PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2012/284/51

Date: 15 October 2021

Queensland Government

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# REPORT

# Teviot Village Concept Stormwater Management Plan and Flood Investigation -

PREPARED FOR VILLA GREEN PTY LTD

16-002518-02C | 22 July 2021

Calibre Professional Services Pty Ltd
ABN 55 070 683 037

PLANS AND DOCUMENTS referred to in the PDA DEVELOPMENT APPROVAL

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**DOCUMENT CONTROL**

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| A | 13.12.2016 | Original Issue | KO | MS (RPEQ 9485) | MS |
| B | 22.06.2021 | Revised bulk-earthworks, stormwater design and development yield | GB, JC, MS | DY | BT (RPEQ 7818) |
| C | 22.07.2021 | Minor change to Lot 9001 | JC | DY | (RPEQ 7818) |

# Executive Summary

Calibre Professional Services Pty Ltd has been commissioned by Villa Green Ltd (the Client) to prepare an update to the Concept Stormwater Management Plan and Flood Investigation previously prepared for the Teviot Village Development located at Pub Lane Greenbank.

The original report (16-002518-02A dated December 2016) was prepared to support the proposed 1,502 lot Teviot Village Development located at Pub Lane Greenbank, within the Greenbank Priority Development Area (PDA) of the Logan City Council (LCC) planning scheme (2015).

Design strategies from the previously approved stormwater management plans by BMD and Hydrology & Water Management Consulting for the site were generally maintained throughout the investigation.

The stormwater management analyses demonstrated that the proposed development will not adversely impact downstream properties with regards to peak flows for the 63% to the 1% Annual Exceedance Probability (AEP) storm events. This was achieved by incorporating flood storage upstream of the proposed waterway crossings to mitigate peak flows.

One-dimensional HEC-RAS flood modelling demonstrated that increases in 1% AEP flood levels were generally constrained to within the site. Flood immunity levels for habitable floors and waterway crossings were also nominated.

For stormwater quality, a strategy comprising bioretention basins and bioretention pods was proposed. ‘At-source’ stormwater quality treatment through bioretention pods located within the road verges throughout the development was adopted in combination with ‘end-of-line’ bioretention basins adjacent to the waterways, with the stormwater drainage network designed to convey the ‘first flush’ of site runoff to end-of-line bioretention basins to complete the stormwater treatment train. MUSIC modelling demonstrated the effectiveness of this stormwater treatment train in achieving the required water quality objectives under the State Planning Policy (SPP, 2016) and the SEQ Water Development Guidelines.

Waterway stability management was addressed by managing 63% AEP flows and flooding along the drainage corridors.

This Concept Stormwater Management Plan and Flood Investigation was approved and the management strategies incorporated into detailed design of the development.

This report (No. 16-002518-02C) has been prepared to provide an update to the flooding and stormwater management strategies now proposed to incorporate development changes, in particular changes to the layout and increase in yield proposed within Stages 7 to 27 (excluding Stages 17 and 18 which were constructed under previous versions of this report).. The analysis and modelling previously undertaken has been updated to identify where changes in the management strategies are required and to confirm that the updated strategies are appropriate in achieving the original peak flow mitigation, flooding and stormwater quality outcomes.

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# 1 Introduction

Calibre Professional Services Pty Ltd has been commissioned by Villa Green Ltd (the Client) to prepare an updated Concept Stormwater Management and Flood Investigation Report to support the proposed changes to the Teviot Village Development located at Pub Lane, Greenbank.

The original Concept Stormwater Management and Flood Investigation Report (No. 16-002518-02A dated December 2016) prepared by Calibre Consulting (now Calibre Professional Services) was prepared to support the Development Application for the proposed Teviot Village Development, located at Pub Lane, within the Greenbank Priority Development Area (PDA) of the Logan City Council (LCC) planning scheme (2015). The development area encompassed by the proposal involved the creation of 1,502 urban residential allotments with associated community facilities, roads and open space areas.

The original report provided flooding and stormwater management analyses and results demonstrating:

- The proposed development would not adversely impact downstream properties with regards to stormwater quantity for the 63% to the 1% Annual Exceedance Probability (AEP) storm events;
- Appropriate flood immunity levels and waterway crossing configurations through one-dimensional hydraulic investigations of the 1% AEP storm event under existing and post-development conditions;
- Relevant Council and State Government requirements with regards to stormwater quality management could be achieved through the provision of Stormwater Quality Improvement Devices (SQIDs) within the development; and
- The stormwater management strategy was effective in achieving the Waterway Stability Management requirements.

This original Concept Stormwater Management Plan and Flood Investigation was subsequently approved and the management strategies incorporated into detailed design of the development.

This report (No. 16-002518-02C) has been prepared to provide an update to the flooding and stormwater management strategies now required to incorporate development changes, in particular changes to the layout and increase in yield proposed within Stages 7 to 27 (excluding Stages 17 and 18 which have already been constructed). Refer to **Appendix A** for details of the updated layout.

The analysis and modelling previously undertake has been updated to identify where changes in the management strategies are required and to confirm that the updated strategies are appropriate in achieving the original peak flow mitigation, flooding and stormwater quality outcomes.

> *This report is generally consistent with the original report. Where changes have been made from the original report these changes are identified as **indented italicised text**, or are noted within the caption of the figure or table.*

## 1.1 Design Objectives

The objectives of the analyses presented in this report are as follows:

- Demonstrate that the development does not result in adverse impacts to downstream or adjacent properties with respect to peak flows. Determine strategies for peak flow mitigation where required.
- Determine the extents of flooding for the western and eastern drainage corridors;
- Determine appropriate flood immunity levels for development areas adjacent to the drainage corridors and demonstrate no increase in maximum 1% AEP flood levels at the downstream boundaries;
- Determine a stormwater quality management strategy to ensure that the development achieves all Water Quality Objectives (WQOs) required under the State Planning Policy (SPP, 2016); and
- Address the waterway stability management required under the SPP (2016).

> *It is noted that the quoted version of the State Planning Policy is no longer current (now SPP 2017 at the time of this report), however the WQOs and waterway stability management requirements with the current version of the policy are consistent with the previous 2016 version. To maintain consistency with the original report, references to the previous version of the SPP remain, yet it is acknowledged that requirements of the current (2017) version will still be met.*

## 1.2 Scope of Works

The scope of works undertaken to address the design objectives are:

- Stormwater Quantity
  - Determine the lawful points of discharge for the site under existing and developed conditions;
  - Undertake analysis to determine which discharge points require peak flow mitigation to ensure all modelled storm events (63% to 1% AEP) are non-worsening; and
  - Develop a strategy to achieve the required peak flow mitigation.
- Local Flooding
  - Undertake one-dimensional HEC-RAS analyses to determine the existing flood conditions through the drainage corridors for the 1% AEP storm event;
  - Undertake analyses to determine the post-development flood conditions for the 1% AEP storm event;
  - Undertake sensitivity scenarios with a higher Manning's n value, and culvert blockage scenarios; and
  - Nominate flood immunity levels in accordance with the relevant LCC planning scheme policy.
- Stormwater Quality:
  - Develop a stormwater quality and total water cycle management strategies incorporating SQIDs; and
  - Model the SQIDs using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to determine their effectiveness in achieving the identified WQOs.
- Waterway Stability Management
  - Develop strategies to satisfy waterway stability management requirements as required under the SPP (2016).

*Please note that while development has commenced, the use of the term 'existing' is still made throughout this report in reference to pre-development conditions.*

## 1.3 Previous Documentation

The following stormwater management plans have previously been completed for the site:

- BMD Consulting (2009), *Storm Water Management Plan for Teviot Downs Estate North of Pub Lane*;
- BMD Consulting (2009), *Watercourse Flood Investigation for Teviot Estate North of Pub Lane*; and
- Hydrology & Water Management Consulting (HWMC) (2012), *Teviot Village Stormwater Management Plan J00110R1V2*.

The primary design strategies and assumptions presented within the above reports have been adopted for this investigation. Reference to these previous reports has been made where applicable.

*Reference is also made to the original report and technical memo previously prepared:*

- *Calibre Consulting (2016), Teviot Village Concept Stormwater Management Plan and Flood Investigation (Report No. 16-002518-02A);*
- *Calibre Professional Services (2020), Technical Memo – Teviot Village (Ref No. 18-001032_TM_01).*

# 2 Site Characteristics

## 2.1 Location

The site is located within the Logan City Council (LCC) local government area. **Figure 2.1** provides an aerial view of the site, which encompasses an area of approximately 153ha.

> *Prior to commencement of development the real property description for the site was Lot 9968 on SP163061. This parcel has now been subdivided as part of the development.*

The site is bound by the Brisbane to Sydney Railway line to the east, the Teviot Downs soccer club to the west and rural residential properties along the remaining boundaries.

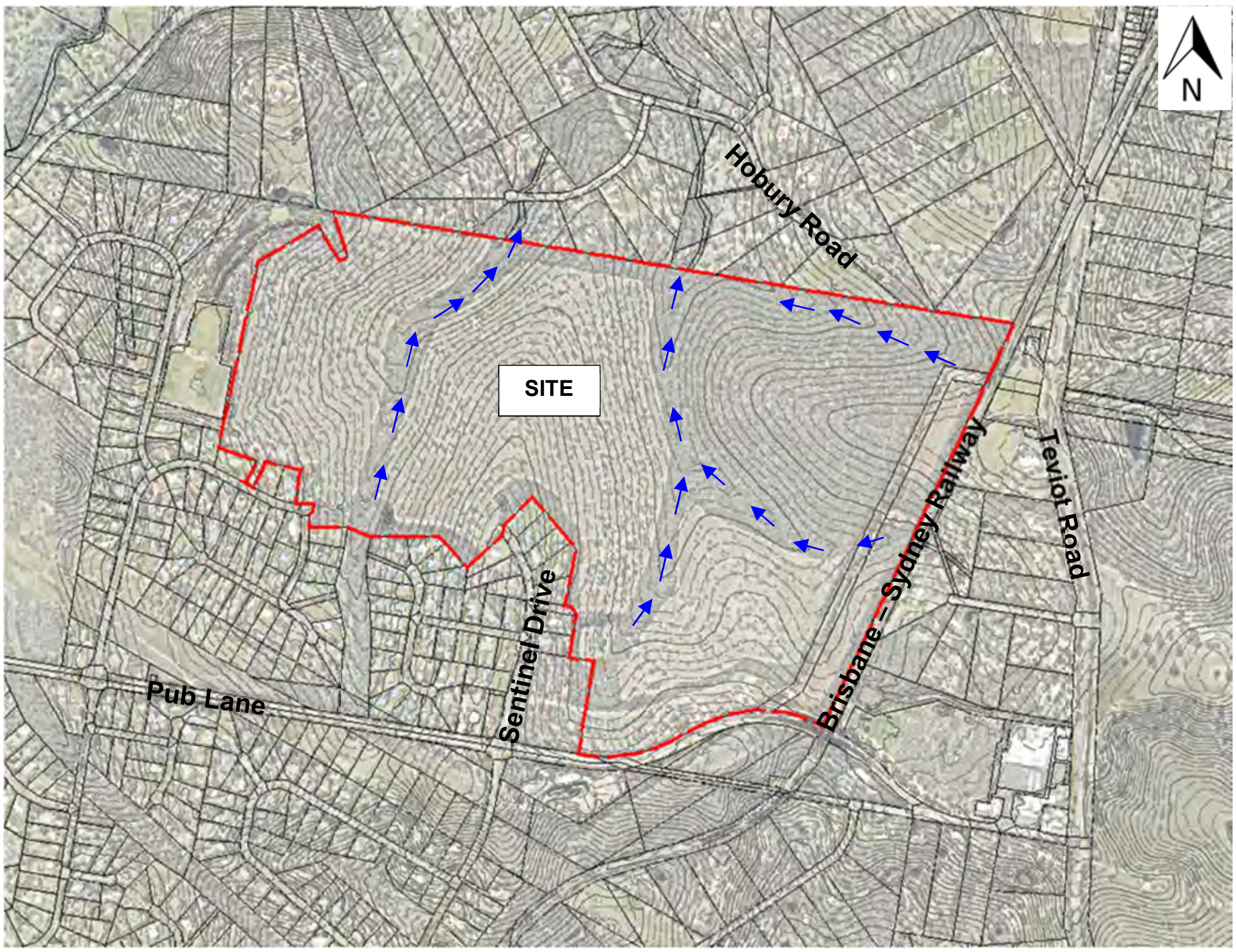



Figure 2.1: Site Location (Source: Nearmap)

## 2.2 Land Use

The existing site is undeveloped with multiple drainage corridors and vegetation as illustrated in **Figure 2.1**. Easements containing water, communications and overhead electricity traverse the eastern boundary of the site.

The proposed development will consist of predominately urban residential land use, with open space areas, parks, and sports fields included.

## 2.3 Existing Topography, Drainage & Flooding

The existing topography of the site varies from RL 75.5m AHD at Sentinel Drive to the south down to RL48.25m AHD at the northern property boundary. Under existing conditions, two drainage corridors traverse the site from south to north as shown in **Figure 2.1**. There are a number of local gullies within the site that connect to these main drainage paths.

The site ultimately discharges to Oxley Creek downstream of New Beith Road. The overland drainage paths within the site are illustrated within LCC's Flood Hazard Overlay mapping. Oxley Creek flooding is not expected to have any impact on downstream tailwater conditions for the extent of the current investigation area.

There is no municipal drainage infrastructure nor private underground stormwater pipes on the site. The runoff under existing conditions follows the topography and discharge to the north.

# 3 Stormwater Quantity

A peak flow analysis has been undertaken using hydrological modelling software (XP-RAFTS). This section investigates peak flow discharges at the external perimeter of the site, as well as downstream from the site to ensure that no adverse impacts occur as a result of the proposed Teviot Village development.

Hydrological modelling has been undertaken for the 63%, 39%, 20%, 10%, 5%, 2% and 1% AEP storm events. In order to quantify the magnitude of peak flow increases due to the proposed development, the following scenarios have been analysed:

- **Existing Scenario** represents the hydrology for the catchment under existing conditions. Catchment parameters (i.e. infiltration loss and lag parameter values) were adopted as per HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012). Peak flow results determined in this scenario were compared with developed peak flow results to assess the change in peak flows at site discharge locations.

- **Developed Unmitigated Scenario** represents the hydrology for the catchment under proposed development conditions with no mitigation measures. Peak flow discharge to the downstream site boundary and locations along the downstream waterway have been considered in the analysis to quantify changes in site discharge.

- **Developed Mitigated Scenario** represents the hydrology for the catchment under proposed development conditions with mitigation measures. Peak flow discharge to the downstream site boundary and locations along the downstream waterway have been considered in the analysis. Proposed mitigation strategies have been presented to ensure no increase in peak flow discharge at site's northern boundary.

The proposed mitigation strategy presented within HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012) has been adopted. This strategy proposes the use of planned road crossings and flood storage capacity within the natural drainage corridors as mitigation. Hydraulic investigations in **Section 4** of this report provide flood immunity levels for the proposed development.

*Updates have been made to the XP-RAFTS hydrological modelling for the Developed Unmitigated and Developed Mitigated scenarios to account for the changes in development layout and yield since the original report. Changes to the configuration of road crossings and associated upstream flood storages have also been made where required in order to maintain no increases in peak flow downstream.*

*No changes have been made to the existing scenario model or model parameters previously adopted.*

## 3.1 XP-RAFTS Model Parameters

Hydrological modelling for this investigation has incorporated the previously approved design strategy and assumptions presented within HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012). Although catchment areas between Calibre and HWMC's previous analysis differ slightly due to the use of updated survey information, HWMC's assumptions of Manning's roughness, Impervious Percentage, vectored slope, link lagging and rainfall loss parameters have been adopted.

The 1% AEP peak flow was verified against the Rational Method Calculation in HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012). No further calibration or verification has been undertaken by Calibre. The existing scenario peak flow results presented in **Section 3.2.4** are similar to results presented within HWMC's report.

General XP-RAFTS parameters adopted in accordance with HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012) are provided in **Table 3.1**.

Table 3.1: XP-RAFTS Calibration Parameter Summary

| XP-RAFTS Model Parameter | Value |
|---|---|
| Storage multiplication co-efficient (Bx) | 1.3 |
| Pervious Initial Rainfall Loss (mm) | 5 |
| Pervious Continuing Rainfall Loss (mm/hr) | 2.5 |
| Impervious Initial Rainfall Loss (mm) | 1 |
| Impervious Continuing Rainfall Loss (mm/hr) | 0 |
| Pervious Manning's 'n' Roughness Value | 0.045 |
| Impervious Manning's 'n' Roughness Value | 0.025 |

## 3.2 Existing Scenario

The existing scenario was undertaken to determine peak flows discharging from the site under existing conditions.

### 3.2.1 Catchment Characteristics

Existing scenario catchments were delineated based on survey and aerial information. As previously mentioned, catchment areas differ slightly to those presented in previous reports due to updated survey information.

Catchments were split into pervious and impervious sub-catchments within XP-RAFTS. Site catchment impervious areas were retained as per HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012). Vectored slope values were adopted as per the previous HWMC stormwater management plan for all site catchments. Catchment parameters for additional investigation areas included within this analysis (such as downstream external catchments downstream) were calculated based on client supplied survey.

