

# **Volume 5: Appendix 13.8 – Flood Modelling Study Report**



**CONTROL SHEET**

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**PROJECT TITLE:** Kintore to Hurlie OHL  
**REPORT TITLE:** Flood Modelling Study  
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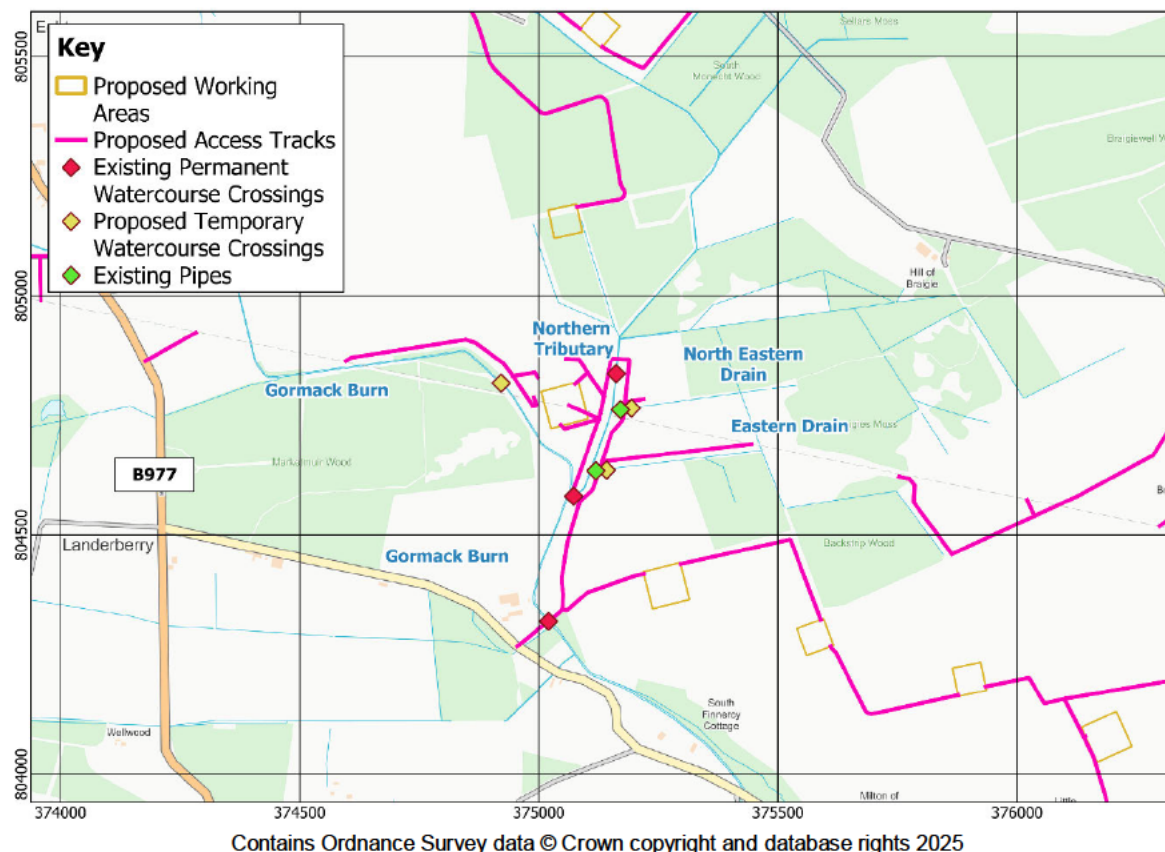
## 1. Introduction

Fairhurst was appointed to carry out a flood modelling study in support of the proposed development of an overhead line from Hurlie to Kintore. The proposed access track alignment for the development requires watercourse crossings as shown in **Figure 1**. The proposals are:

- Access tracks are to be set no higher than existing ground level.
- The existing permanent crossings are to be repaired with no change to the dimensions.
- The proposed temporary crossings are to be flat deck crossings spanning the existing banktops.

Hydraulic modelling has been undertaken to assess the flood risk from the Gormack Burn, Northern Tributary, Eastern Drain and North Eastern Drain.

This report forms an appendix to the EIA and presents information relevant to the Kintore to Tealing 400 kV Overhead Line (OHL) Connection (the Proposed Development). It should be read in conjunction with Volume 2, Chapter 13: Hydrology, Hydrogeology, Geology and Soils. Fairhurst are assisting MGroup with the Engineering Services relating to the new 400kV connection between Kintore and Hurlie section of the Proposed Development.



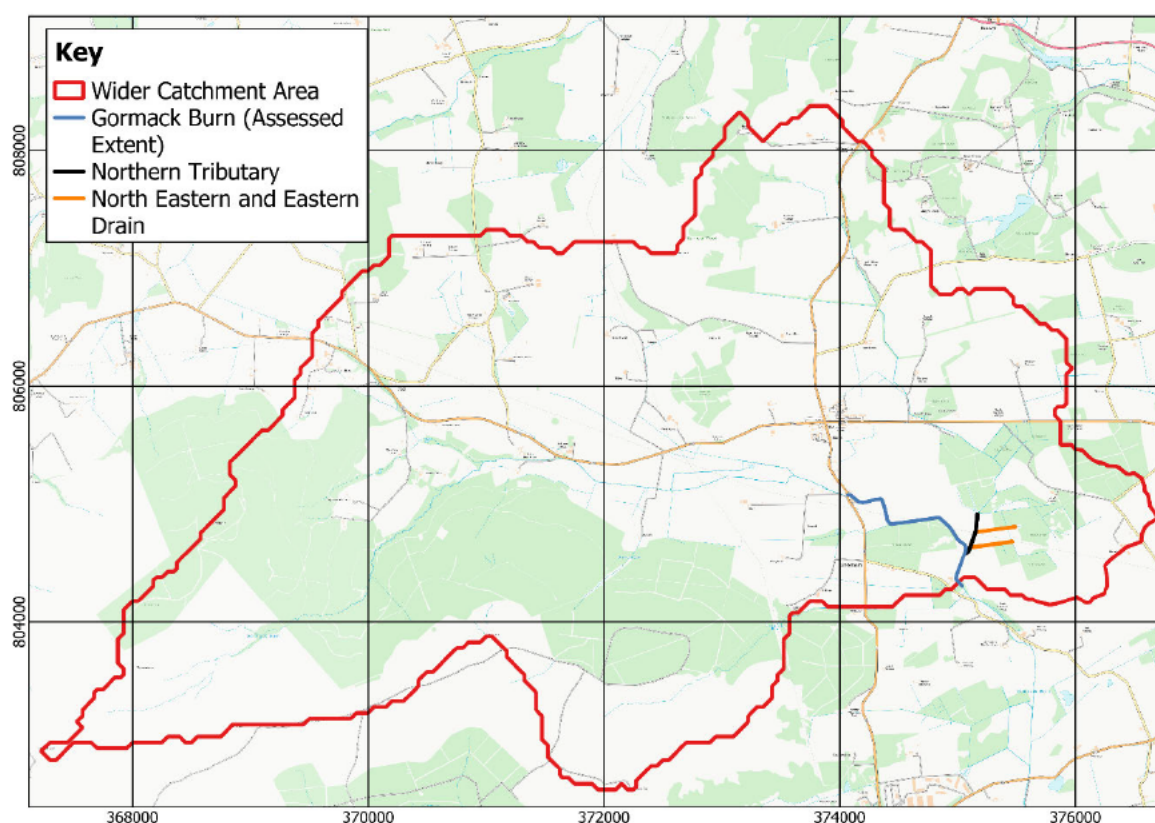
**Figure 1: Proposed Site Layout**

## 2. Hydrology

Hydraulic modelling has been undertaken to quantify existing flooding conditions from the Gormack Burn, the Northern Tributary and the Eastern and North Eastern drainage ditches.

### 2.1 Catchment

The Gormack Burn drains a total catchment area of 28.30 km<sup>2</sup> at the downstream end of the model extent, based on data from the Flood Estimation Handbook (FEH) Web Service website<sup>1</sup> (Figure 2).

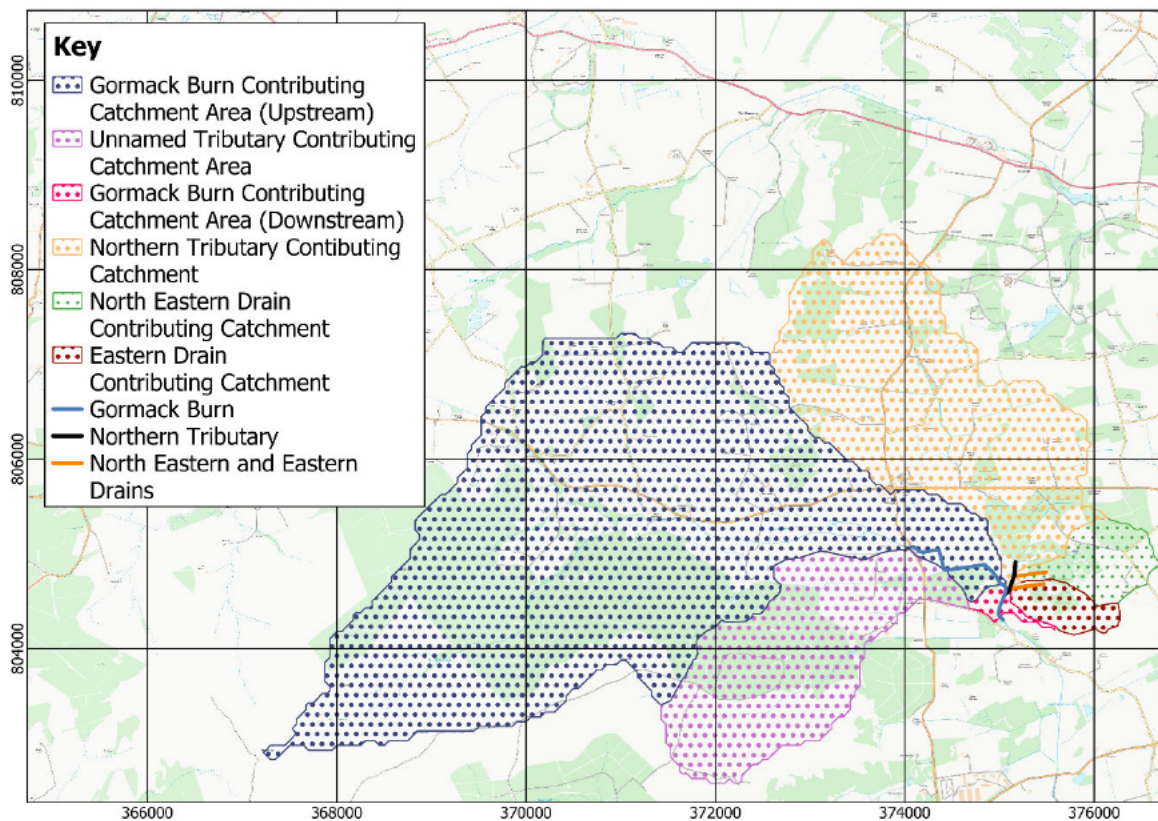


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**Figure 2: Full Contributing Catchment Area at the Downstream Extent of the Gormack Burn**

For this assessment, the hydrology of the Gormack Burn, Northern Tributary and the Eastern and North Eastern drainage ditches has been considered separately. The contributing catchment areas for each channel has been derived based on Nextmap data and these are illustrated in Figure 3. There is no gauge available along the channel, therefore, catchment descriptors have been obtained for the channels and used to estimate runoff. The adopted descriptors are detailed in Table 1.

