



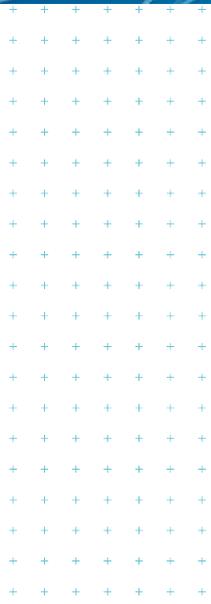
**Huia Replacement Water  
Treatment Plant Project**  
**Preliminary Land Stability Assessment**

**Prepared for**  
Watercare Services Limited

**Prepared by**  
Tonkin & Taylor Ltd

**Date**  
May 2019

**Job Number**  
30848.2000



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## Table of contents

|                     |                                                  |          |
|---------------------|--------------------------------------------------|----------|
| <b>1</b>            | <b>Introduction</b>                              | <b>1</b> |
| <b>2</b>            | <b>Purpose</b>                                   | <b>1</b> |
| <b>3</b>            | <b>Site Description and Ground Model</b>         | <b>1</b> |
| <b>4</b>            | <b>Proposed Earthworks</b>                       | <b>2</b> |
| 4.1                 | Replacement WTP Site                             | 2        |
| 4.2                 | Reservoir 1 and Tunnel Shaft/Valve Chamber Sites | 2        |
| 4.3                 | Reservoir 2 Site                                 | 2        |
| <b>5</b>            | <b>Assessment of Effects</b>                     | <b>2</b> |
| 5.1                 | Effects of earthworks on land stability          | 2        |
| 5.1.1               | Excavation Collapse/Retention System Deflection  | 3        |
| 5.1.2               | Removal of Buttrressing Material                 | 3        |
| 5.1.3               | Placement of Fill                                | 3        |
| 5.2                 | Effects of vegetation removal on hazard risk     | 4        |
| <b>6</b>            | <b>Conclusions</b>                               | <b>4</b> |
| <b>7</b>            | <b>Applicability</b>                             | <b>5</b> |
| <b>Appendix A :</b> | <b>Drawings and Figures</b>                      |          |

## Executive Summary

The Huia WTP was constructed in 1929 and is now nearing the end of its operational life. Watercare proposes to construct a new WTP to replace the aging Huia WTP. As part of this project, Watercare is also proposing to construct two treated water reservoirs to increase treated water storage within the western supply zone.

The replacement WTP will be constructed on the corner of Manuka Road and Woodlands Park Road directly across from the existing Huia WTP site. A new 25ML treated water reservoir (Reservoir 1) will be located on the northern side of Woodlands Park Road, with another 25ML reservoir (Reservoir 2) subsequently constructed on the existing Huia WTP site, once the existing plant has been decommissioned. Reservoir 2 will be constructed above ground but will still potentially require some earthworks.

The proposed works also includes construction of the North Harbour 2 watermain (NH2) valve chamber and tunnelling reception shaft within the Reservoir 1 site.

The replacement WTP, reservoirs and tunnel shaft/valve chamber sites will require substantial earthworks to be undertaken. This report presents our geotechnical assessment of the effects of the proposed earthworks, with respect to:

- Potential effects of earthworks on the stability and safety of surrounding land, buildings and structures; and
- The role of existing vegetation in avoiding or mitigating natural hazards, and the extent to which vegetation removal will increase any natural hazard risk.

The majority of the replacement WTP site will be raised by between 1 and 5 m above existing ground level. Cutting will be required primarily to remove a topographic high located in the central part of the site as well as to construct the in-ground structures. These excavations are typically in the order of 2 to 8 m deep.

Development of the Reservoir 1 site will require excavations to be made to a depth of up to approximately 15 m. The proposed earthworks will be limited to the footprint of the reservoir. The tunnel shaft is expected to be approximately 16 m in diameter and 13 m deep.

Reservoir 2 will largely be located on or near existing ground level, although cuts of up to 3 m and fills of up to 9 m will be required to form the building platform.

Land instability could potentially arise from the following scenarios:

- The failure or collapse of an open excavation;
- Excessive deflection of excavation retention systems;
- The removal of soil or rock from the toe of a slope; and
- The initiation of a landslide by the placement of fill on a steep or already unstable slope.

The most significant excavations are those required to construct Reservoir 1. The depth of these excavations will require the installation of secant pile walls (or similar) as a means of temporary and permanent slope retention. This will limit ground movement to the soil located immediately behind the walls and these will only be a few millimetres in size. Displacement of materials into the excavation could only extend as far back as the base rock escarpment. The private dwellings located on the escarpment would not be affected. The existing WTP and filter station are too far from the reservoir excavations for them to potentially be affected by displacements originating at the reservoir excavations.

The construction of the tanks in the replacement WTP site will also require excavations to be undertaken. Any instability associated with the replacement WTP excavations will be limited to the immediate vicinity and therefore not affect land outside of the Watercare construction sites. The tunnel shaft will be both smaller in plan and depth than the Reservoir 1 excavation. The same requirements for stability and support at the Reservoir 1 excavation will apply at the smaller tunnel shaft.

The only areas of significant fill placement is the replacement WTP and the Reservoir 2 site. Both of these areas are gently sloping and do not exhibit signs of historic or on-going slope instability. The relatively modest re-profiling proposed for the replacement WTP site does not represent a significant enough change to induce instability. Fill slopes of significant heights and steepness are proposed for Reservoir 2. These will require specific engineering design and the probable use of techniques such as geofabric reinforcement (MSE) to achieve suitable levels of stability. Such design and construction is routine in Auckland to mitigate the risk of instability.

Vegetation removal has the potential to increase the risk of natural hazards. Both the replacement WTP and Reservoir 1 sites are located on a gently sloping bench that does not rely on vegetation to provide stability. The removal of vegetation has the potential to increase soil erosion, scour and/or flooding. This will need to be addressed by standard erosion and sediment control procedures during construction, as well as stormwater management.

The only geological hazard for the project site is the potential for landslides or rockfall to occur on the escarpment and deposit debris onto the reservoirs. T+T (2018) showed that extensive landslide/rockfall debris has accumulated at the base of the escarpment as a result of historic events of this type. However, all of this instability is associated with the face or crest of the escarpment, well above the elevation of any vegetation clearance required for the Reservoir 1 or replacement WTP sites.

We conclude that the removal of vegetation as part of the project will only have a minor adverse impact on the site's existing natural hazard risk.

Achieving stable earthworks depends firstly on an appropriate level of geotechnical engineering analysis during detailed design. This would ensure that all earth retention structures are adequately sized. Secondly, it will be necessary to monitor the deformation of the retention structures to ensure that they are performing as expected and that the deformations are not negatively impacting other property, structure or services. This can be achieved by setting monitoring requirements in the Groundwater and Surface Contingency and Monitoring Plan (GSMCP). This plan would define the magnitude of allowable deformation, the number of monitoring points as well as appropriate alarm and alert levels. These would be included in the consent conditions once the design had advanced to a sufficiently detailed stage.

## 1 Introduction

Watercare Services Limited (Watercare) is responsible for the treatment and supply of potable water and for the collection, treatment and disposal of wastewater to around 1.5 million people in Auckland. Watercare is a Council Controlled Organisation (CCO), wholly owned by the Auckland Council.

Watercare operates five dams within the Waitākere Ranges, including the Upper and Lower Huia Dams and the Upper and Lower Nihotupu Dams. Water from these western water supply dams is treated at the Huia and Waitākere Water Treatment Plants before being distributed via the water transmission network, primarily to west and north Auckland. The Huia Water Treatment Plant (Huia WTP) is the third largest water treatment plant in Auckland and is a crucial component of Auckland's water supply network, treating approximately 20% of Auckland's water.

The Huia WTP was constructed in 1929 and is now nearing the end of its operational life (90 years old). Watercare therefore proposes to construct a new WTP to replace the aging Huia WTP. As part of this project Watercare is also proposing to construct two treated water reservoirs (50ML total capacity) to increase treated water storage within the western supply zone.

The replacement WTP will be constructed on the corner of Manuka Road and Woodlands Park Road directly across from the existing Huia WTP site. It will have a treatment capacity of 140 mega-litres per day (MLD). A new 25ML treated water reservoir (Reservoir 1) will be located on the northern side of Woodlands Park Road, with another 25ML reservoir (Reservoir 2) subsequently constructed on the existing Huia WTP site once the existing plant has been decommissioned. The proposed works also includes construction of the North Harbour 2 watermain (NH2) valve chamber and tunnelling reception shaft within the Reservoir 1 site.

This report has been prepared to support Watercare's resource consent application for the Huia Replacement WTP Project. Specifically it addresses the issue of earthworks effects on surrounding land and vegetation.

## 2 Purpose

The replacement WTP, reservoirs and tunnel shaft/valve chamber sites will require substantial earthworks to be undertaken. This report presents our geotechnical assessment of the effects of the proposed works with respect to:

- Potential effects of earthworks on the stability and safety of surrounding land, buildings and structures; and
- The role of existing vegetation in avoiding or mitigating natural hazards, and the extent to which vegetation removal will increase any natural hazard risk.