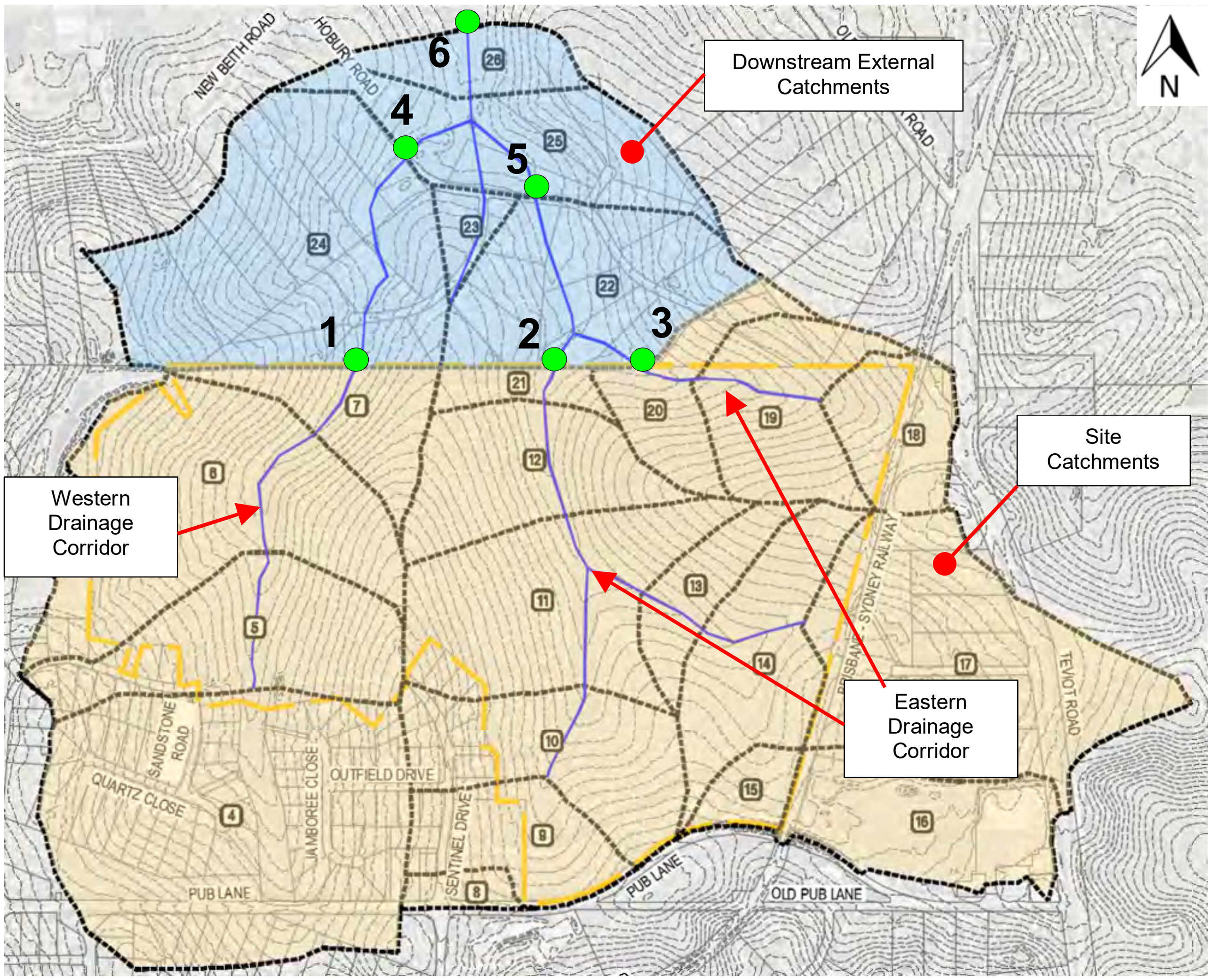



Figure 3.1: Existing Scenario XP-RAFTS Catchment Layout

A summary of the existing catchment details is provided in **Table** 3.2. Refer to Drawing No. 16-002518-SK10 in **Appendix D** for existing catchment layout details.

Table 3.2: Existing Scenario Catchment Details

| Catchment | Catchment Area (ha) | Impervious Percentage | Vectored Slope (%) |
|---|---|---|---|
| Site Catchments | | | |
| 4 | 46.59 | 9.8 | 3.6 |
| 5 | 18.39 | 5.2 | 3.6 |
| 6 | 31.19 | 3.75 | 3.6 |
| 7 | 8.51 | 0.01 | 4.8 |
| 8 | 2.1 | 27.76 | 4.5 |
| 9 | 9.86 | 2.16 | 5.1 |
| 10 | 15.79 | 1.99 | 5.3 |
| 11 | 22.91 | 0.4 | 5.3 |
| 12 | 14.43 | 0.01 | 5.5 |
| 13 | 6.18 | 0.02 | 4 |
| 14 | 14.44 | 0.01 | 3.6 |
| 15 | 3.35 | 0.03 | 2.5 |
| 16 | 14.87 | 13.7 | 1.7 |
| 17 | 32.95 | 4.81 | 1.9 |
| 18 | 8.48 | 1.86 | 4 |
| 19 | 12.98 | 1.03 | 5.2 |
| 20 | 8.84 | 0.01 | 5.7 |
| 21 | 3.18 | 0 | 5.5 |
| Downstream External Catchments | | | |
| 22 | 20.2 | 10 | 2.6 |
| 23 | 2.58 | 10 | 3 |
| 24 | 36.32 | 10 | 3.2 |
| 25 | 16.48 | 10 | 2.5 |
| 26 | 6.2 | 5 | 3.6 |

### 3.2.2 Channel Routing

Routing of upstream catchments through downstream drainage paths was simulated in XP-RAFTS using 'link lagging'. Site link lag times were adopted from BMD Consulting's Storm Water Management Plan for Teviot Downs Estate North of Pub Lane (2009).

Calculation of lag times for external downstream catchments was undertaken using flowpath length of the downstream catchment and assuming an average channel velocity of 1.0m/s.

### 3.2.3 Rainfall Data

Rainfall IFD data provided within Appendix C of HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012) was applied in XP-RAFTS using the automatic storm generator. **Table 3.3** summarises the IFD data utilised in this analysis.

Table 3.3: Rainfall IFD Input Data (AR&R)

| $^{2}I_{1}$ | $^{2}I_{12}$ | $^{2}I_{72}$ | $^{50}I_{1}$ | $^{50}I_{12}$ | $^{50}I_{72}$ | F2 | F50 | G |
|---|---|---|---|---|---|---|---|---|
| 45.66 | 7.55 | 2.2 | 85.96 | 15.25 | 4.76 | 4.39 | 17.15 | 0.15 |

*An assessment of rainfall intensities between those initially adopted (as determined using the input data presented in **Table 3.3**) and intensities sourced from the Bureau of Meteorology Design Rainfall Data System (2016) web page was undertaken. The comparison found the intensities initially adopted to be higher (on average by 5mm/hr) than the 2016 intensities for storm durations between 30 and 180 minutes  Based on this comparison the input data used to generate rainfall intensities as summarised in **Table 3.3** was considered to be appropriate for the updated modelling.*

### 3.2.4 Existing Peak Flow Results

Modelling was undertaken for the all storm events up to and including the 1% AEP storm event with a storm duration of 60-minutes (this was the critical duration for the investigation area). Peak flow results for the existing scenario have been provided in **Table 3.4** at the site discharge locations, and downstream locations as depicted in **Figure 3.1**.

Table 3.4: Existing Peak Flow Results

| | Peak Flow Discharge at Point Location ($m^3/s$) | | | | | |
|---|---|---|---|---|---|---|
| AEP (%) | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| 63 | 5.33 | 8.25 | 2.41 | 6.85 | 11.61 | 19.70 |
| 39 | 7.87 | 12.05 | 3.51 | 10.18 | 16.95 | 28.89 |
| 20 | 11.19 | 16.98 | 4.94 | 14.60 | 23.93 | 40.72 |
| 10 | 13.31 | 20.07 | 5.83 | 17.38 | 28.26 | 48.14 |
| 5 | 16.26 | 24.32 | 7.06 | 21.25 | 34.26 | 58.45 |
| 2 | 20.09 | 29.49 | 8.49 | 26.25 | 41.54 | 71.33 |
| 1 | 23.34 | 34.02 | 9.79 | 30.48 | 47.93 | 82.41 |

The peak flows at Points 1, 2 and 3 as presented in **Table 3.4** are generally consistent with the existing scenario peak flows determined by HWMC at the same locations. Refer to HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012).

## 3.3 Developed Unmitigated Scenario

The developed unmitigated scenario was modelled to demonstrate variances in peak flow as a result of the proposed development.

### 3.3.1 Catchment Characteristics

*Updated developed scenario catchments were delineated based on current bulk earthwork designs and the new development layout. Refer to Drawing No. 16-002518-SK11 in **Appendix D** for developed scenario catchment delineation.*

*With the new development layout providing a detailed breakdown of road, lot, park and reserve areas, the impervious percentage assumptions were updated to account for these surface types and land uses. The values used to determine the overall impervious percentage for each catchment containing development is provided in **Table 3.5**.*

Table 3.5: Developed Scenario Land Use Impervious Percentage

| Land use | Impervious Percentage |
|---|---|
| Road Reserve | 90% |
| Development Roofs (assumed 215$m^2$ per development allotment) | 100% |
| Development Ground within Allotments | 25% |
| Park (formal) | 20% |
| Remaining development areas of the site (i.e. lots and road reserve) | 65% |

*The impervious percentage and vectored slope of undeveloped and external catchment areas remains consistent with the existing scenario. All development areas have adopted a vectored slope of 4% as bulk earthworks grading varies from 3% to 5%. A summary of the developed catchment details is provided in **Table 3.6**.*

Table 3.6: Developed Scenario Catchment Details

| Catchment | Catchment Area (ha) | Impervious Percentage | Vectored Slope (%) |
|---|---|---|---|
| Site Catchments | | | |
| 4 | 46.27 | 9.8 | 3.6 |
| 5A | 4.93 | 38.64 | 4 |
| 5D | 8.42 | 36.34 | 4 |
| 5E | 1.08 | 0 | 3.6 |
| 5F | 6.28 | 10 | 3.6 |

| Catchment | Catchment Area (ha) | Impervious Percentage | Vectored Slope (%) |
|---|---|---|---|
| 5C | 4.79 | 21.32 | 4 |
| 5B | 2.71 | 0.04 | 3.6 |
| 6A | 4.07 | 16.27 | 3.6 |
| 7B3 | 2.05 | 45.76 | 3.6 |
| 6B | 10.87 | 49.76 | 4 |
| 6D | 1.02 | 0 | 4 |
| 6C | 0.89 | 48.85 | 4 |
| 7B | 8.32 | 52.53 | 3 |
| 7A | 3.73 | 0.03 | 4.8 |
| 8 | 2.1 | 27.76 | 4.5 |
| 9A | 5.86 | 59.84 | 5.1 |
| 9C | 4.94 | 15 | 5.1 |
| 9B | 3.23 | 23.22 | 5.1 |
| 10 | 1.94 | 0.05 | 5.3 |
| 11B | 9.93 | 59.43 | 4 |
| 21A | 2.05 | 37.68 | 4 |
| 11B1 | 2.44 | 10 | 4 |
| 16 | 14.87 | 13.7 | 1.7 |
| 15 | 2.38 | 0.03 | 2.5 |
| 17 | 32.95 | 4.81 | 1.9 |
| 14C | 5.53 | 82.32 | 4 |
| 14B | 3.42 | 0 | 4 |
| 14A | 6.37 | 0.02 | 3.6 |
| 13 | 1.18 | 0.09 | 4 |
| 11C3 | 5.35 | 0 | 4 |
| 11D | 12.18 | 79.28 | 4 |
| 11A | 5.05 | 1.44 | 5.3 |
| 12B | 7.07 | 0 | 4 |
| 12A | 3.19 | 10.68 | 5.5 |
| 11C1 | 6.2 | 0 | 4 |
| 20B | 8.43 | 0 | 4 |
| 19A | 6.56 | 1.03 | 5.2 |
| 12D | 2.82 | 0.04 | 5.5 |
| 18 | 9.22 | 1.86 | 4 |
| 20A | 3.92 | 0.01 | 5.7 |
| Downstream External Catchments | | | |
| 22 | 20.2 | 10 | 2.6 |
| 23 | 2.58 | 10 | 3 |
| 24 | 36.32 | 10 | 3.2 |
| 25 | 16.48 | 10 | 2.5 |
| 26 | 6.2 | 5 | 3.6 |

### 3.3.2 Infiltration Loss & Lag Parameters

The same infiltration loss and lag parameter values were adopted as per the existing scenario (refer to **Section 3.1**), which are consistent with HWMC's Stormwater Management Plan (Report No. J00110R1V2 dated 5 July 2012).

### 3.3.3 Channel Routing

Channel routing (XP-RAFTS Link Routing) was modelled as per the existing scenario presented in **Section 3.2.2**. Any new flow paths created in the developed scenario were calculated using the methodology presented.

### 3.3.4 Rainfall Data

Rainfall data was generated as per the existing scenario in **Section 3.2.3**.

### 3.3.5 Developed Unmitigated Peak Flow Results

Modelling was undertaken for the all standard storm events up to and including the 1% AEP storm event with a storm duration of 60-minutes (this was the critical duration for the investigation area). Peak flow results for the developed unmitigated scenario have been provided in **Table 3.7** at the site discharge locations, and downstream locations as depicted in **Figure 3.1**.

Table 3.7: Developed Unmitigated Peak Flow Results

| | Peak Flow Discharge at Point Location ($m^3/s$) | | | | | |
|---|---|---|---|---|---|---|
| AEP (%) | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| 63 | 7.32 | 10.2 | 2.26 | 8.89 | 13.3 | 23.24 |
| 39 | 10.18 | 14.41 | 3.28 | 12.59 | 19.04 | 33.36 |
| 20 | 14.09 | 19.78 | 4.61 | 17.63 | 26.4 | 46.47 |
| 10 | 16.55 | 23.08 | 5.43 | 20.8 | 30.94 | 54.64 |
| 5 | 19.96 | 27.6 | 6.56 | 25.2 | 37.17 | 65.91 |
| 2 | 23.81 | 32.74 | 7.88 | 30.36 | 44.38 | 79.12 |
| 1 | 27.42 | 37.43 | 9.09 | 35.08 | 50.87 | 91.05 |

**Table 3.8** presents the variance in peak flow compared to the existing scenario.

Table 3.8: Developed Unmitigated Peak Flow Variance

| | Peak Flow Discharge at Point Location ($m^3/s$) | | | | | |
|---|---|---|---|---|---|---|
| AEP (%) | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| 63 | 37.3% | 23.6% | -6.2% | 29.8% | 14.6% | 18.0% |
| 39 | 29.4% | 19.6% | -6.6% | 23.7% | 12.3% | 15.5% |
| 20 | 25.9% | 16.5% | -6.7% | 20.8% | 10.3% | 14.1% |
| 10 | 24.3% | 15.0% | -6.9% | 19.7% | 9.5% | 13.5% |
| 5 | 22.8% | 13.5% | -7.1% | 18.6% | 8.5% | 12.8% |
| 2 | 18.5% | 11.0% | -7.2% | 15.7% | 6.8% | 10.9% |
| 1 | 17.5% | 10.0% | -7.2% | 15.1% | 6.1% | 10.5% |

Comparisons provided in **Table 3.8** presents the variance in peak flow compared to the existing scenario.

**Table 3.8** shows that peak flow generated from the site is increased following the proposed development. Reductions in peak flow for the 63% to the 1% AEP storm events occur at Point 3 due to a reduction in contributing catchment area.

Due to increases in peak flow at the site boundary, and downstream catchment locations, peak flow mitigation is proposed for the development.

## 3.4 Developed Mitigated Scenario

The developed mitigated scenario was undertaken to demonstrate no adverse impacts in peak flow discharge as a result of the development incorporating the proposed mitigation measures. The proposed mitigation strategy utilises waterway crossings as shown on Drawing No. 16-002518-SK12 in **Appendix D**.

### 3.4.1 Proposed Mitigation Measures

The proposed mitigation strategy for the Teviot Village development is to utilise existing flood storage within the drainage corridor and control peak flows through cross drainage. Four crossing locations are proposed for the development which include three vehicular crossings and one pedestrian / bike crossing. The proposed vehicular and pedestrian crossings will be flood immune to the 10% AEP storm event, while vehicular crossings may have overtopping during the rarer events with flow depths no greater than 300mm above the top of road embankment at the sag, and depth-velocity products below 0.3 m2/s for storm events up to and including the 1% AEP storm. Where possible, vehicular crossings are designed such that no overtopping occurs for design storm events up to and including the 1% AEP event. Where overtopping occurs during events exceeding the 10% AEP design storm, the maximum depth and depth-velocity products are within limitations specified within QUDM (2017)..

The following sections discuss the modelling of mitigation strategies.

## Western Drainage Corridor Crossing

***Table 3.9*** *provides details of the updated detention parameters at the western drainage crossing as modelled in XP-RAFTS. Refer to Drawing No. 16-002518-SK12 in* ***Appendix D*** *for the location and conceptual crossing details.*

Table 3.9: Western Drainage Corridor Crossing A

| Detention Parameter | Western Crossing Detention |
|---|---|
| Detention Volume to Embankment | 10,216m$^3$ |
| Crossing Embankment Level (m AHD) | 57.15 |
| Primary Outlet | 1 x 1200mm x 600 RCBC at RL 54.50m AHD |
| Secondary Outlet | 1 x 2400mm x 900 RCBC at RL 56m AHD |

*The stage-storage discharge relationship adopted for the western detention storage was generated from surface model for the western drainage corridor incorporating existing survey and design surfaces. The adopted stage-storage-discharge curve is provided in* ***Table 3.10****.*

Table 3.10: Western Drainage Corridor Crossing A Stage Storage Discharge Relationship

| Stage (m AHD) | Accumulated Storage (m$^3$) | Discharge (m$^3$/s) | Detention Arrangement |
|---|---|---|---|
| 54.50 | 0 | 0.00 | Primary Outlet |
| 54.60 | 0 | 0.07 | |
| 54.70 | 1 | 0.18 | |
| 54.80 | 3 | 0.34 | |
| 54.90 | 6 | 0.52 | |
| 55.00 | 11 | 0.72 | |
| 55.10 | 22 | 0.95 | |
| 55.20 | 43 | 1.20 | |
| 55.30 | 78 | 1.46 | |
| 55.40 | 139 | 1.57 | |
| 55.50 | 237 | 1.68 | |
| 55.60 | 382 | 1.78 | |
| 55.70 | 579 | 1.87 | |
| 55.80 | 833 | 1.97 | |
| 55.90 | 1139 | 2.06 | |
| 56.00 | 1497 | 2.14 | Secondary Outlet |
| 56.10 | 1915 | 2.36 | |
| 56.20 | 2392 | 2.68 | |
| 56.30 | 2925 | 3.07 | |
| 56.40 | 3515 | 3.51 | |
| 56.50 | 4162 | 4.00 | |
| 56.60 | 4877 | 4.53 | |
| 56.70 | 5671 | 5.10 | |
| 56.80 | 6546 | 5.71 | |
| 56.90 | 7493 | 6.35 | |
| 57.00 | 8511 | 7.02 | |
| 57.10 | 9618 | 7.72 | |
| 57.15 | 10216 | 8.36 | Top of Embankment Level (57.15) |
| 57.20 | 10814 | 9.00 | |
| 57.30 | 12083 | 11.67 | |
| 57.40 | 13431 | 15.33 | |
| 57.50 | 14779 | 18.99 | |

The upstream Water Surface Levels (WSLs) for all AEP design storm events are summarised in **Table 3.11**.