<sup>1</sup> FEH Web Service: <https://fehweb.ceh.ac.uk/>



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**Figure 3: Assessed Contributing Sub-Catchment Areas**

**Table 1: FEH Catchment Descriptors**

| Descriptor Name              | Descriptor Value (Gormack Burn - Total) | Descriptor Value (Northern Tributary) | Descriptor Value (Eastern Drain) | Descriptor Value (North Eastern Drain) |
|------------------------------|-----------------------------------------|---------------------------------------|----------------------------------|----------------------------------------|
| <b>AREA (km<sup>2</sup>)</b> | 20.42                                   | 6.34                                  | 0.43                             | 0.76                                   |
| <b>SAAR</b>                  | 843                                     | 804                                   | 812                              | 812                                    |
| <b>PROPWET (mm)</b>          | 0.53                                    | 0.53                                  | 0.53                             | 0.53                                   |
| <b>SPRHOST (%)</b>           | 35.75                                   | 29.38                                 | 29.8                             | 29.8                                   |
| <b>DPLBAR (km)</b>           | 4.88                                    | 2.71                                  | 0.59                             | 0.59                                   |
| <b>DPSBAR (m/km)</b>         | 116                                     | 58                                    | 39.5                             | 39.5                                   |
| <b>URBEXT1990</b>            | 0.0014                                  | 0.0014                                | 0                                | 0                                      |
| <b>URBEXT2000</b>            | 0.0011                                  | 0.0014                                | 0                                | 0                                      |
| <b>BFIHOST</b>               | 0.524                                   | 0.576                                 | 0.598                            | 0.598                                  |
| <b>BFIHOST19</b>             | 0.442                                   | 0.551                                 | 0.548                            | 0.548                                  |

## 2.2 Peak Flow Estimation

NPF4 requires that new developments be assessed against a 1 in 200 year flood with allowances for climate change. This section details the methods utilised to derive flows for the aforementioned sub-catchments.

Catchment descriptors were utilised to derive runoff using the FEH Rainfall Runoff (FEH RR) method and the Revitalised Flood Hydrograph (ReFH2) method. The catchment areas are considered too small for the FEH statistical method to be appropriate, therefore this method has been discounted.

Results are detailed in **Table 2**. The FEH RR method results were higher than those derived in the ReFH2 method, therefore, these values were generally adopted for the assessment at all sub-catchments to provide a conservative approach. Peak flows for each sub-catchment have been derived for a critical storm duration of 5.1 hours based on the critical storm duration of the full contributing catchment area.

Current SEPA guidance<sup>2</sup> (2025) on applying climate change allowances in FRAs for land use planning recommends that climate change be accounted for in small catchments (less than 30 km<sup>2</sup>) by applying a defined increase in peak rainfall intensity, which varies depending on the location of the catchment. The site is situated in the North East Scotland River Basin Region so a 37% increase in rainfall has been applied to the derived 1 in 200 year flow by adjusting the design rainfall, to provide an estimate of the 1 in 200 year + climate change (+ CC) flood flows. The resulting increase in peak flows for all sub-catchments, is detailed in **Table 2**.

<sup>2</sup> SEPA (2025). Climate change allowances for flood risk assessment in land use planning Version 6. [online] Available at: [https://www.sepa.org.uk/media/jjwpuxso/climate-change-allowances-guidance\\_v6.pdf](https://www.sepa.org.uk/media/jjwpuxso/climate-change-allowances-guidance_v6.pdf)

**Table 2: 1 in 200 year + Climate Change Peak Flow Estimates (m<sup>3</sup>/s)**

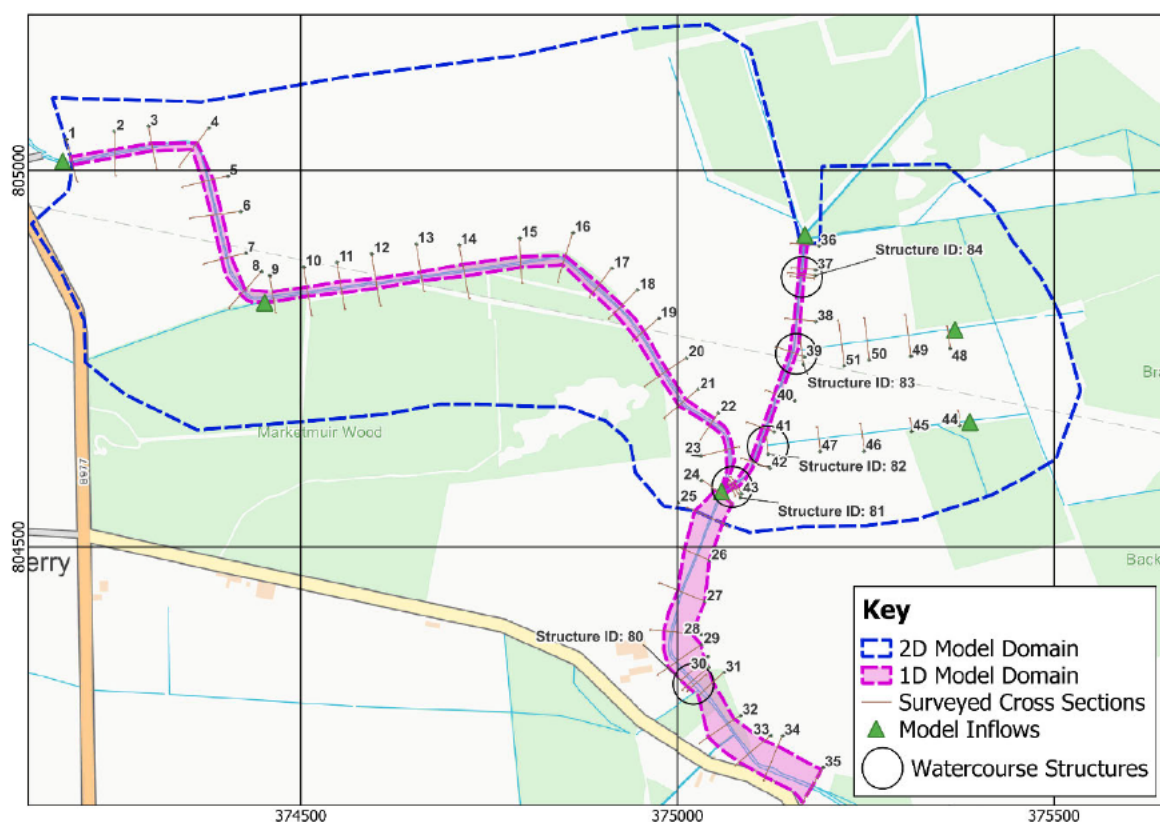
| Gormack Burn – Total | Northern Tributary | Eastern Drain | North Eastern Drain |
|----------------------|--------------------|---------------|---------------------|
| 47.79                | 10.10              | 0.57          | 1.67                |

### 3. Hydraulic Modelling

Hydraulic modelling was undertaken to provide a quantitative assessment of the fluvial flood risk for the Gormack Burn, Northern Tributary and the Eastern and North Eastern Drains using a 1D/2D model. Full details of the modelling study are presented in this section.

#### 3.1 Model Construction

A 1D/2D linked hydraulic model of the channels has been constructed using the industry standard Flood Modeller and TUFLOW software packages. The set-up of the model is shown in **Figure 4**.



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**Figure 4: Model Set-Up**

The 1D model represents all the assessed channels with a total length of 2.51 km. This has been constructed based on surveyed cross sections (Drawing No. 6325/01, **Appendix A**). Cross section information is available at a total of 51 locations, at sections representative of channel characteristics and where there are existing structures present with the potential to influence the river hydraulics and subsequently the conveyance of water within the channel. The 1D model incorporates a number of structures which are identified in **Figure 4** and described in **Table 3**.

**Table 3: Existing Watercourse Structures**

| Structure ID | Description & Approximate Dimensions               |
|--------------|----------------------------------------------------|
| 84           | 2 m wide by 2.3 m high rectangular stone bridge    |
| 83           | 600 mm diameter circular pipe                      |
| 82           | 500 mm diameter circular pipe                      |
| 81           | 2.1 m wide by 2.18 m high rectangular stone bridge |
| 80           | 5.24 m wide by 3.80 m high arched stone bridge     |

The 2D domain covers an area of 0.48 km<sup>2</sup> and has been constructed using a combination of topographic survey data within the area of interest and Nextmap data. A fixed mesh of 4 m has been applied in the discretisation of the surface topography with a 2 m grid quadtree refinement included along the banks of the Gormack Burn and the Northern Tributary. This was found sufficient to resolve flow pathways.

### 3.2 Model Roughness

The composition of bed material within a watercourse has a significant influence on the way that water flows through the watercourse channel. This is represented within the hydraulic model using Manning's roughness values. Manning's roughness within the 2D domain was set to a global value of 0.1 to represent agricultural crops, with higher values of 0.15 to applied to wooded areas. Throughout the 1D model a Manning's roughness value of 0.04 was used for the channel. This value is considered to be a reasonably conservative roughness representing the overhanging vegetation and presence of stones and weeds observed along the channel from the site photographs.

