder Retaining Wall	1.5
6	K	Fill Batter	1.6
7	E	Boulder Retaining Wall	2.7

Note (i) Rounded to one decimal place.

All cut/fill batters will need to undergo inspections by DP during construction and at the completion of the earthworks operation to confirm suitability in relation to long term stability and confirmation that the batters comply with sealed plan and design requirements and DP recommendations.

2.2 Proposed Cut Batter Along the Northern Boundary

It is understood that cuts of up to 6 m are expected along the northern boundary of the site as part of the bulk earthworks operation. Directly north and adjacent to the northern boundary is an existing combination piled car park structure and a car park on grade. Gassmans have indicated that they anticipate that piles supporting the elevated carpark structure are founded approximately 3 m below existing ground level with an estimated pile diameter of 0.6 m.

In accordance with the previous geotechnical report, by others, the closest boreholes to this area of cut indicated residual sands and clays up to 1 m thick then very low strength sandstone grading low strength with depth. This profile was assumed as part of this assessment.

A series of cross sections indicating proposed cut profiles and a plan showing section locations were provided to DP by Gassmans, as attached, and were used as part of this assessment.

Using the same analysis methods for the bulk earthworks assessment (Section 2.1), and two sections were selected along the alignment which were considered typical for the proposed excavation along this alignment. The sections analysed were as follows:

- Chainage 40; and
- Chainage 120.

The parameters provided in Table 1 were used for this assessment.

The results of the analysis for the proposed cut along the northern boundary, as shown in Table 3, indicated a FOS against failure of at least 1.5 in each instance as required. Therefore, the outcomes were considered acceptable with regards to long term stability subject to the assumptions made in this report.

Table 3: Results of Slope Stability Analysis (Eastern Batter)

Figure	Section	Cut Batter	Factor of Safety[(i)]
8	120	Adjacent Carpark at Grade	2.7
9	40	Adjacent Existing Piles	1.9

Note (i) Rounded to one decimal place.

2.3 Cut Adjacent Stapylton Jacobs Well Road

It is understood that as part of the works for the development, widening of the carriageway of the existing Stapylton Jacobs Well Road will be required for dual laning.

As part of the proposed design, steepening of the existing batter to avoid impacts of existing high pressure gas main, communications and water services will be required. The existing rising main in the existing batter is proposed to be decommissioned and replaced with a trunk gravity main to the opposite side of the road.

Based on the closest borehole information from the previous investigation and a visual inspection carried out by a senior engineering geologist from our Gold Coast office, the subsurface profile in the existing cut batter appeared to comprise residual soil over weathered metasandstone where observed. The cut varied in height from grade up to 3 m and was approximately 80 m long.

The rock mass observed was a highly weathered, low to medium strength, grey yellow orange metasandstone which was closely fractured, closely jointed, where joint planes were discontinuous, open in parts and clean.

Figures 10 to 12 indicate typical cut batter conditions encountered at the time of the assessment.

Figure 10 Cut batter looking southwest

Figure 11: Cut batter looking northeast

Figure 12: Typical rock outcrop observed in the existing cut batter

A structural mapping exercise using a hand held compass and inclinometer was carried out where measurements and observation of the rock mass, including predominant discontinuities, were recorded.

The cut had a strike of 270° and was cut at an angle of between 45° and 50°.

The following major discontinuities were recorded during the mapping exercise:

Table 4: Outcrop Discontinuities

Discontinuity Type	Dip Range (Degrees)/Dep Direction Range (Degrees)
Joint	40 – 60/330 – 350
Joint	60 – 80/005 – 020
Joint	70 – 85/080 – 100

The above joint sets form a 'wedge' failure block given the orientation of the cut which 'daylights' out of the cut face. The resultant *'wedge'* blocks, are typically 'soccer' ball in size.

Considering the subsurface conditions observed, the following unsupported cut batter angles are recommended for the proposed change of geometry:

- Soil and extremely low strength rock – 1V:2H; and
- Weathered metasandstone (very low strength or stronger) – 1V:0.75H

If steeper cut angles are required, the use of a retaining system such as soil nails and rock anchors mesh and structure are recommended. This method of support would require no footing and the geometry of the cut could be remodelled to near vertical. This however, would be subject to further investigation and the location of services.

3. Limitations

Douglas Partners Pty Ltd (DP) has prepared this additional geotechnical investigation report for the proposed industrial development along Stapylton Jacobs Well Road, Stapylton in accordance with DP's proposed GLD190342 (Rev 3) dated 21 October 2019.

This report is provided for the exclusive use of FRIC Pty Ltd or their consulting engineers, as authorised, for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are relient on the accuracy of the sub-surface conditions as detailed in the above mentioned Morrison Geotechnics report at the specific sampling and testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after field testing has been completed.

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. DP should be contacted to provide specific advice with respect to a Safety Report where it is to be prepared.

We trust that the above advice meets your requirements. If you have any queries or require additional information, please contact us.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Gary Samuels
Associate/Branch Manager

Andrew Middleton
Principal

Attachments: About this Report
Stability Outputs
Easterly Boundary Layout Plan and Cross Sections

