Pacific Geotech
Consulting Geotechnical Engineers

# GEOTECHNICAL REVIEW & GLOBAL STABILITY ASSESSMENT:

## Proposed New Road Embankment

## Wongawallan Drive Extension

## Yarrabilba Precinct 5 MIBA

## Golding Contractors

## February 2025

## PG-5335-B

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Pacific Geotech
Consulting Geotechnical Engineers

Ref: PG-5335-B, 2025-02-03, GSR VER 1
Author: Robert Maxwell

10th February, 2025

Golding Contractors
Email: jack.williams@golding.com.au
Cc: jedda.david@stockland.com.au

**ATTN: JACK WILLIAMS**

Dear Sir,

**GEOTECHNICAL REVIEW & GLOBAL STABILITY ASSESSMENT**
**PROPOSED NEW ROAD EMBANKMENT**
**WONGAWALLAN DRIVE EXTENSION, YARRABILBA PRECINCT 5 MIBA**

## 1.0 INTRODUCTION

This report contains the results of the geotechnical review and global stability assessment of the proposed new road embankment for the extension of Wongawallan Drive crossing over Quinzeh Creek at the above site.

As part of the planning of the OPW application, Pacific Geotech has been commissioned by Golding Contractors on behalf of Stockland to undertake the geotechnical review and global stability assessment outlined in our proposal PG-5335-B, 2025-01-13 PR VER 1.

The scope of works included the following:

- Review of available geotechnical information and preliminary design drawings for Wongawallan Drive Extension by MPN Consultants, Ref. No. 9951-1 Drawing Set.
- Development of a geotechnical model of the site.
- Global stability analysis of selected embankment sections using proprietary computer modelling software SlopeW.
- Commentary on the results of the global stability analysis and provide design and construction recommendations to improve the geotechnical stability.

It is understood that a factor of safety (FOS) against long term global instability of no less than 1.5 is considered acceptable for design of the new road embankment.

## 2.0 SUBSURFACE CONDITIONS

Subsurface conditions along the alignment of the proposed Wongawallan Drive Extension were previously investigated by Pacific Geotech and the detailed borehole records and site plan are attached to this letter.

The subsurface conditions encountered during the investigation and envisaged to be present along the alignment of the proposed Wongawallan Drive extension typically comprised fill materials, overlying natural alluvial sands. The natural alluvial sands are expected to be saturated and very loose to loose with clayey sand layers. The alluvial sands are anticipated to be underlain by natural clays which are inferred from DCP testing to be at a depth in the order of 2.3m below surface level at the test location. Significant variation in depths to the natural clay must be expected within the Quinzeh Creek crossing due to the presence of deeply incised paleochannels which are sand filled.

Groundwater was encountered at a depth of 0.7m in the hand auger at the time of drilling. The groundwater levels are expected to fluctuate with the flows in Quinzeh Creek and with seasonal and climatic conditions.

## 3.0 GLOBAL STABILITY OF PROPOSED NEW ROAD EMBANKMENT

The global stability assessment of the proposed new road embankment has been carried out using the 'Slope/W' computer program developed by GeoStudio. This program allows the use of Bishop's Modified, Janbu's Simplified and Morgenstern-Price Methods applied to circular, composite and fully specified failure surfaces.

Failure conditions are analysed by dividing the failure body into a number of vertical slices. The forces acting on each slice are evaluated and the equilibrium of the entire failure body is determined by assessing the forces on all the slices.

A factor of safety is computed for each failure surface considered. A minimum factor of safety for the section under analysis is found by analysing a large number of potential failure surfaces.

The global stability analysis was undertaken on 4 typical embankment sections for the long-term conditions. A surcharge of 10kPa has been applied to the crest of the embankment slopes to simulate the typical traffic loadings.

### 3.1 Geometry

The following embankment sections were selected for modelling, which represent the typical worst-case section for global stability.

- CH940
- CH960
- CH1000
- CH1040

The proposed development layout and sections of the proposed new road embankment are shown in Figures 1 to 5 below.