### 3.3 Boundary Conditions

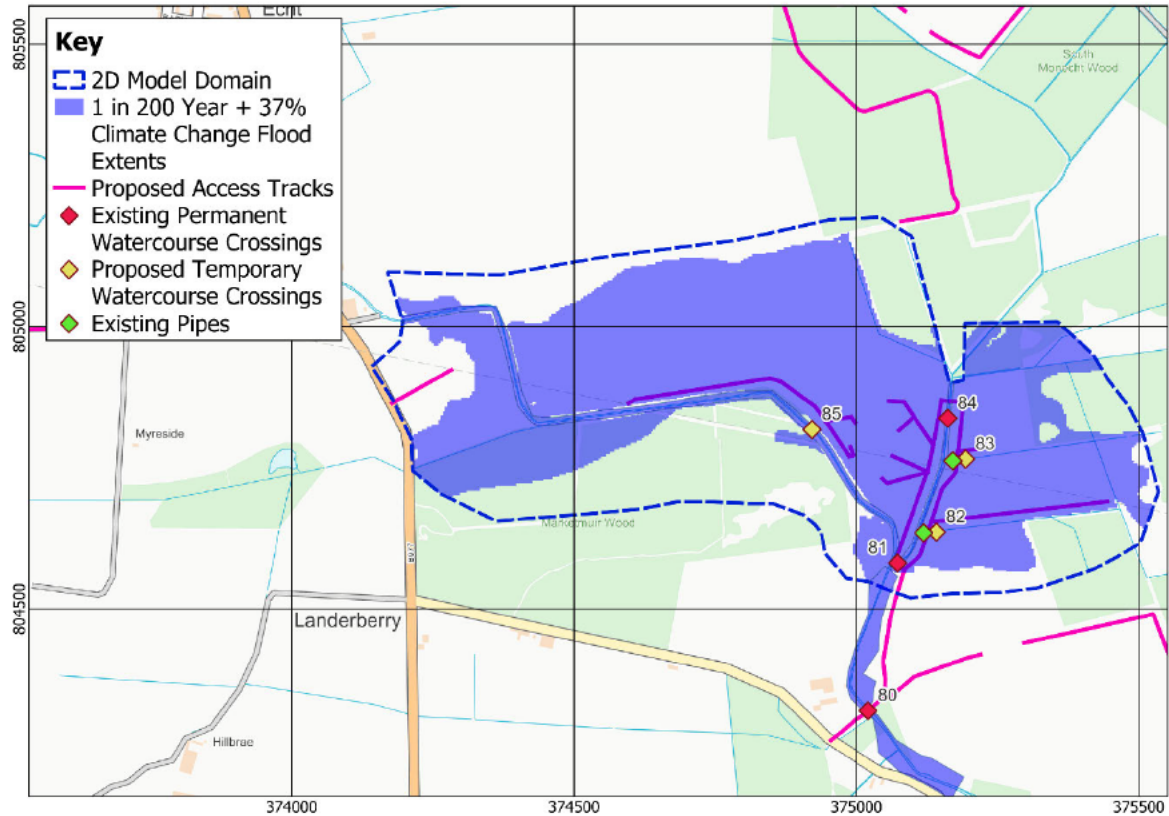
Boundary condition locations are illustrated on **Figure 4**. The model inflows consist of flow-time hydrographs at the upstream end of the 1D networks, generated using flow estimation methods presented in **Section 2**. The downstream boundary is set to a normal-depth condition with the slope set to the average slope of the channel at the downstream extent.

### 3.4 Model Results

Model results indicate that in a 1 in 200 year plus 37% climate change scenario there would be extensive out of bank flooding within the study area upstream of the confluence of Gormack Burn and the Northern Tributary. Within this area all existing and proposed crossing locations are below the peak flood level. Existing ground levels on the route of the proposed access track are also below the flood level.

Downstream of the confluence the model results indicate that flood extents are confined to the channel and adjacent lower-lying grounds at the banks. There is an existing building to the west of the channel in this location, however this is outside of the flood risk area. The existing bridge structure downstream

of the confluence (Structure ID: 80) has capacity to convey the 1 in 200 year plus climate change flows without any surcharging.



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**Figure 5: 200 Year + 37% Climate Change Flood Extents under Existing Conditions**

**Table 4: Water Levels upstream of Existing and Proposed Watercourse Structures**

| Structure ID | 200 + Climate Change Water Level (mAOD) |
|--------------|-----------------------------------------|
| 85           | 84.24                                   |
| 84           | 83.84                                   |
| 83           | 83.83                                   |
| 82           | 83.79                                   |
| 81           | 83.75                                   |
| 80           | 82.77                                   |

### 3.5 Development Proposals

The development proposals for access tracks and watercourse crossings in this area are:

- Access tracks are to be set no higher than existing ground level.
- The existing permanent crossings are to be repaired with no change to the dimensions.
- The proposed temporary crossings are to be flat deck crossings spanning the existing banktops.

The existing permanent bridges to be used as part of the development (80 and 81) will be repaired to provide a permanent access track for operational and maintenance use only. The existing bridge decks will be removed and replaced with a thinner deck at the same level.

All proposed crossings will be designed to maintain and not reduce the existing capacity of the channel insofar as possible. Designing the structure for a 1 in 200 year plus climate change flow would result in having to raise the bridge deck and access track which would require raised embankments (i.e. land raising in the floodplain), which is not feasible in this location.

Given the rural setting, if a flow greater than the existing capacity of the channel were to occur it would flow over the bridge decks into the adjacent farmland and then back into the channel (as it does at present) and would not increase flood risk to others. There are no nearby built receptors which are at risk and there is considered to be no increased flood risk to others.

On this basis the proposals will not result in an increase in flood risk to nearby receptors other than localised impacts to the existing surrounding agricultural land. There will be no land raising in the flood risk area and no flood protection measures will be required.

## 4. Conclusion

Fairhurst was appointed to carry out a flood modelling study support of the proposed development of an overhead line from Hurlie to Kintore. Hydraulic modelling has been undertaken to assess the flood risk from the Gormack Burn, Northern Tributary, Eastern Drain and North Eastern Drain.

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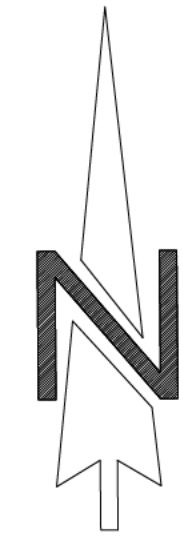
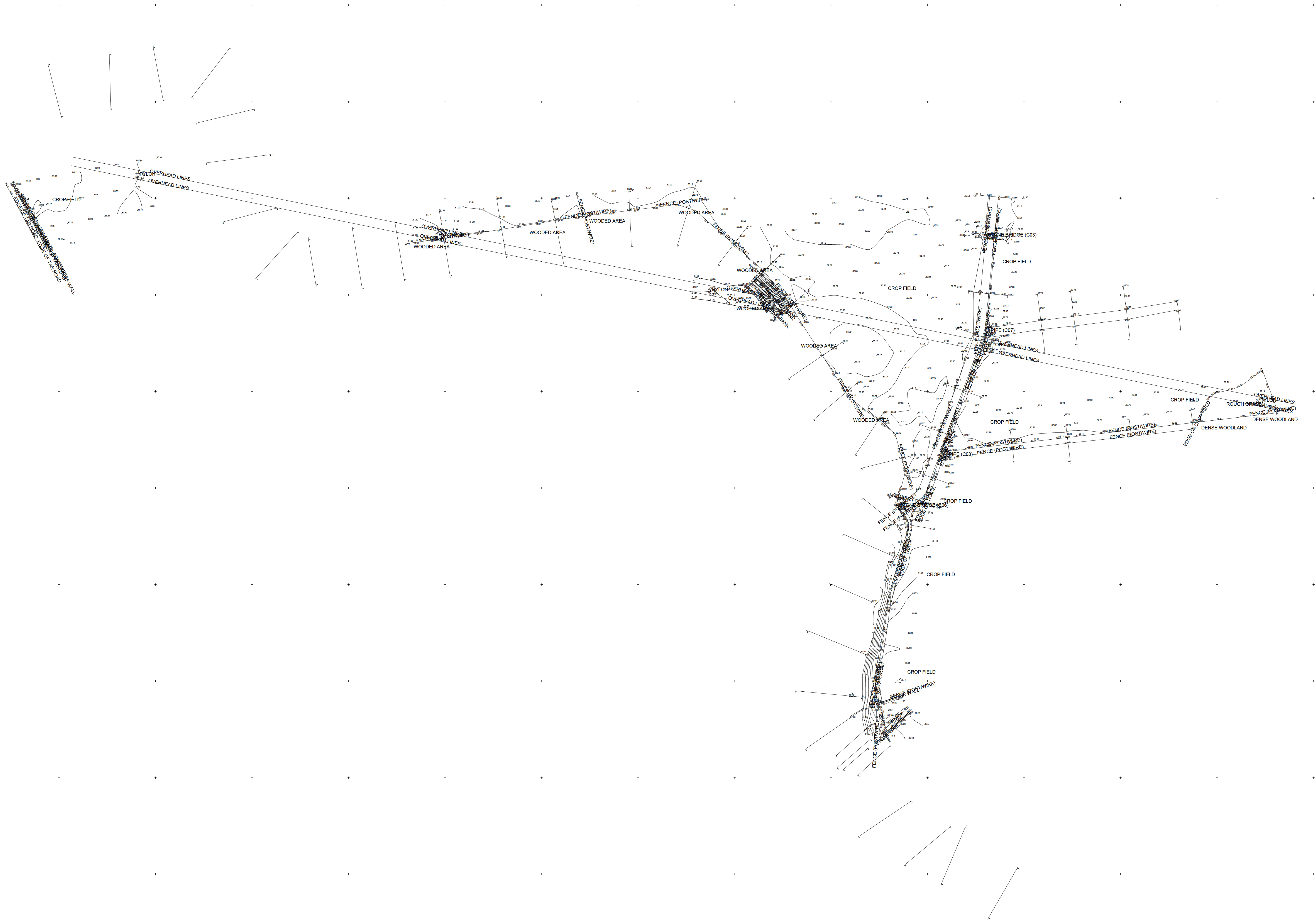
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## Appendix A

### Topographic Survey



## LEGEND

| SYMBOLS            |  |           |  |
|--------------------|--|-----------|--|
| BOREHOLE           |  | STUMP     |  |
| CONTROL STATION    |  | TRIAL PIT |  |
| GATE               |  | TREE      |  |
| SERVICE COVER      |  |           |  |
| LINE STYLES        |  |           |  |
| BOTTOM OF BANK     |  |           |  |
| BUILDING FOOTPRINT |  |           |  |
| BUSH CANOPY        |  |           |  |
| CHANGE OF SURFACE  |  |           |  |
| CHANNEL LINE       |  |           |  |
| FENCE              |  |           |  |
| HEDGE              |  |           |  |
| OVERHEAD WIRES     |  |           |  |
| ELECTRIC           |  |           |  |
| TELECOM            |  |           |  |
| PATH EDGE          |  |           |  |
| ROAD CENTRE LINE   |  |           |  |
| STRIP GULLY        |  |           |  |
| TOP OF BANK        |  |           |  |
| TOP OF KERB        |  |           |  |
| TREE CANOPY        |  |           |  |
| WALL               |  |           |  |