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

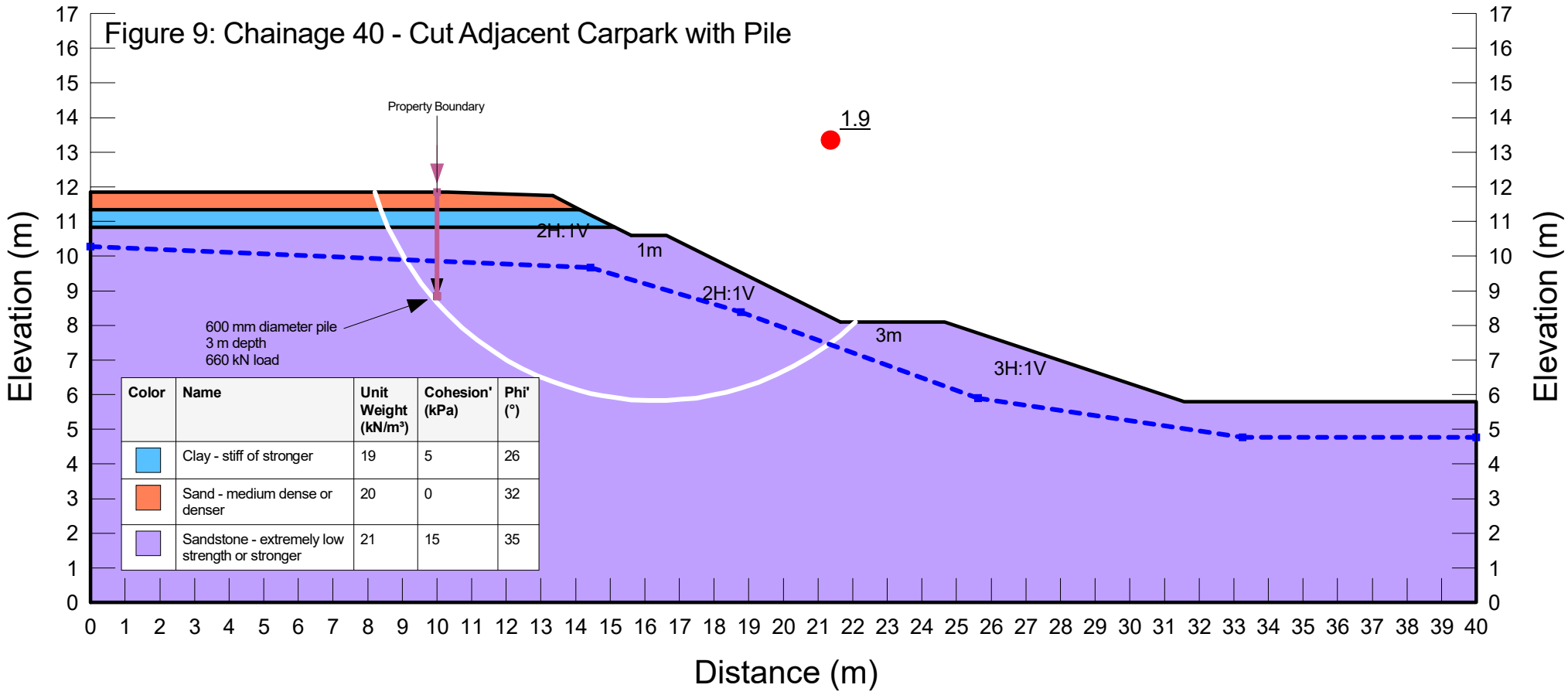
Information for Contractual Purposes

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

Site Inspection

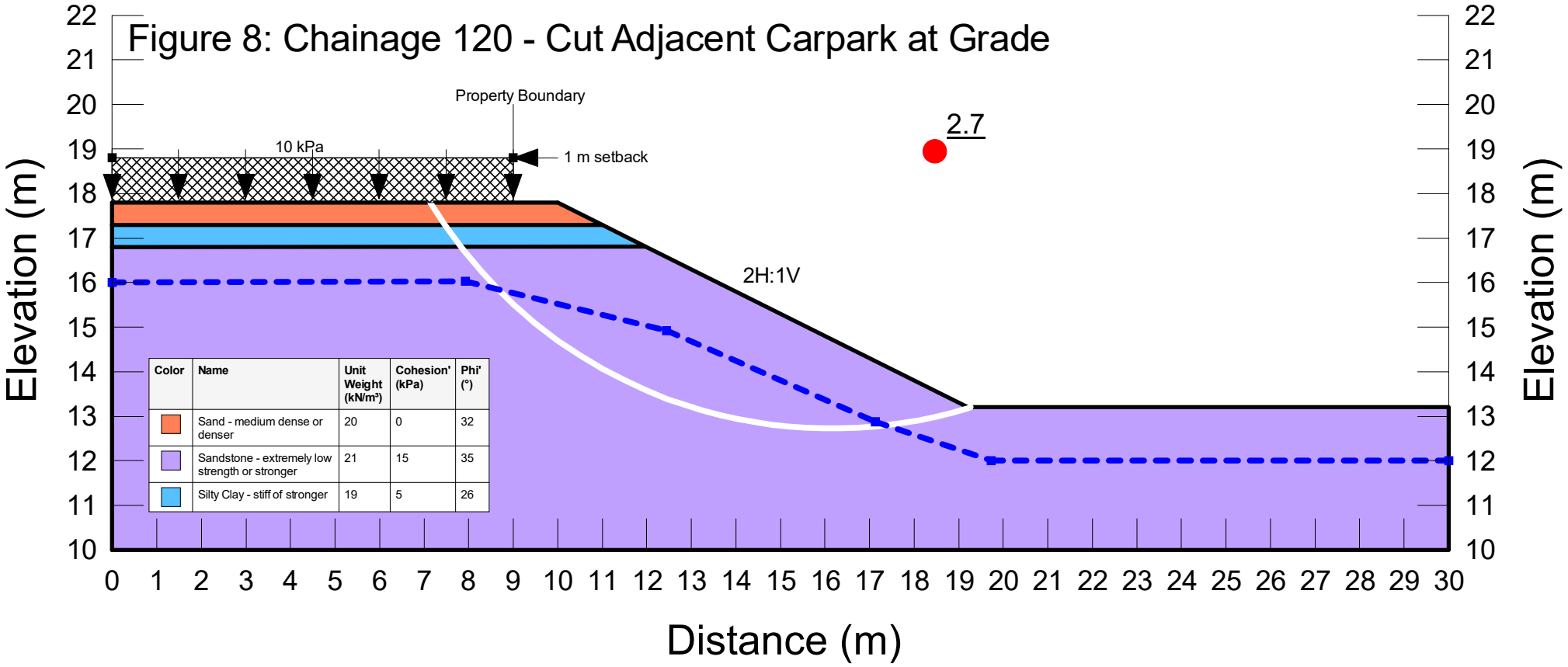
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Figure 9: Chainage 40 - Cut Adjacent Carpark with Pile



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Clay - stiff of stronger	19	5	26
	Sand - medium dense or denser	20	0	32
	Sandstone - extremely low strength or stronger	21	15	35

Figure 8: Chainage 120 - Cut Adjacent Carpark at Grade



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Sand - medium dense or denser	20	0	32
	Sandstone - extremely low strength or stronger	21	15	35
	Silty Clay - stiff of stronger	19	5	26