**FIGURE 1 PROPOSED DEVELOPMENT LAYOUT**

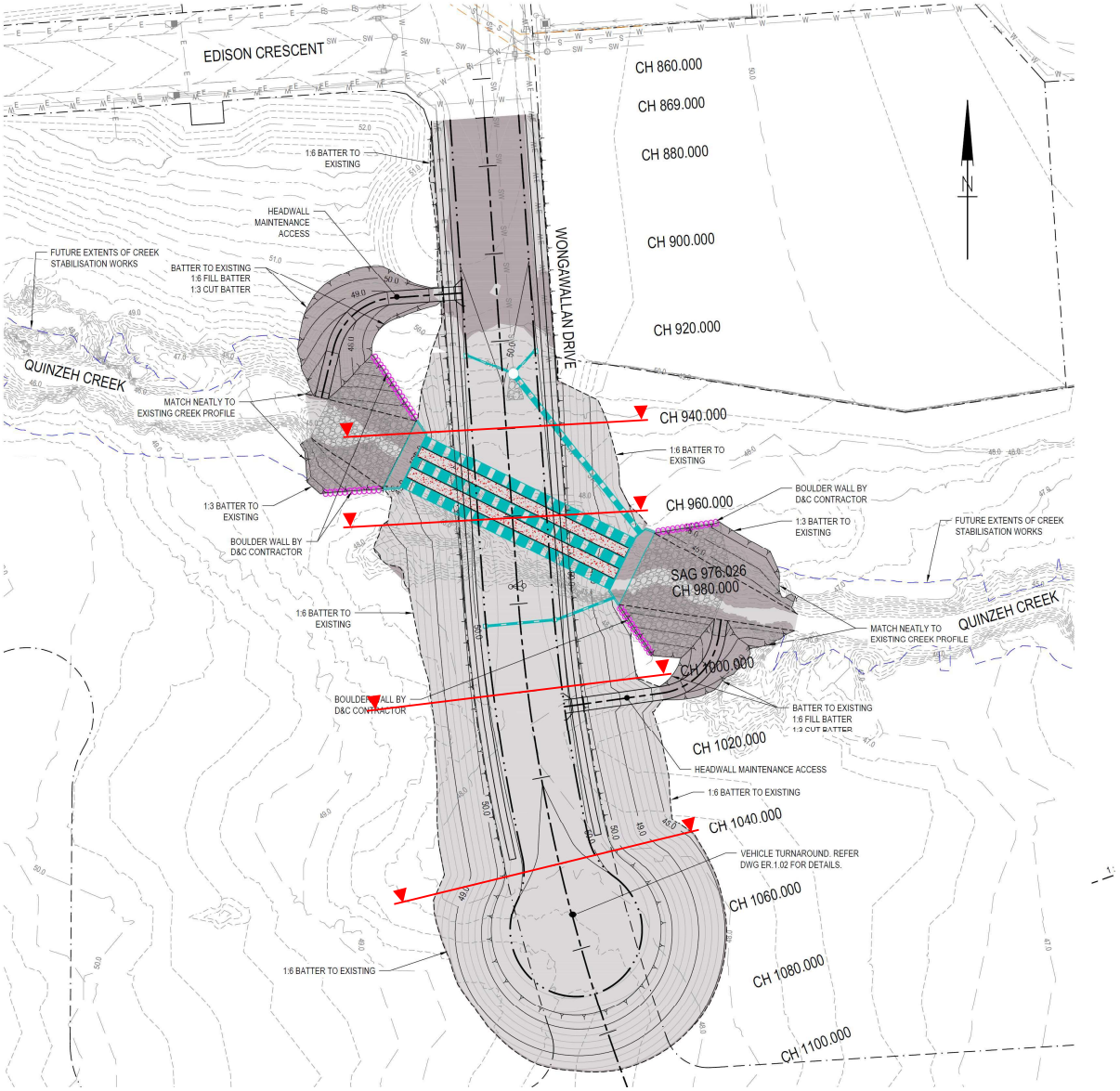


**FIGURE 2 EMBANKMENT SECTION - CH940**

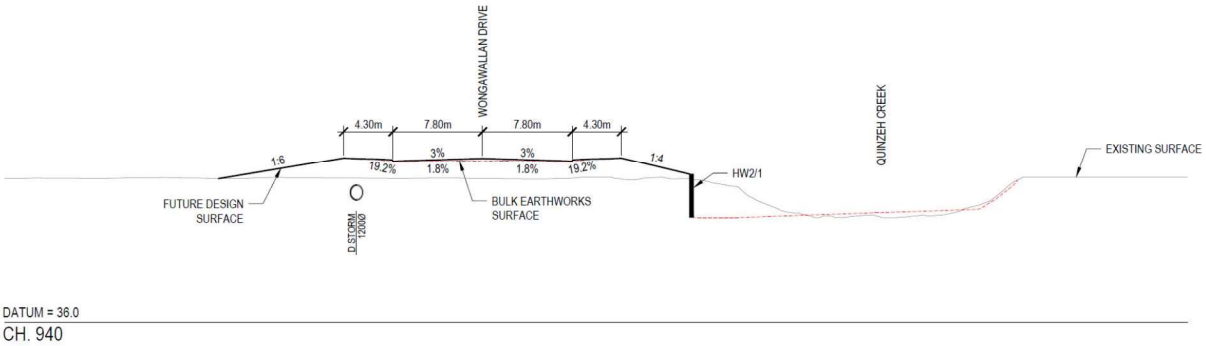



**FIGURE 3 EMBANKMENT SECTION - CH960**

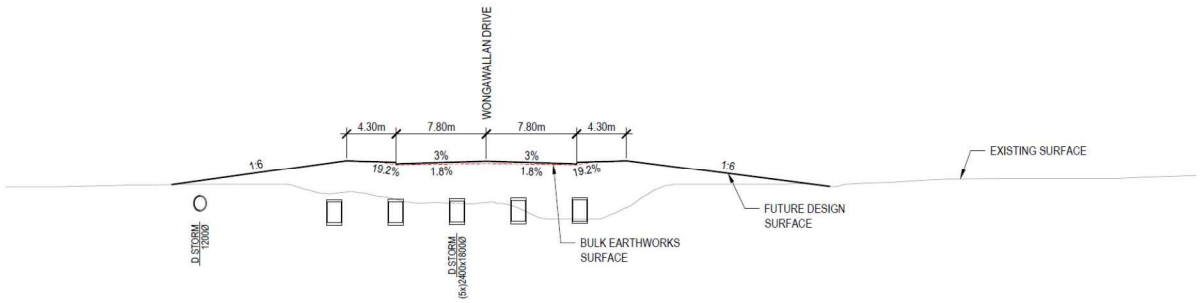



**FIGURE 4 EMBANKMENT SECTION – CH1000**

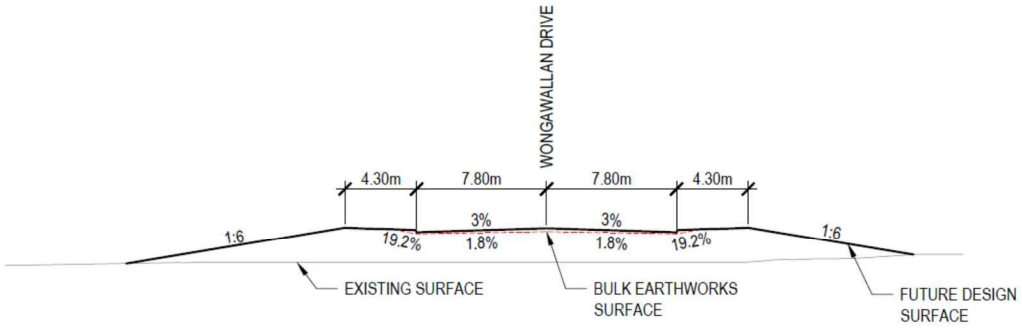
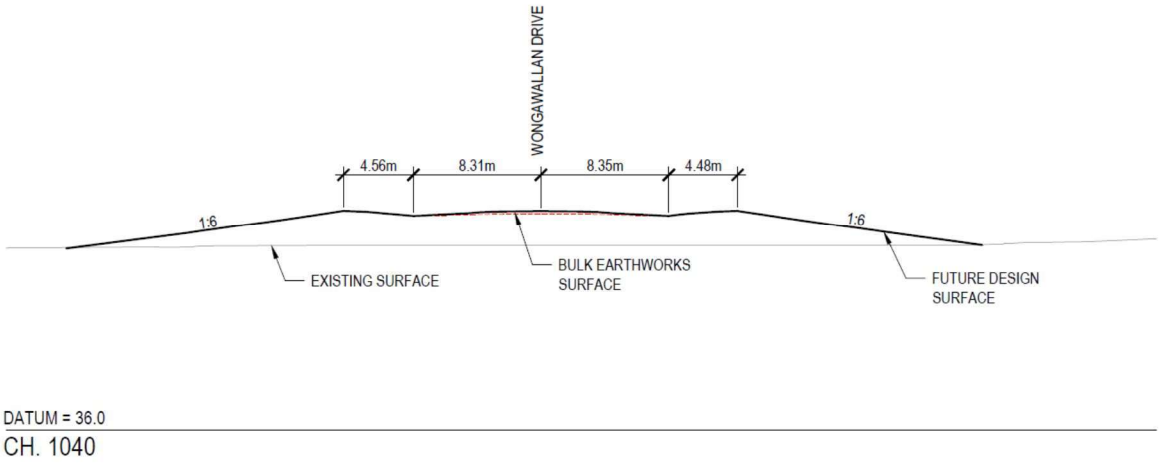


**FIGURE 5 EMBANKMENT SECTION – CH1040**




### 3.2 Geotechnical Stability Model

For the global stability analysis, the following details have been adopted for the proposed new road embankment.

The results of the previous investigations, published correlations, and engineering judgement were used to assess the design geotechnical parameters given in Table 1.

**TABLE 1 GEOTECHNICAL DESIGN PARAMETERS**

| Material | Density (kN/m³) | Geotechnical Design Parameters | |
|---|---|---|---|
| | | c' (kPa) | Φ' (°) |
| Controlled Fill* | 19 | 2 | 24 |
| Natural Silty Sands – Very Loose to Loose | 17 | 0 | 25 |
| Natural Clay – Very Stiff or stronger | 19 | 4 | 26 |
| Rock Mattress | 22 | 0 | 45 |

Notes: * Depends on fill material type and level of compaction. Assumes material compacted under 'Level 1' supervision.

### 3.3 Phreatic conditions

The following phreatic conditions were adopted for the global stability analysis:

- Normal flow condition – Groundwater level at RL44m.
- Flood condition – Groundwater level at RL49.5m.
- Rapid Draw Down condition – Groundwater elevated at 49.5m in embankment and surrounding water level at normal flow conditions (RL44m).

### 3.4 Global Stability Analysis Results

The results of the global stability analysis for the proposed embankment geometry and three phreatic conditions are presented in Table 2 below.

**TABLE 2 GLOBAL STABILITY ANALYSIS RESULTS**

| Embankment Section | Phreatic Conditions | Factor of Safety (FoS) |
|---|---|---|
| CH940 | Normal | 2.04 |
| | Flood | 2.29 |
| | Rapid Drawdown | 1.60 |
| CH960 | Normal | 3.37 |
| | Flood | 2.74 |
| | Rapid Drawdown | 2.39 |
| CH1000 | Normal | 1.99 |
| | Flood | 3.41 |
| | Rapid Drawdown | 1.56 |
| CH1040 | Normal | 2.20 |
| | Flood | 2.23 |
| | Rapid Drawdown | 1.63 |

The global stability output plots from Slope/W are attached to this report.

The results of the global stability analysis indicate a factor of safety (FoS) of greater than 1.5 can be achieved under the normal, flood and rapid drawdown conditions, where the embedment is keyed a minimum 0.5m depth into the stiff (or stronger) natural clays. Where the clay embedment is not able to be practically achieved, consideration maybe given to supporting the section of embankment on a crushed rock mattress.