Full details of the project are provided in the "Huia Replacement WTP Assessment of Environmental Effects Report prepared by Tonkin + Taylor Ltd (May 2019)".

## 3 Site Description and Ground Model

A general layout plan showing the major elements referred to in this report is presented as Figure A1 in Appendix A.

The proposed WTP, Reservoir 1 and tunnel shaft/valve chamber sites are located on a heavily vegetated natural bench formed within the south-facing flank of the Waitakere Ranges. The bench slopes gently to the south and is defined to the north by a steep rock escarpment. The existing WTP and Reservoir 2 site is also located on this topographic bench.

A geotechnical and hydrogeological assessment of the replacement WTP, Reservoir 1 and tunnel shaft/valve chamber sites was undertaken by Tonkin & Taylor (T+T) in 2019<sup>1</sup>, which summarises the previous geotechnical work that has been done at the site, geology and hydrogeology, and presents a ground and groundwater models. The ground and groundwater models developed for both sites are attached as Figures A2 to A4 in Appendix A. The assessment did not extend to the Reservoir 2 site as the proposed excavations did not extend to beneath the groundwater level.

## **4 Proposed Earthworks**

### **4.1 Replacement WTP Site**

A plan of the proposed earthworks for the replacement WTP site is presented as Dwg No. 51-3357505-C006 (Appendix A). A cross-section through the centre of the site is presented as Dwg. No. 51-3357505-C013. These drawings show that a majority of the site will be raised by between 1 m and 5 m above existing ground level. Cutting will be required primarily to remove a topographic high, located in the central part of the site, as well as to construct the in-ground structures.

### **4.2 Reservoir 1 and Tunnel Shaft/Valve Chamber Sites**

Development of Reservoir 1 and the tunnel shaft/valve chamber will require excavations to be made to a depth of up to approximately 15 m, as indicated by the cut-fill plan Dwg. No. 35255336.K119 (Appendix A). Typical cross-sections through Reservoir 1 are presented on Dwg No. 35255336.K133 (Appendix A). The proposed earthworks will be limited to the footprint of the reservoir. The tunnel shaft is expected to be approximately 16 m in diameter and 13 m deep.

### **4.3 Reservoir 2 Site**

Reservoir 2 will be constructed above ground level within the existing WTP site. Construction of a level building platform will require some minor cutting (up to 3 m) but substantially more fill placement (up to 9 m). Typical cross sections through Reservoir 2 are presented on Dwg No. 35255336.K123 in Appendix A.

## **5 Assessment of Effects**

### **5.1 Effects of earthworks on land stability**

Earthworks have the potential to adversely affect the stability and safety of surrounding land, buildings and structures if not undertaken with the appropriate geotechnical engineering input and to the appropriate standard.

The closest structures to the proposed development are as follows:

- The Nihotupu Filter Station located at the junction of Woodlands Park Road and Scenic Drive. This disused Watercare facility is located some 50 m from the proposed replacement WTP site and 140 m from proposed Reservoir 1. Proposed Reservoir 2 will be constructed within the existing WTP site once existing structures are removed;
- Private dwellings located on the top of the rock escarpment. These properties are located approximately 60 m to 90 m to the north of the proposed Reservoir 1 location; and
- The existing Huia WTP and associated structures which is approximately 80 m southwest of the proposed Reservoir 1 site and 130 m west of the replacement WTP site.

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<sup>1</sup> Tonkin & Taylor (2018). Huia Replacement Water Treatment Plant, Groundwater and Settlement Effects Report. Report prepared for Watercare Services Limited.

Land instability could potentially arise from the following scenarios:

- The failure or collapse of an open excavation. The effects could potentially extend out a distance of 3 times the excavation depth, although a distance approximately equivalent to the excavation depth is more likely;
- Excessive deflection of excavation retention systems generating lateral and vertical movements behind the walls;
- The removal of soil or rock from the toe of a slope resulting in upslope displacement; and
- The initiation of a landslide by the placement of fill on a slope that would have an adverse effect on the existing slope stability equilibrium. The landslide would likely not only encapsulate the area of filling but also potentially an equivalent area downslope (debris inundation).

These land instability scenarios are explored below.

### **5.1.1 Excavation Collapse/Retention System Deflection**

The most significant excavations are those required to construct Reservoir 1. The depth of these excavations will require the installation of secant pile walls (or similar) as a means of temporary and permanent slope retention. This will limit ground movement to the soil located immediately behind the walls and these will only be a few millimetres in size.

If no support of the excavation was provided, failure of the upslope materials into the excavation could only extend as far back as the base rock escarpment (Figure A3). The private dwellings located on the escarpment are unlikely to be affected.

The existing WTP and filter station are considered to be too far from the reservoir excavations for them to potentially be affected by displacements originating at the reservoir excavations.

The construction of the tanks in the replacement WTP site will also require excavations to be undertaken. At this time the construction methodology for the replacement WTP is indicative, however whether these excavations are actively retained as set out in the indicative construction methodology, or simply cut back in places as required, they will need to achieve standard levels of stability. Any instability associated with the WTP excavations will be limited to the immediate vicinity and therefore not affect land outside of the Watercare construction sites.

The tunnel shaft excavation will be both smaller in plan and depth than the Reservoir 1 excavation. The same requirements for stability and support at the Reservoir 1 excavation will apply at the smaller tunnel shaft.

### **5.1.2 Removal of Buttressing Material**

A significant quantity of slope colluvium and landslide debris has accumulated at the base of the rock escarpment (Figure A3), which will remain in place. The escarpment is formed from rock and does not rely on this accumulated soil to buttress or support it. Therefore, if this accumulated material slumped into the reservoir excavation due to a failure in the retention system it would not destabilise the escarpment.

### **5.1.3 Placement of Fill**

The placement of significant quantities of fill on a marginally stable slope may potentially induce slope instability (a landslide). Fill placement on an existing slope is required at both the replacement WTP and Reservoir 2 sites.

The replacement WTP area is gently sloping (approximately 4°) and does not exhibit signs of historic or on-going instability. We consider that the relatively modest re-profiling proposed for the proposed WTP site is unlikely to induce slope instability.

Fills of up to 9 m height are required as the Reservoir 2 location. The existing WTP site is generally flat to gently sloping and exhibits no indications of existing instability. The steep nature of the proposed fills will require specific investigation and design, including probable geotextile reinforcement (e.g. MSE) of the fill batter to ensure long-term stability. This is a standard engineering design and construction method utilised in the Auckland area to mitigate the risk of slope instability.

## **5.2 Effects of vegetation removal on hazard risk**

Vegetation removal has the potential to increase the risk of natural hazards. Both the replacement WTP and Reservoir 1 sites are located on a gently sloping bench that is not considered to rely on vegetation to provide stability. However, the removal of vegetation has the potential to increase localised slope instability, scour, soil erosion or flooding. These hazards will need to be addressed including implementation of standard erosion and sediment control procedures during construction and stormwater management.

The sole geological hazard for the project site is the potential for landslides or rockfall to occur on the escarpment and deposit debris onto the reservoirs. T+T (2018) showed that extensive landslide/rockfall debris has accumulated at the base of the escarpment as a result of historic slope failures. However, this historic slope instability is associated with the face or crest of the escarpment, well above the elevation of any vegetation clearance required for the Reservoir 1 or replacement WTP sites.

We consider that the removal of vegetation, as part of the project construction activity, will have negligible to minor impact the site's existing natural hazard risk.

## **6 Conclusions**

Watercare is proposing to construct a replacement WTP, and in-ground reservoir (Reservoir 1), above-ground reservoir (Reservoir 2) and tunnel shaft/valve chamber on generally flat to gently sloping sites located in the Waitakere Ranges.

The sites are heavily vegetated with the exception of the existing WTP where the proposed Reservoir 2 is to be constructed. We assess that any adverse impacts of the proposed earthworks works, including the removal of vegetation, will be minor on the existing natural hazards in the adjoining environment, including potential landslides from the escarpment.

Achieving stable earthworks depends firstly on an appropriate level of geotechnical engineering input during detailed design. This would ensure that all earth retention structures are adequately sized. Secondly, it will be necessary to monitor the deformation of the retention structures to ensure that they are performing as expected, and that the deformations are not adversely impacting other property, structure or services. This can be achieved by setting monitoring requirements in the Groundwater and Surface Contingency and Monitoring Plan (GSMCP). This plan would define the magnitude of allowable deformation, the number of monitoring points as well as appropriate alarm and alert levels. These would be included in the consent conditions once the design had advanced to a sufficiently detailed stage.