Table 3.11: Developed Mitigated Scenario Western Crossing A WSLs

| AEP (%) | WSL (m AHD) |
|---|---|
| 63 | 56.38 |
| 39 | 56.67 |
| 20 | 56.96 |
| 10 | 57.11 |
| 5 | 57.25 |
| 2 | 57.35 |
| 1 | 57.41 |

*Results indicate that the crossing will only overtop in the 5%, 2% and 1% AEP event, however the depth of overtopping is lower than 270mm and depth velocity products expected to be less than 0.23m$^2$/s.*

## Eastern Drainage Corridor Crossing A

***Table 3.12** provides details of the updated eastern drainage corridor crossing A detention parameters modelled in XP-RAFTS. This crossing is located on tributary 630 of the eastern drainage corridor. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for crossing details. It is noted that while invert levels have changed the number and type of culvert conduits has not. This crossing has already been constructed.*

Table 3.12: Eastern Drainage Corridor Crossing A

| Detention Parameter | Eastern Crossing A Detention |
|---|---|
| Detention Volume to Embankment Level | 16,210m$^3$ |
| Crossing Embankment Level (m AHD) | 56.90m |
| Primary Outlet Pipes | 5 x 1800mm x 600mm RCBC at RL 54.20m AHD |

*The stage-storage discharge relationship adopted for the proposed detention storage was generated from surface model for the eastern drainage corridor incorporating existing survey and design surfaces. The adopted stage-storage-discharge curve is provided in **Table 3.13**.*

Table 3.13: Eastern Drainage Corridor A Crossing Stage Storage Discharge Relationship

| Stage (m AHD) | Accumulated Storage (m$^3$) | Discharge (m$^3$/s) | Detention Arrangement |
|---|---|---|---|
| 54.2 | 0 | 0.00 | Primary Outlet |
| 54.3 | 5 | 0.49 | |
| 54.4 | 27 | 1.37 | |
| 54.5 | 77 | 2.52 | |
| 54.6 | 159 | 3.88 | |
| 54.7 | 279 | 5.42 | |
| 54.8 | 442 | 7.13 | |
| 54.9 | 650 | 8.98 | |
| 55 | 899 | 10.97 | |
| 55.1 | 1192 | 11.78 | |
| 55.2 | 1532 | 12.56 | |
| 55.3 | 1924 | 13.31 | |
| 55.4 | 2366 | 14.04 | |
| 55.5 | 2859 | 14.74 | |
| 55.6 | 3404 | 15.42 | |
| 55.7 | 4034 | 16.08 | |
| 55.8 | 4746 | 16.73 | |
| 55.9 | 5514 | 17.36 | |
| 56 | 6332 | 17.98 | |
| 56.1 | 7204 | 18.58 | |
| 56.2 | 8133 | 19.17 | |
| 56.3 | 9119 | 19.75 | |
| 56.4 | 10161 | 20.32 | |
| 56.5 | 11258 | 20.88 | |
| 56.6 | 12413 | 21.42 | |
| 56.7 | 13625 | 21.96 | |
| 56.8 | 14891 | 22.50 | |
| 56.9 | 16210 | 23.13 | Top of Embankment Level (56.90) |

The upstream WSLs for all AEP design storm events are summarised in **Table 3.14**.

Table 3.14: Developed Mitigated Scenario Eastern Crossing A WSLs

| AEP (%) | WSL (m AHD) |
|---|---|
| 63 | 54.56 |
| 39 | 54.66 |
| 20 | 54.78 |
| 10 | 54.84 |
| 5 | 54.93 |
| 2 | 55.05 |
| 1 | 55.26 |

*Results indicate that the crossing is not overtopped in the 1% AEP storm event, with over 1m of freeboard.*

## Eastern Drainage Corridor Crossing B

***Table 3.15** provides details of the updated eastern drainage corridor crossing B detention parameters modelled in XP-RAFTS. This vehicular crossing is located on tributary 0 of the eastern drainage corridor. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for crossing details.*

Table 3.15: Eastern Drainage Corridor Crossing B

| Detention Parameter | Eastern Crossing B Detention |
|---|---|
| Detention Volume to Embankment Level | 44,210m$^3$ |
| Crossing Embankment Level (m AHD) | 53.70m |
| Primary Outlet Pipes | 3 x 2400mm x 900mm RCBC at RL 49.70m AHD |

*The stage-storage-discharge relationship adopted for the proposed detention storage was generated from surface model for the eastern drainage corridor incorporating existing survey and design surfaces. The adopted stage storage curve is provided in **Table 3.16**.*

Table 3.16: Eastern Drainage Corridor B Crossing Stage Storage Discharge Relationship

| Stage (m AHD) | Accumulated Storage (m$^3$) | Discharge (m$^3$/s) | Detention Arrangement |
|---|---|---|---|
| 49.7 | 0 | 0.00 | Primary Outlet |
| 49.8 | 7 | 0.39 | |
| 49.9 | 18 | 1.10 | |
| 50 | 32 | 2.02 | |
| 50.1 | 48 | 3.10 | |
| 50.2 | 66 | 4.34 | |
| 50.3 | 87 | 5.70 | |
| 50.4 | 111 | 7.19 | |
| 50.5 | 140 | 8.78 | |
| 50.6 | 177 | 10.47 | |
| 50.7 | 228 | 12.27 | |
| 50.8 | 303 | 14.15 | |
| 50.9 | 406 | 16.13 | |
| 51 | 545 | 16.92 | |
| 51.1 | 730 | 17.70 | |
| 51.2 | 974 | 18.46 | |
| 51.3 | 1284 | 19.20 | |
| 51.4 | 1666 | 19.92 | |
| 51.5 | 2125 | 20.63 | |
| 51.6 | 2673 | 21.32 | |
| 51.7 | 3323 | 22.00 | |
| 51.8 | 4092 | 22.66 | |
| 51.9 | 4980 | 23.32 | |
| 52 | 5982 | 23.96 | |
| 52.1 | 7107 | 24.59 | |
| 52.2 | 8362 | 25.21 | |
| 52.3 | 9756 | 25.82 | |
| 52.4 | 11289 | 26.42 | |
| 52.5 | 12954 | 27.01 | |
| 52.6 | 14747 | 27.60 | |

| Stage (m AHD) | Accumulated Storage ($m^3$) | Discharge ($m^3/s$) | Detention Arrangement |
|---|---|---|---|
| 52.7 | 16667 | 28.17 | |
| 52.8 | 18724 | 28.74 | |
| 52.9 | 20944 | 29.30 | |
| 53 | 23327 | 29.86 | |
| 53.1 | 25861 | 30.41 | |
| 53.2 | 28542 | 30.95 | |
| 53.3 | 31369 | 31.49 | |
| 53.4 | 34341 | 32.02 | |
| 53.5 | 37462 | 32.54 | |
| 53.6 | 40752 | 33.06 | |
| 53.7 | 44214 | 33.58 | Top of Embankment Level (53.70) |

The flood storage WSLs for all AEP design storm events are summarised in **Table 3.17**.

Table 3.17: Developed Mitigated Scenario Eastern Crossing B WSLs

| AEP (%) | WSL (m AHD) |
|---|---|
| 63 | 50.49 |
| 39 | 50.69 |
| 20 | 50.93 |
| 10 | 51.22 |
| 5 | 51.58 |
| 2 | 51.94 |
| 1 | 52.21 |

*Results indicate that there is just under 1.5m of freeboard to the crossing minimum embankment level (53.70m AHD) in the 1% AEP storm event.*

## Eastern Drainage Corridor Crossing C

***Table 3.18** provides updated details of the eastern drainage corridor crossing C detention parameters modelled in XP-RAFTS. This crossing is located at the downstream end of the eastern drainage corridor and is proposed for bike / pedestrian use. It has been designed to remain immune for storm events up to and including the 10% AEP storm event. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for crossing details.*

Table 3.18: Eastern Drainage Corridor Crossing C

| Detention Parameter | Eastern Crossing C Detention |
|---|---|
| Detention Volume to Embankment Level | 19,330m3 |
| Crossing Embankment Level (m AHD) | 51.00m |
| Primary Outlet Pipes | 4 x 900mm RCP at RL 48.59m AHD |
| Secondary Outlet Pipes | 6 x 1500mm x 600 x RCBC at RL 50.00m AHD |

*The stage-storage discharge relationship adopted for the proposed detention storage was generated from surface model for the eastern drainage corridor incorporating existing survey and design surfaces. The adopted stage-storage-discharge curve is provided in **Table 3.19**.*

Table 3.19: Eastern Drainage Corridor C Crossing Stage Storage Discharge Relationship

| Stage (m AHD) | Accumulated Storage (m3) | Discharge (m3/s) | Detention Arrangement |
|---|---|---|---|
| 48.59 | 0 | 0.00 | Primary Outlet |
| 48.6 | 0 | 0.00 | |
| 48.7 | 18 | 0.13 | |
| 48.8 | 55 | 0.38 | |
| 48.9 | 126 | 0.71 | |
| 49 | 239 | 1.13 | |
| 49.1 | 418 | 1.61 | |
| 49.2 | 672 | 2.15 | |
| 49.3 | 992 | 2.75 | |
| 49.4 | 1381 | 3.41 | |
| 49.5 | 1844 | 4.13 | |
| 49.6 | 2387 | 4.89 | |

| Stage (m AHD) | Accumulated Storage (m3) | Discharge (m3/s) | Detention Arrangement |
|---|---|---|---|
| 49.7 | 3011 | 5.82 | |
| 49.8 | 3714 | 6.15 | |
| 49.9 | 4500 | 6.46 | |
| 50 | 5373 | 6.77 | Secondary Outlet |
| 50.1 | 6337 | 7.55 | |
| 50.2 | 7399 | 8.73 | |
| 50.3 | 8568 | 10.17 | |
| 50.4 | 9843 | 11.80 | |
| 50.5 | 11215 | 13.62 | |
| 50.6 | 12676 | 15.59 | |
| 50.7 | 14223 | 17.71 | |
| 50.8 | 15851 | 19.96 | |
| 50.9 | 17556 | 21.02 | |
| 51 | 19332 | 22.05 | Top of Embankment Level (51.00) |
| 51.1 | 21109 | 23.08 | |
| 51.2 | 22885 | 24.11 | |
| 51.3 | 24661 | 25.15 | |

The flood storage WSLs for all AEP design storm events are summarised in **Table 3.20**.

Table 3.20: Developed Mitigated Scenario Eastern Crossing C WSLs

| AEP (%) | WSL (m AHD) |
|---|---|
| 63 | 50.08 |
| 39 | 50.35 |
| 20 | 50.58 |
| 10 | 50.71 |
| 5 | 50.87 |
| 2 | 51.07 |
| 1 | 51.23 |

*Results indicate the crossing is overtopped by 70mm in the 2% AEP event and 230mm in the 1% AEP storm event. These conditions are within the maximum depth and depth velocity product limitations as specified within QUDM (2017).*

### 3.4.2 Developed Mitigated Peaks Flow Results

Modelling was undertaken for the all storm events up to and including the 1% AEP storm event with a storm duration of 60 minutes (this was the critical duration for the investigation area). Peak flow results for the developed mitigated scenario are provided in **Table 3.21** at the site discharge locations, and downstream locations as depicted in **Figure 3.1**.

Table 3.21: Developed Mitigated Peak Flow Results

| | Peak Flow Discharge at Point Location (m3/s) | | | | | |
|---|---|---|---|---|---|---|
| AEP (%) | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| 63 | 5.43 | 7.95 | 2.26 | 6.99 | 10.99 | 18.87 |
| 39 | 7.15 | 11.69 | 3.28 | 9.58 | 16.10 | 27.35 |
| 20 | 9.66 | 16.28 | 4.61 | 13.14 | 22.44 | 37.96 |
| 10 | 11.15 | 19.11 | 5.43 | 15.35 | 26.10 | 44.08 |
| 5 | 13.56 | 21.75 | 6.56 | 18.37 | 30.29 | 51.74 |
| 2 | 18.15 | 23.71 | 7.88 | 23.96 | 33.79 | 60.87 |
| 1 | 21.82 | 25.23 | 9.09 | 28.76 | 36.55 | 69.14 |

Table 3.22: Developed Mitigated Peak Flow Variance

| | Peak Flow Variance at Point Location (%) | | | | | |
|---|---|---|---|---|---|---|
| AEP (%) | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 | Point 6 |
| 63 | 1.9% | -3.6% | -6.2% | 2.0% | -5.3% | -4.2% |
| 39 | -9.2% | -3.0% | -6.5% | -5.9% | -5.0% | -5.3% |
| 20 | -13.7% | -4.1% | -6.7% | -10.0% | -6.2% | -6.8% |
| 10 | -16.2% | -4.8% | -6.9% | -11.7% | -7.6% | -8.4% |
| 5 | -16.6% | -10.6% | -7.1% | -13.6% | -11.6% | -11.5% |
| 2 | -9.6% | -19.6% | -7.2% | -8.7% | -18.7% | -14.7% |
| 1 | -6.5% | -25.8% | -7.1% | -5.6% | -23.7% | -16.1% |

*Peak flow comparisons provided in **Table** 3.22 show that proposed mitigation measures adequately alleviate increases in peak flow from the site in all AEP storm events. It is noted that the 63% AEP peak flow at Points 1 and 4 are higher than existing, however the increases are no greater than 2% are are considered negligible.*

The one-dimensional HEC-RAS hydraulic flood investigation presented in **Section 4** used the hydrological results from the existing and developed mitigated scenario. Crossing drainage configurations and flood immunity levels were confirmed during this investigation.

# 4 Flood Investigation

The objective of this one-dimensional flood investigation is to determine 1% AEP Existing and Developed Scenario peak flood levels and velocities along the drainage paths through the site. The flood levels determined from this flood analysis have been used to nominate flood immunity levels for the development (refer to **Section 4.3**).

The 1% AEP peak flow values from the hydrological analysis in **Section 3** were applied to nominated cross sections along the drainage corridors. Inflow locations for existing and developed scenarios are indicated on Drawing No. 16-002518-SK12 in **Appendix D**.

- HEC-RAS modelling was undertaken for the following scenarios:
- Existing Scenario 1% AEP;
- Developed Scenario 1% AEP; and
- Sensitivity Scenarios, as follows;
  - High Manning's n (0.15) in 1% AEP;
  - 25% Blockage Scenario of Crossings in 1% AEP storm event; and
  - 100% Blockage Scenario of Crossings in 10% AEP.

*The HEC RAS modelling has been updated for the developed and sensitivity scenarios to incorporate the updated hydrological model results, earthworks design of drainage corridor crossing undertaken since the original report.*

## 4.1 Existing Scenario

### 4.1.1 Geometry Data

Cross sections for the existing scenario were draped against an existing surface Digital Elevation Model (DEM) generated from Lidar survey data.

A Manning's n value of 0.06 was adopted for the main channel of the modelled drainage path. Overbank areas adopted a Manning's n value of 0.1. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for HEC-RAS cross section locations.

### 4.1.2 Peak Flow Input

The existing scenario peak flow rates at various points along the drainage corridor were obtained from the XP-RAFTS model. **Table 4.1** presents the existing scenario peak flow rates utilised for HEC-RAS analyses. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for HEC-RAS inflow locations.

Table 4.1: Existing Scenario Peak Flows

| Reach | HEC-RAS Cross Section | 1% AEP ($m^3/s$) |
|---|---|---|
| 81 - (Eastern Corridor – Northern Tributary) | 594 | 2.69 |
| | 338 | 6.93 |
| | 187 | 10.13 |
| 630 - (Eastern Corridor – Main Tributary) | 1154 | 5.47 |
| | 970 | 13.09 |
| | 798 | 15.18 |
| 21 - (Eastern Corridor – Southern Tributary) | 493 | 4.22 |
| | 269 | 9.21 |
| 0 - (Eastern Corridor – Main Tributary) | 593 | 24.4 |
| | 536 | 31.15 |
| | 270 | 35.88 |
| | 161 | 37.2 |
| 40 - (Western Corridor) | 864 | 9.89 |
| | 594 | 14.7 |
| | 413 | 22.01 |
| | 102 | 24.93 |

### 4.1.3 Boundary Conditions

The following boundary conditions were adopted for the HEC-RAS model. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for reach and junction locations.

#### Western Corridor

- Reach 40.
  - Upstream: Inflow applied to represent external upstream catchment and normal depth slope 1%; and
  - Downstream: Normal depth slope 1%.

#### Eastern Corridor

- Reach 630.
  - Upstream: Inflow applied to represent external upstream catchment and normal depth slope 1.65%; and
  - Downstream: Junction Node.
- Reach 21.
  - Upstream: Inflow applied to represent external upstream catchment and normal depth slope 1.65%; and
  - Downstream: Junction Node.
- Reach 0.
  - Upstream: Junction Node; and
  - Downstream: Normal depth slope 1.65%.
- Reach 81.
  - Upstream: Inflow applied to represent external upstream catchment and normal depth slope 1.9%; and
  - Downstream: Normal depth slope 1.9%.

### 4.1.4 Existing Flood Results

The 1% AEP flood conditions along the drainage path for the existing scenario are presented in **Table 4.2**. The existing scenario 1% AEP flood extent is shown on Drawing No. 16-002518-SK12 in **Appendix D**.