Subject to inspection and testing of the stripped subgrade by Pacific Geotech to confirm the undrained shear strength, it is envisaged the crushed rock mattress would comprised the following - *NOTE: Rock mattress design may need to be altered at this point subject to results of the subgrade assessment by Pacific Geotech with an increase in thickness required if the shear strength is less than 50kPa.*

1. A lower layer of approved Geotextile/Geogrid (Tensar TX150 or Combigrid 60/60 or similar approved).
2. A minimum 1.2m thick layer of 75/150 crushed shot rock (or approved equivalent). The shot rock must be placed using end dumping techniques and compacted using the mechanical interlock method with a large excavator (>20t). The shot rock layer must pass a proof roll using a heavily loaded heavy rigid truck prior to placement of the next layer.

3. An optional additional layer of Bidim A39 (or similar approved) can be placed over the shot rock before placement of the MRTS Subtype 2.3 to assist in reducing potential loss of the road base gravel into the shot rock.
4. A 200mm thick layer of MRTS Subtype 2.3 shall be placed over the shot rock in maximum 200mm thick layers and compacted to 100% standard dry density ratio at +/- 2% of standard optimum moisture content.

Hold points should be incorporated into the project ITP to allow confirmation by Pacific Geotech the above points materials and processes have been adopted.

## 4.0 LIMITATIONS

We have prepared this global stability assessment report for the proposed new road embankment at Wongawallan Drive Extension, Yarrabilba Precinct 5 MIBA. The report is provided for the exclusive use of Golding Contractors, for this project only and for the purposes outlined in the report. It should not be used by, or relied upon, for other projects on the same or different sites or by a third party. In preparing this report, we have relied upon information provided by the client or their agents.

The results are indicative of the subsurface conditions on site only at the specific testing locations. Subsurface conditions can change between test locations and the design and construction should take the spacing of the testing and testing methods adopted and the potential for variation between the test locations.

This is not to reduce the level of responsibility accepted by Pacific Geotech, but rather to ensure that the parties who may rely on the information contained in this report are aware of the responsibilities they assume in doing so.

**R. MAXWELL (RPEQ 16596)**
For and on behalf of
**PACIFIC GEOTECH PTY LTD**

Attached Borehole Record Sheets
Site Plan
SlopeW Output

**Pacific Geotech**

3 Jowett St, Coomera QLD 4209

Phone: (07) 5636 4680

# Geotechnical Log - Borehole

## HA01

| | | | | | |
|---|---|---|---|---|---|
| **UTM** | : 56J | **Drill Rig** | : Hand Auger | **Job Number** | : PG-5335-G |
| **Latitude** | : -27.810000 | **Driller Supplier** | : | **Client** | : LendLease Communities (Yarrabilba) Pty Ltd |
| **Longitude** | : 153.100278 | **Logged By** | : Sai Zin Thu Oo | **Project** | : Precinct 5B, 5C, 5D,13A and 7C |
| **Ground Elevation** | : Not Surveyed | **Reviewed By** | : | **Location** | : MIBA South, Yarrabilba |
| **Total Depth** | : 2 m BGL | **Date** | : 29/10/2024 | **Loc Comment** | : |

| Drilling Method | Water | Depth (m) | DCP graph | Soil Origin | Graphic Log | Classification Code | Material Description | Moisture | Testing | Samples |
|---|---|---|---|---|---|---|---|---|---|---|
| Hand Auger | ▼ | 0.5 | 2 1 1 1 1 | Natural | | SP | NATURAL SAND SP loose, light grey and light brown, fine to medium grained, trace medium plasticity clay, moist, trace of m-plasticity sandy clay lenses. | M | | |
| | | 0.7 | 2 4 | Natural | | SP | As above, but loose to medium dense, wet to moist. | W-M | | |
| | | 1 | 2 3 3 4 6 | Natural | | SP | NATURAL SAND SP loose to medium dense, dark grey-brown, fine to medium grained, with medium to high plasticity clay, wet. | W | | |
| | | 1.2 | 5 5 6 5 4 3 2 2 | Natural | | SP | NATURAL SAND SP loose to medium dense, light yellow brown, fine to medium grained, wet. | | | |
| | | 3 | 4 4 6 10 14 17 20/R80 | | | | **HA01 Terminated at 2m** | | | |

**Water**

- Water inflow
- Water outflow
- Ground water Level during drilling

**Weathering**

- XW : Extremely weathered
- DW : Distinctly weathered
- HW : Highly weathered
- MW : Moderately weathered
- SW : Slightly weathered
- FR : Fresh

**Altering**

- XA : Extremely alterated
- DA : Distinctly alterated
- HA : Highly alterated
- MA : Moderately alterated
- SA : Slightly alterated

**Consistency**

- VS : Very soft
- S : Soft
- F : Firm
- St : Stiff
- VSt : Very stiff
- H : Hard
- FR : Friable

**Moisture**

- D : Dry
- M : Moist
- W : Wet

**Density**

- VL : Very loose
- L : Loose
- MD : Medium dense
- D : Dense
- VD : Very dense

**Rock Strength**

- VLS : Very low
- LS : Low
- MS : Medium
- HS : High
- VH : Very high
- XH : Extremely high

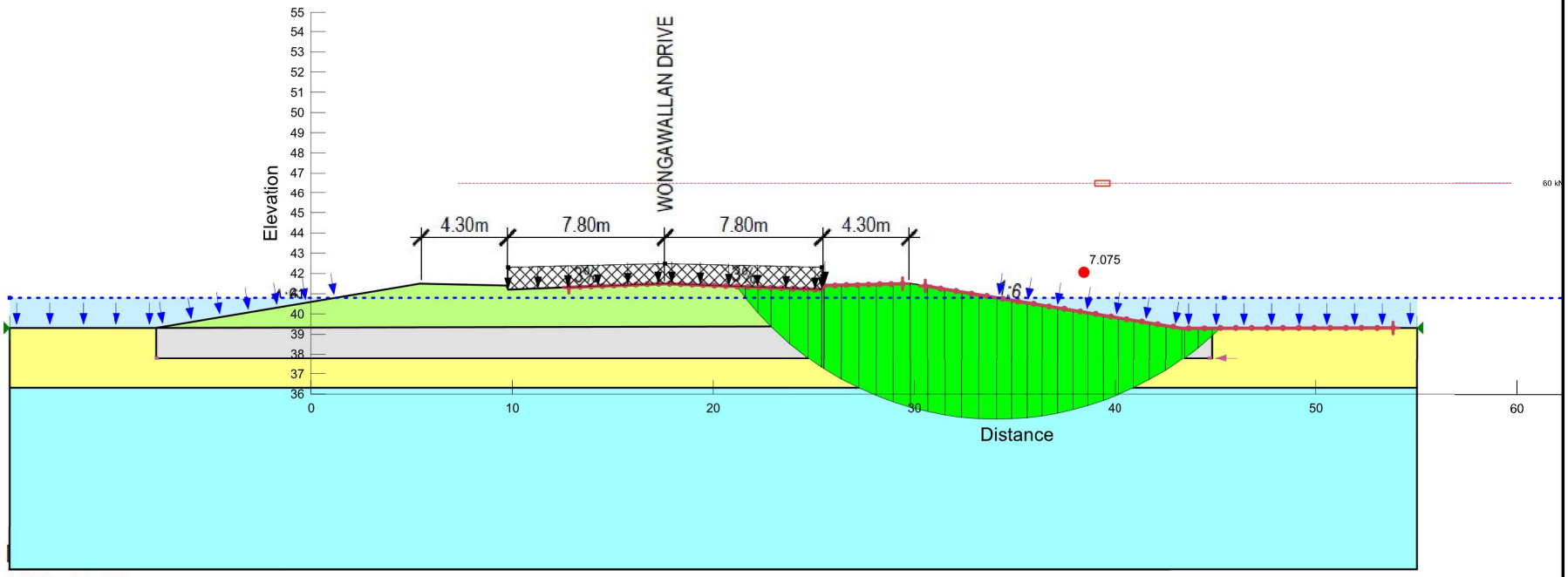
**Tests&Results**

- U50 : Undisturbed 50mm diam tube.
- D : Disturbed sample.
- SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP : Hand penetrometer estimate of unconfined compressive strength, kPa.
- S : Vane shear value kPa.
- DCP : Dynamic Cone Penetrometer test.