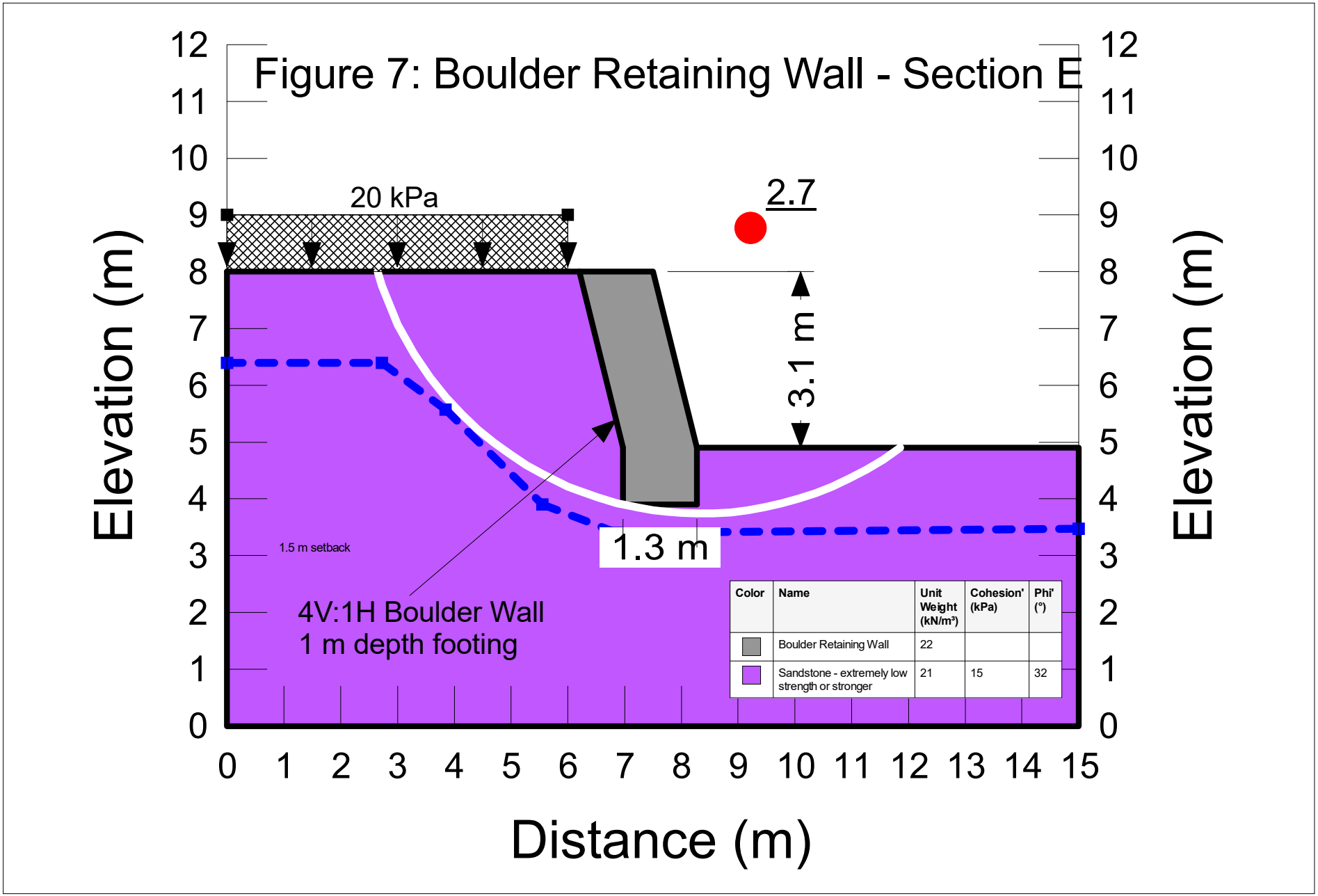
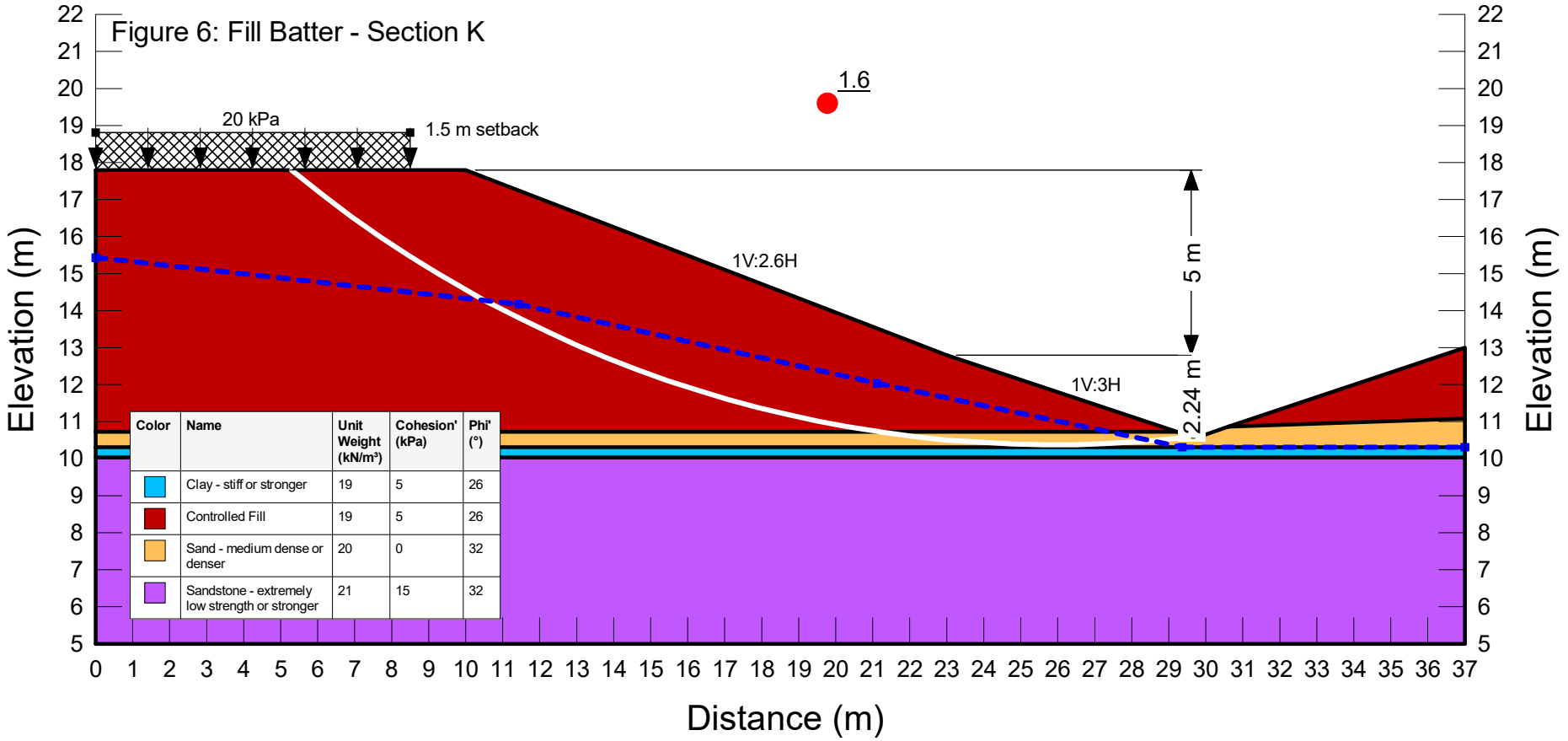