Table 4.2: Existing Scenario 1% AEP Flood Conditions

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) | Maximum Flood Depth (m) | Average Velocity (m/s) | Depth-Velocity Product ($m^2/s$) |
|---|---|---|---|---|---|
| West – 40 | 864 | 58.49 | 1.12 | 0.70 | 0.78 |
| West – 40 | 813 | 58.07 | 0.98 | 0.82 | 0.80 |
| West – 40 | 752 | 57.44 | 0.73 | 0.76 | 0.55 |
| West – 40 | 711 | 57.02 | 0.98 | 0.85 | 0.83 |
| West – 40 | 661 | 56.59 | 0.53 | 0.66 | 0.35 |
| West – 40 | 594 | 55.81 | 0.45 | 0.97 | 0.44 |
| West – 40 | 574 | 55.48 | 0.84 | 0.95 | 0.80 |
| West – 40 | 519 | 54.89 | 0.58 | 0.75 | 0.44 |
| West – 40 | 488 | 54.42 | 0.37 | 1.08 | 0.40 |
| West – 40 | 438 | 53.75 | 0.49 | 0.72 | 0.35 |
| West – 40 | 413 | 53.53 | 1.16 | 0.85 | 0.99 |
| West – 40 | 352 | 53.10 | 1.49 | 0.76 | 1.13 |
| West – 40 | 297 | 52.60 | 0.87 | 1.11 | 0.97 |
| West – 40 | 246 | 52.17 | 1.78 | 0.90 | 1.60 |
| West – 40 | 219 | 51.95 | 1.04 | 1.01 | 1.05 |
| West – 40 | 201 | 51.80 | 1.47 | 0.97 | 1.43 |
| West – 40 | 153 | 51.37 | 1.17 | 1.03 | 1.21 |
| West – 40 | 102 | 51.09 | 1.51 | 0.81 | 1.22 |
| West – 40 | 69 | 50.93 | 1.92 | 0.86 | 1.65 |
| West – 40 | 40 | 50.72 | 1.04 | 0.98 | 1.02 |
| East – 21 | 493 | 59.70 | 0.34 | 0.67 | 0.23 |
| East – 21 | 444 | 58.52 | 0.26 | 0.92 | 0.24 |
| East – 21 | 393 | 57.39 | 0.28 | 0.59 | 0.17 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) | Maximum Flood Depth (m) | Average Velocity (m/s) | Depth-Velocity Product (m²/s) |
|---|---|---|---|---|---|
| East – 21 | 342 | 56.01 | 0.16 | 0.96 | 0.15 |
| East – 21 | 309 | 55.40 | 0.29 | 0.50 | 0.15 |
| East – 21 | 269 | 54.99 | 0.47 | 0.74 | 0.35 |
| East – 21 | 219 | 54.47 | 0.55 | 0.76 | 0.42 |
| East – 21 | 169 | 53.91 | 0.52 | 0.79 | 0.41 |
| East – 21 | 119 | 53.35 | 0.80 | 0.82 | 0.66 |
| East – 21 | 69 | 52.71 | 0.47 | 0.83 | 0.39 |
| East – 21 | 45 | 52.39 | 0.43 | 0.77 | 0.33 |
| East – 21 | 28 | 52.17 | 0.47 | 0.84 | 0.39 |
| East – 21 | 21 | 52.10 | 0.49 | 0.82 | 0.40 |
| East – 630 | 1154 | 57.77 | 0.31 | 0.64 | 0.20 |
| East – 630 | 1104 | 57.09 | 0.35 | 0.68 | 0.24 |
| East – 630 | 1054 | 56.14 | 0.30 | 0.83 | 0.25 |
| East – 630 | 1004 | 55.41 | 0.33 | 0.56 | 0.18 |
| East – 630 | 970 | 55.10 | 0.70 | 0.63 | 0.44 |
| East – 630 | 939 | 54.79 | 0.37 | 0.69 | 0.26 |
| East – 630 | 874 | 54.23 | 0.42 | 0.59 | 0.25 |
| East – 630 | 850 | 54.08 | 0.54 | 0.57 | 0.31 |
| East – 630 | 798 | 53.67 | 0.64 | 0.79 | 0.51 |
| East – 630 | 748 | 53.21 | 0.60 | 0.85 | 0.51 |
| East – 630 | 698 | 52.77 | 0.63 | 0.76 | 0.48 |
| East – 630 | 657 | 51.94 | 0.99 | 1.68 | 1.66 |
| East – 0 | 593 | 51.99 | 0.95 | 0.70 | 0.67 |
| East – 0 | 585 | 51.96 | 0.94 | 0.69 | 0.65 |
| East – 0 | 536 | 51.62 | 1.02 | 1.10 | 1.12 |
| East – 0 | 507 | 51.38 | 2.00 | 0.99 | 1.98 |
| East – 0 | 444 | 51.05 | 1.83 | 0.86 | 1.57 |
| East – 0 | 417 | 50.90 | 1.75 | 0.95 | 1.66 |
| East – 0 | 367 | 50.54 | 1.01 | 1.01 | 1.02 |
| East – 0 | 326 | 50.25 | 1.04 | 0.97 | 1.01 |
| East – 0 | 270 | 49.78 | 0.90 | 1.07 | 0.96 |
| East – 0 | 234 | 49.44 | 0.78 | 0.99 | 0.77 |
| East – 0 | 191 | 49.07 | 1.53 | 0.98 | 1.50 |
| East – 0 | 161 | 48.82 | 1.34 | 0.98 | 1.31 |
| East – 0 | 132 | 48.44 | 1.07 | 1.20 | 1.28 |
| East – 81 | 594 | 58.24 | 0.21 | 0.58 | 0.12 |
| East – 81 | 544 | 56.85 | 0.17 | 0.86 | 0.15 |
| East – 81 | 494 | 55.78 | 0.26 | 0.51 | 0.13 |
| East – 81 | 444 | 54.52 | 0.23 | 1.06 | 0.24 |
| East – 81 | 391 | 53.69 | 0.30 | 0.43 | 0.13 |
| East – 81 | 338 | 52.79 | 0.33 | 1.03 | 0.34 |
| East – 81 | 290 | 51.84 | 0.37 | 0.74 | 0.27 |
| East – 81 | 239 | 50.88 | 0.48 | 0.92 | 0.44 |
| East – 81 | 187 | 50.19 | 0.57 | 0.79 | 0.45 |
| East – 81 | 131 | 49.45 | 0.47 | 0.97 | 0.46 |

## 4.2 Developed Scenario

*Changes to the developed scenario HEC RAS model have been made to incorporate the updated hydrological model results and earthworks design undertaken since the original report.*

### 4.2.1 Geometry Data

*Updated cross sections for the developed scenario were draped against a superimposed surface model generated from the current earthworks design and survey data.*

Manning's n roughness values were unchanged from the existing scenario modelling. HEC-RAS cross section locations did not differ between existing and developed scenario modelling. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for HEC-RAS cross section locations.

*There are four main crossings proposed through the drainage paths. These crossings were sized during the initial hydrological analyses which have now been further refined. Refer to **Section 3** of the report for details of the hydrological analysis.*

**Table 4.3** summarises the crossing configurations modelled in HEC-RAS. Ineffective flow areas upstream and downstream of the culvert crossings assume a contraction angle of 1:1 and expansion angle of 1:1.5 in accordance with Chapter 6 of the *HEC-RAS Hydraulic Reference Manual v4.1* (2010).

Table 4.3: Developed Scenario HEC-RAS Crossing Configurations

| Crossing Location [A] | Western Crossing A | Eastern Crossing A | Eastern Crossing B | Eastern Crossing C |
|---|---|---|---|---|
| Primary Culvert Configuration | 1 x 1200 x 600 RCBC | 5 x 1800mm x 600mm RCBC | 3 x 2400mm x 900mm RCBC | 4 x 900mm RCP |
| Invert Levels (m AHD) | US = 54.50<br>DS = 54.42 | US = 54.20<br>DS = 54.12 | US = 49.70<br>DS = 49.62 | US = 48.59<br>DS = 48.52 |
| Secondary Culvert Configuration | 1 x 2400 x 900mm RCBC | N/A | N/A | 6 x 1500mm x 600mm RCBC |
| Invert Levels (m AHD) | US = 56.00<br>DS = 55.92 | N/A | N/A | US = 50.00<br>DS = 49.97 |
| Culvert Length (m) | 30 | 30 | 40 | 15 |
| Deck Level (High Chord) (m AHD) | 57.15 | 56.9 | 53.7 | 51.0 |

[A] Refer to Drawing No. 16-002518-SK12 in **Appendix D** for crossing locations.

All culvert crossings presented in **Table 4.3** adopted the following general parameters:

- Solution Criteria: Highest U.S. Energy Gradient;
- Entrance Loss Coefficient: 0.5;
- Exit Loss Coefficient: 1;
- Manning's n (Top & Bottom): 0.013; and
- Headwall Configuration: Flared Wingwalls – 30 to 75 degrees.

### 4.2.2 Peak Flow Input

*The updated developed scenario peak flow rates at various points along the drainage corridor were obtained from the XP-RAFTS model. **Table 4.4** presents the developed mitigated scenario peak flow rates utilised for HEC-RAS analyses. Refer to Drawing No. 16-002518-SK12 in **Appendix D** for HEC-RAS inflow locations.*

Table 4.4: Developed Scenario Peak Flows

| Reach | HEC-RAS Cross Section | 1% AEP ($m^3/s$) |
|---|---|---|
| 81 - (Eastern Corridor – Northern Tributary) | 594 | 2.88 |
| | 338 | 5.08 |
| | 187 | 9.09 |
| 630 - (Eastern Corridor – Main Tributary) | 1154 | 5.47 |
| | 1104 | 8.78 |
| | 970 | 12.32 |
| | 874 | 13.54 |
| | 748 | 13.24 |
| | 698 | 17.7 |
| 21 - (Eastern Corridor – Southern Tributary) | 393 | 7.28 |
| | 269 | 8.10 |
| 0 - (Eastern Corridor – Main Tributary) | 593 | 25.8 |
| | 536 | 31.07 |
| | 444 | 31.07 |
| | 367 | 27.42 |
| | 270 | 28.10 |
| | 191 | 25.05 |
| | 161 | 25.23 |
| 40 - (Western Corridor) | 864 | 9.84 |
| | 574 | 17.54 |
| | 519 | 17.54 |
| | 219 | 19.69 |
| | 102 | 21.82 |

### 4.2.3 Boundary Conditions

Boundary conditions adopted for the existing scenario as presented in **Section 4.1.3** remain unchanged for the developed scenario.

### 4.2.4 Developed Flood Results

The 1% AEP flood conditions along the drainage path for the Developed Mitigated Scenario are presented in **Table 4.5**.

Table 4.5: Developed Mitigated Scenario 1% AEP Flood Conditions

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) | Maximum Flood Depth (m) | Average Velocity (m/s) | Depth-Velocity Product ($m^2/s$) |
|---|---|---|---|---|---|
| West – 40 | 864 | 58.50 | 1.06 | 0.69 | 0.73 |
| West – 40 | 813 | 58.13 | 0.75 | 0.77 | 0.58 |
| West – 40 | 752 | 57.48 | 0.74 | 0.69 | 0.51 |
| West – 40 | 711 | 57.41 [A] | 1.02 | 0.38 | 0.39 |
| West – 40 | 661 | 57.41 [A] | 1.26 | 0.18 | 0.23 |
| West – 40 | 594 | 57.41 [A] | 1.96 | 0.08 | 0.16 |
| West – 40 | 574 | 57.41 [A] | 2.83 | 0.11 | 0.31 |
| Western Culvert Crossing | | | | | |
| West – 40 | 519 | 54.91 | 0.58 | 0.89 | 0.52 |
| West – 40 | 488 | 54.52 | 0.47 | 0.92 | 0.43 |
| West – 40 | 438 | 53.77 | 0.5 | 0.85 | 0.43 |
| West – 40 | 413 | 53.49 | 0.81 | 0.78 | 0.63 |
| West – 40 | 352 | 52.99 | 1.2 | 0.73 | 0.88 |
| West – 40 | 297 | 52.59 | 0.89 | 0.94 | 0.84 |
| West – 40 | 246 | 52.11 | 1.68 | 0.84 | 1.41 |
| West – 40 | 219 | 51.89 | 0.92 | 1.06 | 0.98 |
| West – 40 | 201 | 51.72 | 1.29 | 0.96 | 1.24 |
| West – 40 | 153 | 51.33 | 1.17 | 0.98 | 1.15 |
| West – 40 | 102 | 51.05 | 1.52 | 0.78 | 1.19 |
| West – 40 | 69 | 50.88 | 1.73 | 0.88 | 1.52 |
| West – 40 | 40 | 50.66 | 1.06 | 0.97 | 1.03 |
| East – 21 | 393 | 57.37 | 1.07 | 0.72 | 0.77 |
| East – 21 | 342 | 56.07 | 1.27 | 1.22 | 1.55 |
| East – 21 | 309 | 55.47 | 0.35 | 0.64 | 0.22 |
| East – 21 | 269 | 54.98 | 0.51 | 0.70 | 0.36 |
| East – 21 | 219 | 54.45 | 0.52 | 0.75 | 0.39 |
| East – 21 | 169 | 53.91 | 0.51 | 0.72 | 0.37 |
| East – 21 | 119 | 53.69 | 1.06 | 0.31 | 0.33 |
| East – 21 | 69 | 53.68 | 1.43 | 0.10 | 0.14 |
| East – 21 | 45 | 53.68 | 1.71 | 0.09 | 0.15 |
| East – 21 | 28 | 53.68 | 1.97 | 0.09 | 0.18 |
| East – 21 | 21 | 53.68 | 2.06 | 0.09 | 0.19 |
| East – 630 | 1154 | 57.77 | 0.3 | 0.65 | 0.20 |
| East – 630 | 1104 | 57.14 | 0.4 | 0.83 | 0.33 |
| East – 630 | 1054 | 56.24 | 0.41 | 0.78 | 0.32 |
| East – 630 | 1004 | 55.53 | 0.45 | 0.61 | 0.27 |
| East – 630 | 970 | 55.33 | 1.01 | 0.53 | 0.54 |
| East – 630 | 939 | 55.30 | 1.1 | 0.28 | 0.31 |
| Eastern Culvert Crossing A | | | | | |
| East – 630 | 874 | 54.35 | 0.54 | 0.70 | 0.38 |
| East – 630 | 850 | 54.15 | 0.61 | 0.81 | 0.49 |
| East – 630 | 798 | 53.75 | 0.91 | 0.61 | 0.56 |
| East – 630 | 748 | 53.70 | 1.09 | 0.31 | 0.34 |
| East – 630 | 698 | 53.68 | 1.54 | 0.22 | 0.34 |
| East – 630 | 657 | 53.68 | 1.86 | 0.13 | 0.24 |
| East – 630 | 646 | 53.68 | 1.94 | 0.14 | 0.27 |
| East – 630 | 637 | 53.68 | 2 | 0.14 | 0.28 |
| East – 630 | 630 | 53.68 | 2.08 | 0.14 | 0.29 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) | Maximum Flood Depth (m) | Average Velocity (m/s) | Depth-Velocity Product (m²/s) |
|---|---|---|---|---|---|
| East – 0 | 593 | 53.68 | 2.62 | 0.13 | 0.34 |
| East – 0 | 585 | 53.68 | 2.65 | 0.13 | 0.34 |
| East – 0 | 536 | 53.68 | 3.07 | 0.16 | 0.49 |
| East – 0 | 507 | 53.68 | 4.01 | 0.14 | 0.56 |
| Eastern Culvert Crossing B | | | | | |
| East – 0 | 444 | 51.24 | 1.78 | 0.65 | 1.16 |
| East – 0 | 417 | 51.23 [A] | 1.97 | 0.67 | 1.32 |
| East – 0 | 367 | 51.23 [A] | 1.56 | 0.44 | 0.69 |
| East – 0 | 326 | 51.23 [A] | 1.87 | 0.32 | 0.60 |
| East – 0 | 270 | 51.23 [A] | 2.19 | 0.19 | 0.42 |
| East – 0 | 234 | 51.23 [A] | 2.49 | 0.15 | 0.37 |
| Eastern Culvert Crossing C | | | | | |
| East – 0 | 190 | 48.98 | 1.27 | 0.81 | 1.03 |
| East – 0 | 161 | 48.73 | 1.23 | 0.90 | 1.11 |
| East – 0 | 132 | 48.40 | 1.03 | 1.05 | 1.08 |
| East – 81 | 594 | 58.22 | 0.19 | 0.69 | 0.13 |
| East – 81 | 544 | 56.88 | 0.2 | 0.66 | 0.13 |
| East – 81 | 494 | 55.75 | 0.23 | 0.65 | 0.15 |
| East – 81 | 444 | 54.59 | 0.29 | 0.65 | 0.19 |
| East – 81 | 391 | 53.62 | 0.24 | 0.65 | 0.16 |
| East – 81 | 338 | 52.78 | 0.32 | 0.84 | 0.27 |
| East – 81 | 290 | 51.76 | 0.27 | 0.77 | 0.21 |
| East – 81 | 239 | 50.85 | 0.42 | 0.72 | 0.30 |
| East – 81 | 187 | 50.15 | 0.54 | 0.84 | 0.45 |
| East – 81 | 131 | 49.43 | 0.46 | 0.95 | 0.44 |

[A] Note: WSLs upstream of waterway crossings from the XP-RAFTS detention analysis presented in **Section 3.4** are higher and are presented within this table. Refer to **Section 4.2.5** for further discussion.

Although the flood levels along the drainage path increase through the site as a result of the peak flow increases and the proposed fill, this will not create adverse impacts because:

- Increases are contained within the site;
- Appropriate flood immunity will be provided for the development;
- The 1% AEP flood levels at the downstream boundaries are lower in the developed scenario; and
- Upstream catchment connections are proposed where required. Refer to Drawing No. 16-002518-SK12 for concept. **Table 4.6** presents the flooding at crossing locations.

Table 4.6: Developed Scenario HEC-RAS 1% AEP Crossing Results

| Crossing Location | Culvert # | Through Culvert Peak Flow (m3/s) | Upstream Flood Level (m AHD) | Downstream Flood Level (m AHD) | Culvert Upstream Velocity (m/s) | Culvert Downstream Velocity (m/s) |
|---|---|---|---|---|---|---|
| Western Crossing RL 57.5 | Primary #1 | 3.47 | 57.41 [A] | 54.91 | 4.82 | 4.82 |
| | Secondary #2 | 4.79 | | | 2.69 | 2.98 |
| Eastern Crossing A RL 56.9 | Primary #1 | 12.32 | 55.30 | 54.35 | 2.28 | 2.99 |
| Eastern Crossing B RL 53.5 | Primary #1 | 31.07 | 53.68 | 51.24 | 4.79 | 4.79 |
| Eastern Crossing C RL 51.0 | Primary #1 | 10.74 | 51.23 [A] | 48.98 | 4.22 | 4.22 |
| | Secondary #2 | 13.49 | | | 2.5 | 2.5 |
| | Weir Flow | 3.19 | | | N/A | N/A |

[A] Note: WSLs from the XP-RAFTS detention analysis presented in **Section 3.4** are higher and are presented within this table. Refer to **Section 4.2.5** for further discussion.

It is recommended that the culvert crossing design is confirmed during subsequent detailed design phases.

### 4.2.5 Detention Storage Water Surface Levels

The HEC-RAS modelling undertaken along the drainage corridors is one-dimensional steady state water surface calculation based on the one-dimensional energy equation. This does not take into account the stage-storage-discharge characteristics of detention basins and the dynamic rainfall patterns.

As a result, WSLs over storage areas within the one-dimensional steady state HEC-RAS model vary to those calculated by XP-RAFTS in **Section 3.4**. Consequently, the XP-RAFTS WSLs have been adopted at locations noted in **Table 4.5**.

### 4.2.6 Sensitivity Scenarios

#### High Manning's

A sensitivity scenario with a higher Manning's n value of 0.15 has been modelled for confirming the freeboard to the habitable floors. All other HEC-RAS parameters, including peak flow rates and boundary conditions were retained as per the Developed Scenario. The 1% AEP flood levels along the drainage path for the sensitivity scenario are presented in **Table 4.7**. All vehicular crossings remain immune to overtopping during this scenario.