Pacific Geotech
Consulting Geotechnical Engineers

| | | | |
|---|---|---|---|
| TITLE: **TEST LOCATION PLAN** | | | DRAWING NO.: PG-5335-B-01 |
| JOB LOCATION: **Wongawallan Drive Extension, Yarrabilba** | | | SCALE: NOT TO SCALE |
| CLIENT: **Golding Contractors Pty Ltd** | DATE: 29.10.24 | DRAWN: SZTO | SIZE: A4 |

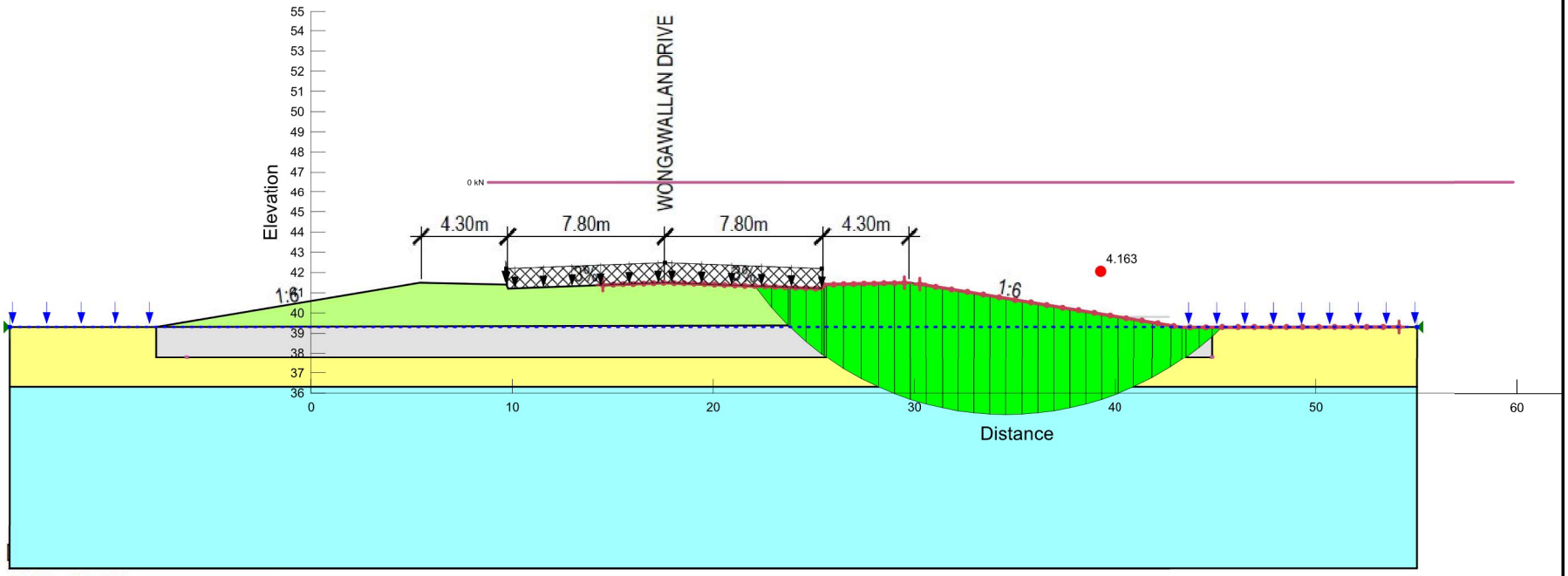
| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effec Frict Angl |
|---|---|---|---|---|
| | Controlled Embankment Fill | 19 | 2 | 24 |
| | Natural Clay - Very Stiff | 19 | 4 | 26 |
| | Natural Silty Sand - Very Loose to Loose | 17 | 0 | 25 |
| | Rock Mattress | 22 | 0 | 45 |




CH. 1000

| | |
|---|---|
| CH1000 - Slope Stability - Flood | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:300 |

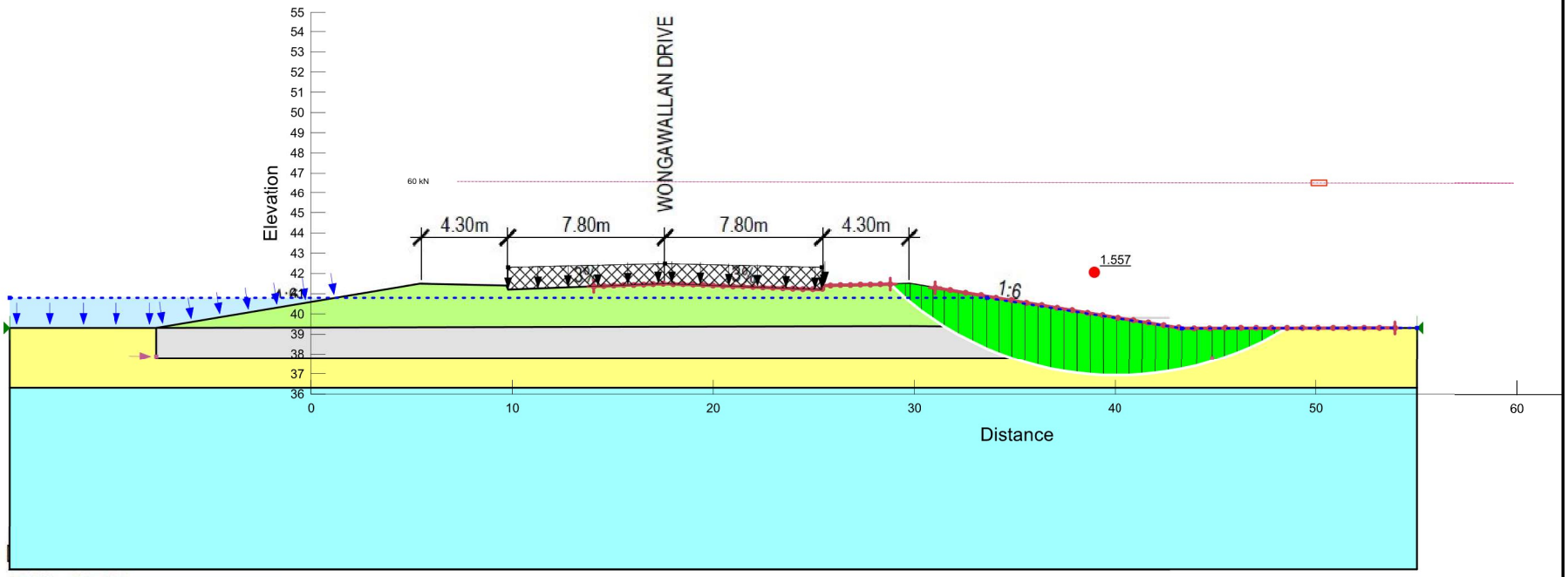
| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effec Frict Angl |
|---|---|---|---|---|
| | Controlled Embankment Fill | 19 | 2 | 24 |
| | Natural Clay - Very Stiff | 19 | 4 | 26 |
| | Natural Silty Sand - Very Loose to Loose | 17 | 0 | 25 |
| | Rock Mattress | 22 | 0 | 45 |




CH. 1000

| | |
|---|---|
| CH1000 - Slope Stability - Normal | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:300 |