Figure 7: Boulder Retaining Wall - Section E
20 kPa
2.7
3.1 m
1.3 m
1.5 m setback
4V:1H Boulder Wall
1 m depth footing
Color
Name
Unit Weight (kN/m³)
Cohesion' (kPa)
Phi' (°)
Boulder Retaining Wall
22
Sandstone - extremely low strength or stronger
21
15
32
Elevation (m)
Elevation (m)
Distance (m)
0 1 2 3 4 5 6 7 8 9 10 11 12
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Figure 6: Fill Batter - Section K



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Clay - stiff or stronger	19	5	26
	Controlled Fill	19	5	26
	Sand - medium dense or denser	20	0	32
	Sandstone - extremely low strength or stronger	21	15	32

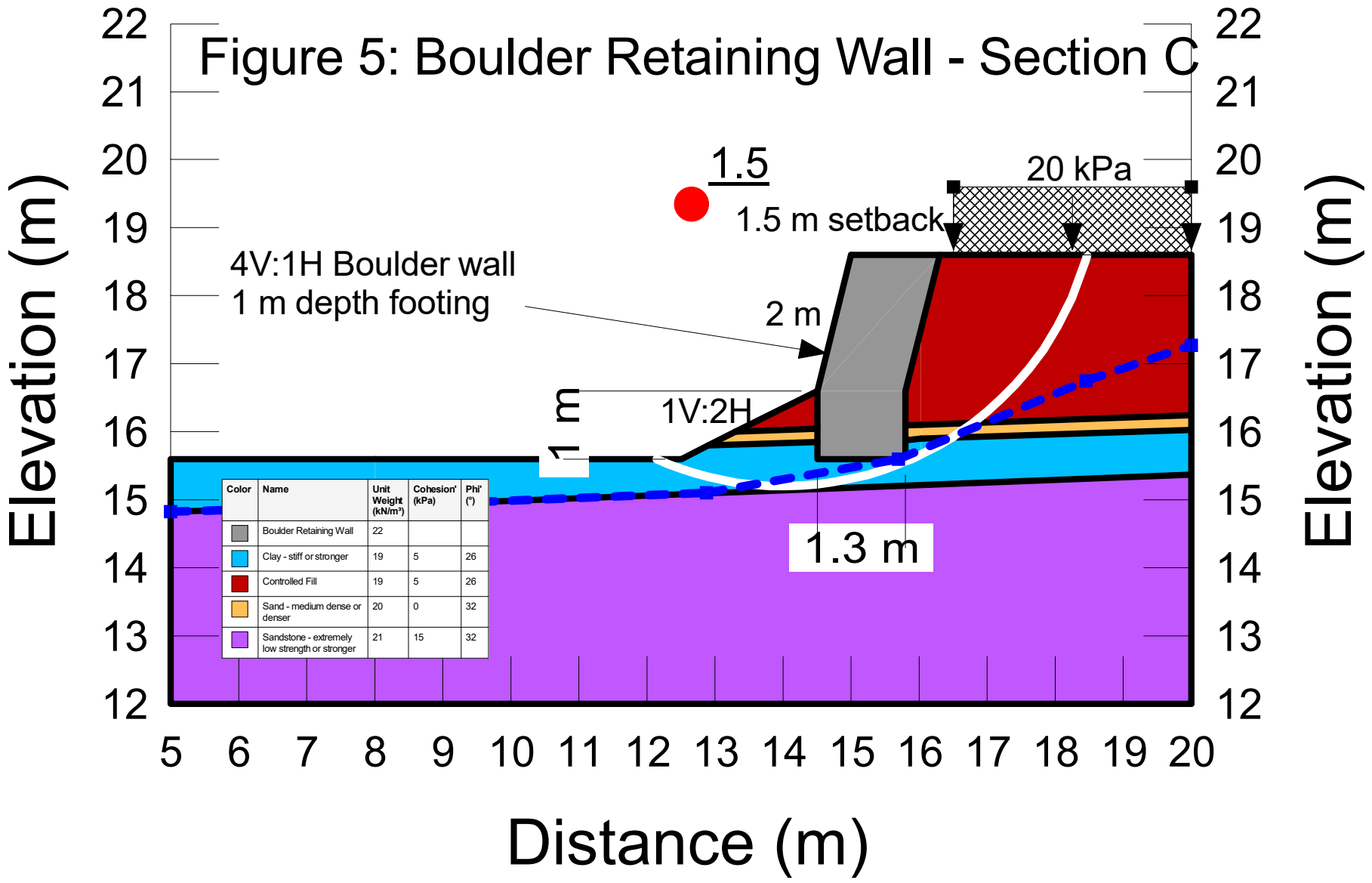


Figure 5: Boulder Retaining Wall - Section C
1.5
1.5 m setback
20 kPa
4V:1H Boulder wall
1 m depth footing
2 m
1V:2H
1 m
1.3 m
Color | Name | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°)
Boulder Retaining Wall | 22
Clay - stiff or stronger | 19 | 5 | 26
Controlled Fill | 19 | 5 | 26
Sand - medium dense or denser | 20 | 0 | 32
Sandstone - extremely low strength or stronger | 21 | 15 | 32
Elevation (m)
Elevation (m)
22 21 20 19 18 17 16 15 14 13 12
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Distance (m)