## ABBREVIATIONS

|                            |                          |
|----------------------------|--------------------------|
| AV = AIR VALVE             | LP = LAMPOST             |
| BH = BOREHOLE              | MH = MANHOLE             |
| BOI = BOLLARD              | MKR = MARKER             |
| BOX = ELEC / BT BOX        | PIT = TRIAL PIT          |
| BT = BRITISH TELECOM       | PEG = MARKER PEG         |
| EA = EAVES LEVEL           | RD = RIDGE LEVEL         |
| EC = ELECTRICITY COVER     | RS = ROAD SIGN           |
| EP = ELECTRICITY POLE      | SB = SIGN BOARD          |
| FFL = FINISHED FLOOR LEVEL | SC = STOP COCK           |
| FP = FLAG POLE             | SV = STOP VALVE          |
| G = GULLY                  | TCB = TELEPHONE CALL BOX |
| GAS = BRITISH GAS          | TL = TRAFFIC LIGHT       |
| HY = FIRE HYDRANT          | TOW = TOP OF WALL        |
| IC = INSPECTION COVER      | TP = TELEGRAPH POLE      |
| IL = INVERT LEVEL          | TV = TELEVISION          |
| SG = STRIP GULLY           | WM = WATER METER         |

## NOTES

- GRID IS RELATED TO O.S. GRID
- ALL LEVELS RELATE TO O.S.B.M. ASCERTAINED BY LOGGING G.P.S. DATA
- CONTOURS ARE AT 0.50 (m) INTERVALS
- CONTOURS AT VERTICAL FEATURES ARE INDICATIVE
- LEVELS FOR ROAD ARE TAKEN ALONG CHANNEL LINE
- WHILE EVERY EFFORT HAS BEEN MADE TO LOCATE THE POSITION OF ALL SERVICE COVERS (eg. manholes) IT SHOULD BE NOTED THAT THIS MAY NOT HAVE BEEN POSSIBLE AT THE TIME OF SURVEY DUE TO GROUND COVER OR LOCAL OBSTRUCTIONS.
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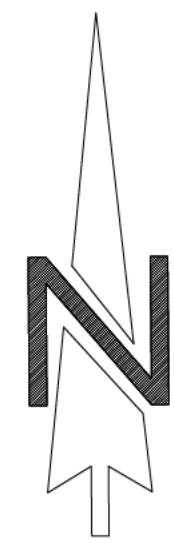
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## LEGEND