## 7 Applicability

This report has been prepared for the exclusive use of our client Watercare Services Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:



.....  
Kevin J. Hind

Technical Director

Authorised for Tonkin & Taylor Ltd by:



.....  
Peter Roan

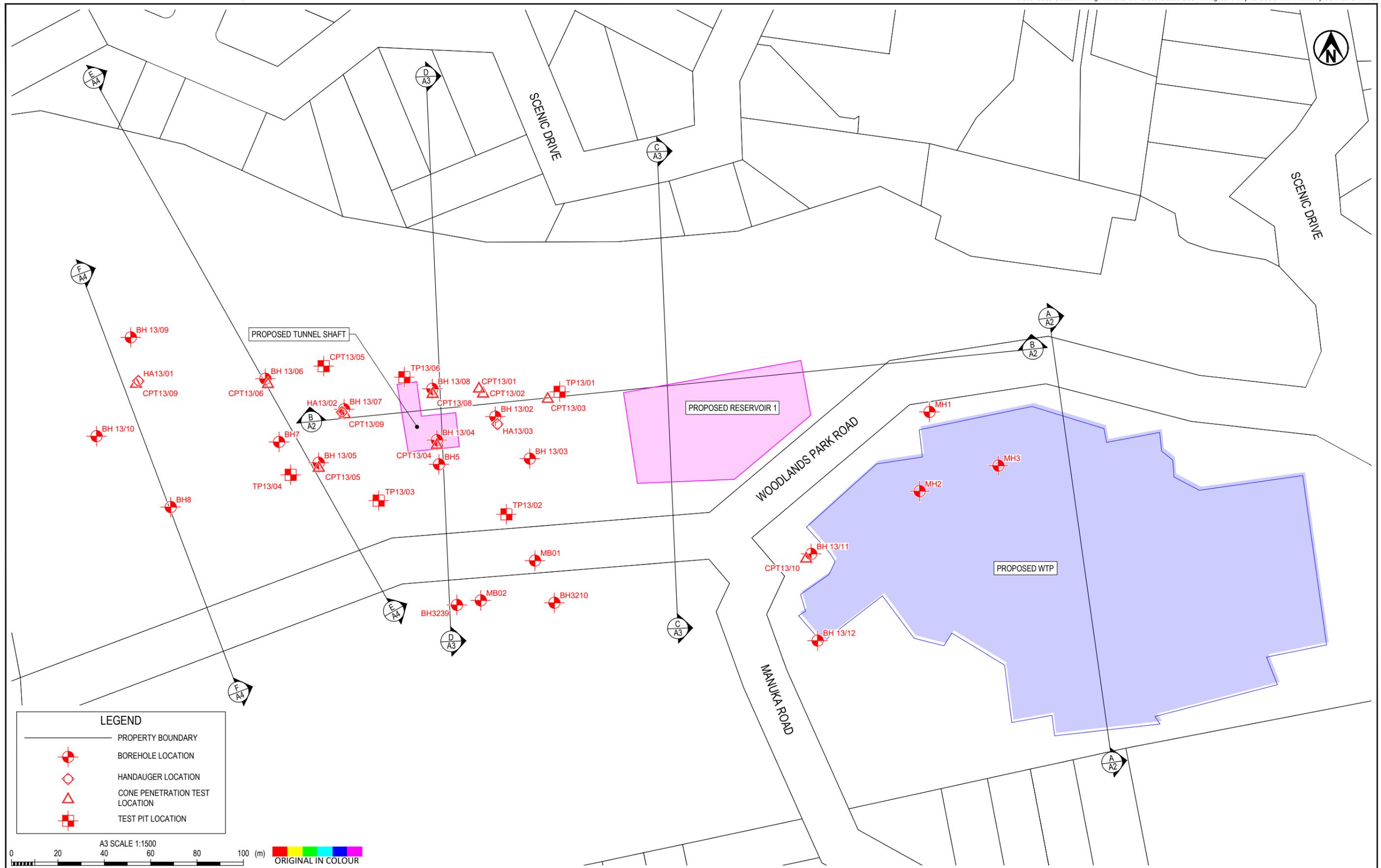
Project Director

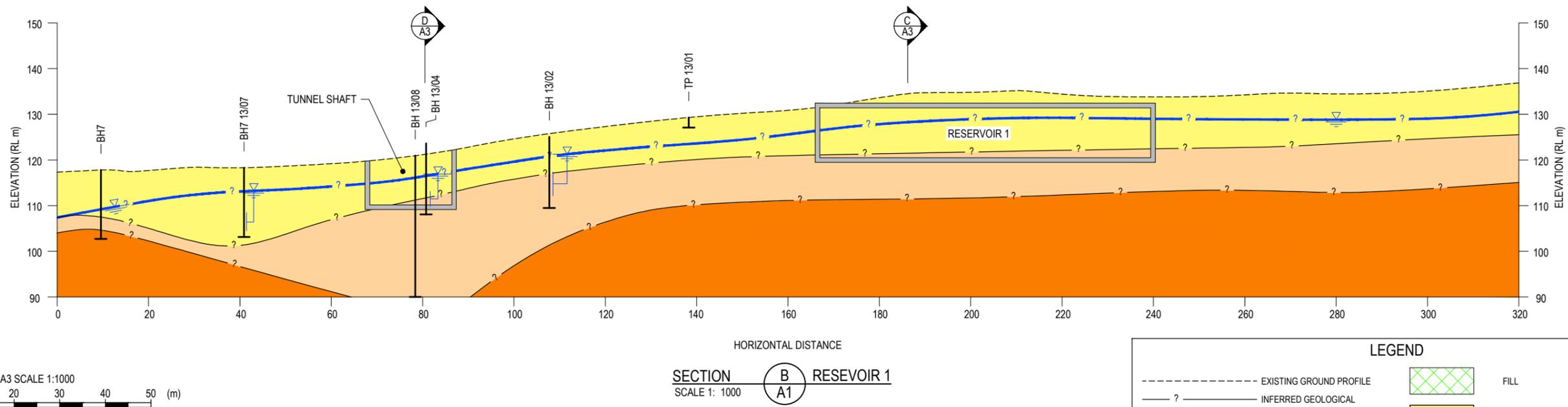
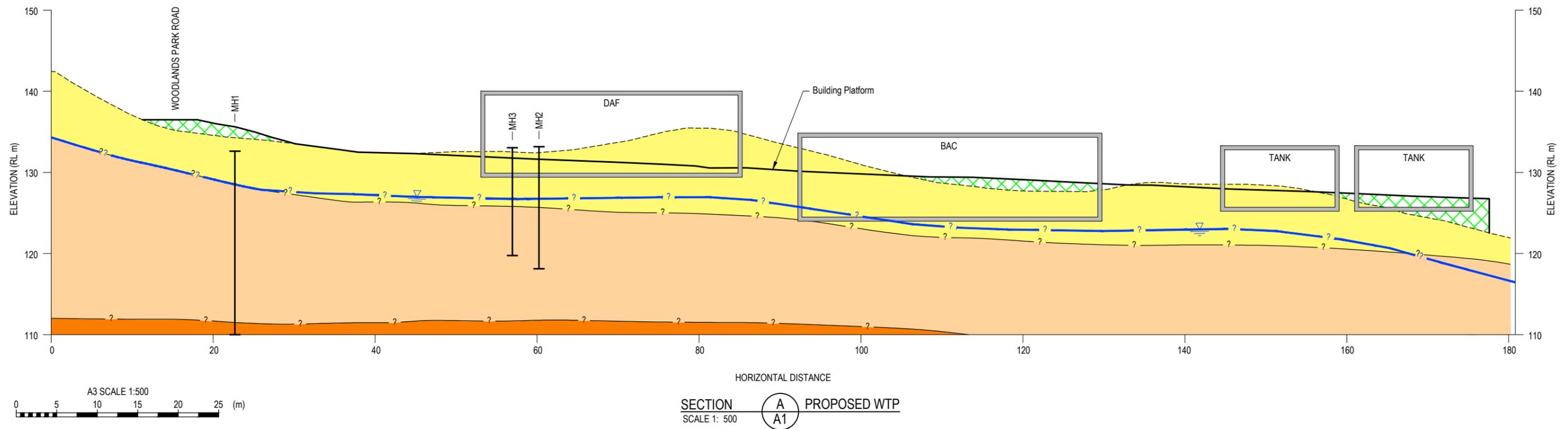
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## **Appendix A: Drawings and Figures**