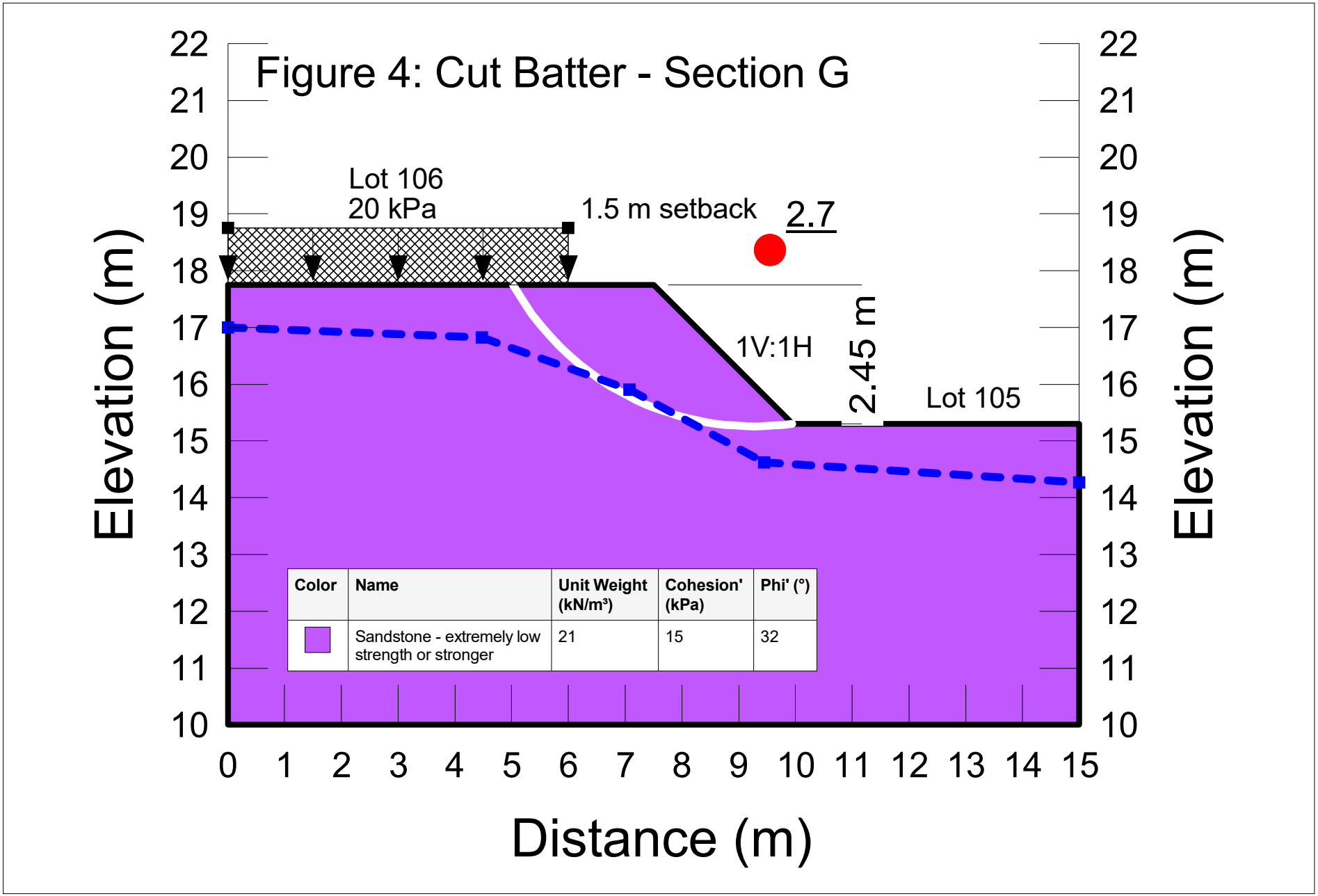


Figure 4: Cut Batter - Section G
Lot 106
20 kPa
1.5 m setback
2.7
1V:1H
2.45 m
Lot 105
Elevation (m)
Distance (m)
Color
Name
Unit Weight (kN/m³)
Cohesion' (kPa)
Phi' (°)
Sandstone - extremely low strength or stronger
21
15
32