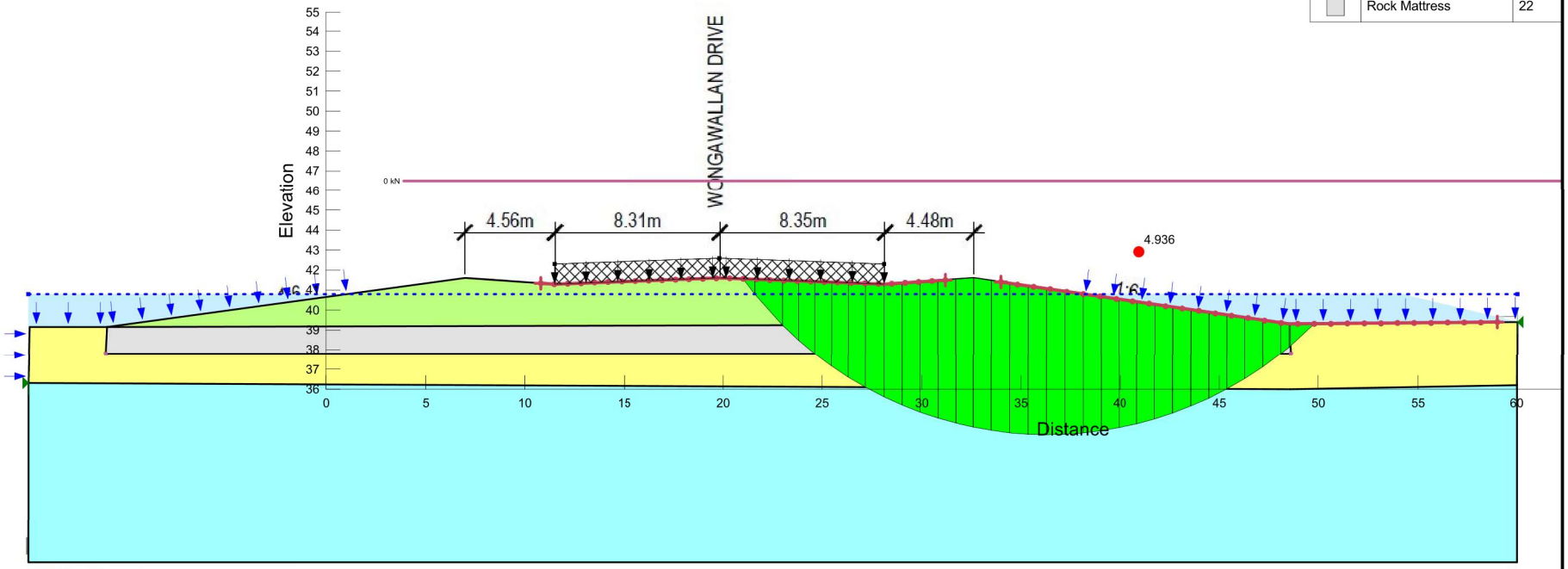
| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effec Frict Angl |
|---|---|---|---|---|
| | Controlled Embankment Fill | 19 | 2 | 24 |
| | Natural Clay - Very Stiff | 19 | 4 | 26 |
| | Natural Silty Sand - Very Loose to Loose | 17 | 0 | 25 |
| | Rock Mattress | 22 | 0 | 45 |




CH. 1000

| |
|---|
| CH1000 - Slope Stability - Rapid Drawdown |
| PG-5335-B Wongawallan Dr Ext.gsz |
| 06/02/2025 1:300 |

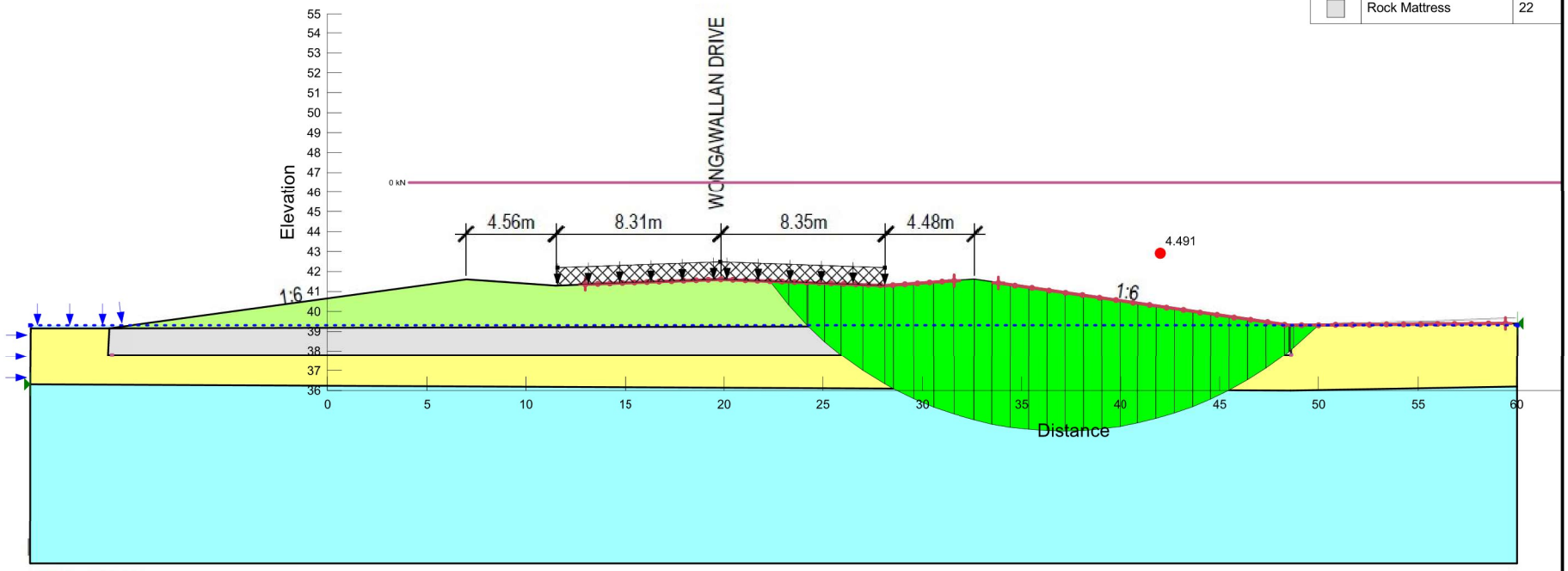
| Color | Name | Unit Weight (kN/m³) |
|---|---|---|
| | Controlled Embankment Fill | 19 |
| | Natural Clay - Very Stiff | 19 |
| | Natural Silty Sand - Very Loose to Loose | 17 |
| | Rock Mattress | 22 |




CH. 1040

| | |
|---|---|
| CH1040 - Slope Stability - Flood | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:225.48318 |

| Color | Name | Unit Weight (kN/m³) |
|---|---|---|
| | Controlled Embankment Fill | 19 |
| | Natural Clay - Very Stiff | 19 |
| | Natural Silty Sand - Very Loose to Loose | 17 |
| | Rock Mattress | 22 |