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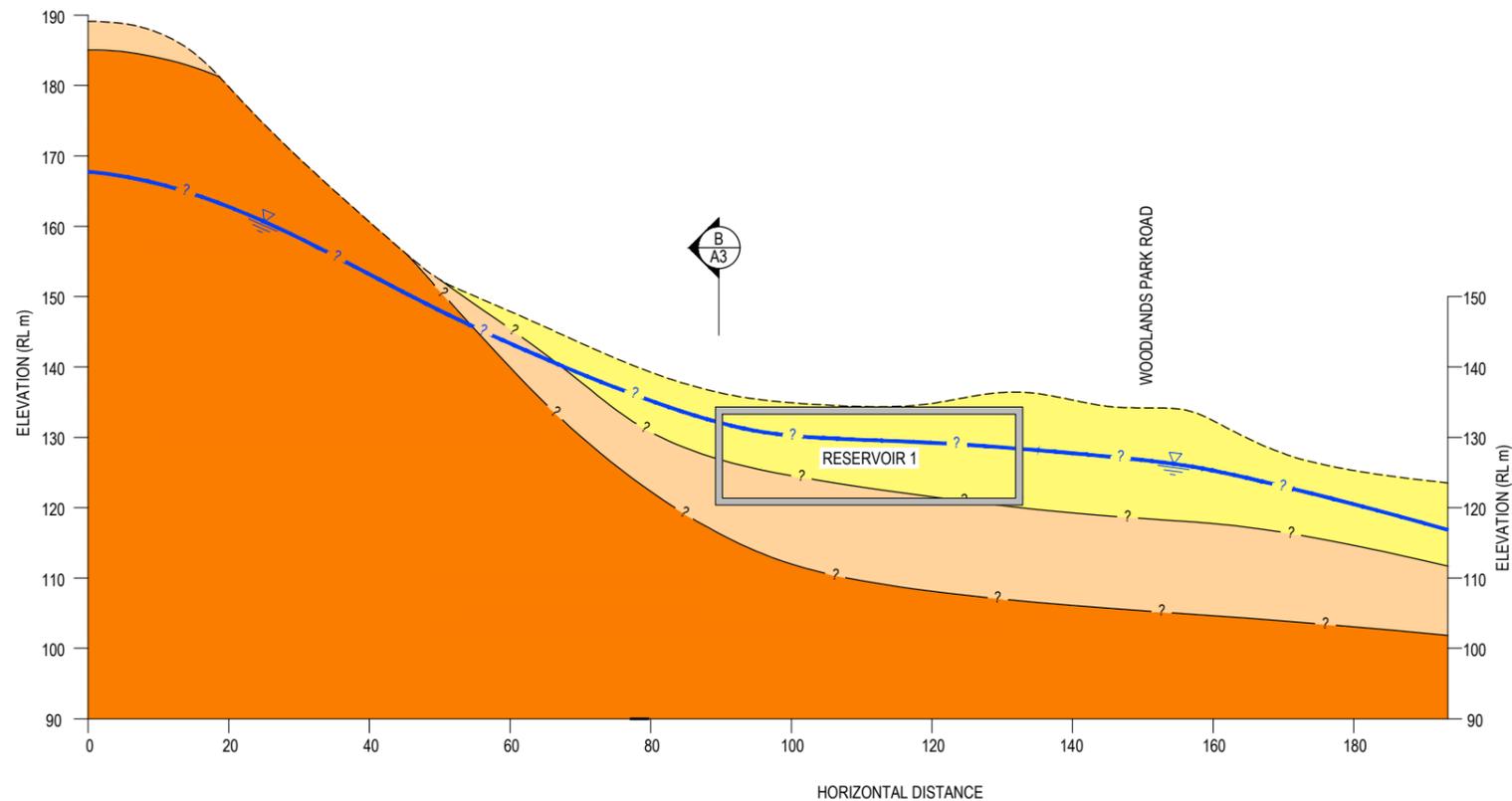
| LEGEND |                                   |  |                                                                 |
|--------|-----------------------------------|--|-----------------------------------------------------------------|
| ---    | EXISTING GROUND PROFILE           |  | FILL                                                            |
| — ? —  | INFERRED GEOLOGICAL BOUNDARY      |  | COLLUVIUM / LANDSLIDE DEBRIS                                    |
| — ? —  | ASSUMED PERCHED GROUNDWATER LEVEL |  | COMPLETELY WEATHERED TO HIGHLY WEATHERED CORNWALLIS FORMATION   |
|        | GROUNDWATER LEVEL IN PIEZOMETER   |  | MODERATELY WEATHERED TO SLIGHTLY WEATHERED CORNWALLIS FORMATION |

ORIGINAL IN COLOUR

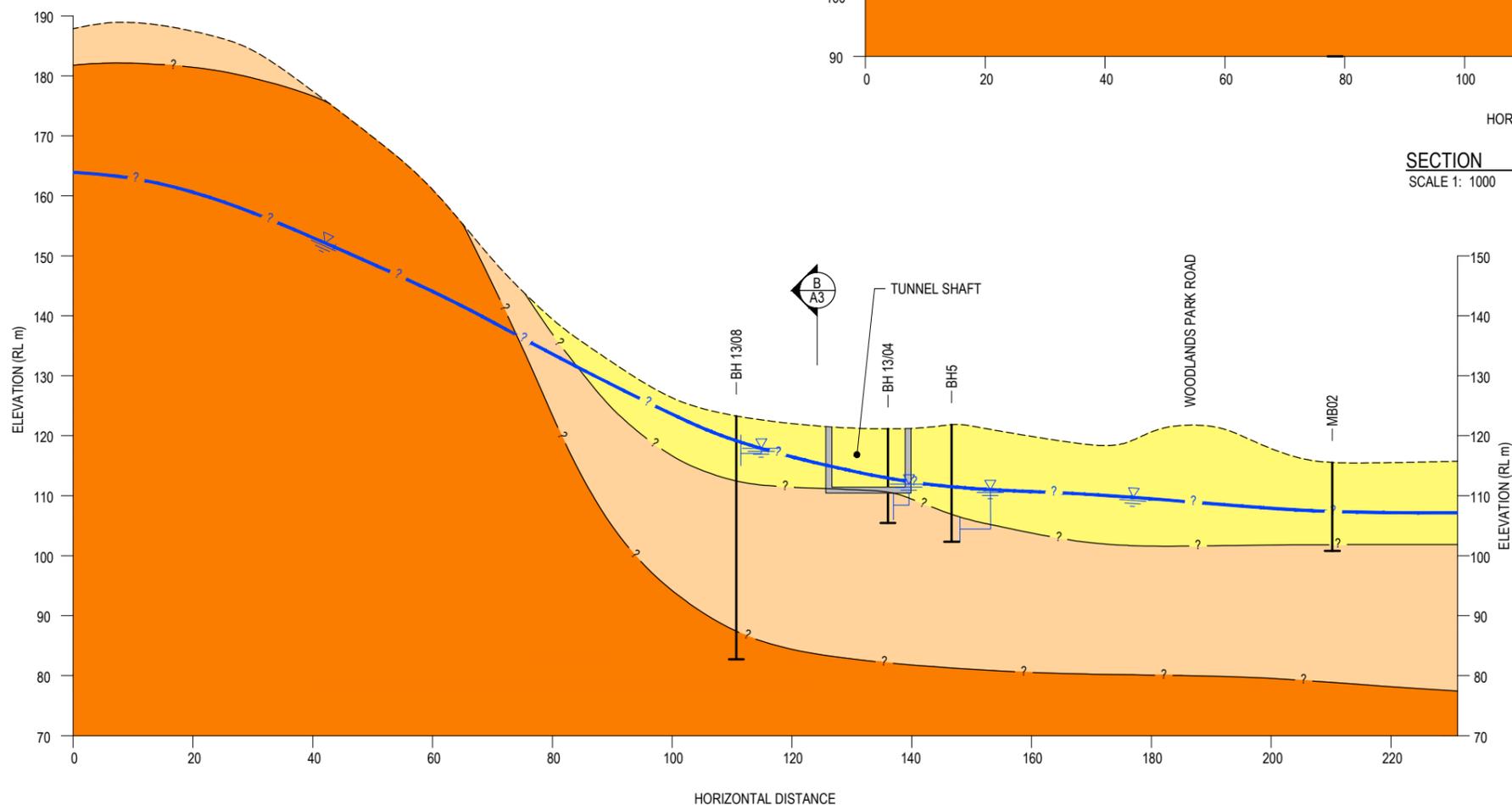
NOTES:  
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

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| DESIGNED               | KJH  | May.19    |
| DRAWN                  | JC   | May.19    |
| CHECKED                | KJH  | May.19    |
| KJH                    |      | 22 May.19 |
| APPROVED               | DATE |           |

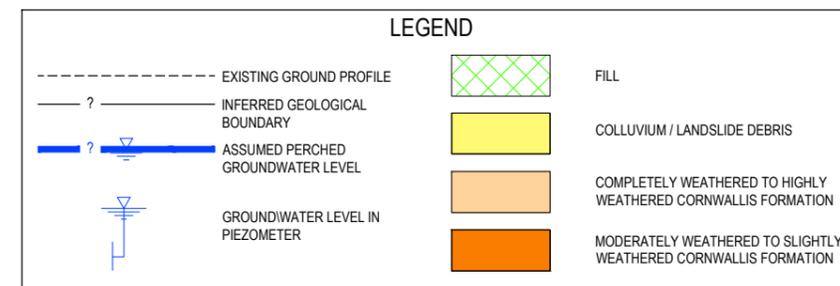
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| PROJECT    | <b>HUIA WTP REPLACEMENT PROJECT</b>                               |                   |
| TITLE      | WOODLANDS PARK ROAD, TITIRANGI<br>GEOLOGICAL CROSS SECTIONS A & B |                   |
| SCALE (A3) | AS SHOWN                                                          | FIG No. FIGURE A2 |
| REV        | 1                                                                 |                   |



SECTION C RESEVOIR 1  
SCALE 1: 1000



SECTION D WEST OF RESEVOIR 1  
SCALE 1: 1000



NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.