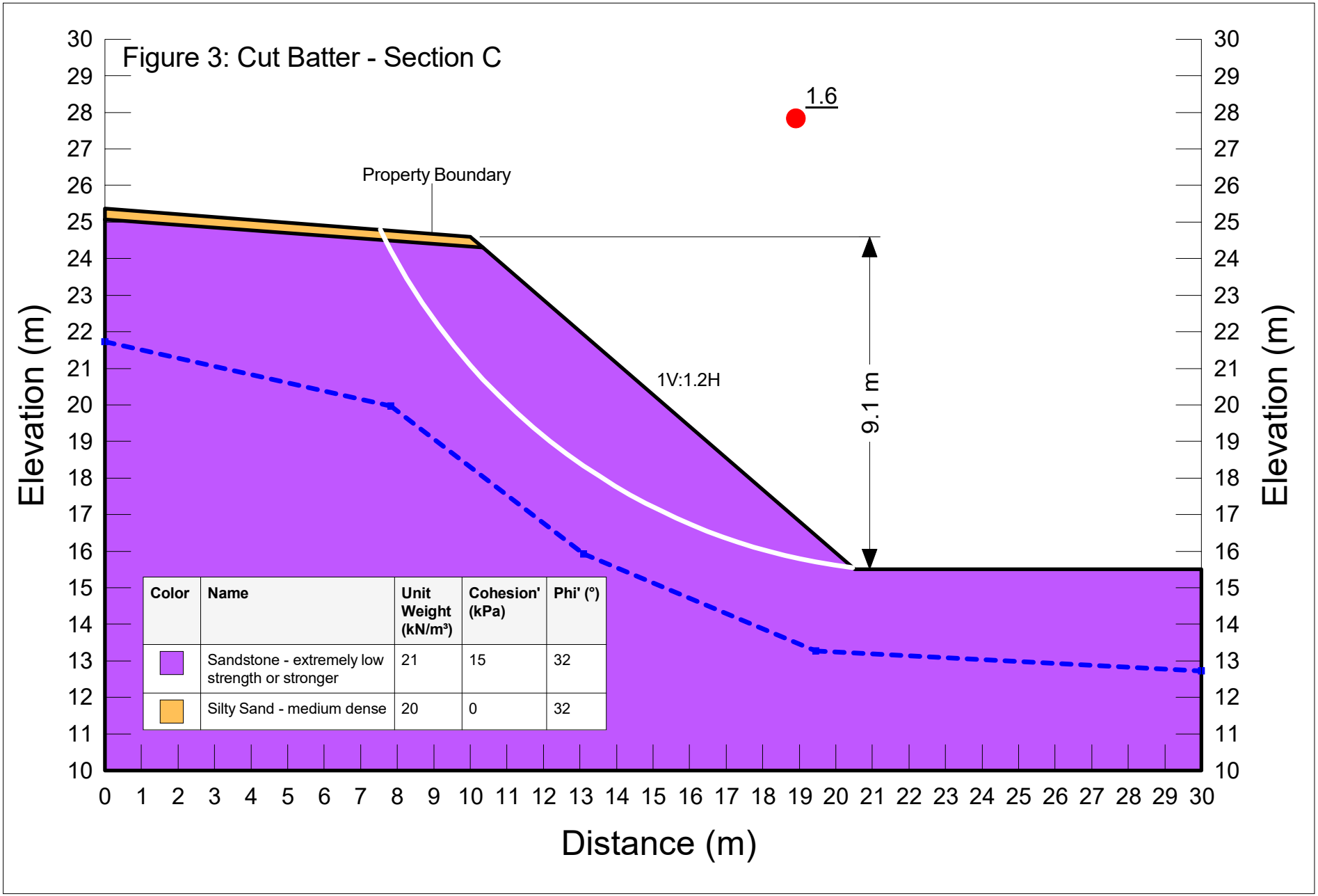
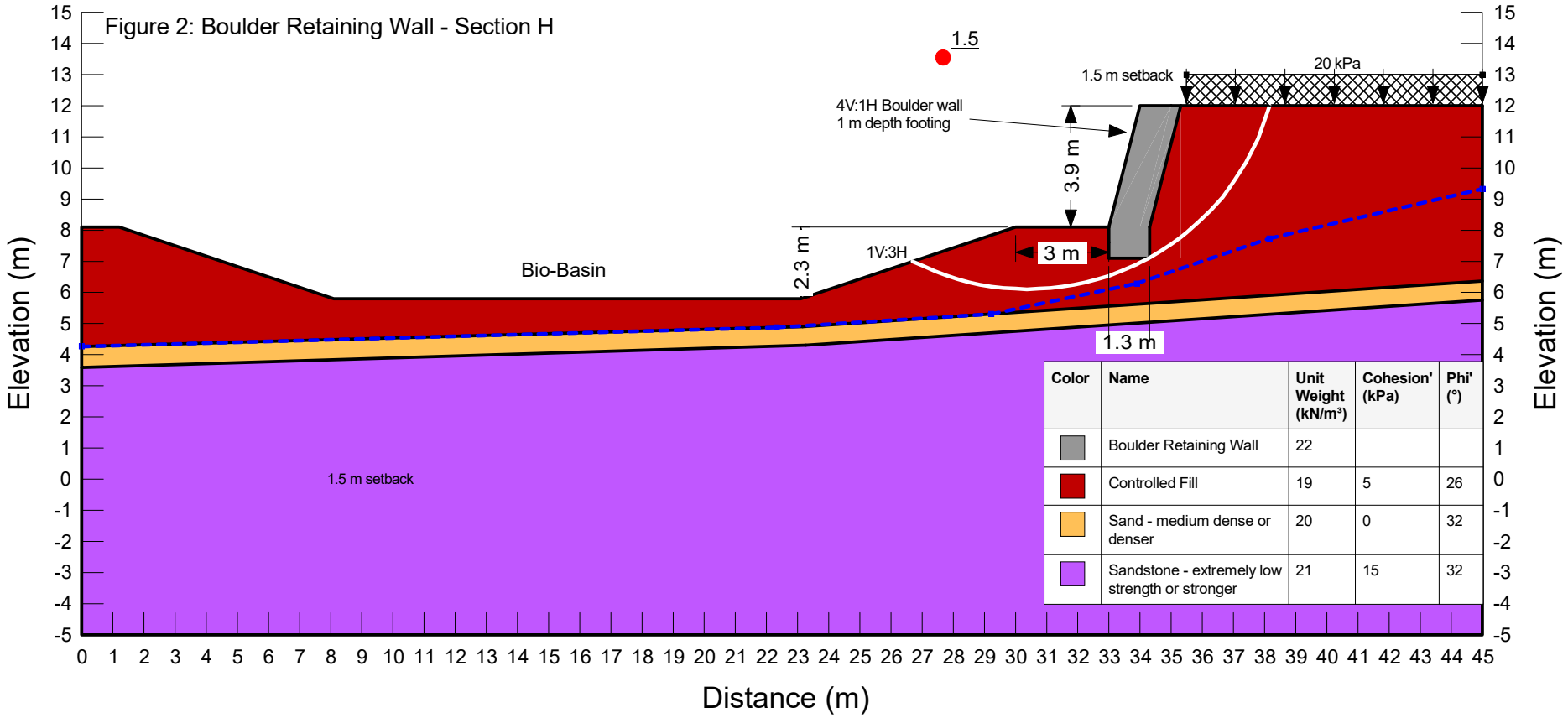