Table 4.7: Sensitivity Scenario – High Manning's 1% AEP Local Flood Levels

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| West – 40 | 864 | 58.79 |
| West – 40 | 813 | 58.36 |
| West – 40 | 752 | 57.73 |
| West – 40 | 711 | 57.46 |
| West – 40 | 661 | 57.35 |
| West – 40 | 594 | 57.33 |
| West – 40 | 574 | 57.33 |
| Western Culvert Crossing | | |
| West – 40 | 519 | 55.15 |
| West – 40 | 488 | 54.76 |
| West – 40 | 438 | 54.02 |
| West – 40 | 413 | 53.78 |
| West – 40 | 352 | 53.33 |
| West – 40 | 297 | 52.94 |
| West – 40 | 246 | 52.52 |
| West – 40 | 219 | 52.31 |
| West – 40 | 201 | 52.15 |
| West – 40 | 153 | 51.79 |
| West – 40 | 102 | 51.49 |
| West – 40 | 69 | 51.27 |
| West – 40 | 40 | 51.02 |
| East – 21 | 393 | 57.56 |
| East – 21 | 342 | 56.15 |
| East – 21 | 309 | 55.64 |
| East – 21 | 269 | 55.20 |
| East – 21 | 219 | 54.68 |
| East – 21 | 169 | 54.15 |
| East – 21 | 119 | 53.83 |
| East – 21 | 69 | 53.79 |
| East – 21 | 45 | 53.79 |
| East – 21 | 28 | 53.78 |
| East – 21 | 21 | 53.78 |
| East – 630 | 1154 | 57.92 |
| East – 630 | 1104 | 57.32 |
| East – 630 | 1054 | 56.42 |
| East – 630 | 1004 | 55.75 |
| East – 630 | 970 | 55.46 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| East – 630 | 939 | 55.30 |
| Eastern Culvert Crossing A | | |
| East – 630 | 874 | 54.63 |
| East – 630 | 850 | 54.43 |
| East – 630 | 798 | 53.99 |
| East – 630 | 748 | 53.85 |
| East – 630 | 698 | 53.81 |
| East – 630 | 657 | 53.79 |
| East – 630 | 646 | 53.79 |
| East – 630 | 637 | 53.79 |
| East – 630 | 630 | 53.79 |
| East – 0 | 593 | 53.77 |
| East – 0 | 585 | 53.77 |
| East – 0 | 536 | 53.77 |
| East – 0 | 507 | 53.76 |
| Eastern Culvert Crossing B | | |
| East – 0 | 444 | 51.61 |
| East – 0 | 417 | 51.49 |
| East – 0 | 367 | 51.25 |
| East – 0 | 326 | 51.15 |
| East – 0 | 270 | 51.09 |
| East – 0 | 234 | 51.08 |
| Eastern Culvert Crossing C | | |
| East – 0 | 190 | 49.34 |
| East – 0 | 161 | 49.04 |
| East – 0 | 132 | 48.68 |
| East – 81 | 594 | 58.32 |
| East – 81 | 544 | 56.99 |
| East – 81 | 494 | 55.85 |
| East – 81 | 444 | 54.72 |
| East – 81 | 391 | 53.76 |
| East – 81 | 338 | 52.93 |
| East – 81 | 290 | 51.92 |
| East – 81 | 239 | 51.01 |
| East – 81 | 187 | 50.40 |
| East – 81 | 131 | 49.64 |

## 25% Culvert Blockage

A sensitivity scenario incorporating a 25% sedimentation culvert blockage has been modelled for confirming the flood immunity levels for the habitable floors. All other HEC-RAS parameters, including peak flow rates and boundary conditions were retained as per the developed scenario. The 1% AEP flood levels along the drainage path for the sensitivity scenario are presented in **Table 4.8**. All vehicular crossings remain immune to overtopping during this scenario.

Table 4.8: Sensitivity Scenario – 25% Blockage 1% AEP Local Flood Levels

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| West – 40 | 864 | 58.50 |
| West – 40 | 813 | 58.13 |
| West – 40 | 752 | 57.49 |
| West – 40 | 711 | 57.38 |
| West – 40 | 661 | 57.36 |
| West – 40 | 594 | 57.36 |
| West – 40 | 574 | 57.36 |
| Western Culvert Crossing | | |
| West – 40 | 519 | 54.91 |
| West – 40 | 488 | 54.52 |
| West – 40 | 438 | 53.77 |
| West – 40 | 413 | 53.49 |
| West – 40 | 352 | 52.99 |
| West – 40 | 297 | 52.59 |
| West – 40 | 246 | 52.11 |
| West – 40 | 219 | 51.89 |
| West – 40 | 201 | 51.72 |
| West – 40 | 153 | 51.33 |
| West – 40 | 102 | 51.05 |
| West – 40 | 69 | 50.88 |
| West – 40 | 40 | 50.66 |
| East – 21 | 393 | 57.37 |
| East – 21 | 342 | 56.07 |
| East – 21 | 309 | 55.47 |
| East – 21 | 269 | 54.98 |
| East – 21 | 219 | 54.45 |
| East – 21 | 169 | 53.96 |
| East – 21 | 119 | 53.87 |
| East – 21 | 69 | 53.87 |
| East – 21 | 45 | 53.87 |
| East – 21 | 28 | 53.87 |
| East – 21 | 21 | 53.87 |
| East – 630 | 1154 | 57.77 |
| East – 630 | 1104 | 57.14 |
| East – 630 | 1054 | 56.24 |
| East – 630 | 1004 | 55.71 |
| East – 630 | 970 | 55.68 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| East – 630 | 939 | 55.68 |
| Eastern Culvert Crossing A | | |
| East – 630 | 874 | 54.36 |
| East – 630 | 850 | 54.16 |
| East – 630 | 798 | 53.90 |
| East – 630 | 748 | 53.87 |
| East – 630 | 698 | 53.87 |
| East – 630 | 657 | 53.87 |
| East – 630 | 646 | 53.87 |
| East – 630 | 637 | 53.87 |
| East – 630 | 630 | 53.87 |
| East – 0 | 593 | 53.87 |
| East – 0 | 585 | 53.86 |
| East – 0 | 536 | 53.86 |
| East – 0 | 507 | 53.86 |
| Eastern Culvert Crossing B | | |
| East – 0 | 444 | 51.28 |
| East – 0 | 417 | 51.23 |
| East – 0 | 367 | 51.16 |
| East – 0 | 326 | 51.15 |
| East – 0 | 270 | 51.14 |
| East – 0 | 234 | 51.14 |
| Eastern Culvert Crossing C | | |
| East – 0 | 190 | 48.98 |
| East – 0 | 161 | 48.73 |
| East – 0 | 132 | 48.40 |
| East – 81 | 594 | 58.22 |
| East – 81 | 544 | 56.88 |
| East – 81 | 494 | 55.75 |
| East – 81 | 444 | 54.59 |
| East – 81 | 391 | 53.62 |
| East – 81 | 338 | 52.78 |
| East – 81 | 290 | 51.76 |
| East – 81 | 239 | 50.85 |
| East – 81 | 187 | 50.15 |
| East – 81 | 131 | 49.43 |

## 100% Culvert Blockage

A sensitivity scenario incorporating 100% culvert blockage has been modelled for confirming the flood immunity levels for the habitable floors. The 10% AEP was modelled. All other HEC-RAS parameters, including peak flow rates and boundary conditions were retained as per the developed scenario. The 10% AEP flood levels along the drainage path for the sensitivity scenario are presented in **Table 4.9**.

Table 4.9: Sensitivity Scenario – 100% Blockage 10% AEP Local Flood Levels

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| West – 40 | 864 | 58.34 |
| West – 40 | 813 | 57.99 |
| West – 40 | 752 | 57.40 |
| West – 40 | 711 | 57.34 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| West – 40 | 661 | 57.33 |
| West – 40 | 594 | 57.33 |
| West – 40 | 574 | 57.33 |
| Western Culvert Crossing | | |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| West – 40 | 519 | 54.80 |
| West – 40 | 488 | 54.43 |
| West – 40 | 438 | 53.67 |
| West – 40 | 413 | 53.38 |
| West – 40 | 352 | 52.84 |
| West – 40 | 297 | 52.45 |
| West – 40 | 246 | 51.89 |
| West – 40 | 219 | 51.62 |
| West – 40 | 201 | 51.45 |
| West – 40 | 153 | 51.06 |
| West – 40 | 102 | 50.79 |
| West – 40 | 69 | 50.66 |
| West – 40 | 40 | 50.46 |
| East – 21 | 393 | 57.28 |
| East – 21 | 342 | 56.03 |
| East – 21 | 309 | 55.41 |
| East – 21 | 269 | 54.89 |
| East – 21 | 219 | 54.36 |
| East – 21 | 169 | 54.06 |
| East – 21 | 119 | 54.04 |
| East – 21 | 69 | 54.04 |
| East – 21 | 45 | 54.04 |
| East – 21 | 28 | 54.04 |
| East – 21 | 21 | 54.04 |
| East – 630 | 1154 | 57.69 |
| East – 630 | 1104 | 57.11 |
| East – 630 | 1054 | 57.07 |
| East – 630 | 1004 | 57.07 |
| East – 630 | 970 | 57.07 |
| East – 630 | 939 | 57.07 |
| Eastern Culvert Crossing A | | |
| East – 630 | 874 | 54.25 |
| East – 630 | 850 | 54.12 |

| River - Reach | HEC-RAS Cross Section | Flood Level (m AHD) |
|---|---|---|
| East – 630 | 798 | 54.05 |
| East – 630 | 748 | 54.04 |
| East – 630 | 698 | 54.04 |
| East – 630 | 657 | 54.04 |
| East – 630 | 646 | 54.04 |
| East – 630 | 637 | 54.04 |
| East – 630 | 630 | 54.04 |
| East – 0 | 593 | 54.04 |
| East – 0 | 585 | 54.04 |
| East – 0 | 536 | 54.04 |
| East – 0 | 507 | 54.04 |
| Eastern Culvert Crossing B | | |
| East – 0 | 444 | 51.29 |
| East – 0 | 417 | 51.27 |
| East – 0 | 367 | 51.25 |
| East – 0 | 326 | 51.24 |
| East – 0 | 270 | 51.24 |
| East – 0 | 234 | 51.24 |
| Eastern Culvert Crossing C | | |
| East – 0 | 190 | 48.89 |
| East – 0 | 161 | 48.65 |
| East – 0 | 132 | 48.34 |
| East – 81 | 594 | 58.17 |
| East – 81 | 544 | 56.84 |
| East – 81 | 494 | 55.71 |
| East – 81 | 444 | 54.54 |
| East – 81 | 391 | 53.57 |
| East – 81 | 338 | 52.71 |
| East – 81 | 290 | 51.70 |
| East – 81 | 239 | 50.78 |
| East – 81 | 187 | 50.05 |
| East – 81 | 131 | 49.35 |

In this sensitivity scenario, all four crossings are overtopped due to 100% blockage of the culverts. Maximum flow depths across the Western and Eastern A crossings remain below 200mm in accordance with the requirements QUDM (2013) for roadway flood depth during a minor storm. Additionally, depth-velocity products for all four crossings are well below 0.3$m^2$/s in accordance with QUDM (2013). However, the remaining crossings (Eastern Crossings B & C) will be non-trafficable during this event. Nonetheless, emergency evacuation routes remain available for all areas of the development.

Flood immunity for habitable floor levels adjacent to each drainage corridor have been assigned based on EDQ standards. Refer to **Section 4.3** for further details on flood immunity levels adopted for the development.

## 4.3 Flood Immunity

### 4.3.1 Flood Immunity Standards

**Table 4.10** provides details of flood immunity levels for the development. The habitable floor flood immunity is in accordance with LCC guidelines as required under Table 1 of the PDA Guideline No. 15 Protection from Flood and Storm Tide Inundation (2015). The park flood immunity standards are in accordance with Table 5 of the PDA Guideline No. 12 Park Planning and Design (2015).

Table 4.10: Table 4 10: Flood Immunity Standards

| Floor Type | Flood Immunity Standard |
|---|---|
| Habitable Floor | Greater of:<br>1% AEP + 500mm or<br>Sensitivity Scenario |

### 4.3.2 Flood Immunity Levels

The minimum flood immunity level along the drainage corridors are presented in **Table 4.11**. These are based on the minimum flood immunity standards presented in **Table 4.10**.

Table 4.11: Minimum Flood Immunity Levels

| River - Reach | HEC-RAS Cross Section | Minimum Habitable Floor Levels (m AHD) |
|---|---|---|
| West – 40 | 864 | 61.11 |
| West – 40 | 813 | 60.60 |
| West – 40 | 752 | 59.06 |
| West – 40 | 711 | 60.16 |
| West – 40 | 661 | 58.18 |
| West – 40 | 594 | 58.13 |
| West – 40 | 574 | 57.97 |
| **Western Culvert Crossing** | | |
| West – 40 | 519 | 57.10 |
| West – 40 | 488 | 56.68 |
| West – 40 | 438 | 56.33 |
| West – 40 | 413 | 56.16 |
| West – 40 | 352 | 55.26 |
| West – 40 | 297 | 56.93 |
| West – 40 | 246 | 56.32 |
| West – 40 | 219 | 55.84 |
| West – 40 | 201 | 56.19 |
| West – 40 | 153 | 55.80 |
| West – 40 | 102 | 56.30 |
| West – 40 | 69 | 57.05 |
| West – 40 | 40 | 57.05 |
| East – 21 | 393 | 60.01 |
| East – 21 | 342 | 57.38 |
| East – 21 | 309 | 59.06 |
| East – 21 | 269 | 56.81 |
| East – 21 | 219 | 57.84 |
| East – 21 | 169 | 55.62 |
| East – 21 | 119 | 55.14 |
| East – 21 | 69 | 55.70 |
| East – 21 | 45 | 56.25 |
| East – 21 | 28 | 55.62 |
| East – 21 | 21 | 55.39 |
| East – 630 | 1154 | 58.78 |
| East – 630 | 1104 | 59.10 |
| East – 630 | 1054 | 58.03 |
| East – 630 | 1004 | 57.72 |

| River - Reach | HEC-RAS Cross Section | Minimum Habitable Floor Levels (m AHD) |
|---|---|---|
| East – 630 | 970 | 57.52 |
| East – 630 | 939 | 57.64 |
| **Eastern Culvert Crossing A** | | |
| East – 630 | 874 | 56.52 |
| East – 630 | 850 | 56.14 |
| East – 630 | 798 | 55.75 |
| East – 630 | 748 | 54.82 |
| East – 630 | 698 | 54.87 |
| East – 630 | 657 | 54.87 |
| East – 0 | 593 | 55.34 |
| East – 0 | 585 | 55.38 |
| East – 0 | 536 | 55.45 |
| East – 0 | 507 | 54.95 |
| **Eastern Culvert Crossing B** | | |
| East – 0 | 444 | 54.00 |
| East – 0 | 417 | 53.75 |
| East – 0 | 367 | 53.30 |
| East – 0 | 326 | 53.45 |
| East – 0 | 270 | 52.50 |
| East – 0 | 234 | 52.84 |
| **Eastern Culvert Crossing C** | | |
| East – 0 | 190 | 53.40 |
| East – 0 | 161 | 53.41 |
| East – 0 | 132 | 53.41 |
| East – 81 | 594 | 59.83 |
| East – 81 | 544 | 59.34 |
| East – 81 | 494 | 58.17 |
| East – 81 | 444 | 57.19 |
| East – 81 | 391 | 56.64 |
| East – 81 | 338 | 55.58 |
| East – 81 | 290 | 55.62 |
| East – 81 | 239 | 53.93 |
| East – 81 | 187 | 53.70 |
| East – 81 | 131 | 53.38 |
| East – 81 | 119 | 55.19 |

Note: Minimum habitable floor level immunity levels have been rounded up to nearest 5mm.

**Table 4.12** provides the minimum road crossing levels. These are based on the permissible 1% AEP flood/detention levels for vehicular crossings and the 10% AEP flood/detention level for the pathway/bike.

Table 4.12: Minimum Road Crossing Levels

| Crossing | RL (m AHD) |
|---|---|
| Western | 57.15 |
| Eastern A | 56.90 |
| Eastern B | 53.70 |
| Eastern C | 51.00 |

# 5 Stormwater Quality

To improve the quality of the runoff leaving the site, a treatment train incorporating Stormwater Quality Improvement Devices (SQIDs) is proposed. SQIDs will intercept and capture pollutants so that any potential stormwater quality impacts from the site will be mitigated and the required WQOs will be achieved.

This section of the report discusses:

- The identification of key stormwater pollutants associated with the proposed development;
- The WQOs applicable for the site;
- Proposed SQIDs for stormwater quality management; and
- Modelling of the proposed SQIDs to assess if they achieve the required WQOs.

## 5.1 Pollutants of Concern

Typical key pollutants expected to be generated during the operational (post-construction) phase of an urban development are listed as follows, with those presented in capitals being the key pollutants to be targeted for treatment:

- LITTER
- SEDIMENT
- Oxygen demanding substances (possibly present)
- NUTRIENTS (Nitrogen & Phosphorus)
- Pathogens / Faecal coliforms
- Hydrocarbons
- HEAVY METALS (associated with fine sediments)
- Surfactants
- Organochlorines & organophosphates
- Thermal pollution
- pH altering substances

Only the key pollutants will be further addressed in this report; however, the treatment train developed will adequately mitigate the other pollutant loads. As heavy metals will predominately be associated with fine sediment, controls proposed to reduce total suspended solids will also adequately reduce loads of heavy metals.

## 5.2 Water Quality Objectives

The load reduction WQOs presented in **Table 5.1** have been adopted from Appendix 3 of the SPP (2016).

Table 5.1: Water Quality Objectives

| Pollutant | Total Suspended Solids | Total Phosphorus | Total Nitrogen | Gross Pollutants |
|---|---|---|---|---|
| Load Reduction Target | 80% | 60% | 45% | 90% |

## 5.3 Stormwater Quality Management Strategy

To mitigate the potential increase in pollutant loads generated by the development area, a stormwater quality management strategy comprising of various bioretention treatment systems is proposed. The following SQIDs are proposed:

- End-of-Line Bioretention Basins located along the perimeter of each drainage corridor; and
- At-Source Bioretention Pod or Swale systems integrated within road reserves.

Refer to Drawing No. 15-002518-SK13 in **Appendix D** for the stormwater quality catchment delineation and proposed treatment locations.

Due to the multiple site discharge locations, assessment of stormwater quality has been undertaken for runoff discharging from the western drainage corridor and runoff discharging from the eastern drainage corridors.

Bioretention systems utilise sandy loam soil based media to filter runoff. Sediment particles and suspended solids are trapped within vegetation and on the surface of the filter media while micro-organisms and vegetation remove dissolved nutrients (nitrogen and phosphorus) through biological uptake processes. Subsoil drainage provided below the filter media allows for the treated water to discharge from the bioretention systems. Details regarding the maintenance of the bioretention systems are presented in **Section 5.6**.

## 5.4 MUSIC Modelling Methodology

*Updated water quality modelling has been undertaken using MUSIC Version 6.3. MUSIC enables the user to conceptualise the transfer of pollutants through a stormwater drainage system and provides an aid in quantifying the effectiveness of the proposed stormwater quality treatment train. MUSIC only provides quantitative modelling for Total Suspended Solids (TSS), Total Phosphorous (TP), Total Nitrogen (TN) and Gross Pollutants (GP).*

*The updated MUSIC model was setup in accordance with Healthy Land & Water MUSIC Modelling Guidelines (2018).*

### 5.4.1 Meteorological Data

Six-minute pluviographic data was sourced from the eWater website for Greenbank Thompson Road (Station No. 040659).