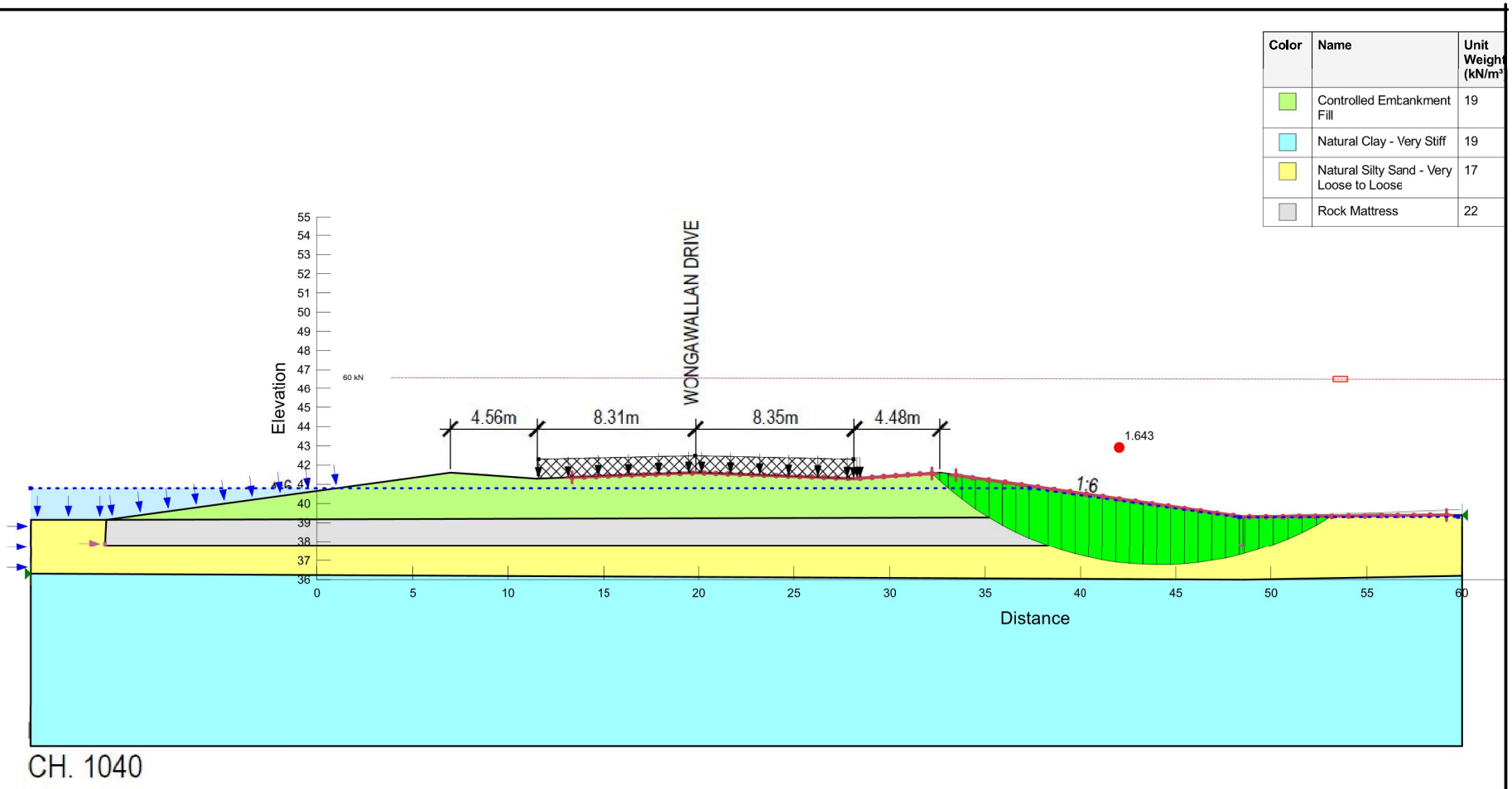



CH. 1040

CH1040 - Slope Stability - Normal

PG-5335-B Wongawallan Dr Ext.gsz

06/02/2025 1:225.48318




| |
|---|
| CH1040 - Slope Stability - Rapid Drawdown |
| PG-5335-B Wongawallan Dr Ext.gsz |
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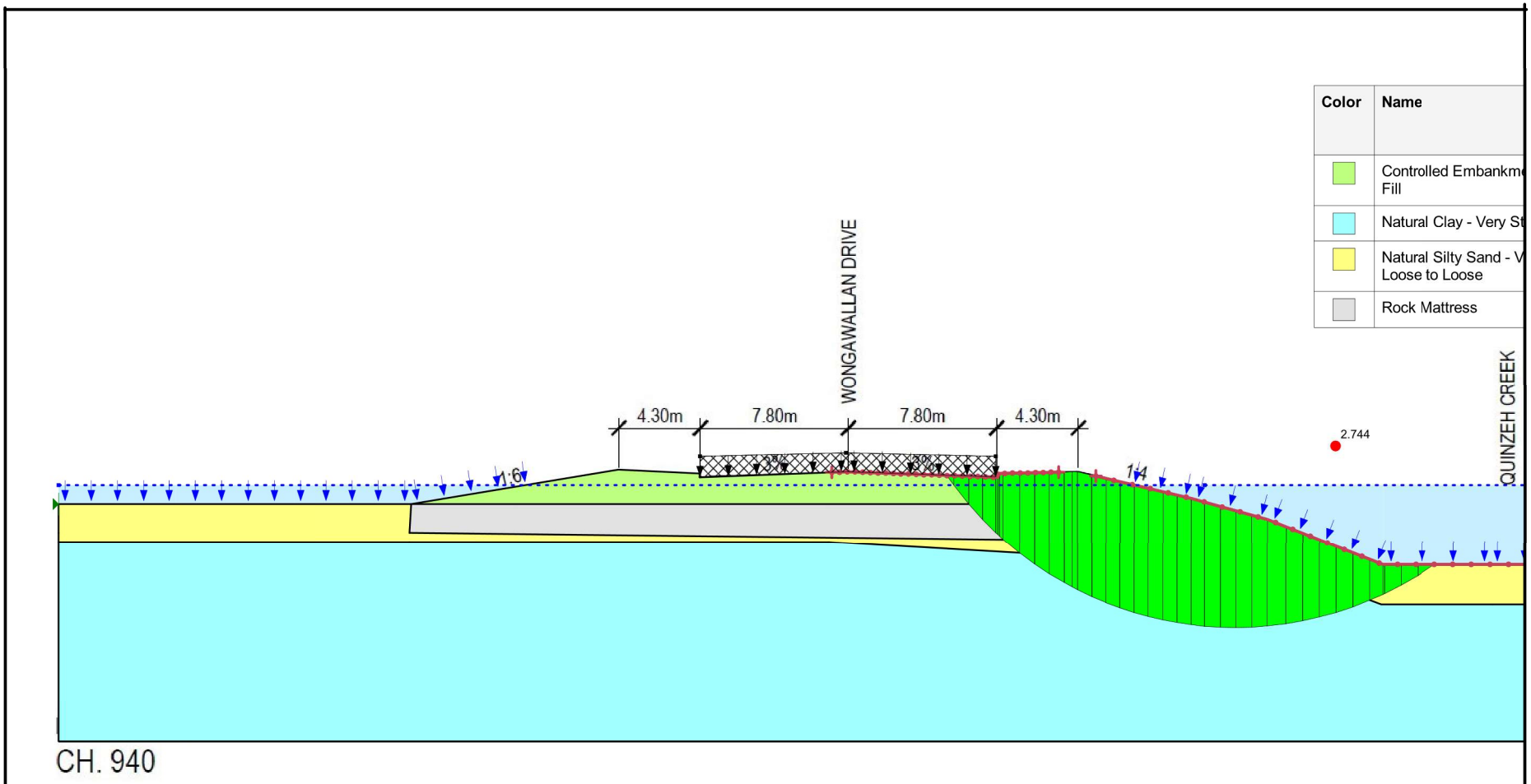
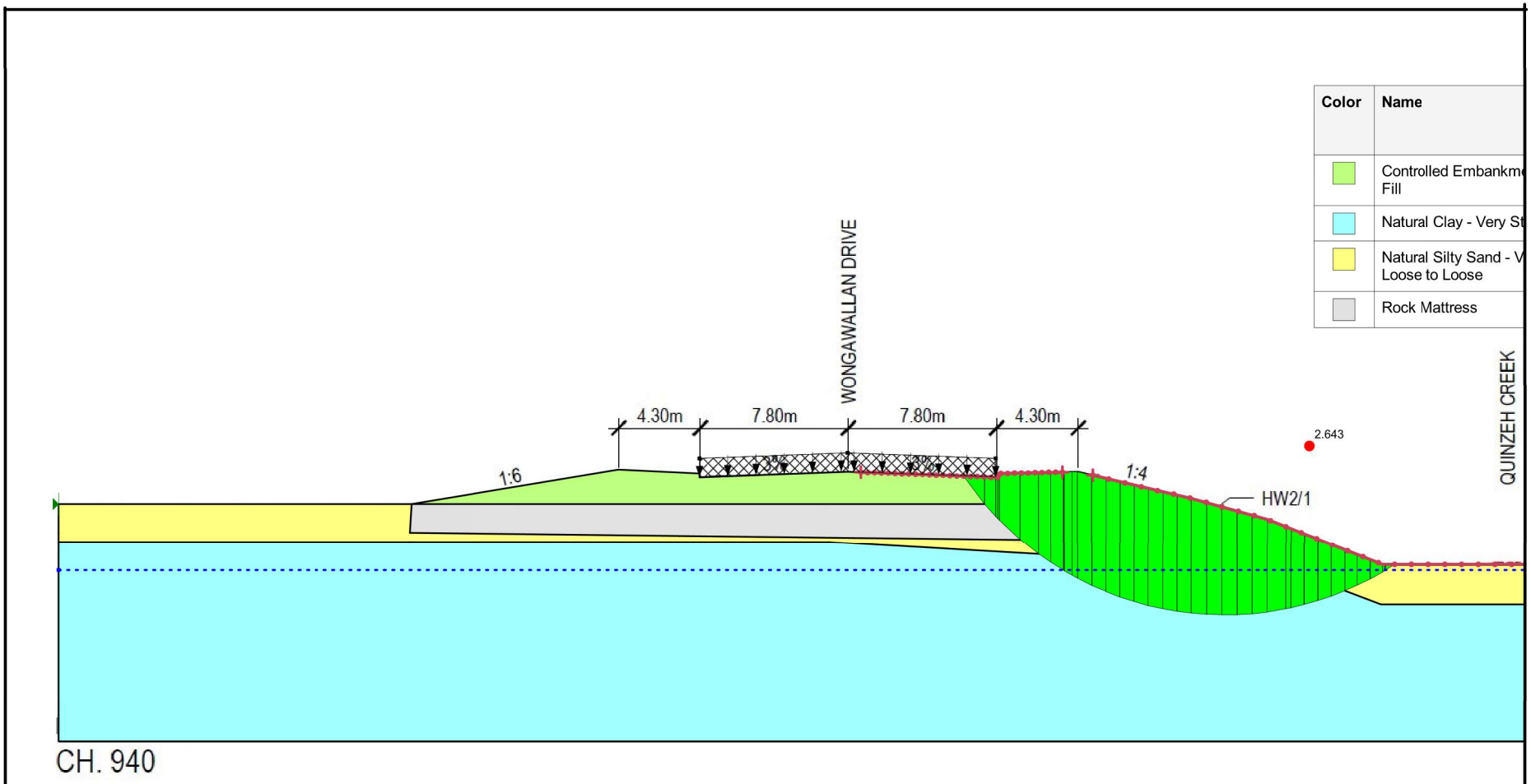
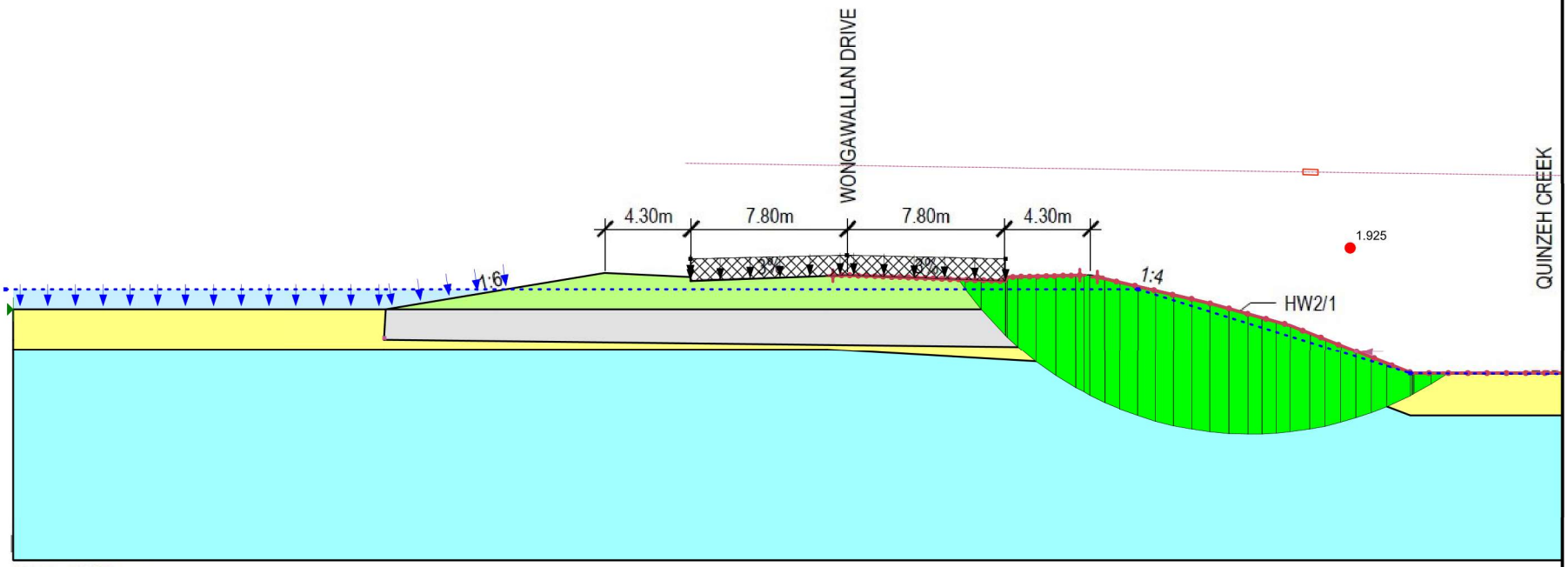