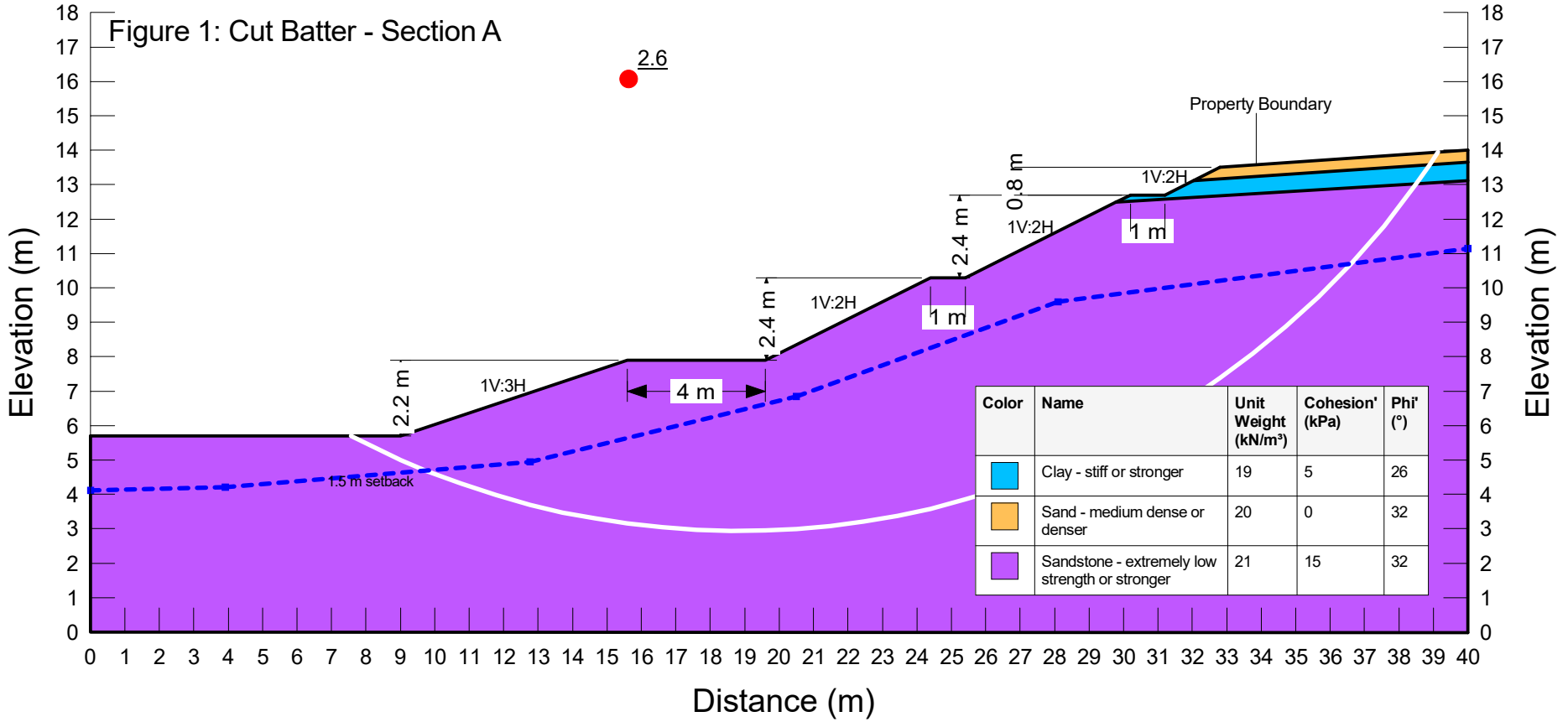
Figure 3: Cut Batter - Section C
1.6
Property Boundary
1V:1.2H
9.1 m
Elevation (m)
Distance (m)
Color | Name | Unit Weight (kN/m³) | Cohesion' (kPa) | Phi' (°)
Sandstone - extremely low strength or stronger | 21 | 15 | 32
Silty Sand - medium dense | 20 | 0 | 32

Figure 2: Boulder Retaining Wall - Section H

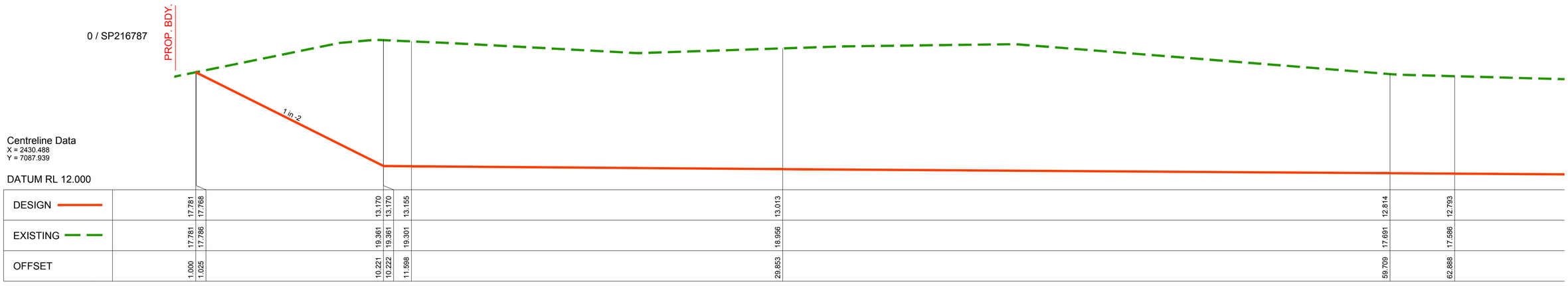


Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Boulder Retaining Wall	22		
	Controlled Fill	19	5	26
	Sand - medium dense or denser	20	0	32
	Sandstone - extremely low strength or stronger	21	15	32

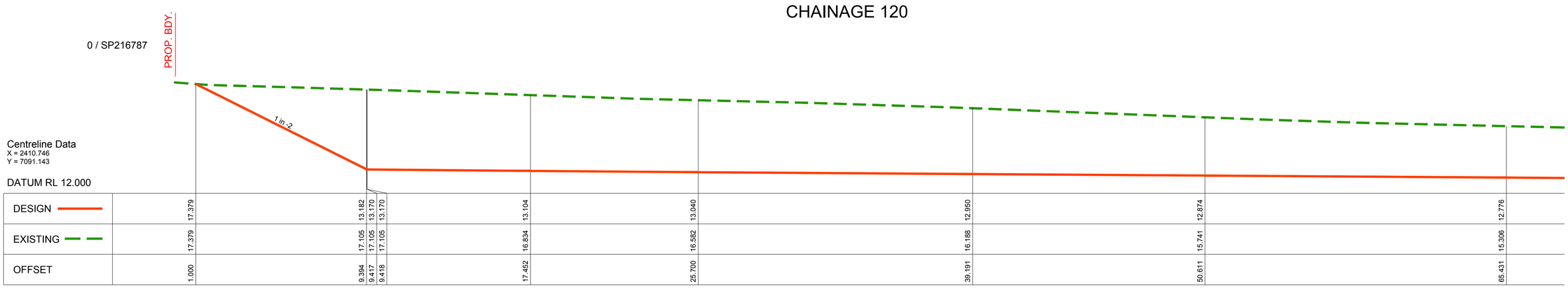
Figure 1: Cut Batter - Section A



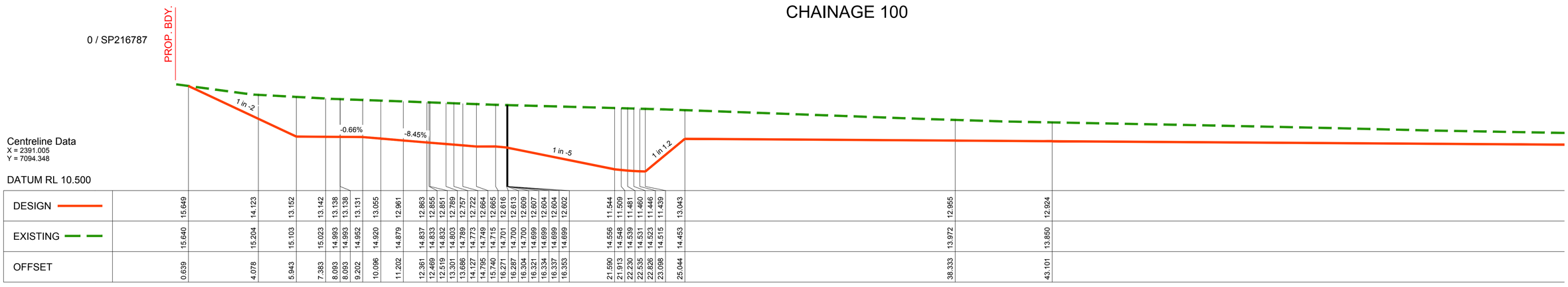
Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Clay - stiff or stronger	19	5	26
	Sand - medium dense or denser	20	0	32
	Sandstone - extremely low strength or stronger	21	15	32