*In accordance with Table A1.1 from the Music Modelling Guidelines (2018), the 10-year period from 1 January 1980 to 31 December 1989 has been adopted for the rainfall duration. The mean annual rainfall for this period based on 6-minute pluviograph data is 784mm.*

*Monthly Mean Potential Evapotranspiration (PET) data for the Greenbank Thompson Road Station also provided in Table A1.1 has been input into the model.*

### 5.4.2 Source Nodes

Source nodes represent catchments areas for MUSIC modelling purposes. The split catchment approach has been used in accordance with the MUSIC Modelling Guidelines (2010), which divides each catchment into three types of surfaces: Roof, Road and Ground. Refer to Calibre Drawing No. 16-002518-SK13 in **Appendix D** for MUSIC modelling catchment delineation.

*Rainfall runoff and pollutant export parameters were assigned for the different land use areas in accordance with Table A1.2 and Table B1.3 of the MUSIC Modelling Guidelines (2018).*

*The Impervious Percentage assumptions presented in **Table 5.2** have been adopted in generally in accordance with Table B1.1 of the MUSIC Modelling Guidelines (2018). A higher than recommended value for impervious percentage has been conservatively adopted for road area.*

Table 5.2: Land Use Impervious Percentage Values

| Land Use | Impervious Percentage |
|---|---|
| Roof | 100% |
| Road Reserve | 90% |
| Ground (includes park areas) | 25% |

The source node areas presented in **Table 5.3** were implemented in MUSIC modelling. Refer to **Appendix C** for MUSIC model data.

It is noted that only the development footprint areas (including parks and sports fields) have been included in the MUSIC analyses. Undeveloped areas, particularly those within the drainage corridors and upstream external catchments have been excluded from the MUSIC analysis. Refer to Drawing No. 15-002518-SK13 in **Appendix D** for the MUSIC catchment delineation. The catchment naming convention has been adopted to align with the stormwater quantity catchments identified in **Section 3** of this report for consistency.

Table 5.3: MUSIC Source Nodes

| MUSIC Catchment | Total Area (ha) | Road (ha) | Roof (ha) | Ground (ha) |
|---|---|---|---|---|
| 5A | 4.933 | 1.333 | 0.573 | 3.027 |
| 5B | 4.894 | 0.882 | 0.541 | 3.471 |
| 5C | 6.823 | 1.290 | 0.640 | 4.893 |
| 5D | 3.545 | 1.376 | 0.268 | 1.901 |
| 6B | 2.719 | 0.860 | 0.489 | 1.370 |
| 6C | 6.964 | 2.473 | 1.111 | 3.381 |
| 7B1 | 2.615 | 0.968 | 0.379 | 1.269 |
| 7B2 | 1.638 | 0.667 | 0.247 | 0.724 |
| 7B3 | 2.051 | 0.495 | 0.444 | 1.113 |
| 7B4 | 1.242 | 0.452 | 0.199 | 0.592 |
| 7B5 | 2.829 | 0.946 | 0.517 | 1.366 |
| 9A | 5.762 | 1.398 | 1.845 | 2.519 |
| 11B | 11.331 | 3.035 | 3.375 | 4.921 |
| 11C1 | 1.896 | 0.645 | 0.351 | 0.900 |
| 11C2 | 4.303 | 1.591 | 0.863 | 1.849 |
| 11C3 | 5.353 | 1.634 | 0.996 | 2.723 |
| 11D1 | 3.940 | 1.335 | 1.465 | 1.140 |
| 11D2 | 4.700 | 1.462 | 1.731 | 1.507 |
| 11D3 | 3.425 | 1.076 | 1.304 | 1.045 |
| 12B1 | 2.200 | 0.774 | 0.380 | 1.047 |
| 12B3 | 3.254 | 1.204 | 0.568 | 1.481 |
| 12B4 | 1.612 | 0.581 | 0.267 | 0.764 |
| 14B | 3.420 | 1.290 | 0.434 | 1.696 |
| 14C | 5.437 | 2.066 | 1.461 | 1.910 |
| 20B1 | 3.125 | 1.097 | 0.558 | 1.470 |
| 20B2 | 5.304 | 1.935 | 0.809 | 2.560 |
| 21A | 2.052 | 0.430 | 0.343 | 1.279 |

### 5.4.3 Drainage Links

*Default drainage link settings have been adopted for the model. MUSIC default settings apply a conservative approach in assessing treatment performance, assuming all flows and pollutants from the catchment arrive at the treatment node at the same time.*

### 5.4.4 Treatment Nodes

#### Bioretention Treatment

*Bioretention treatment was modelled with the filter areas presented in **Table 5.4**. For Bioretention Pods and Swales the filter areas presented are the total filter area within each catchment that as been proportionally split across multiple elements.*

Table 5.4: Bioretention Filter Areas & Depths

<table>
<tr><th>MUSIC Catchment</th><th>Basin Filter Area (m²)</th><th>Basin Filter Depth (mm)</th><th>Swale Filter Length (m)A</th><th>Swale Filter Area (m²)</th><th>Swale Filter Depth (mm)</th><th>Pod Filter Area (m²)</th></tr>
<tr><td>5A</td><td rowspan="2">700</td><td rowspan="2">400</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5C</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5B</td><td rowspan="2">330</td><td rowspan="2">500</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5D</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6B</td><td rowspan="2">1000</td><td rowspan="2">500</td><td>125</td><td>112.5</td><td>400</td><td></td></tr>
<tr><td>6C</td><td>45</td><td>37.5</td><td>400</td><td></td></tr>
<tr><td>7B1</td><td rowspan="5">810</td><td rowspan="5">400</td><td>150</td><td>100</td><td>400</td><td></td></tr>
<tr><td>7B2</td><td>290</td><td>75</td><td>400</td><td></td></tr>
<tr><td>7B3</td><td>350</td><td>105</td><td>400</td><td></td></tr>
<tr><td>7B4</td><td>200</td><td>217.5</td><td>400</td><td></td></tr>
<tr><td>7B5</td><td>100</td><td>37.5</td><td>400</td><td></td></tr>
<tr><td>9A</td><td></td><td></td><td>20</td><td></td><td>750</td><td>359</td></tr>
</table>

<table>
<tr><th>MUSIC Catchment</th><th>Basin Filter Area (m²)</th><th>Basin Filter Depth (mm)</th><th>Swale Filter Length (m)^A</th><th>Swale Filter Area (m²)</th><th>Swale Filter Depth (mm)</th><th>Pod Filter Area (m²)</th></tr>
<tr><td>11B</td><td></td><td></td><td>243</td><td>219</td><td>500</td><td>459</td></tr>
<tr><td>11C1</td><td>526</td><td>400</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11C2</td><td>365</td><td>400</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11C3</td><td>735</td><td>400</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11D1</td><td>371</td><td>500</td><td></td><td></td><td></td><td>224</td></tr>
<tr><td>11D2</td><td></td><td></td><td></td><td></td><td></td><td>263</td></tr>
<tr><td>11D3</td><td>560</td><td>500</td><td></td><td></td><td></td><td>37.5</td></tr>
<tr><td>12B1</td><td rowspan="3">350</td><td rowspan="3">400</td><td>110</td><td>55</td><td>400</td><td></td></tr>
<tr><td>12B3</td><td></td><td></td><td></td><td>224</td></tr>
<tr><td>12B4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14B</td><td>550</td><td>400</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14C</td><td>500</td><td>400</td><td></td><td></td><td></td><td>234</td></tr>
<tr><td>20B1</td><td rowspan="2">350</td><td rowspan="2">400</td><td>200</td><td>60</td><td>400</td><td></td></tr>
<tr><td>20B2</td><td>250</td><td>90</td><td>400</td><td></td></tr>
</table>

^A It is noted that effective swale length has been incorporated into the configuration of the MUSIC model.
A Filter depth of 500mm has been adopted for all Bioretention Pods.

*Extended Detention Depths were applied across all Bioretention nodes as indicated in **Table 5.5**.*

Table 5.5: Adopted Bioretention Filter Extended Detention Depth

| Bioretention System | Extended Detention Depth (mm) |
|---|---|
| Basin | 300 |
| Swales | 0 |
| Pods | 200 |

*The following parameters were applied consistently across all bioretention nodes:*

*Overflow Weir Width set to the surface area of the filter divided by 10 in accordance with Table 4.6 of the MUSIC Modelling Guidelines (2018);*

- *50mg/kg filter media Orthophosphate content;*
- *400mg/kg filter media TN content; and*
- *200mm/hr filter media saturated hydraulic conductivity.*

## 5.5 MUSIC Modelling Results

Updated results for the proposed stormwater quality management strategies are presented in **Table 5.6**, **Table 5.7** and **Table 5.8**.

Table 5.6: MUSIC Model Results for Western Drainage Corridor

| Description | TSS | TP | TN | GP |
|---|---|---|---|---|
| WQO (%) | 80 | 60 | 45 | 90 |
| Source Loads (kg/yr) | 27,400 | 57 | 344 | 4,620 |
| Residual Loads (kg/yr) | 4,260 | 13.8 | 163 | 0 |
| Load Reduction Achieved (%) | 84.4 | 75.8 | 52.7 | 100 |
| Load Reduction Achieved > WQO? | YES | YES | YES | YES |

Table 5.7: MUSIC Model Results for Eastern Drainage Corridor

| Description | TSS | TP | TN | GP |
|---|---|---|---|---|
| WQO (%) | 80 | 60 | 45 | 90 |
| Source Loads (kg/yr) | 55,400 | 112 | 641 | 8,530 |
| Residual Loads (kg/yr) | 10,700 | 32.8 | 340 | 349 |
| Load Reduction Achieved (%) | 80.6 | 70.8 | 47 | 95.9 |
| Load Reduction Achieved > WQO? | YES | YES | YES | YES |

Table 5.8: Combined MUSIC Model Results

| Description | TSS | TP | TN | GP |
|---|---|---|---|---|
| WQO (%) | 80 | 60 | 45 | 90 |
| Source Loads (kg/yr) | 82,700 | 170 | 986 | 13,200 |
| Residual Loads (kg/yr) | 15,000 | 46.6 | 503 | 349 |
| Load Reduction Achieved (%) | 81.9 | 72.5 | 49 | 97.3 |
| Load Reduction Achieved > WQO? | YES | YES | YES | YES |

The above results demonstrate that the proposed stormwater quality management strategy achieves the WQOs required under the SPP (2016).

## 5.6 Construction & Operational Management of SQIDs

The following sections provide detail of the procedures to be adopted for the construction and operational management of the bioretention pods. No testing or monitoring of water quality is proposed. The level of operation management and maintenance proposed from herein is considered best practice and if followed will ensure these treatment devices will operate to their design intent.

### 5.6.1 Construction & Establishment

For bioretention systems to perform as designed there is a need to protect filter media and vegetation during construction. A staged construction and establishment methodology is therefore proposed generally in accordance with Option 1 of Table 3.6 and Section 3.8.1 of the Water by Design Construction and Establishment Guidelines (2010). A summary of this methodology is presented below:

1. Civil Works (Functional Installation) – Earthworks and shaping to create the layout and functional elements of the bioretention systems will be undertaken as part of the civil works phase. The installation of these functional elements (e.g. inlets, outlets structures, subsoil drainage, transition layers and filter media) shall be undertaken as per the methodology detailed in Section 3.9.1 in the Water by Design Construction and Establishment Guidelines (2010). Prior to the commencement of the following phase, sediment fences will be erected around the perimeter of the systems to avoid the entry of sediment. Laying a temporary filter cloth (or 25mm thick layer of course sand, 25mm of topsoil and followed by a layer of turf) over the pod shall protect the bioretention systems during the construction and building phases.
2. Building Phase Protection (Building Construction) – During this phase the sediment fences shall remain around the perimeter of the systems to restrict sediment inflow. Clear indications of the restriction of traffic to the bioretention systems shall also be displayed.
3. Landscape Establishment (Operational Establishment) – Remove the temporary protective measures and remove any accumulation of sediment when the Building Phase is 80-90% complete. The systems shall be planted with vegetation and landscaping as proposed. Sufficient watering and removal of weeds shall be undertaken. This phase shall be performed in accordance with Section 3.9.3 of the Water by Design Construction and Establishment Guidelines (2010).

### 5.6.2 Operational Phase Management & Maintenance

Once the bioretention systems are installed, they must be inspected and maintained at recommended intervals to ensure they are functioning properly and satisfy the design intent. The following sections provide a summary of the maintenance requirements.

#### Inspection Requirements

Checklists have been developed for maintenance inspection of bioretention systems. The condition and maintenance carried out will be recorded on the checklist at the time the inspection and/or maintenance is undertaken. A copy of the checklist is presented in **Appendix C**.

Maintenance personnel are to be encouraged to report and document changes in vegetation type within bioretention systems. Photographic documentation and mapping of vegetation types are to be recorded annually to determine changes in vegetation over time. Photographs of each device are to be taken at the same location annually. Through these procedures a reliable maintenance database can be developed and used to determine if the maintenance undertaken is ensuring that the bioretention systems are functioning as intended.

It should be noted that except for periods of extended wet weather, mosquitoes are unlikely to be an issue as surface water within the bioretention systems is not expected to remain for more than one day.

### Weed Removal

Maintenance personnel will need to identify species of both terrestrial and semi-aquatic weeds common to the area. As the bioretention systems are “dry” SQIDs, aquatic weed infestation is unlikely. When weeds have been identified they are to be removed by hand immediately or eradication methods scheduled before the infestation becomes larger and more difficult to control. It should be noted that herbicides should not be used in the removal of invasive weeds as this has negative impacts on downstream water quality.

### Replanting

Replanting of vegetation is to be carried out to replace dead or damaged vegetation, vegetation that has been removed by scour or erosion, or vegetation that is being re-planted following tilling or the replacement of filter media. Removed vegetation should be replaced by plants of similar size and species, or as indicated on the appropriate Landscaping Plans.

### Filter Inspection & Replacement

Fine sediment and silt may accumulate within the filter media of the bioretention systems over time. Removal of sediment and silt trapped within the filter media is expected to be the most costly maintenance requirement for these SQIDs.

It is recommended that visual inspection of the infiltration properties be undertaken at least three times per year with more frequent inspections no greater than three months apart between October and May. This is to determine whether built-up fine sediment and silt has reached a point where the filter media has become clogged.

The infiltration properties of the filter media of each bioretention system needs to be checked after a period of significant rainfall event, which is defined as a 24 hour period with rainfall greater than 200mm, or a shorter period with an average rainfall intensity greater than 20mm/hr. This is an ideal period to assess the infiltration properties as water should not pond for an extended period. Therefore, inspections should occur within 24 hours after a suitable rainfall event.

In the event that isolated boggy patches occur within a pod, or a pod remains saturated for an extended period, then the subsoil drainage pipes may be blocked. If this is not the case and no other blockages have been observed then surface of the media is to be tilled (raked and aerated) to a depth of 150mm. This will require temporarily removing and storing the surface vegetation and topsoil (if present) prior to tilling the filter media surface. Should the infiltration properties be improved then the removed topsoil layer can once again be established and vegetation replanted.

Should tilling prove unsuccessful or if an infiltration check indicates filter media may be clogged, then the top portion of the filter media is to be replaced as follows:

1. Removal of topsoil, surface vegetation and store for re-establishment;
2. Remove the top 150mm of filter media and dispose of in an approved manner;
3. Till the remaining filter media to a further depth of 300mm;
4. Place a new layer of appropriate filter media as per relevant specifications, free from organic matter, clay and silt; and
5. Replace the topsoil and replant the removed vegetation.

If blockages occur frequently, a filter media with a higher saturated hydraulic conductivity should be considered. Reassessing the species and planting density of vegetation is also an option.

Unless changes to the filter media specification are made through a review of the SQID performance, the filter media to be used for the bioretention pod is to be a Sandy Loam as per the FAWB Guidelines for Filter Media in Biofiltration Systems (Version 3.01, 2009) as included in **Appendix C**.

### Subsoil Drainage Inspection & Cleanout

The build-up of fine sediment and silt within the subsoil drainage pipes is unlikely as it will be trapped by the filter media. However, the subsoil drainage is to be checked annually for blockages that may be caused by foreign matter entering through cleanout inspection openings or by small fauna. This can be done by either:

- Observing the condition of the subsoil drain through the cleanout and inspection openings located towards the downstream end of a subsoil drainage pipe;

- Observing the amount of sediment and silt flushed into the downstream field inlet when water is pumped into the upstream end of the subsoil drainage line (through a cleanout and inspection opening).

If a considerable amount of sediment and silt is observed or carried into the downstream inlet, then each subsoil drainage line must be flushed out with high pressure water. Water is to be pumped into each subsoil drainage pipe through the upstream cleanout inspection opening until all sediment has been ejected from the pipe. To collect the water and ejected sediment within the downstream pit a temporary barrier is to be placed over the downstream pipe opening (such as sand bags) and a pump used to draw the water, sediment and silt out of the pit and irrigated onto areas of open space away from each pod. This will ensure the sediment and silt does not enter the downstream waterway.

### 5.6.3 General Requirements

#### Yearly Review of Maintenance Management Plan

Each year a review is to be carried out to determine if the programmed inspection and maintenance (including checklists) is ensuring each SQID is functioning as intended. The review should include an assessment of the maintenance database to determine whether the programmed inspections and maintenance is effective. Information on the database should be assessed to determine whether any noticeable changes are evident in vegetation, presence of fauna and operational efficiency of any structures or features of the device. This will further provide indicators as to whether sufficient information is being recorded for management purposes.

#### Maintenance Personnel Safety (OH&S)

The Workplace Health and Safety ACT 1995 requires that all reasonably practicable steps be taken to protect an employee's health in a workplace. Organisations involved in the inspection and maintenance of the SQIDs should therefore:

- Have a documented occupational health and safety policy in place;
- Ensure all staff and maintenance personnel are aware of and abide by the policy; and
- The policy provides a mechanism for review and improvement.

As part of the policy personnel involved in the maintenance of the SQIDs are to have sufficient resources (such as personnel protective equipment, training etc.) to carry out the task in a safe manner.

#### General Public Safety

The safety of the general public in the area of the SQID being maintained also needs to be ensured. Given that inspection and maintenance tasks will to some degree encroach on resident's lot access sufficient notice and safety precautions are warranted and must be followed. This includes, but is not limited to:

- Issuing letter notices to residents 3-4 days prior to inspection and maintenance
- Placing safety barriers around maintenance site (including the road, if required)
- Placing warning signage appropriately at key locations around the maintenance sites (these are not to be removed until all works have finished).

# 6 Waterway Stability Management

*For waterway stability management details of flood conditions and times of inundation have been updated to take into account changes to the hydrological and hydraulic analysis since the original report.*

This section discusses the waterway stability management required under the SPP (2016). This waterway stability management strategy will demonstrate that the receiving drainage corridors on site and Oxley Creek downstream will not be adversely impacted in the 63% AEP storm event.