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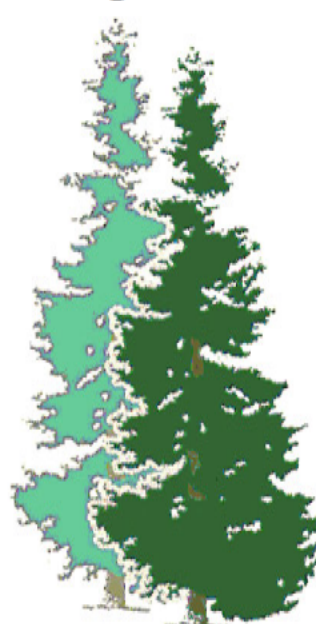
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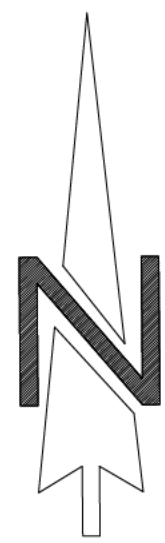
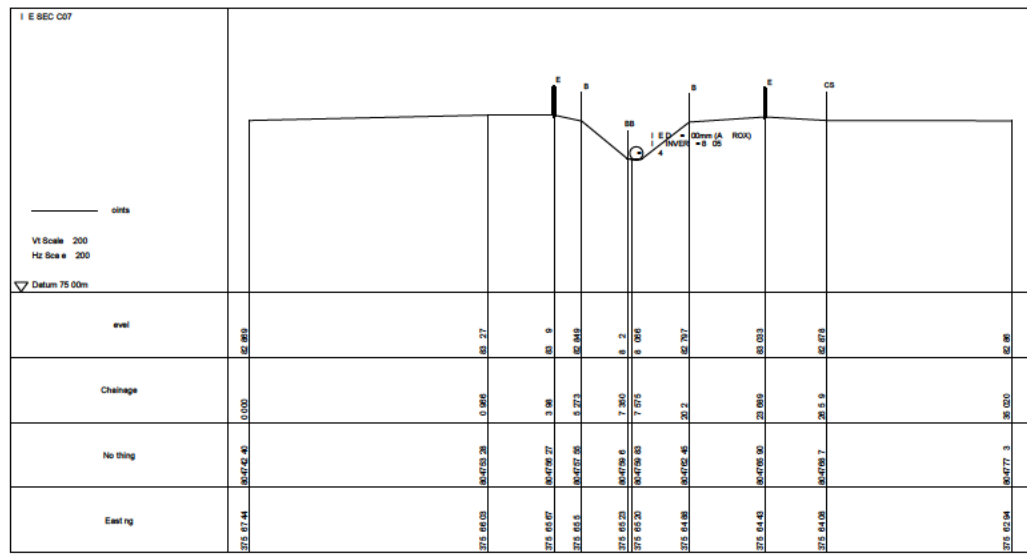
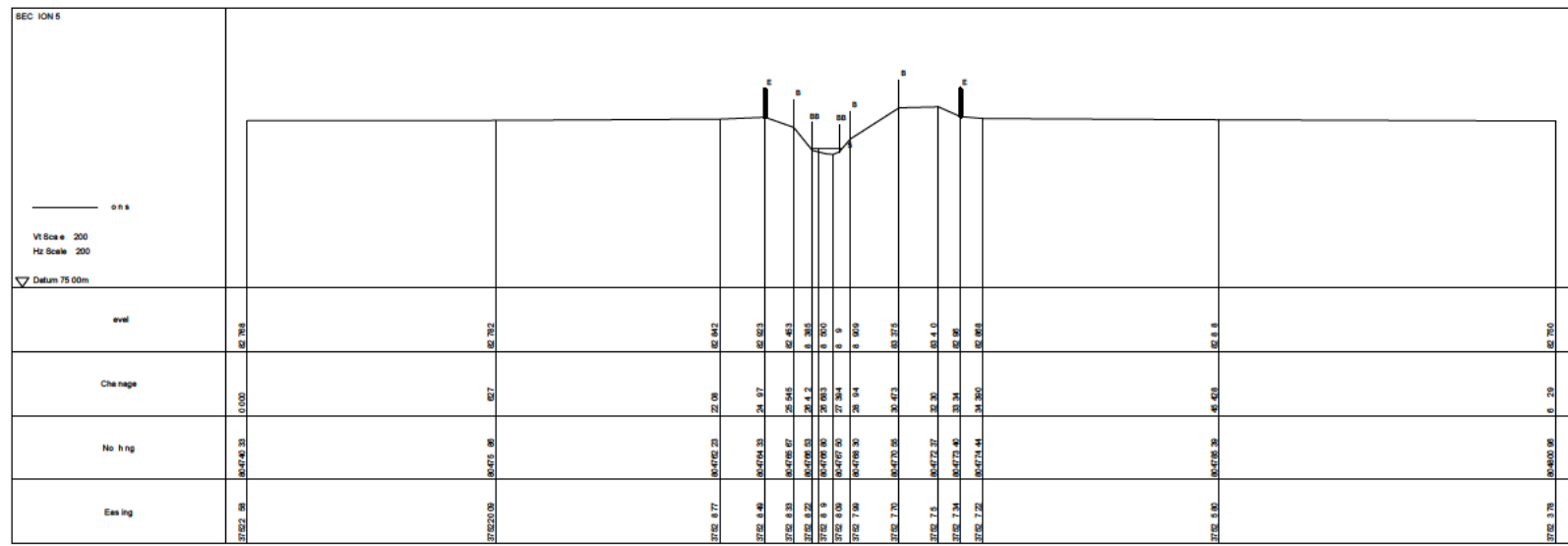
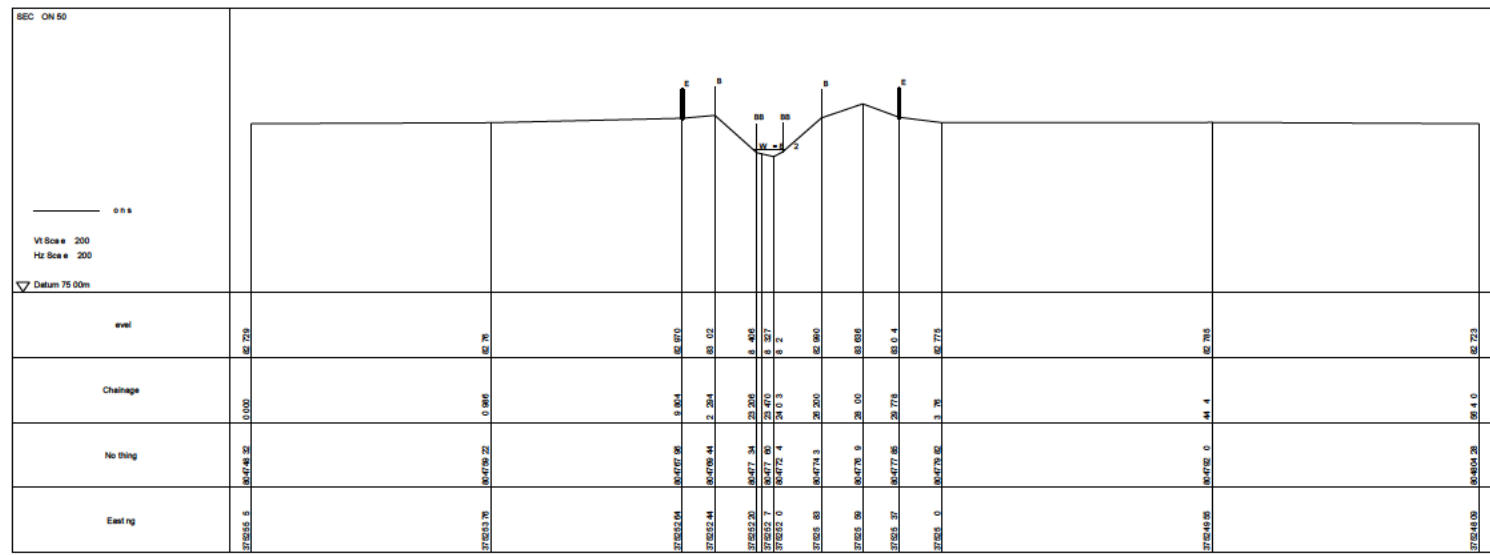
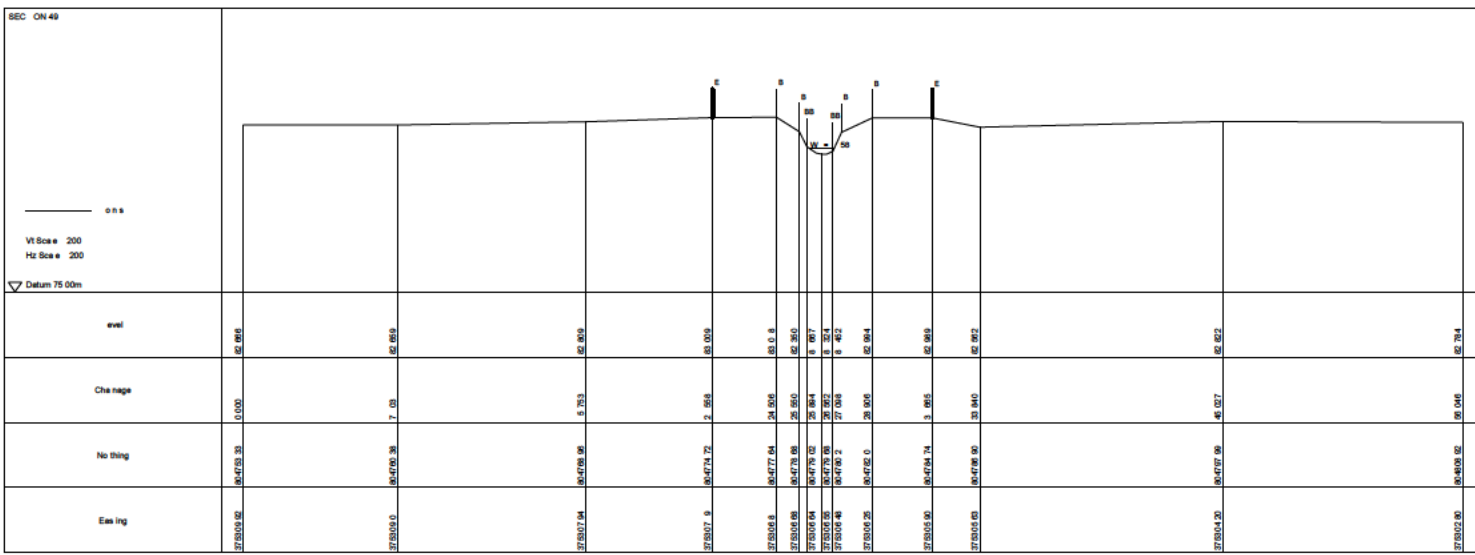
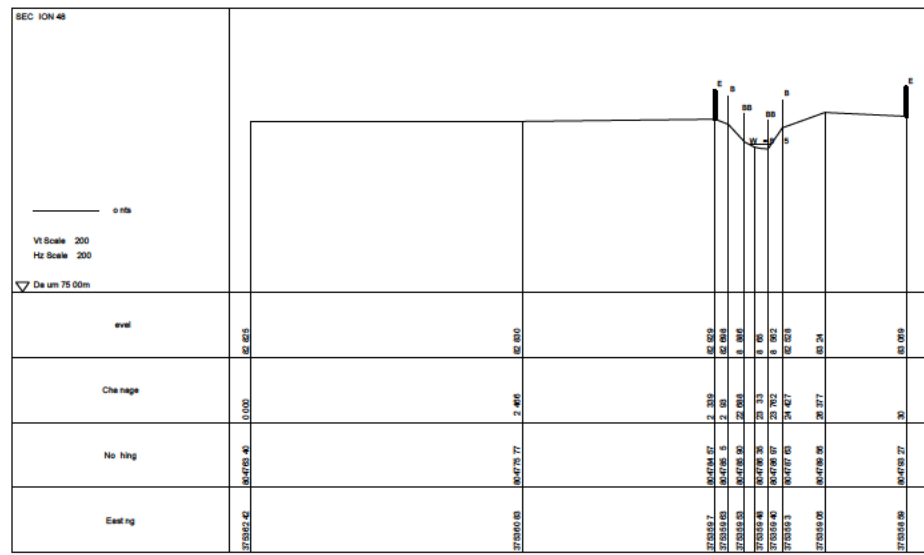