CH. 940

| | |
|---|---|
| CH940 - Slope Stability - Flood | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:300 |

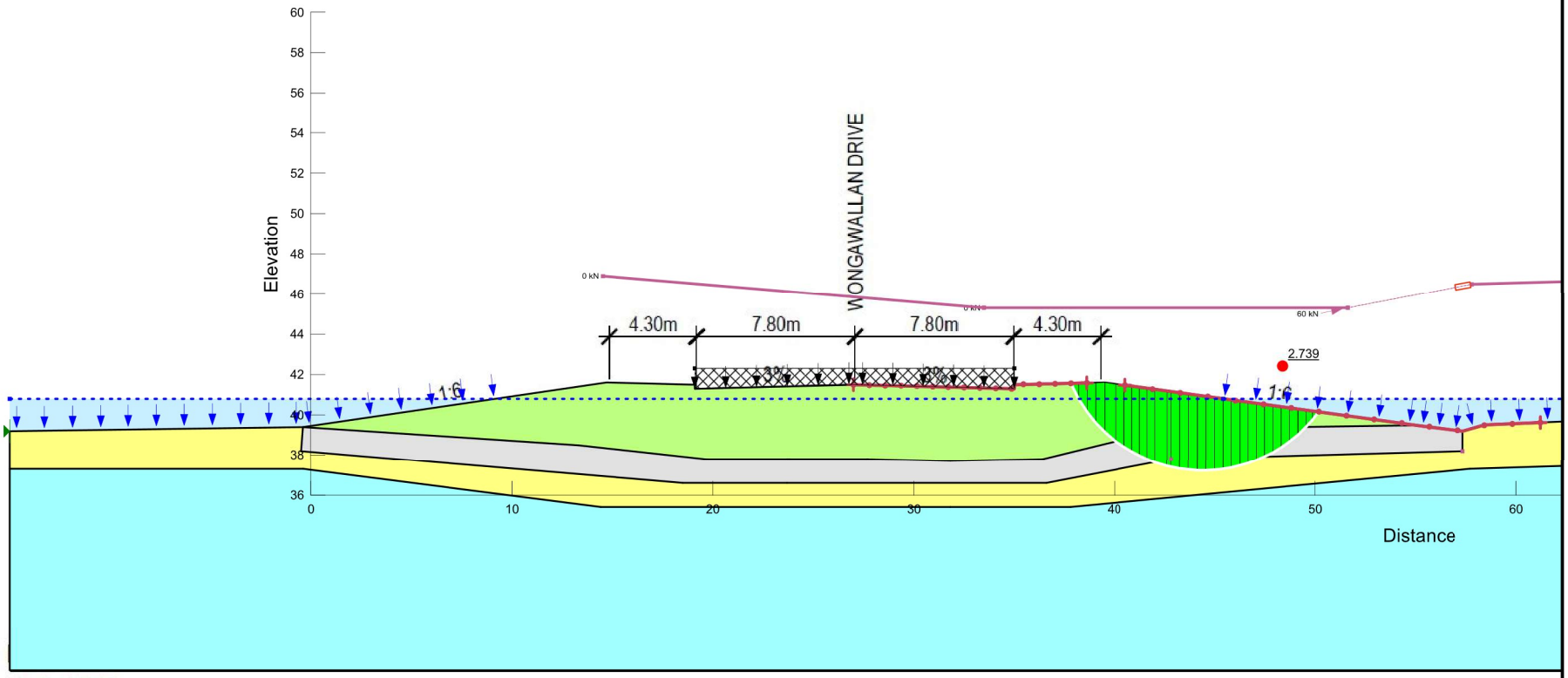



| | |
|---|---|
| CH940 - Slope Stability - Normal | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:300 |