## 6.1 Drainage Corridor Assessment

Hydrological analyses presented within **Section 3** of this report demonstrates a negligible increase in 63% AEP peak flow discharge from the site. Additionally, reductions in peak flow are evident for all design storm events (including the 63% AEP) at the downstream extent of the investigation area (downstream of Hobury Road; upstream of Oxley Creek). Therefore, it is expected that a negligible change in flood condition will be experienced at Oxley Creek.

Although the 63% AEP peak flows increase along the drainage corridors within the site, modelling indicates flow velocities will predominately decrease. Refer to **Table 6.1**. There are a few concentrated locations where the 63% AEP velocity has increased. Locations of increased velocities are associated with culvert outlets and inflow locations as shown on Drawing No. 16-002518-SK12 in **Appendix D**. Appropriately sized energy dissipation in the form of rip-rap at the downstream end of proposed culverts will be installed to mitigate the erosive forces of concentrated flows at culvert outlets. In reality, peak flow concentrations are not expected to occur at HEC-RAS inflow locations. Irrespective of the increases in velocity, the maximum velocity in the waterways for developed conditions is still below 1.5m/s, which is not expected to have the potential to cause scour or erosion.

Table 6.1: Waterway Stability Management 63% AEP Developed Flood Conditions

| River - Reach | HEC-RAS Cross Section | Existing Average Velocity (m/s) | Developed Average Velocity (m/s) | Variance (%) |
|---|---|---|---|---|
| West – 40 | 864 | 0.46 | 0.42 | -9% |
| West – 40 | 813 | 0.65 | 0.53 | -18% |
| West – 40 | 752 | 0.53 | 0.53 | 0% |
| West – 40 | 711 | 0.63 | 0.48 | -24% |
| West – 40 | 661 | 0.39 | 0.12 | -69% |
| West – 40 | 594 | 0.63 | 0.03 | -95% |
| West – 40 | 574 | 0.74 | 0.05 | -93% |
| Western Culvert Crossing | | | | |
| West – 40 | 519 | 0.44 | 0.58 | 32% |
| West – 40 | 488 | 0.74 | 0.59 | -20% |
| West – 40 | 438 | 0.42 | 0.54 | 29% |
| West – 40 | 413 | 0.72 | 0.52 | -28% |
| West – 40 | 352 | 0.42 | 0.50 | 19% |
| West – 40 | 297 | 1.20 | 0.67 | -44% |
| West – 40 | 246 | 0.61 | 0.61 | 0% |
| West – 40 | 219 | 0.77 | 0.85 | 10% |
| West – 40 | 201 | 0.73 | 0.73 | 0% |
| West – 40 | 153 | 0.99 | 0.83 | -16% |
| West – 40 | 102 | 0.47 | 0.46 | -2% |
| West – 40 | 69 | 0.47 | 0.52 | 11% |
| West – 40 | 40 | 0.66 | 0.68 | 3% |
| East – 21 | 393 | 0.43 | 0.82 | 91% |
| East – 21 | 342 | 0.46 | 0.84 | 83% |
| East – 21 | 309 | 0.37 | 0.43 | 16% |
| East – 21 | 269 | 0.51 | 0.49 | -4% |
| East – 21 | 219 | 0.50 | 0.52 | 4% |
| East – 21 | 169 | 0.55 | 0.53 | -4% |
| East – 21 | 119 | 0.60 | 0.59 | -2% |
| East – 21 | 69 | 0.51 | 0.53 | 4% |
| East – 21 | 45 | 0.51 | 0.49 | -4% |
| East – 21 | 28 | 0.50 | 0.48 | -4% |
| East – 21 | 21 | 1.00 | 0.35 | -65% |
| East – 630 | 1154 | 0.34 | 0.40 | 18% |
| East – 630 | 1104 | 0.50 | 0.51 | 2% |

| River - Reach | HEC-RAS Cross Section | Existing Average Velocity (m/s) | Developed Average Velocity (m/s) | Variance (%) |
|---|---|---|---|---|
| East – 630 | 1054 | 0.43 | 0.52 | 21% |
| East – 630 | 1004 | 0.44 | 0.39 | -11% |
| East – 630 | 970 | 0.40 | 0.87 | 118% |
| East – 630 | 939 | 0.43 | 0.27 | -37% |
| Eastern Culvert Crossing A | | | | |
| East – 630 | 874 | 0.41 | 0.47 | 15% |
| East – 630 | 850 | 0.37 | 0.54 | 46% |
| East – 630 | 798 | 0.64 | 0.67 | 5% |
| East – 630 | 748 | 0.43 | 0.55 | 28% |
| East – 630 | 698 | 1.14 | 0.62 | -46% |
| East – 630 | 657 | 0.32 | 0.42 | 31% |
| East – 630 | 646 | 0.34 | 0.52 | 53% |
| East – 630 | 637 | 0.47 | 0.46 | -2% |
| East – 630 | 630 | 0.54 | 0.39 | -28% |
| East – 0 | 593 | 0.48 | 0.57 | 19% |
| East – 0 | 585 | 0.46 | 0.59 | 28% |
| East – 0 | 536 | 0.94 | 1.14 | 21% |
| East – 0 | 507 | 0.89 | 0.47 | -47% |
| Eastern Culvert Crossing B | | | | |
| East – 0 | 444 | 0.52 | 0.46 | -12% |
| East – 0 | 417 | 0.61 | 0.58 | -5% |
| East – 0 | 367 | 0.74 | 0.47 | -36% |
| East – 0 | 326 | 0.61 | 0.28 | -54% |
| East – 0 | 270 | 0.67 | 0.14 | -79% |
| East – 0 | 234 | 0.63 | 0.09 | -86% |
| Eastern Culvert Crossing C | | | | |
| East – 0 | 190 | 0.64 | 0.54 | -16% |
| East – 0 | 161 | 0.64 | 0.65 | 2% |
| East – 0 | 132 | 0.89 | 1.24 | 39% |
| East – 81 | 594 | 0.69 | 0.44 | -36% |
| East – 81 | 544 | 0.57 | 0.42 | -26% |
| East – 81 | 494 | 0.33 | 0.44 | 33% |
| East – 81 | 444 | 0.80 | 0.45 | -44% |
| East – 81 | 391 | 0.24 | 0.41 | 71% |
| East – 81 | 338 | 0.86 | 0.54 | -37% |
| East – 81 | 290 | 0.43 | 0.49 | 14% |
| East – 81 | 239 | 0.80 | 0.46 | -43% |
| East – 81 | 187 | 0.51 | 0.56 | 10% |
| East – 81 | 131 | 0.65 | 0.63 | -3% |

Furthermore, increase in inundation extent throughout the drainage corridor during the 63% AEP storm event is negligible, except for upstream of the culvert crossings where detention is proposed. Refer to **Figure 6.1** for 63% AEP flood extent changes.

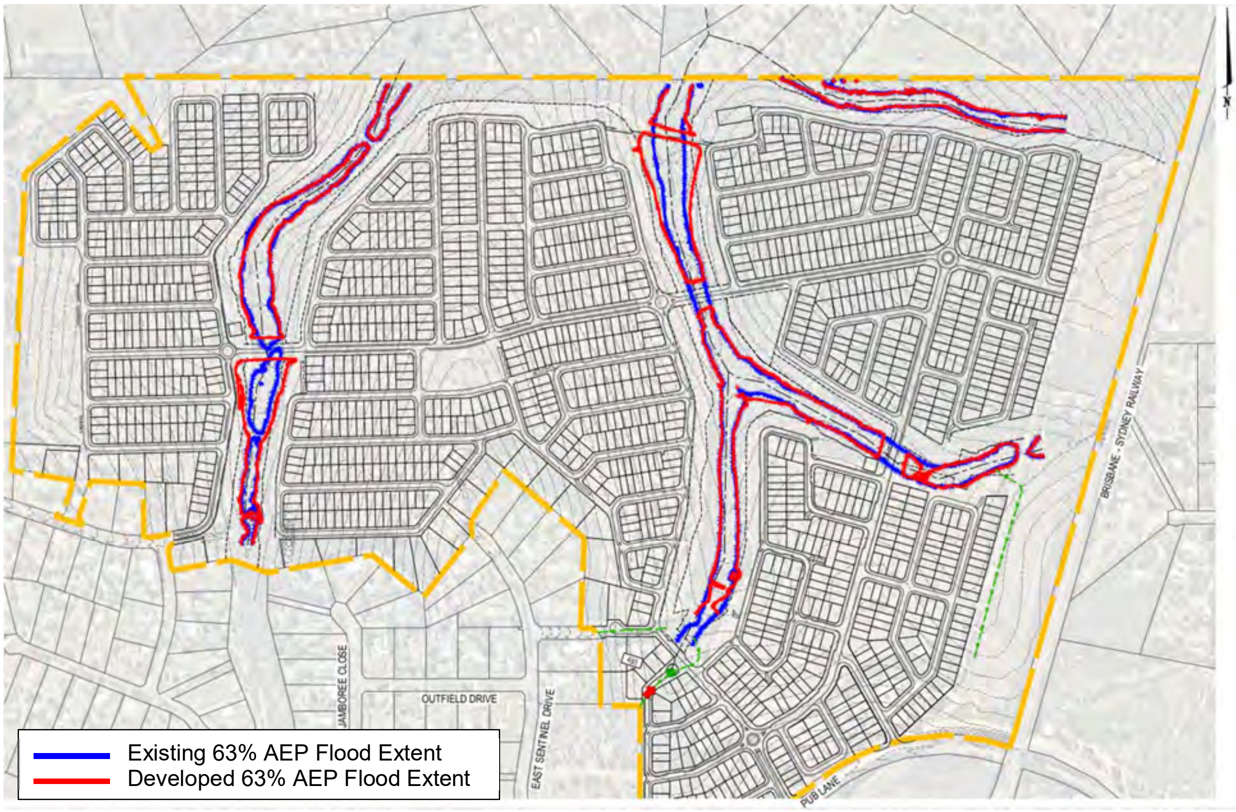



Figure 6.1: 63% AEP Flood Extent

## 6.2 Detention Basin Inundation

*The time of inundation within the detention basins for the 63% AEP have been assessed to demonstrate that vegetation will not be adversely inundated.* ***Figure 6.2*** *shows an updated chart of the detention characteristics over a 9-hour period at the upstream end of the western crossing. As can be seen, ponding depth of greater than 300mm occurs for a period less than three hours.*

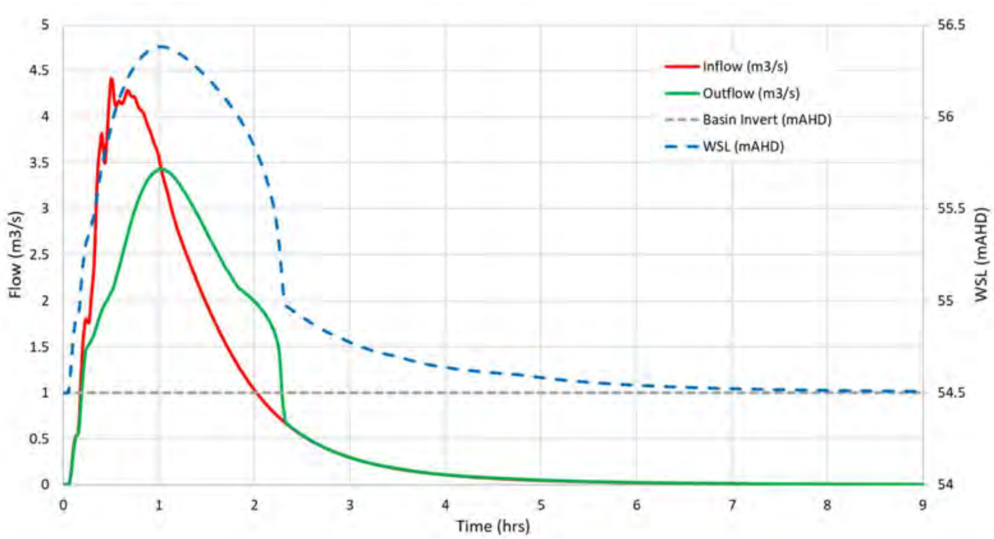



Figure 6.2: Western Crossing 63% AEP Inundation

***Figure 6.3** shows a graph of the detention characteristics over a 5-hour period at the upstream of Eastern Crossing A. As can be seen, the crossing provides minimal detention for the 63% AEP event and ponding depth of greater than 300mm occurs for less than 1 hour.*

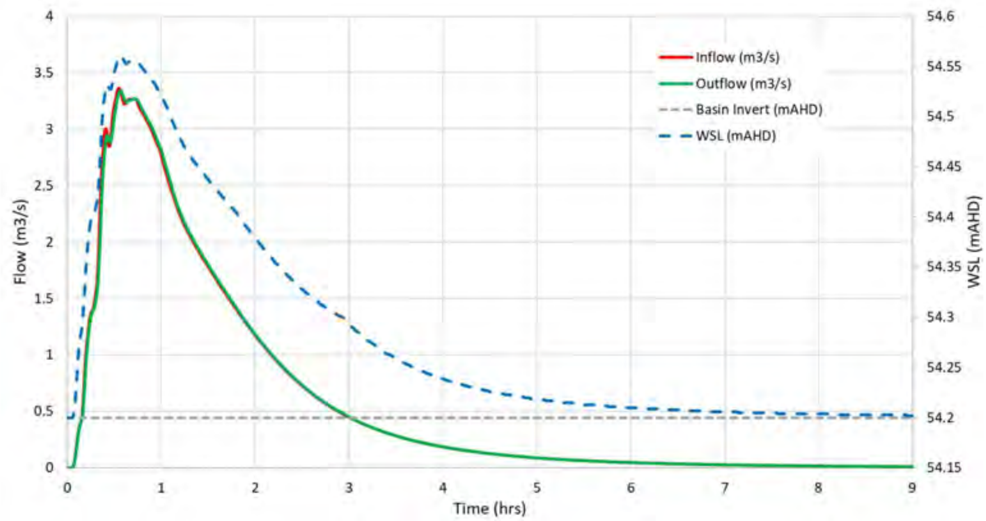



Figure 6.3: Eastern Crossing A 63% AEP Inundation

*Similarly, **Figure 6.4** and **Figure 6.5** show graphs of the detention characteristics over a 9-hour period at the upstream of Eastern Crossing A and B, respectively. Eastern Crossing B provides no detention for the 63% AEP event and ponding depth of greater than 300mm for a period of approximately 1.5 hours.*

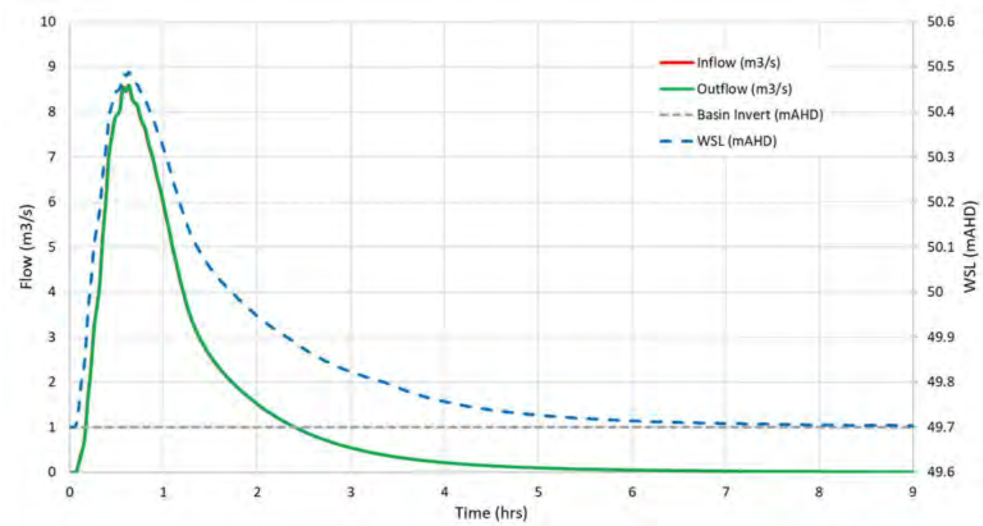



Figure 6.4: Eastern Crossing B 63% AEP Inundation

*Eastern Crossing C however provides significant detention as shown in **Figure 6.5**, however ponding depth of greater than 300mm occurs for less than 3 hours.*

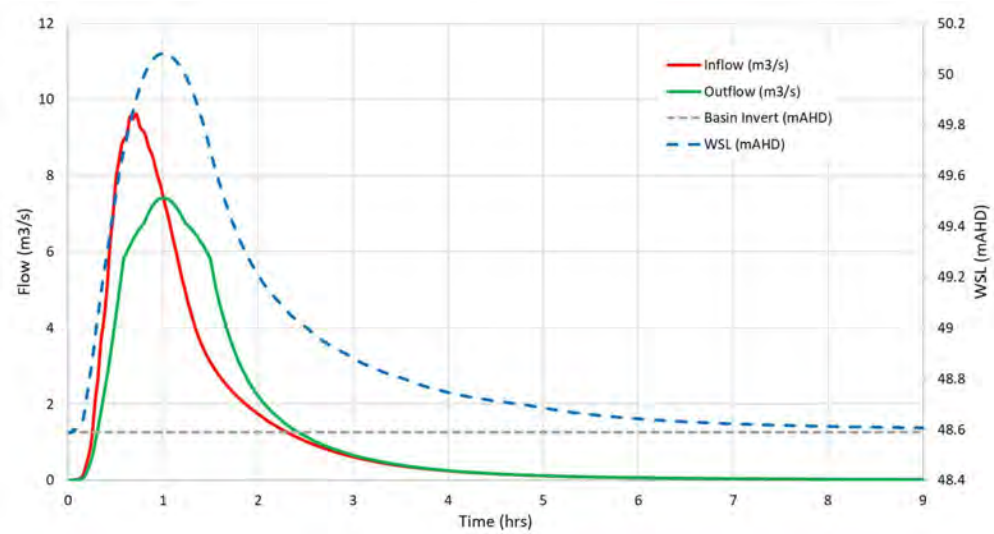



Figure 6.5: Eastern Crossing C 63% AEP Inundation

> *The inundation times during the 63% AEP event at each of the detention basins are not expected to cause adverse impacts to the vegetation within the drainage corridors.*

As such, an appropriate performance based outcome established on modelled velocity and time of inundation has been provided for waterway stability management.

# 7 Conclusion

Calibre Professional Services Pty Ltd has prepared this updated Concept Stormwater Management Plan and Flood Investigation for the proposed Teviot Village Development within the Greater Flagstone PDA.

The original Concept Stormwater Management and Flood Investigation Report (No. 16-002518-02A dated December 2016) was prepared to support Development Application the then proposed Teviot Village Development. The DA and report was subsequently approved and the management strategies incorporated into detailed design.

This updated report (No. 16-002518-02C) has been prepared to provide an update to the flooding and stormwater management strategies now required to incorporate development changes, in particular changes to the layout and increase in yield proposed within Stages 7 to 27 (excluding Stages 17 and 18 that have been constructed).