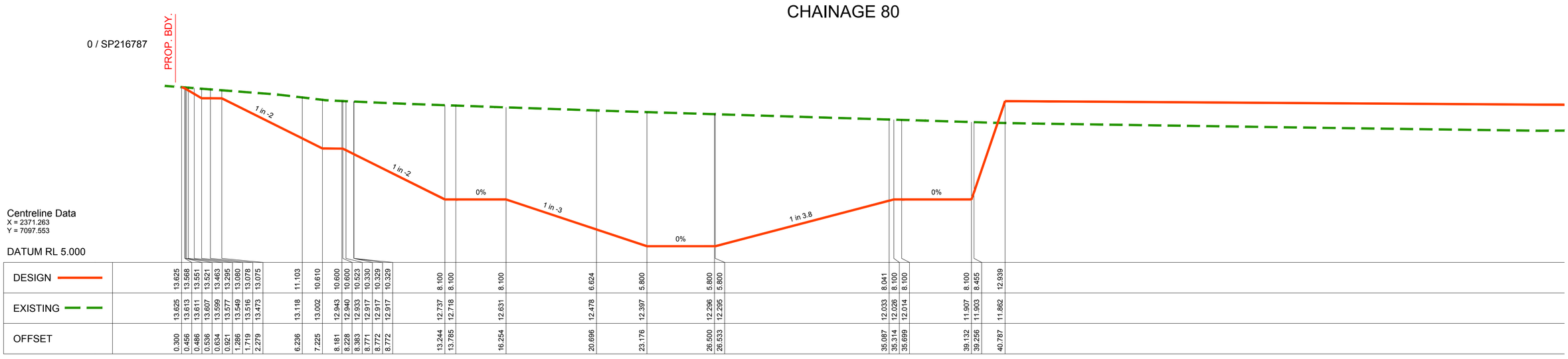
CHAINAGE 120



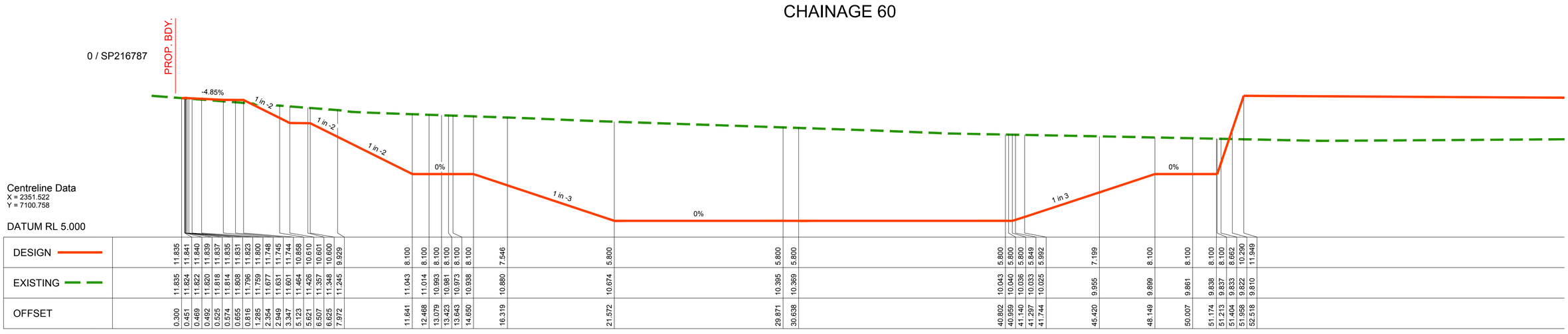
CHAINAGE 100



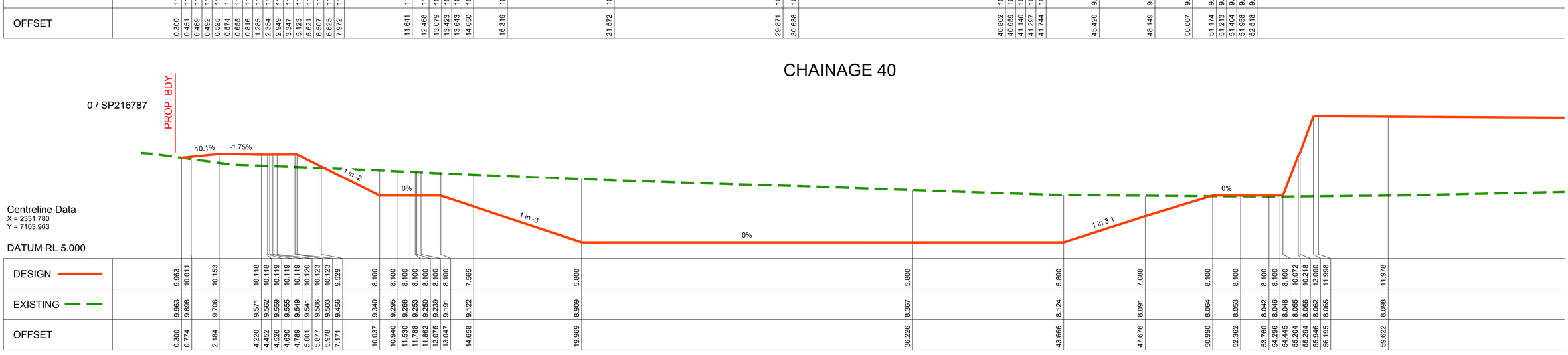
CHAINAGE 80



CHAINAGE 60



CHAINAGE 40



CHAINAGE 20


N
120.0
100.0
80.0
60.0
40.0
20.0
1.0m
0.3m
SP216787
SP29594