PROJECT No. 30848.2000

|          |     |        |
|----------|-----|--------|
| DESIGNED | KJH | May.19 |
| DRAWN    | JC  | May.19 |
| CHECKED  | KJH | May.19 |

KJH 22 May.19

APPROVED DATE

CLIENT **WATERCARE SERVICES LIMITED**

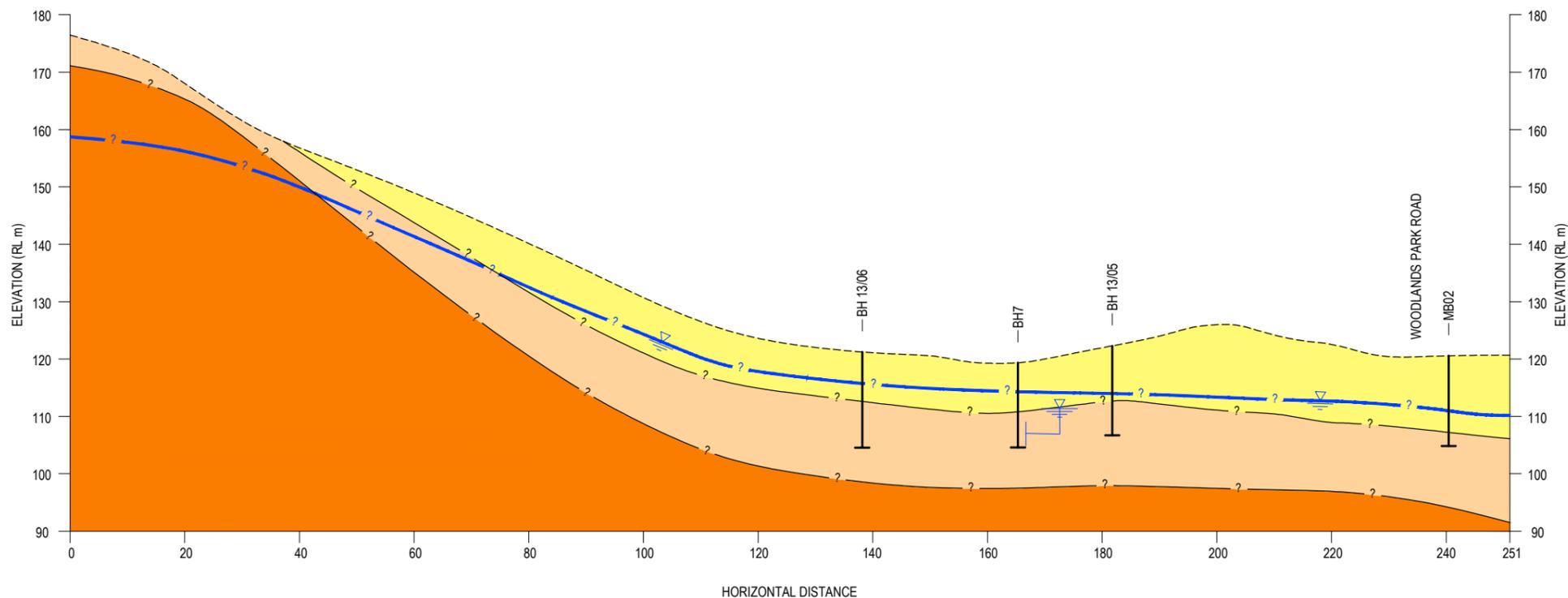
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TITLE **WOODLANDS PARK ROAD, TITIRANGI  
GEOLOGICAL CROSS SECTIONS C & D**

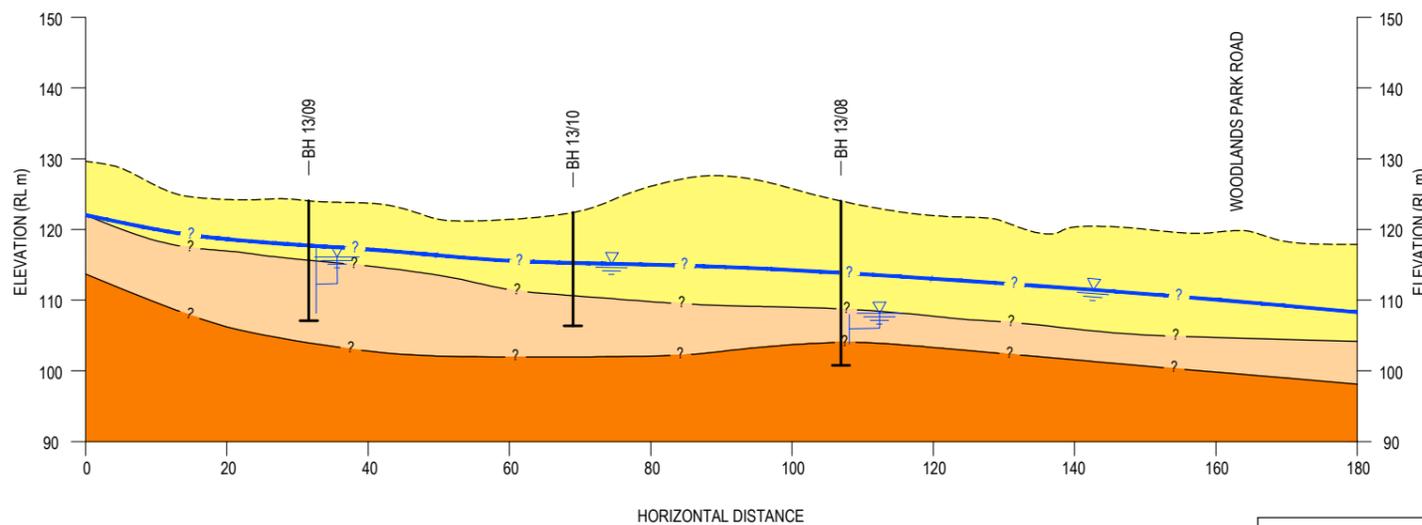
SCALE (A3) 1:1000

FIG No. FIGURE A3

REV 1



SECTION **E** WEST OF RESEVOIR 1  
SCALE 1: 1000 **A1**



SECTION **F** WEST OF RESEVOIR 1  
SCALE 1: 1000 **A1**

| LEGEND |                                   |  |                                                                 |
|--------|-----------------------------------|--|-----------------------------------------------------------------|
| --- ?  | EXISTING GROUND PROFILE           |  | FILL                                                            |
| — ?    | INFERRED GEOLOGICAL BOUNDARY      |  | COLLUVIUM / LANDSLIDE DEBRIS                                    |
| — ?    | ASSUMED PERCHED GROUNDWATER LEVEL |  | COMPLETELY WEATHERED TO HIGHLY WEATHERED CORNWALLIS FORMATION   |
|        | GROUNDWATER LEVEL IN PIEZOMETER   |  | MODERATELY WEATHERED TO SLIGHTLY WEATHERED CORNWALLIS FORMATION |



NOTES:

- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

PROJECT No. 30848.2000

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|----------|-----|--------|
| DESIGNED | KJH | May.19 |
| DRAWN    | JC  | May.19 |
| CHECKED  | KJH | May.19 |

KJH 22 May.19

APPROVED DATE

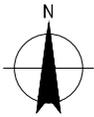
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PROJECT **HUIA WTP REPLACEMENT PROJECT**

TITLE **WOODLANDS PARK ROAD, TITIRANGI**  
**GEOLOGICAL CROSS SECTIONS E & F**

SCALE (A3) AS SHOWN FIG No. FIGURE A4

REV 1





PROPOSED RESERVOIR SITE  
(RESERVOIR NOT SHOWN)

WOODLANDS PARK ROAD AD

SCENIC DRIVE

SCENIC DRIVE SCENIC DRIVE

**CUT FILL VOLUMES**  
 TOTAL CUT VOLUME: 41,460m<sup>3</sup>  
 TOTAL FILL VOLUME: 30,400m<sup>3</sup>  
 TOTAL DISTURBED AREA: 27,200m<sup>2</sup>

| EARTH WORKS CUT / FILL DEPTH |                 | DEPTH COLOUR |
|------------------------------|-----------------|--------------|
| CUT / FILL DEPTH             | DEPTH COLOUR    |              |
| -13 to -12                   | [Dark Brown]    |              |
| -12 to -11                   | [Brown]         |              |
| -11 to -10                   | [Light Brown]   |              |
| -10 to -9                    | [Orange]        |              |
| -9 to -8                     | [Light Orange]  |              |
| -8 to -7                     | [Yellow-Orange] |              |
| -7 to -6                     | [Yellow]        |              |
| -6 to -5                     | [Light Green]   |              |
| -5 to -4                     | [Green]         |              |
| -4 to -3                     | [Light Green]   |              |
| -3 to -2                     | [Green]         |              |
| -2 to -1                     | [Light Green]   |              |
| 0 to 1                       | [Green]         |              |
| 1 to 2                       | [Light Green]   |              |
| 2 to 3                       | [Green]         |              |
| 3 to 4                       | [Light Green]   |              |
| 4 to 5                       | [Green]         |              |
| 5 to 6                       | [Light Green]   |              |
| 6 to 7                       | [Green]         |              |
| 7 to 8                       | [Light Green]   |              |
| 8 to 9                       | [Green]         |              |
| 9 to 10                      | [Light Green]   |              |