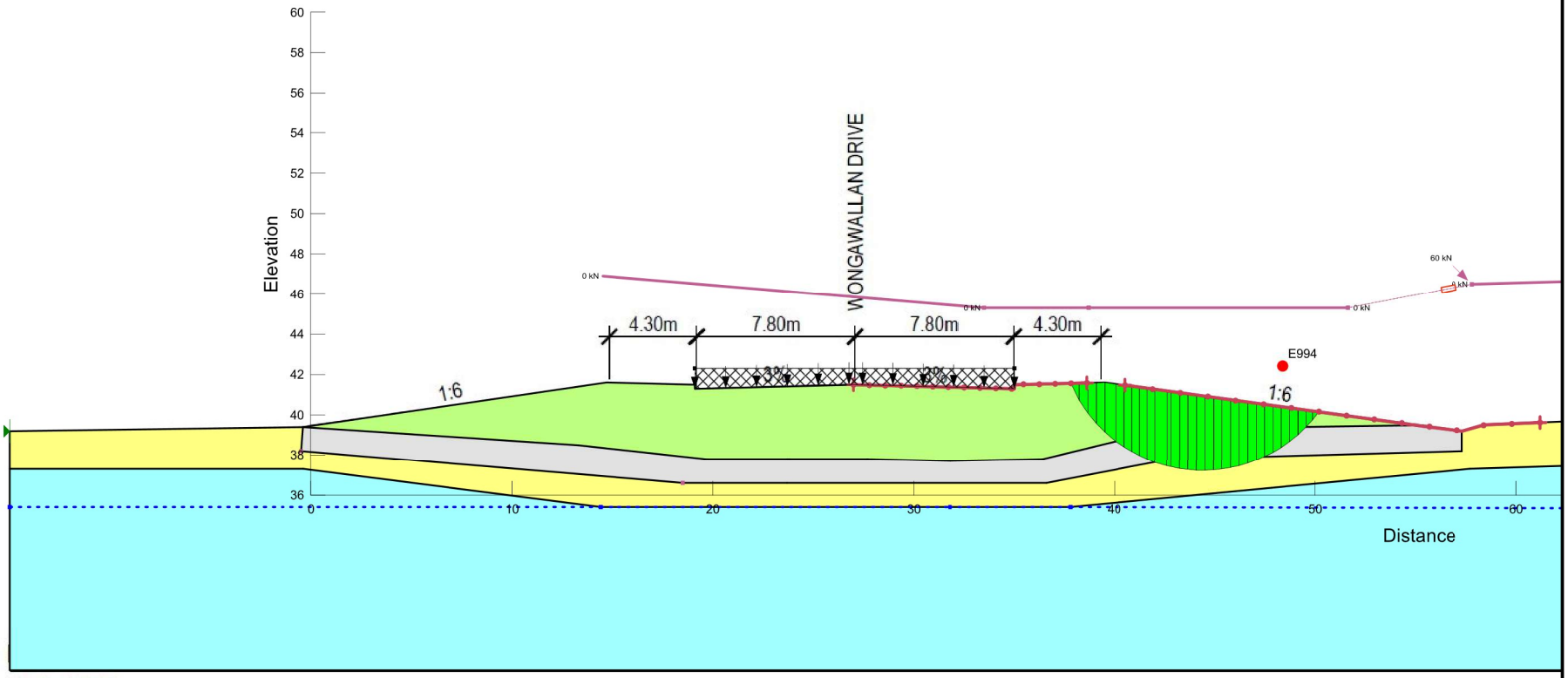

CH. 940

| |
|---|
| CH940 - Slope Stability - Rapid Drawdown |
| PG-5335-B Wongawallan Dr Ext.gsz |
| 06/02/2025 1:300 |



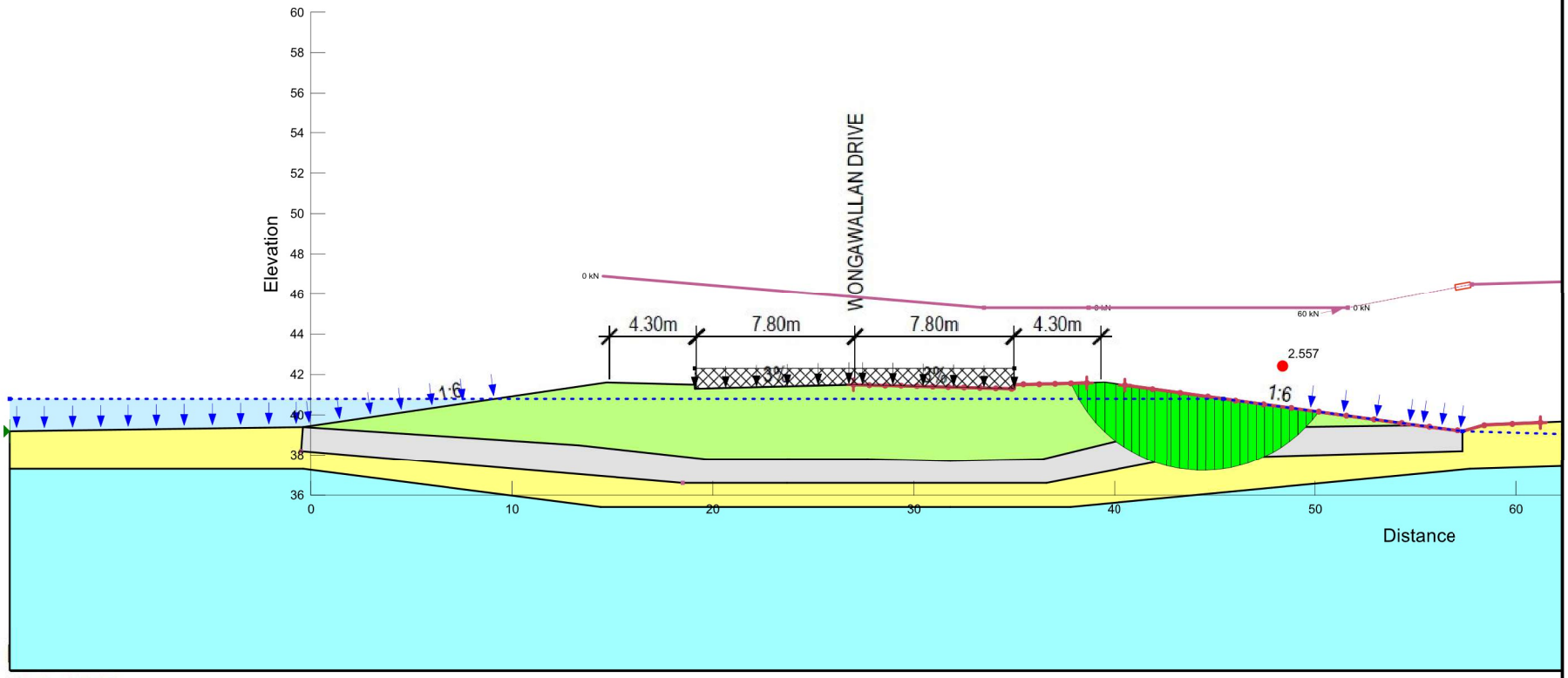

CH. 960

| | |
|---|---|
| CH960 - Slope Stability - Flood | |
| PG-5335-B Wongawallan Dr Ext.gsz | |
| 06/02/2025 | 1:300 |




CH. 960

| |
|---|
| CH960 - Slope Stability - Normal |
| PG-5335-B Wongawallan Dr Ext.gsz |
| 06/02/2025 1:300 |




CH. 960

| |
|---|
| CH960 - Slope Stability - Rapid Drawdown |
| PG-5335-B Wongawallan Dr Ext.gsz |
| 06/02/2025 1:300 |