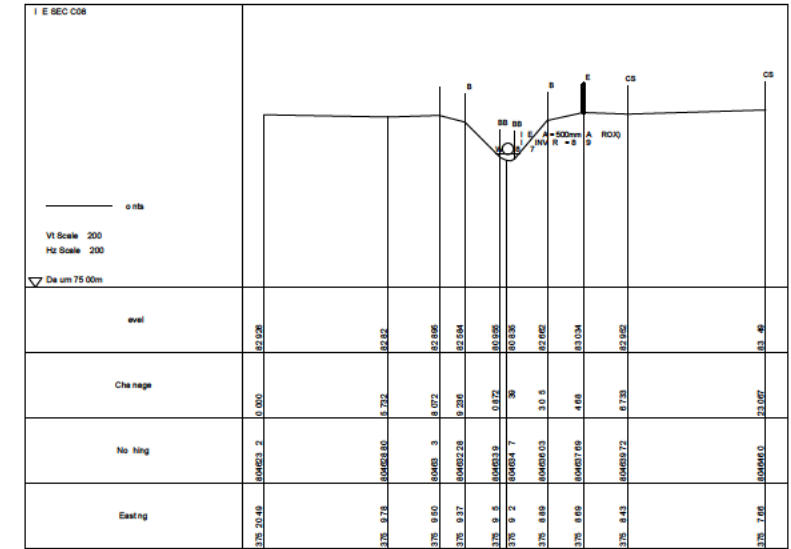
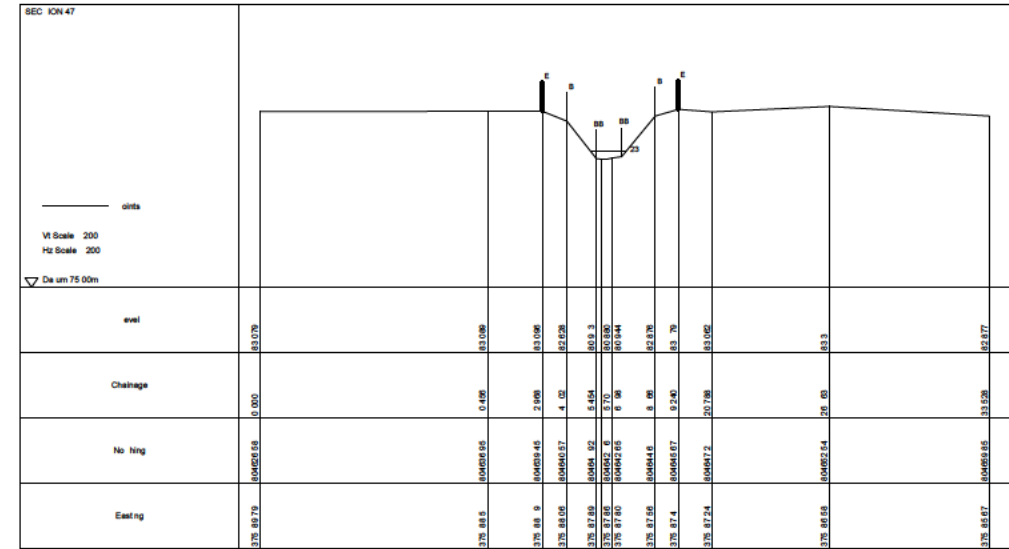
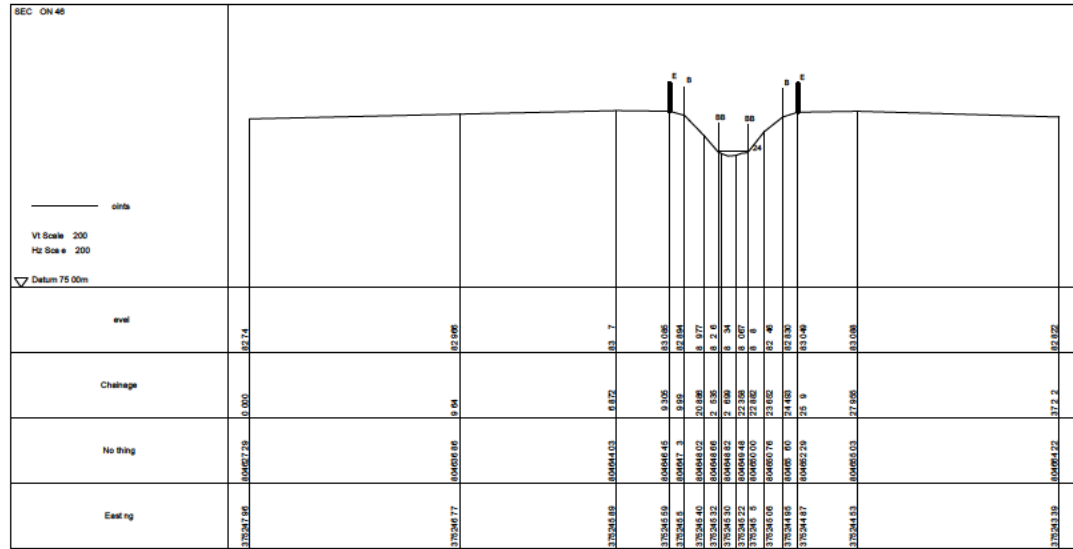
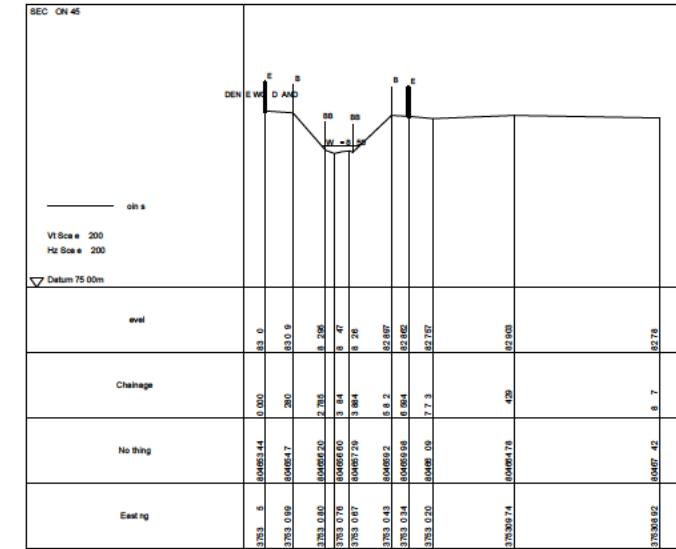
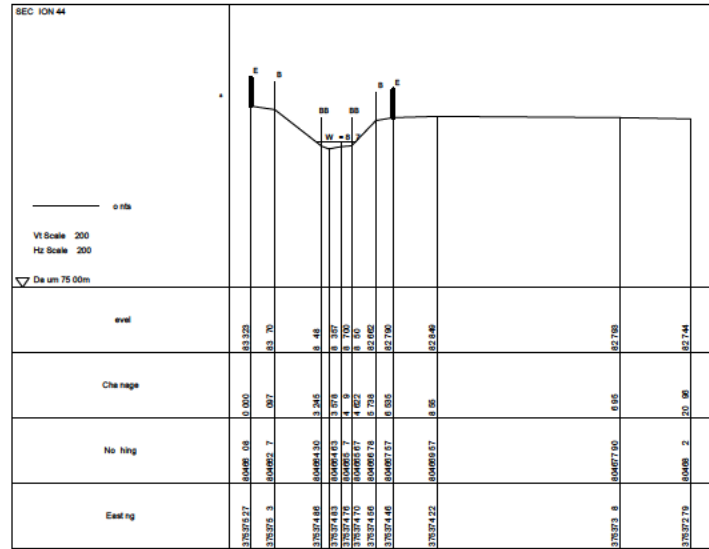
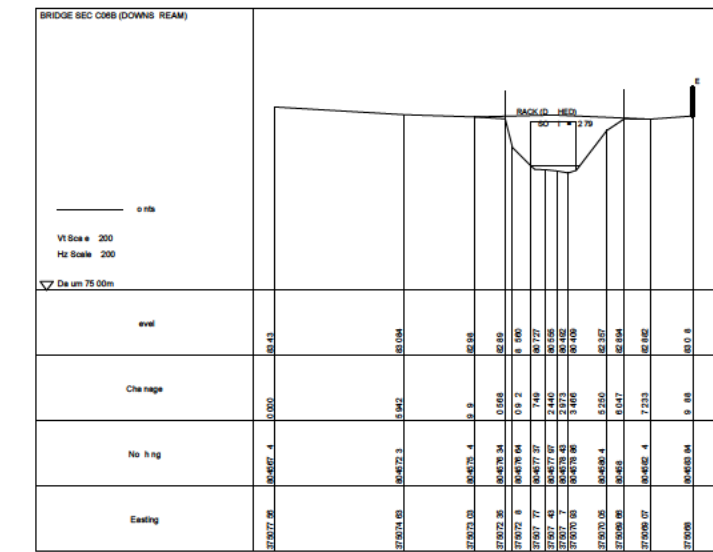
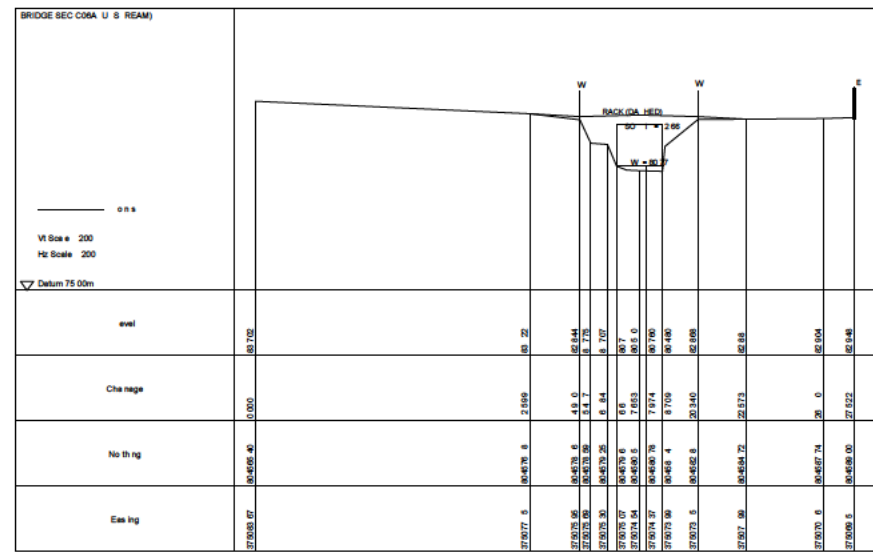
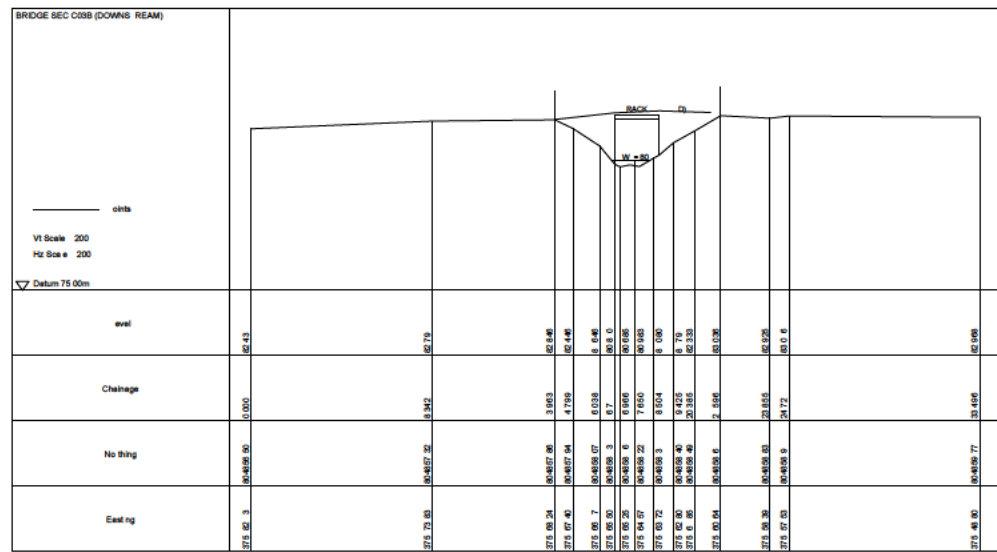
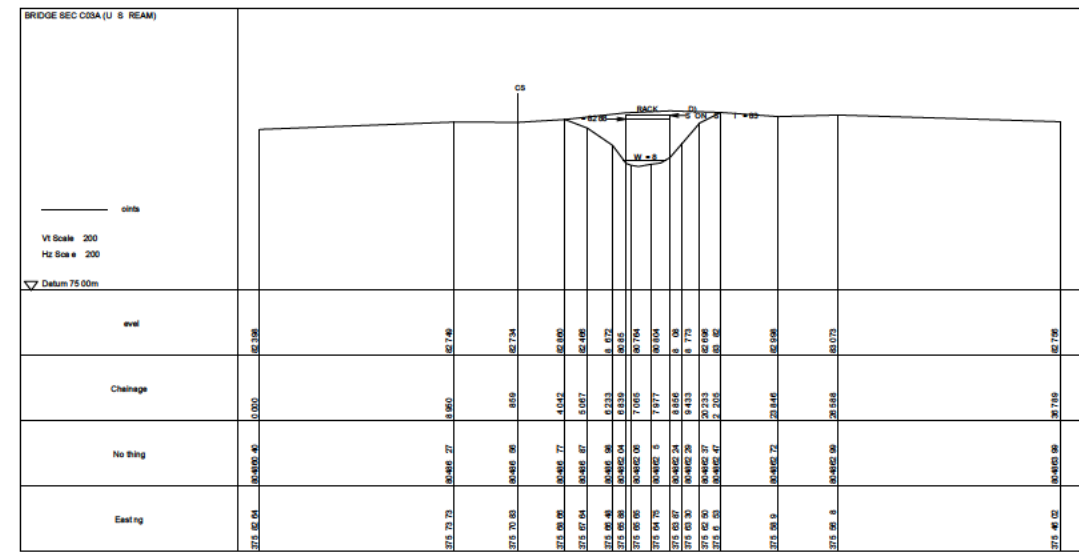
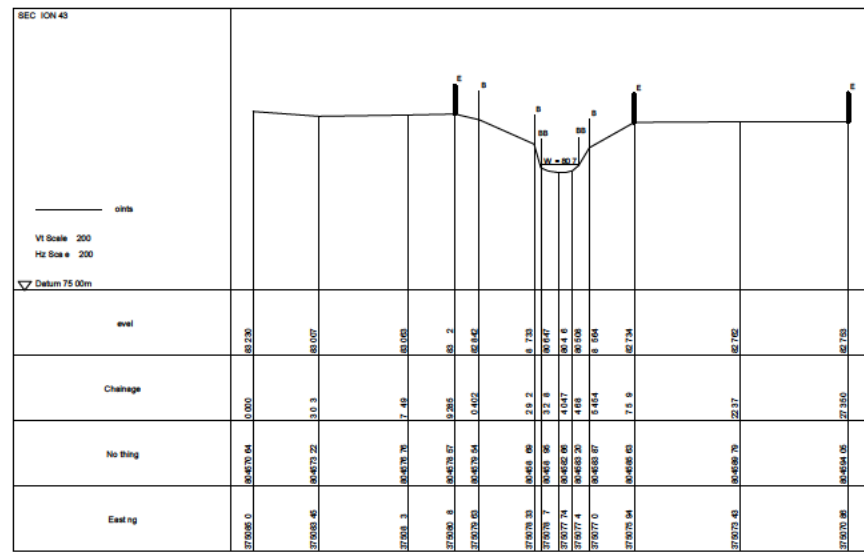
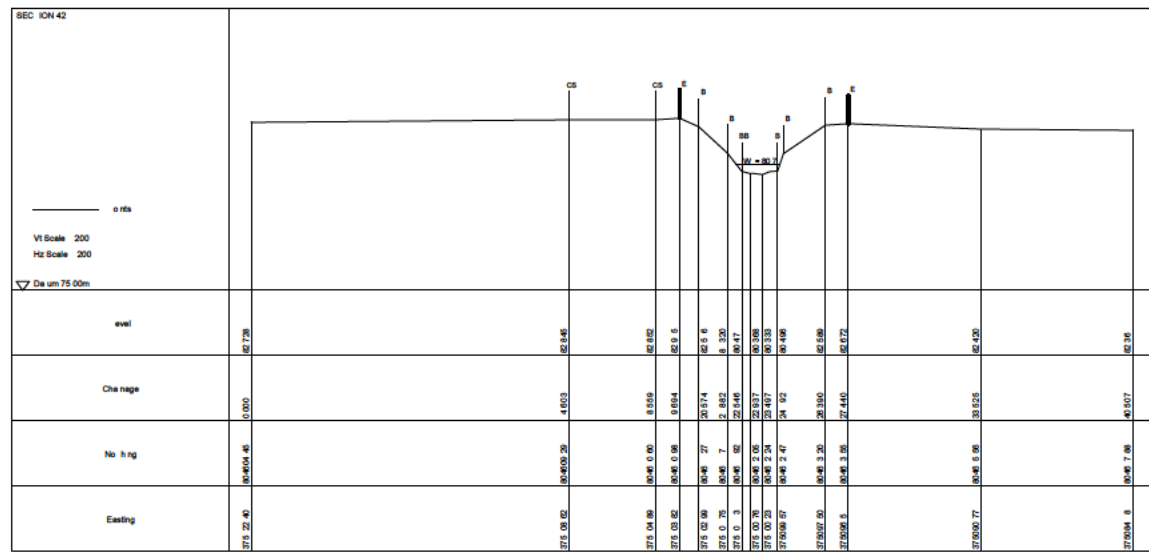