EXISTING HUIA WTP SITE ' SITE

**NOTES:**

- EARTHWORKS SHOWN ARE TO ESTABLISH FINAL WTP PLATFORM ONLY.
- STAGING AND POSSIBLE ENABLING EARTHWORKS REQUIRED NOT SHOWN

PLAN  
SCALE 1:500

| No | Revision    | Note: * indicates signatures on original issue of drawing or last revision of drawing | Drawn | Job Manager | Project Director | Date  |
|----|-------------|---------------------------------------------------------------------------------------|-------|-------------|------------------|-------|
| 1  | FOE CONSENT |                                                                                       | EP    | CG          | PF               | 11/18 |
| 0  | FOR CONSENT |                                                                                       | EP    | CG          | PF               | 10/18 |

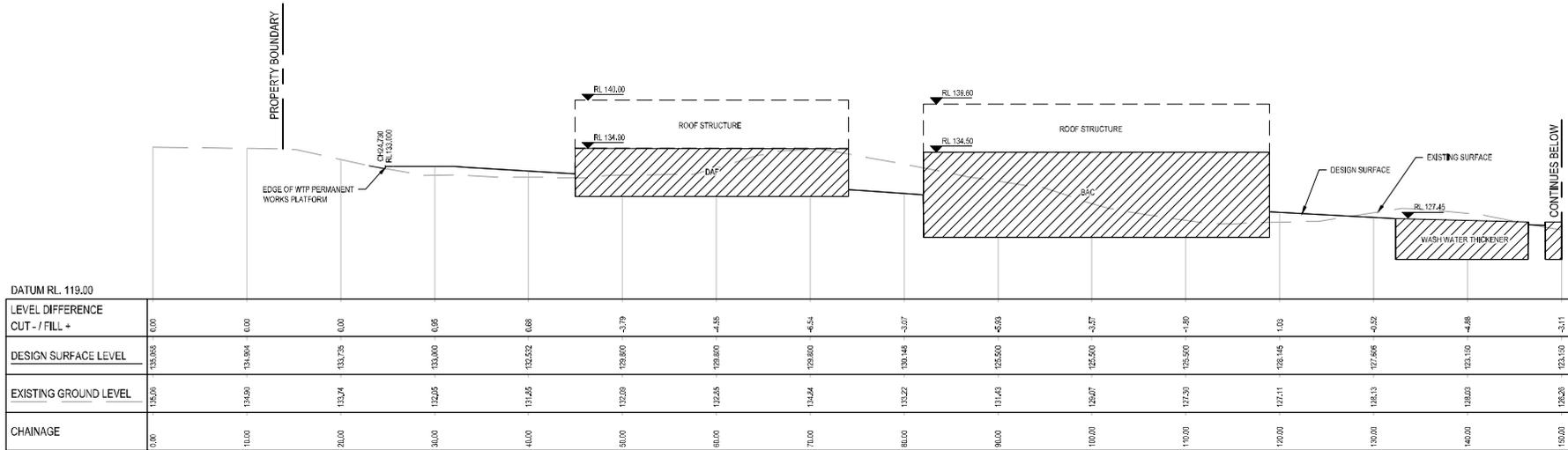


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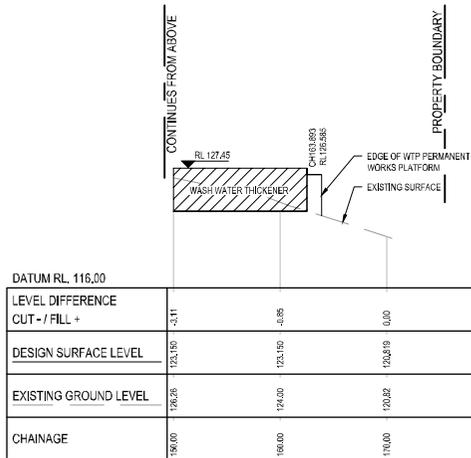
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| Drawn                       | E. PARCIA | Designer                                                                 | A. BLOW  |
| Drafting Check              | C. GAMST  | Design Check                                                             | C. GAMST |
| Approved (Project Director) | P. FREE   | Date                                                                     | 10/2018  |
| Scale                       | 1:500     | This Drawing must not be used for Construction unless signed as Approved |          |

|               |                                                              |
|---------------|--------------------------------------------------------------|
| Client        | <b>WATERCARE SERVICES LTD</b>                                |
| Project       | <b>HUIA REPLACEMENT WATER TREATMENT PLANT</b>                |
| Title         | <b>EARTHWORKS CUT/FILL DEPTHS WATER TREATMENT PLANT SITE</b> |
| Original Size | <b>A1</b>                                                    |
| Drawing No:   | <b>51-3357505-C006</b>                                       |
| Rev:          | <b>1</b>                                                     |



**F SECTION**  
C013 SCALE 1 : 250



**E SECTION**  
C013 SCALE 1 : 250

|    |             |                                                                                       |       |             |                  |       |
|----|-------------|---------------------------------------------------------------------------------------|-------|-------------|------------------|-------|
| No | Revision    | Note: * indicates signatures on original issue of drawing or last revision of drawing | Drawn | Job Manager | Project Director | Date  |
| 1  | FOR CONSENT |                                                                                       | RG    | CG          | PF               | 11/18 |
| 0  | FOR CONSENT |                                                                                       | RG    | CG          | PF               | 10/18 |



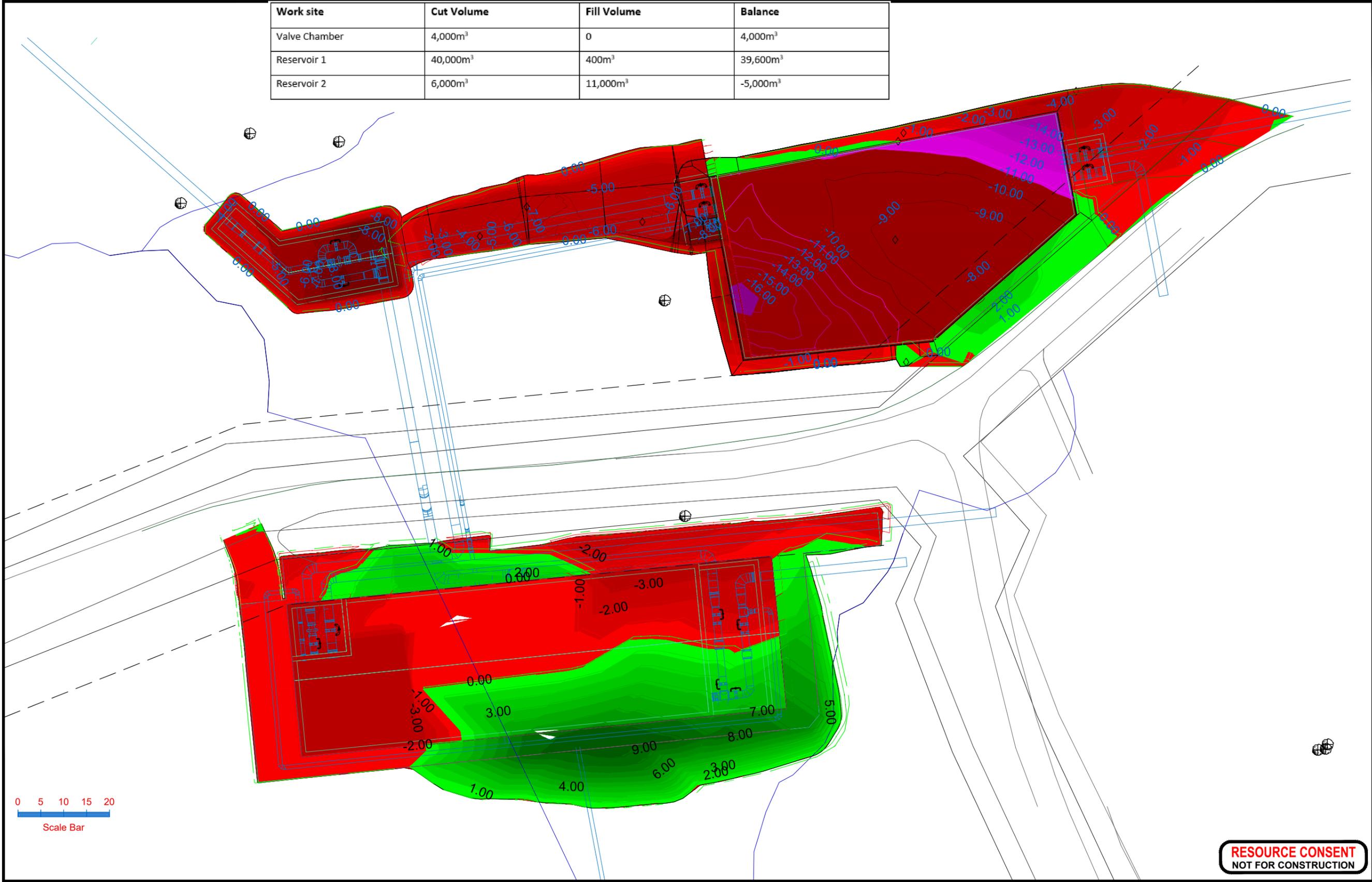
**DO NOT SCALE**  
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Drawn R.GUEVARRA  
Drafting Check C.GAMST  
Approved (Project Director) P.FREE  
Date 10/2018  
Scale 1:250

Designer A.BLOW  
Design Check C.GAMST  
This Drawing must not be used for Construction unless signed as Approved

Client **WATERCARE SERVICES LTD**  
Project **HUIA REPLACEMENT WATER TREATMENT PLANT**  
Title **WATER TREATMENT PLANT SECTIONS, SHEET 5 OF 6**  
Original Size **A1**  
Drawing No: **51-3357505-C013**  
Rev: 1

| Work site     | Cut Volume           | Fill Volume          | Balance              |
|---------------|----------------------|----------------------|----------------------|
| Valve Chamber | 4,000m <sup>3</sup>  | 0                    | 4,000m <sup>3</sup>  |
| Reservoir 1   | 40,000m <sup>3</sup> | 400m <sup>3</sup>    | 39,600m <sup>3</sup> |
| Reservoir 2   | 6,000m <sup>3</sup>  | 11,000m <sup>3</sup> | -5,000m <sup>3</sup> |



**RESOURCE CONSENT**  
NOT FOR CONSTRUCTION

|                  |                  |       |
|------------------|------------------|-------|
| DESIGNED         | SB               | 05-19 |
| DES. APPROVED    | Design Approved  | mm-yy |
| DRAWN            | Drawn            | mm-yy |
| DWG. APPROVED    | Drawing Approved | mm-yy |
| WSL DESIGN MGMT. | WSL Design Mgmt. | mm-yy |
| WSL PROJ. LEAD   | WSL Proj. Lead   | mm-yy |
| BY               | APPD.            | DATE  |

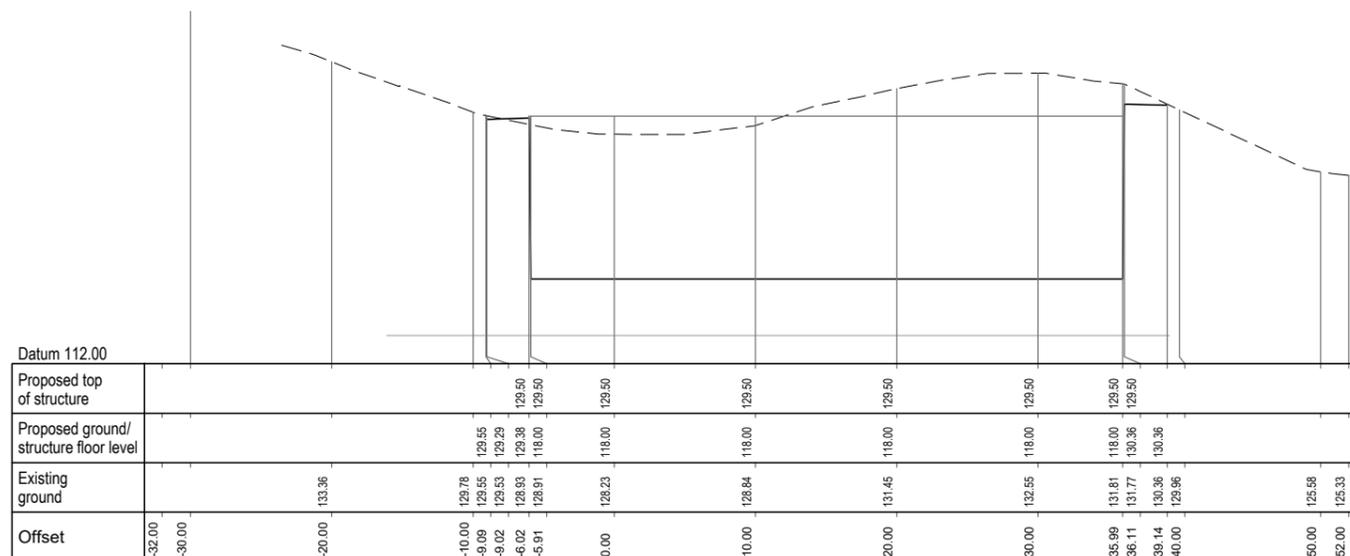


HUIA WATER TREATMENT PLANT REPLACEMENT  
TREATED WATER STORAGE RESERVOIR  
RESERVOIR 1 & 2 AND VALVE CHAMBER LAYOUT - CUT/FILL INFORMATION

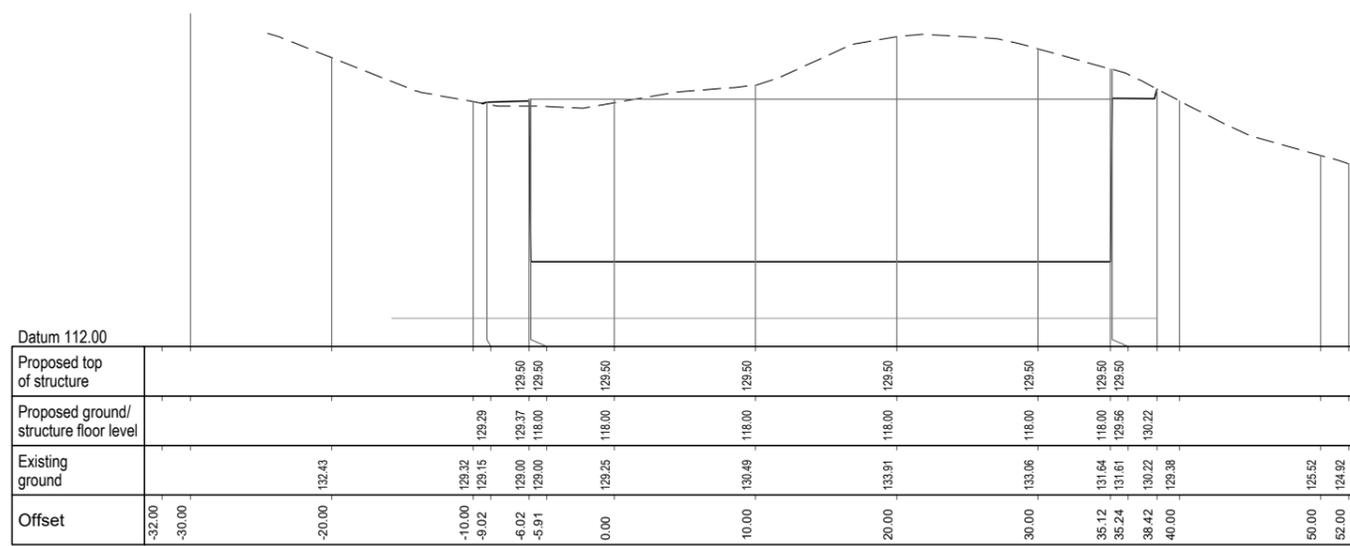
**DRAFT**

|                |               |              |          |
|----------------|---------------|--------------|----------|
| CAD FILE       | 3255336-K119  | DATE         | 17-05-19 |
| ORIGINAL SCALE | A3            | CONTRACT No. | -        |
| REF No.        |               |              |          |
| DWG No.        | 35255336.K119 | ISSUE        | OB       |

|       |          |                    |    |
|-------|----------|--------------------|----|
| OB    | 17.05.19 | ISSUED FOR CONSENT |    |
| ISSUE | DATE     | AMENDMENT          | BY |



CHAINAGE 70



CHAINAGE 60

**RESOURCE CONSENT**  
NOT FOR CONSTRUCTION

|                  |                  |                    |
|------------------|------------------|--------------------|
| DESIGNED         | SB               | 05-19              |
| DES. APPROVED    | Design Approved  | mm-yy              |
| DRAWN            | Drawn            | mm-yy              |
| DWG. APPROVED    | Drawing Approved | mm-yy              |
| WSL DESIGN MGMT. | WSL Design Mgmt. | mm-yy              |
| WSL PROJ. LEAD   | WSL Proj. Lead   | mm-yy              |
| ISSUE            | DATE             | AMENDMENT          |
| OB               | 17.05.19         | ISSUED FOR CONSENT |
|                  |                  | GT                 |
|                  |                  | BY APPD.           |