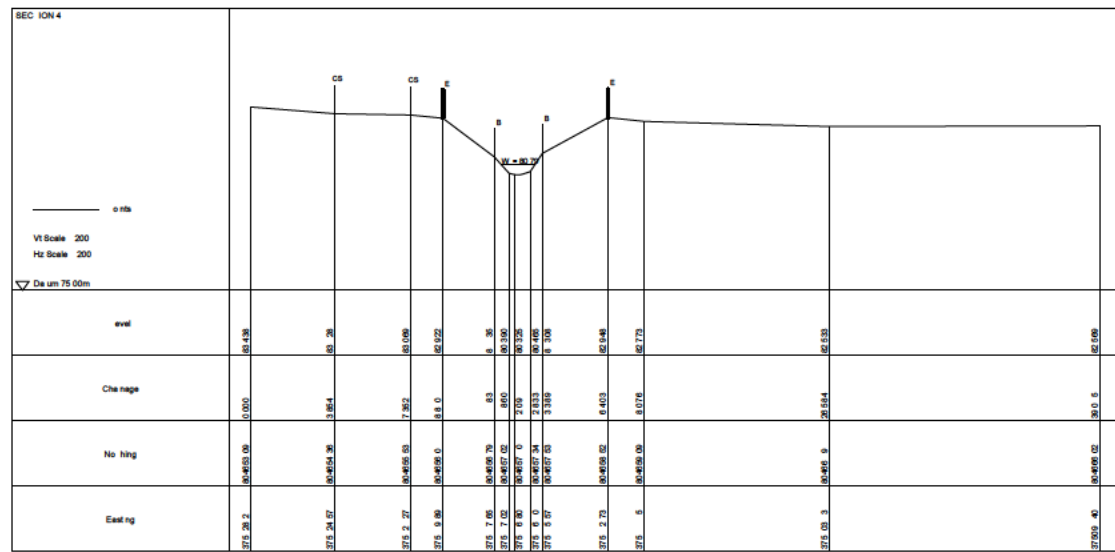
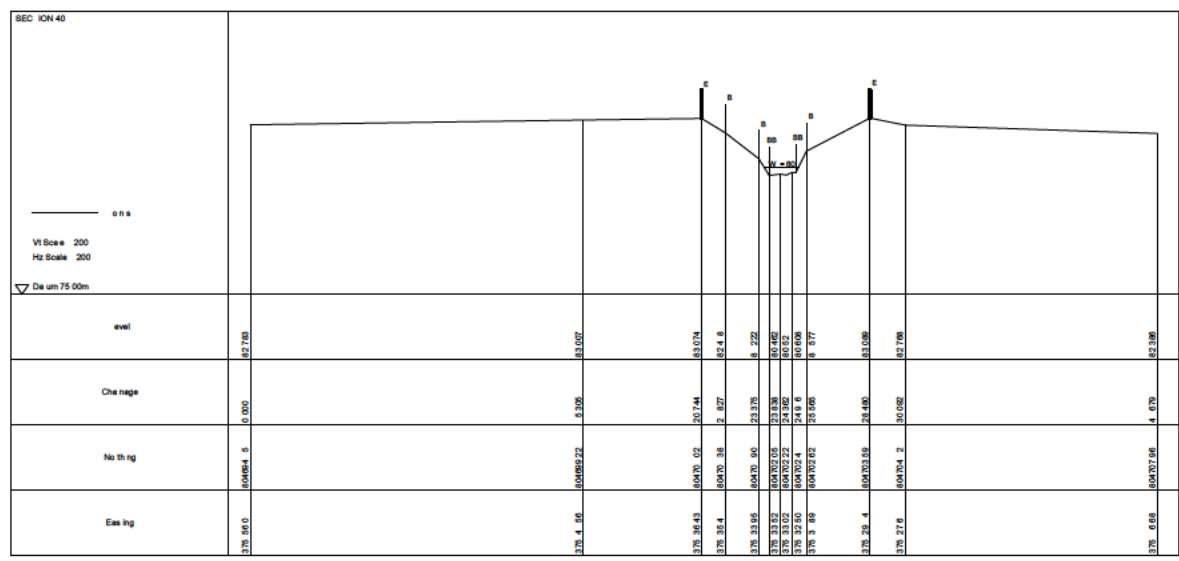
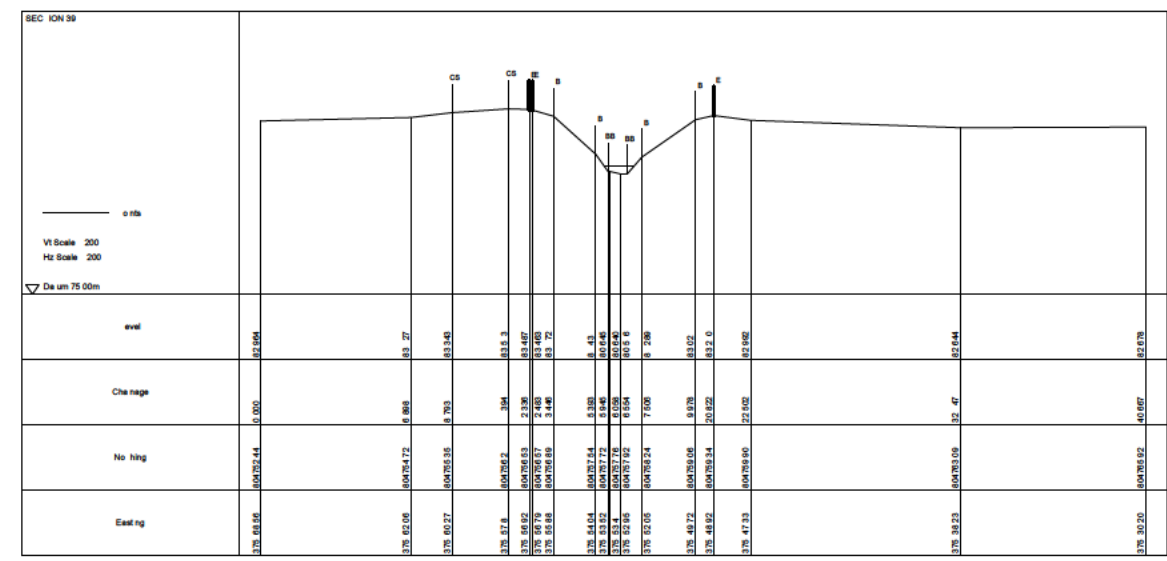
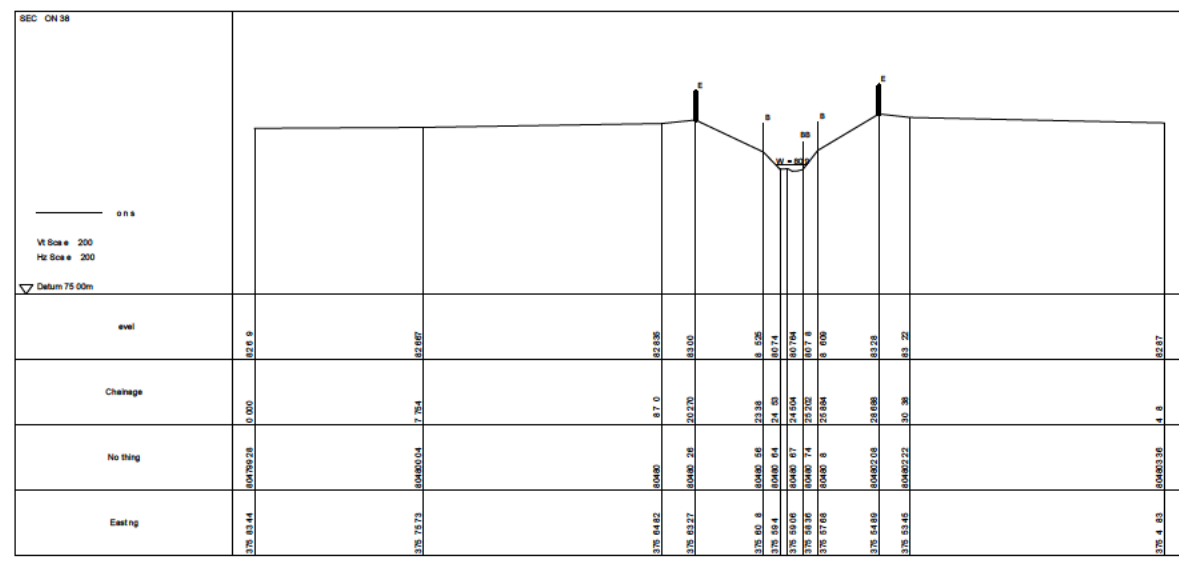
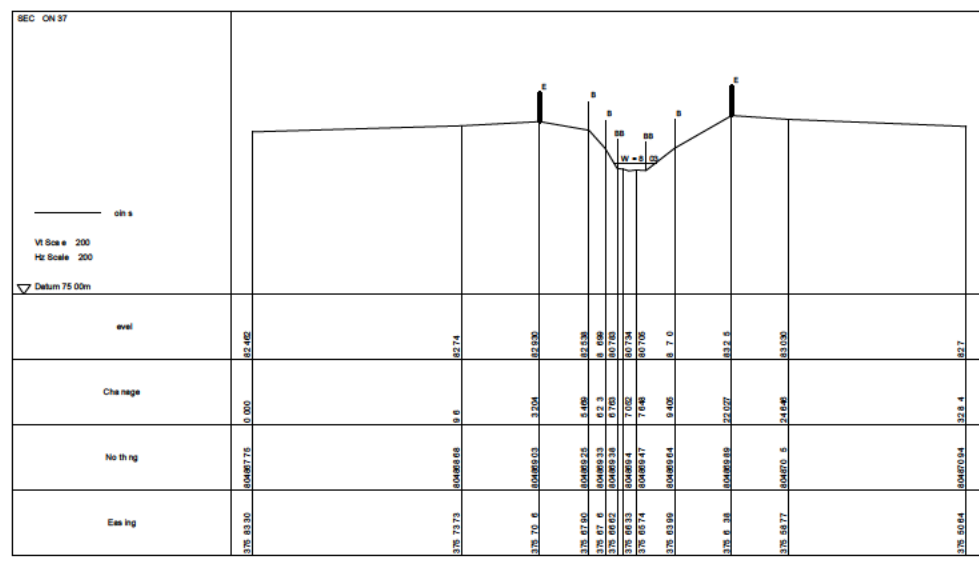
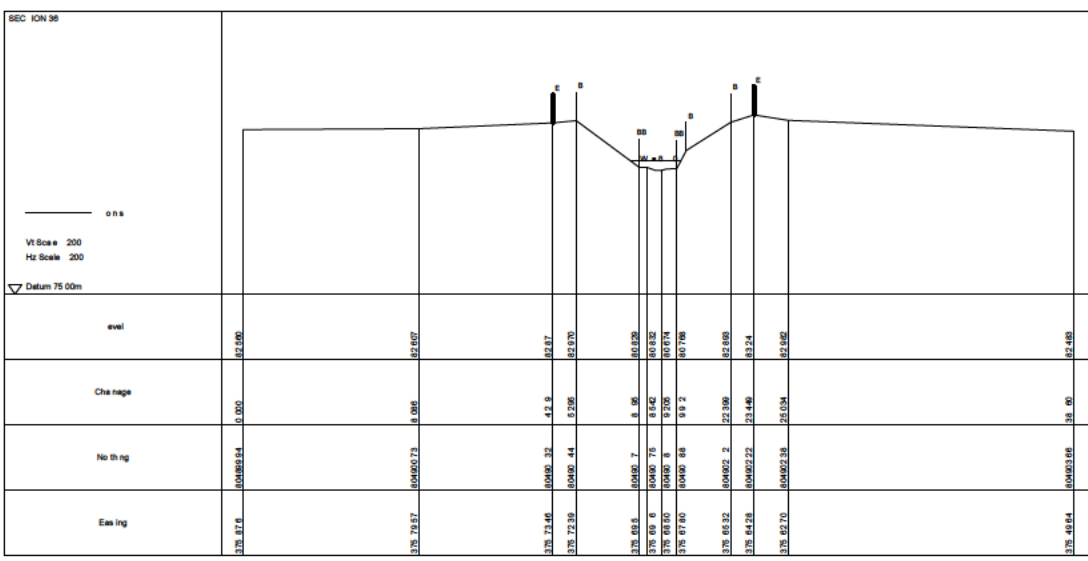
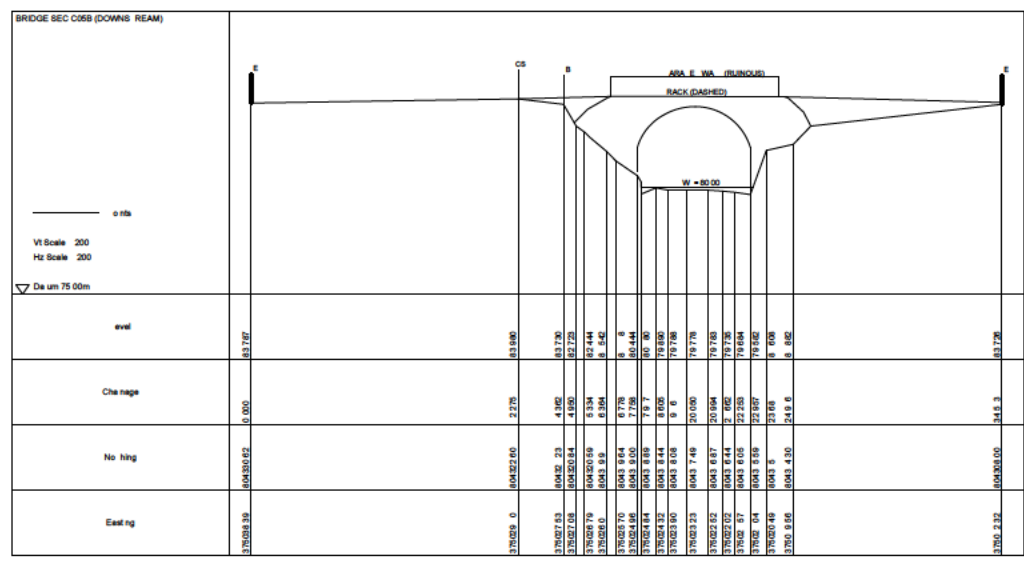
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Title: **HURLIE TO KINTORE  
XU34 & (CLS 37 TO 41)**