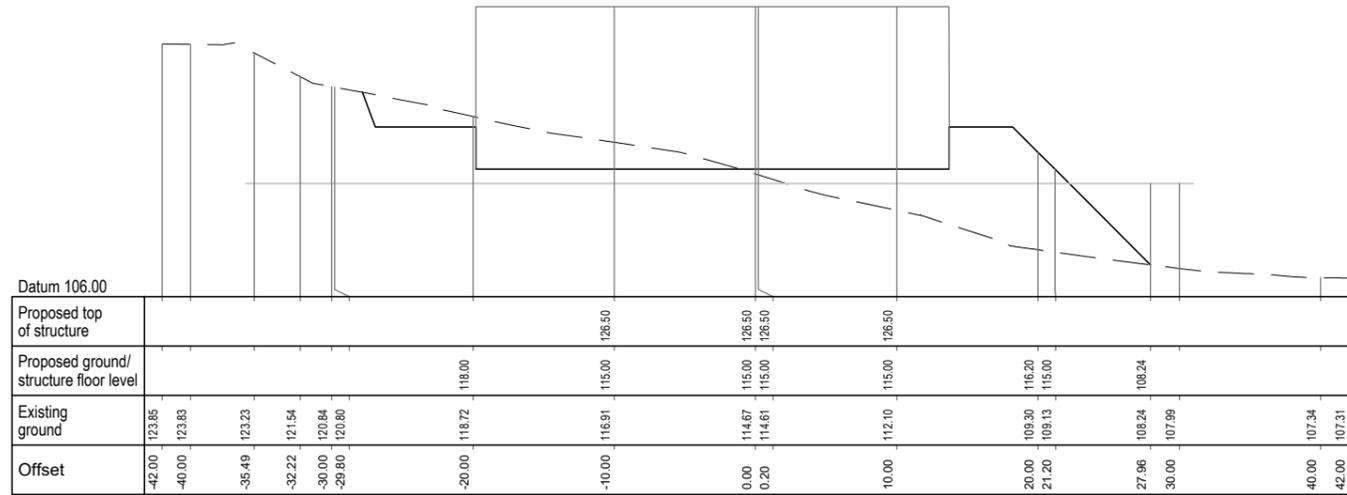
**Watercare**

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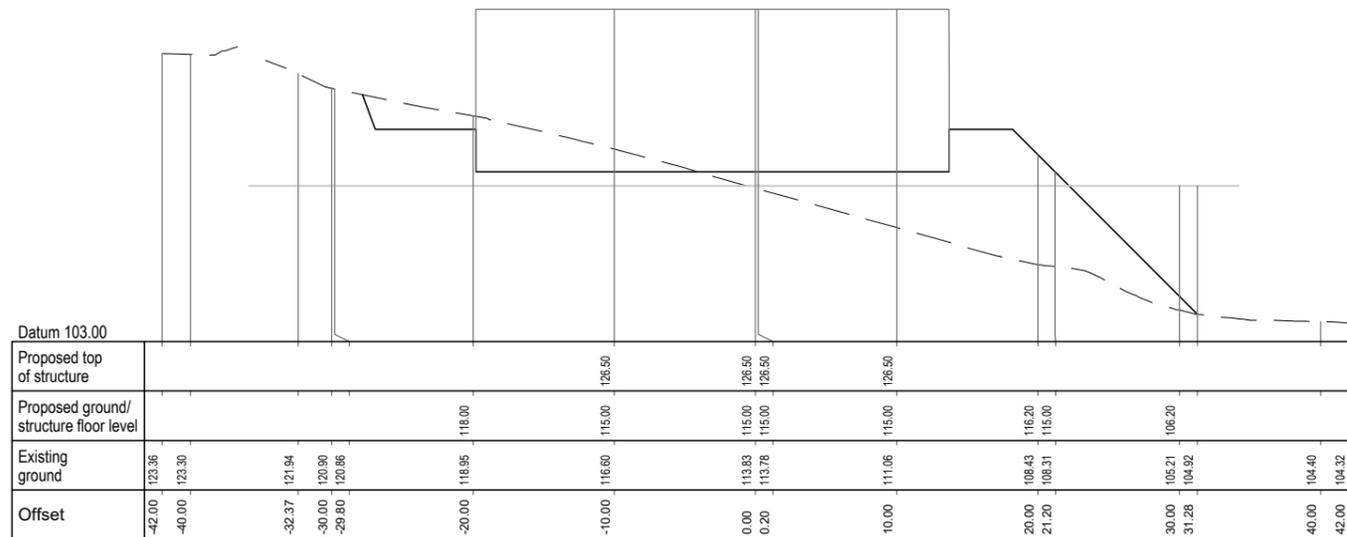
**HUIA WATER TREATMENT PLANT REPLACEMENT**  
**TREATED WATER STORAGE RESERVOIR**  
RESERVOIR 1 CROSS SECTIONS ALONG WEST EAST ALIGNMENT

**DRAFT**

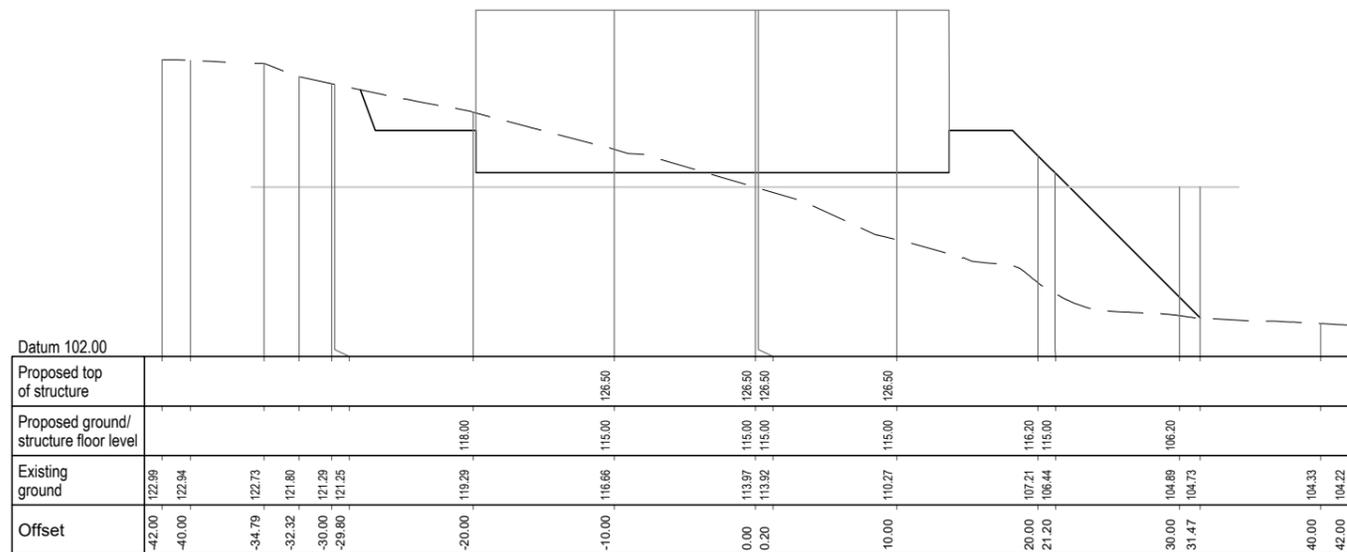
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| CAD FILE       | 3255336-K133  | DATE         | 17-05-19 |
| ORIGINAL SCALE | A3            | CONTRACT No. | -        |
| REF No.        |               |              |          |
| DWG No.        | 35255336.K133 | ISSUE        | OB       |



CHAINAGE 140



CHAINAGE 130



CHAINAGE 120

**RESOURCE CONSENT**  
NOT FOR CONSTRUCTION

|       |          |                    |    |       |
|-------|----------|--------------------|----|-------|
| OB    | 17.05.19 | ISSUED FOR CONSENT | GT |       |
| ISSUE | DATE     | AMENDMENT          | BY | APPD. |

|                  |                  |       |
|------------------|------------------|-------|
| DESIGNED         | SB               | 05-19 |
| DES. APPROVED    | Design Approved  | mm-yy |
| DRAWN            | Drawn            | mm-yy |
| DWG. APPROVED    | Drawing Approved | mm-yy |
| WSL DESIGN MGMT. | WSL Design Mgmt. | mm-yy |
| WSL PROJ. LEAD   | WSL Proj. Lead   | mm-yy |
|                  | BY               | DATE  |

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HUIA WATER TREATMENT PLANT REPLACEMENT  
TREATED WATER STORAGE RESERVOIR  
RESERVOIR 2 CROSS SECTIONS ALONG WEST EAST ALIGNMENT

**DRAFT**

|                |               |              |          |
|----------------|---------------|--------------|----------|
| CAD FILE       | 3255336-K123  | DATE         | 17-05-19 |
| ORIGINAL SCALE | A3            | CONTRACT No. | -        |
|                | 1:500         |              |          |
| REF No.        |               |              |          |
| DWG No.        | 35255336.K123 | ISSUE        | OB       |