Drawn By: L. Nicoll      Scale: 1/500      Date: 23/06/2025

Drawing Number: **6325**      Revision: **01**



## LEGEND

### SYMBOLS

|                 |  |           |  |
|-----------------|--|-----------|--|
| BOREHOLE        |  | STUMP     |  |
| CONTROL STATION |  | TRIAL PIT |  |
| GATE            |  | TREE      |  |
| SERVICE COVER   |  |           |  |

### LINE STYLES

|                    |  |
|--------------------|--|
| BOTTOM OF BANK     |  |
| BUILDING FOOTPRINT |  |
| BUSH CANOPY        |  |
| CHANGE OF SURFACE  |  |
| CHANNEL LINE       |  |
| FENCE              |  |
| HEDGE              |  |
| OVERHEAD WIRES     |  |
| ELECTRIC           |  |
| TELECOM            |  |
| PATH EDGE          |  |
| ROAD CENTRE LINE   |  |
| STRIP GULLY        |  |
| TOP OF BANK        |  |
| TOP OF KERB        |  |
| TREE CANOPY        |  |
| WALL               |  |

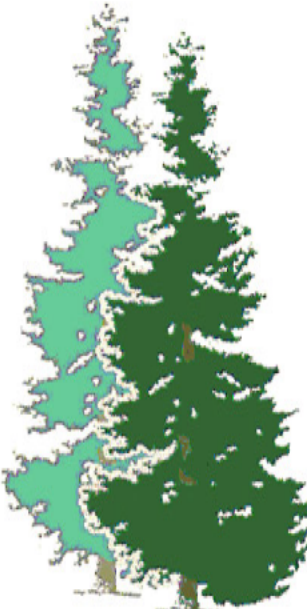
## ABBREVIATIONS

|                            |                          |
|----------------------------|--------------------------|
| AV = AIR VALVE             | LP = LAMPOST             |
| BH = BOREHOLE              | MH = MANHOLE             |
| BOL = BOLLARD              | MKR = MARKER             |
| BOX = ELEC / BT BOX        | PIT = TRIAL PIT          |
| BT = BRITISH TELECOM       | PEG = MARKER PEG         |
| EA = EAVES LEVEL           | RD = RIDGE LEVEL         |
| EC = ELECTRICITY COVER     | RS = ROAD SIGN           |
| EP = ELECTRICITY POLE      | SB = SIGN BOARD          |
| FFL = FINISHED FLOOR LEVEL | SC = STOP COCK           |
| FP = FLAG POLE             | SV = STOP VALVE          |
| G = GULLY                  | TCB = TELEPHONE CALL BOX |
| GAS = BRITISH GAS          | TL = TRAFFIC LIGHT       |
| HY = FIRE HYDRANT          | TOW = TOP OF WALL        |
| IC = INSPECTION COVER      | TP = TELEGRAPH POLE      |
| IL = INVERT LEVEL          | TV = TELEVISION          |
| SG = STRIP GULLY           | WM = WATER METER         |

## NOTES

- GRID IS RELATED TO O.S. GRID
- ALL LEVELS RELATE TO O.S.B.M. ASCERTAINED BY LOGGING G.P.S. DATA
- CONTOURS ARE AT 0.50 (m) INTERVALS
- CONTOURS AT VERTICAL FEATURES ARE INDICATIVE
- LEVELS FOR ROAD ARE TAKEN ALONG CHANNEL LINE
- WHILE EVERY EFFORT HAS BEEN MADE TO LOCATE THE POSITION OF ALL SERVICE COVERS (eg. manholes) IT SHOULD BE NOTED THAT THIS MAY NOT HAVE BEEN POSSIBLE AT THE TIME OF SURVEY DUE TO GROUND COVER OR LOCAL OBSTRUCTIONS.
- ISOLATED MATURE TREES ARE DENOTED BY TRUNK AND ESTIMATED AVERAGE OUTER CANOPY.
- ALL CONTROL STATION COORDINATES SHOULD BE CHECKED AND VERIFIED ON SITE PRIOR TO USE. DOUGLAS LAND SURVEYS SHOULD BE INFORMED OF ANY DISCREPANCIES FOUND.
- OWNERSHIP OF SURVEY DATA REMAINS WITH DOUGLAS LAND SURVEYS, UNTIL INVOICE RELATING TO SUCH DATA HAS BEEN PAID IN FULL.

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|                                                               |                        |                     |
|---------------------------------------------------------------|------------------------|---------------------|
| Title: <b>HURLIE TO KINTORE<br/>XU34 &amp; (CLS 30 TO 41)</b> |                        |                     |
| Drawn By:<br>L. Nicoll                                        | Scale:<br>1/500        | Date:<br>23/06/2025 |
| Drawing<br>Number:<br><b>6325</b>                             | Revision:<br><b>01</b> |                     |

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