The following summarises the outcomes of the updated investigation and analysis.

## 7.1 Stormwater Quantity

Updated XP-RAFTS hydrological modelling undertaken for the developed mitigated scenario, together with the existing scenario results (previously undertaken) demonstrates that with minor changes to the mitigation measures (online detention storage at drainage corridor crossings) peak flow increases at the downstream site boundary can be eliminated. As such, no adverse impacts or actionable nuisances will occur to downstream properties. The following updated crossing configurations provide the online detention:

- Western Crossing:
  - 1 x 1200mm x 600 RCBC and primary culvert and 1 x 2400mm x 900 RCBC secondary culvert;
  - Minimum embankment level at 57.15m AHD; and
  - Detention Volume of 10,220m3
- Eastern Crossing A:
  - 5 x 1800mm x 600mm RCBC primary culverts (unchanged from original report);
  - Minimum embankment level at 56.9m AHD (unchanged from original report); and
  - Detention Volume of 16.210m3
- Eastern Crossing B:
  - 3 x 2400mm x 900mm RCBC primary culverts;
  - Minimum embankment level of 53.7m AHD; and
  - Detention Volume of 44,210m3
- Eastern Crossing C:
  - 4 x 900mm RCP primary culverts and 6 x 1500mm x 600mm RCBC secondary culverts;
  - Minimum embankment level of 51.0m AHD; and
  - Detention Volume of 19,330m3

## 7.2 Flooding

HEC-RAS steady state (one-dimensional) hydraulic analyses determined the existing and developed scenario flood characteristics for the 1% AEP storm event. 1% AEP flood levels increases are generally maintained within the site.

Flood immunity levels for habitable floor levels have been nominated and confirmed via sensitivity scenarios.

## 7.3 Stormwater Quality

The updated stormwater quality management strategy now comprises bioretention swales in addition to ‘end-of-line’ bioretention basins within the waterway corridors and at source bioretention pods (already constructed). Updated MUSIC modelling has confirmed the adequacy of the proposed bioretention systems in meeting the WQOs required under the SPP (2016).

The construction and operational management strategy presented will ensure the bioretention systems continue to operate to their design intent.

### 7.4 Waterway Stability Management

Waterway stability management analyses has been updated to take into account changes to the hydrological and hydraulic analysis since the original report. The updated analysis has determined the following:

- Hydrological modelling results for the 63% AEP storm event indicates negligible increases in peak flow at the downstream site boundary and peak flow reductions further downstream prior to conveyance to Oxley Creek;
- Reductions in average velocities throughout the drainage reserves within the site, with maximum developed velocities less than 1.5m/s, which are not expected to cause scour or erosion; and
- Inundation times at the online detention basins during the 63% AEP storm event are not expected to adversely affect the vegetation.

The above outcomes address the waterway stability management requirement specified in the SPP (2016).

The above outcomes demonstrate there are solutions for managing stormwater and flooding associated with the development. During subsequent phases, further analyses will be required for all the strategies presented.

## 8 Recommendation

It is recommended that this updated Concept Stormwater Management Plan and Flood Investigation be approved and the management strategies presented within this report be incorporated into design of the remaining stages of the development. Future design may result in changes to the concepts, however the design objectives are to be maintained.

## 9 References


- Department of Energy and Water Supply (31 October 2013), *Queensland Urban Drainage Manual* (Vol. 1 3rd Ed.).
- Department of State Development, Infrastructure and Planning (2016 & 2017), *State Planning Policy*.
- EDQ (May 2015) *Guideline 15 Protection from Flood and Storm*.
- Greater Flagstone Urban Development Area Development Scheme dated October 2011.
- Healthy Waterways (2010), *Water Sensitive Urban Design Technical Design Guidelines*.
- Healthy Land & Water (2018), *MUSIC Modelling Guidelines Version*.
- Institution of Engineers, Australia (1987), *Australian Rainfall and Runoff*.
- US Army Corps of Engineers (2010), *HEC-RAS River Analysis System – Hydraulic Reference Manual* v4.1.


## 10 Disclaimer

This report has been prepared on behalf of and for the exclusive use of Villa Green Ltd and is subject to and issued in accordance with the agreement between Calibre Professional Services Pty Ltd.

Our investigation and analysis has been specifically catered for the particular requirements of Villa Green Ltd and may not be applicable beyond this scope. For this reason, any other third parties are not authorised to utilise this report without further input and advice from Calibre Professional Services Pty Ltd.

Calibre Professional Services Pty Ltd accepts no liability or responsibility whatsoever for the report in respect of any use of or reliance upon this report by any third party.

The investigation and analysis has relied on information provided by others. We accept no responsibility for accuracy of material supplied by others. The accuracy of the investigation, analysis and report is dependent upon the accuracy of this information.

TEVIOT VILLAGE CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION -

# Appendix A Site Layout

VILLA GREEN PTY LTD


# Legend

## General

- Site Boundary
- Stage Boundary
- Indicative External Footpath
- Management Lot Area
- In-Line Bus Stop

## Constraints

- 10m Protected Vegetation / Building Exclusion Zone Buffer in Allotment
- Retained Remnant Endangered Regional Ecosystem
- 33m Buffer to Remnant Endangered Regional Ecosystem
- 33m Bushfire Setback
- Developed 1% AEP
- 50m Buffer to Sewer Pump Station

## Yield Breakdown

| Residential Allotments | Typical Allotment Size | | Overall | |
|---|---|---|---|---|
| | Dimension | Area | Yield | % |
| **28m Deep Allotments** | | | | |
| Villa Allotment | 10.5 x 28m | 294m² | 39 | 2.5% |
| Premium Villa Allotment | 12.5 x 28m | 350m² | 463 | 29.6% |
| Courtyard Allotment | 14 x 28m | 392m² | 389 | 24.9% |
| Premium Courtyard Allotment | 16 x 28m | 448m² | 71 | 4.5% |
| **Sub Total 28m Deep Allotments** | | | **962** | **61.5%** |
| **30m Deep Allotments** | | | | |
| Villa Allotment | 10.5 x 30m | 315m² | 33 | 2.1% |
| Premium Villa Allotment | 12.5 x 30m | 375m² | 228 | 14.6% |
| Courtyard Allotment | 14 x 30m | 420m² | 193 | 12.3% |
| Premium Courtyard Allotment | 16 x 30m | 480m² | 38 | 2.4% |
| Traditional Allotment | 20 x 30m | 600m² | 3 | 0.2% |
| **Sub Total 30m Deep Allotments** | | | **495** | **31.6%** |
| **32m Deep Allotments** | | | | |
| Villa Allotment | 10.5 x 32m | 336m² | 11 | 0.7% |
| Premium Villa Allotment | 12.5 x 32m | 400m² | 30 | 1.9% |
| Courtyard Allotment | 14 x 32m | 448m² | 35 | 2.2% |
| Traditional Allotment | 20 x 32m | 640m² | 1 | 0.1% |
| Premium Traditional Allotment | 22 x 32m | 704m² | — | 0.0% |
| **Sub Total 32m Deep Allotments** | | | **77** | **4.9%** |
| **Lifestyle Allotments** | | | | |
| Lifestyle Allotment | n/a | 800 - 1999m² | 7 | 0.4% |
| Premium Lifestyle Allotment | n/a | 2000m² + | 24 | 1.5% |
| **Sub Total Lifestyle Allotments** | | | **31** | **2.0%** |
| | | | | |
| **Total Residential Allotments** | | | **1565** | **100.0%** |
| | | | | |
| **Super Lots** | | | | |
| Service Allotments | | | 1 | |

## Land Budget

| Land Use | Overall | |
|---|---|---|
| | Area | % |
| **Area of Subject Site** | **149.9710 ha** | **100.0%** |
| **Saleable Area** | | |
| Residential Allotments | 68.665 ha | 45.8% |
| Service Allotments | 0.127 ha | 0.1% |
| **Total Area of Allotments** | **68.792 ha** | **45.9%** |
| **Road** | | |
| Local Roads | 24.945 ha | 16.6% |
| Collector Roads | 4.666 ha | 3.1% |
| Trunk Collector Roads | 2.450 ha | 1.6% |
| **Total Area of New Road** | **32.061 ha** | **21.4%** |
| **Open Space** | | |
| District Sports Park | 2.825 ha | 1.9% |
| Linear Open Space (Active) | 13.810 ha | 9.2% |
| Linear Open Space (Conservation) | 19.558 ha | 13.0% |
| Neighbourhood Recreation Park | 1.744 ha | 1.2% |
| Pedestrian Linkage / Landscape Treatment | 0.615 ha | 0.4% |
| Existing Easement | 10.566 ha | 7.0% |
| **Total Open Space** | **49.118 ha** | **32.8%** |

**Note:**
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

**Source Information:**
**Site boundaries:** Land Partners.
**Adjoining information:** DCDB.
**Contours:** Calibre.
**Developed 1% AEP:** Calibre.

**PLAN REF:** 132965 – 26
**Rev No:** M
**DATE:** 15 JULY 2021
**CLIENT:** AVID
**DRAWN BY:** JC
**CHECKED BY:** PHE

0 30 60 90 120 150 1 : 3,000 @ A1

# COVELLA
## PLAN OF SUBDIVISION
## ULTIMATE OVERALL ALLOTMENT LAYOUT
## COMBINED APPLICATIONS

AVID Property Group

**URBAN DESIGN**
Level 4 HQ South
520 Wickham Street
PO Box 1559
Fortitude Valley QLD 4006
T +61 7 3539 9500
W rpsgroup.com

## Land Budget

| Land Use | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6 | Stage 7 | Stage 8 | Stage 9 | Stage 10 | Stage 11 | Stage 12 | Stage 13 | Stage 14 | Stage 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area |
| **Area of Subject Site** | **5.528 ha** | **4.370 ha** | **4.007 ha** | **6.947 ha** | **4.460 ha** | **4.232 ha** | **6.102 ha** | **6.050 ha** | **4.922 ha** | **3.361 ha** | **8.259 ha** | **7.124 ha** | **7.130 ha** | **3.137 ha** | **6.446 ha** |
| **Saleable Area** | | | | | | | | | | | | | | | |
| Residential Allotments | 3.534 ha | 2.344 ha | 2.895 ha | 3.304 ha | 2.455 ha | 2.428 ha | 3.559 ha | 4.041 ha | 2.720 ha | 2.504 ha | 2.768 ha | 2.274 ha | 4.145 ha | 1.654 ha | 2.328 ha |
| Service Allotments | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Total Area of Allotments** | **3.534 ha** | **2.344 ha** | **2.895 ha** | **3.304 ha** | **2.455 ha** | **2.428 ha** | **3.559 ha** | **4.041 ha** | **2.720 ha** | **2.504 ha** | **2.768 ha** | **2.274 ha** | **4.145 ha** | **1.654 ha** | **2.328 ha** |
| **Road** | | | | | | | | | | | | | | | |
| Local Roads | 1.262 ha | 0.631 ha | 1.112 ha | 0.880 ha | 0.797 ha | 0.602 ha | 1.470 ha | 1.165 ha | 0.805 ha | 0.857 ha | 1.458 ha | 1.079 ha | 1.092 ha | 0.923 ha | 1.103 ha |
| Collector Roads | 0.361 ha | — | — | 0.605 ha | 0.234 ha | 0.623 ha | 0.371 ha | — | 0.386 ha | — | — | 0.323 ha | 0.505 ha | — | — |
| Trunk Collector Roads | 0.371 ha | 0.592 ha | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Total Area of New Road** | **1.994 ha** | **1.223 ha** | **1.112 ha** | **1.485 ha** | **1.031 ha** | **1.225 ha** | **1.841 ha** | **1.165 ha** | **1.191 ha** | **0.857 ha** | **1.458 ha** | **1.402 ha** | **1.597 ha** | **0.923 ha** | **1.103 ha** |
| **Open Space** | | | | | | | | | | | | | | | |
| District Sports Park | — | — | — | — | — | — | — | — | — | — | — | 2.825 ha | — | — | — |
| Linear Open Space (Active) | — | 0.167 ha | — | 0.755 ha | 0.452 ha | 0.226 ha | — | 0.442 ha | 0.453 ha | — | 1.377 ha | 0.282 ha | 0.622 ha | 0.261 ha | 2.224 ha |
| Linear Open Space (Conservation) | — | 0.281 ha | — | 1.342 ha | 0.522 ha | 0.353 ha | — | 0.322 ha | 0.558 ha | — | 2.556 ha | 0.341 ha | 0.766 ha | 0.299 ha | 0.791 ha |
| Neighbourhood Recreation Park | — | 0.355 ha | — | — | — | — | 0.666 ha | — | — | — | — | — | — | — | — |
| Pedestrian Linkage / Landscape Treatment | — | — | — | 0.061 ha | — | — | 0.036 ha | 0.080 ha | — | — | 0.100 ha | — | — | — | — |
| Existing Easement | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Total Open Space** | **—** | **0.803 ha** | **—** | **2.158 ha** | **0.974 ha** | **0.579 ha** | **0.702 ha** | **0.844 ha** | **1.011 ha** | **—** | **4.033 ha** | **3.448 ha** | **1.388 ha** | **0.560 ha** | **3.015 ha** |

| Land Use | Stage 16 | Stage 17 | Stage 18 | Stage 19A | Stage 19B | Stage 20 | Stage 21 | Stage 22A | Stage 22B | Stage 22C | Stage 23A | Stage 23B | Stage 24 | Stage 25 | Stage 26 | Stage 27 | No Stage | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | Area | % |
| **Area of Subject Site** | **3.341 ha** | **7.396 ha** | **5.197 ha** | **0.765 ha** | **2.966 ha** | **5.081 ha** | **2.380 ha** | **0.901 ha** | **1.663 ha** | **1.341 ha** | **1.062 ha** | **6.654 ha** | **3.609 ha** | **3.444 ha** | **4.729 ha** | **6.765 ha** | **10.602 ha** | **149.971 ha** | **100.0%** |
| **Saleable Area** | | | | | | | | | | | | | | | | | | | |
| Residential Allotments | 2.159 ha | 2.818 ha | 2.980 ha | 0.310 ha | 1.645 ha | 1.877 ha | 1.337 ha | 0.386 ha | 0.985 ha | 1.140 ha | 0.371 ha | 2.288 ha | 1.670 ha | 1.673 ha | 1.702 ha | 2.371 ha | — | **68.665 ha** | **45.8%** |
| Service Allotments | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 0.127 ha | — | — | **0.127 ha** | **0.1%** |
| **Total Area of Allotments** | **2.159 ha** | **2.818 ha** | **2.980 ha** | **0.310 ha** | **1.645 ha** | **1.877 ha** | **1.337 ha** | **0.386 ha** | **0.985 ha** | **1.140 ha** | **0.371 ha** | **2.288 ha** | **1.670 ha** | **1.673 ha** | **1.829 ha** | **2.371 ha** | **—** | **68.792 ha** | **45.9%** |
| **Road** | | | | | | | | | | | | | | | | | | | |
| Local Roads | 1.109 ha | 1.098 ha | 0.981 ha | 0.029 ha | 0.575 ha | 0.872 ha | 0.053 ha | 0.066 ha | 0.389 ha | 0.047 ha | 0.276 ha | 0.773 ha | 0.810 ha | 0.718 ha | 0.730 ha | 1.183 ha | — | **24.945 ha** | **16.6%** |
| Collector Roads | — | — | — | — | — | — | 0.836 ha | 0.026 ha | 0.289 ha | 0.107 ha | — | — | — | — | — | — | — | **4.666 ha** | **3.1%** |
| Trunk Collector Roads | — | 0.591 ha | — | 0.426 ha | — | — | — | 0.423 ha | — | 0.047 ha | — | — | — | — | — | — | — | **2.450 ha** | **1.6%** |
| **Total Area of New Road** | **1.109 ha** | **1.689 ha** | **0.981 ha** | **0.455 ha** | **0.575 ha** | **0.872 ha** | **0.889 ha** | **0.515 ha** | **0.678 ha** | **0.201 ha** | **0.276 ha** | **0.773 ha** | **0.810 ha** | **0.718 ha** | **0.730 ha** | **1.183 ha** | **—** | **32.061 ha** | **21.4%** |
| **Open Space** | | | | | | | | | | | | | | | | | | | |
| District Sports Park | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **2.825 ha** | **1.9%** |
| Linear Open Space (Active) | — | 1.088 ha | 0.465 ha | — | 0.649 ha | 0.569 ha | 0.057 ha | — | — | — | 0.094 ha | 0.624 ha | 0.343 ha | 0.525 ha | 1.067 ha | 1.068 ha | — | **13.810 ha** | **9.2%** |
| Linear Open Space (Conservation) | — | 1.801 ha | 0.603 ha | — | 0.036 ha | 1.040 ha | 0.097 ha | — | — | — | 0.321 ha | 2.969 ha | 0.786 ha | 0.528 ha | 1.103 ha | 2.107 ha | 0.036 ha | **19.558 ha** | **13.0%** |
| Neighbourhood Recreation Park | — | — | — | — | — | 0.723 ha | — | — | — | — | — | — | — | — | — | — | — | **1.744 ha** | **1.2%** |
| Pedestrian Linkage / Landscape Treatment | 0.073 ha | — | 0.168 ha | — | 0.061 ha | — | — | — | — | — | — | — | — | — | — | 0.036 ha | — | **0.615 ha** | **0.4%** |
| Existing Easement | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 10.566 ha | **10.566 ha** | **7.0%** |
| **Total Open Space** | **0.073 ha** | **2.889 ha** | **1.236 ha** | **—** | **0.746 ha** | **2.332 ha** | **0.154 ha** | **—** | **—** | **—** | **0.415 ha** | **3.593 ha** | **1.129 ha** | **1.053 ha** | **2.170 ha** | **3.211 ha** | **10.602 ha** | **49.118 ha** | **32.8%** |

## Yield Breakdown

| Residential Allotments | Typical Allotment Size | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6 | Stage 7 | Stage 8 | Stage 9 | Stage 10 | Stage 11 | Stage 12 | Stage 13 | Stage 14 | Stage 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dimensions | Area | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots |
| **28m Deep Allotments** | | | | | | | | | | | | | | | | | |
| Villa Allotment | 10.5 x 28m | 294m² | 2 | — | 4 | 5 | 3 | 2 | 3 | — | 2 | — | 1 | — | — | — | — |
| Premium Villa Allotment | 12.5 x 28m | 350m² | 7 | 3 | 9 | 7 | 13 | 12 | 17 | 36 | 43 | 28 | 29 | 35 | 10 | 20 | 24 |
| Courtyard Allotment | 14 x 28m | 392m² | 14 | 2 | 14 | 6 | 9 | 15 | 22 | 20 | 19 | 28 | 16 | 23 | 21 | 22 | 32 |
| Premium Courtyard Allotment | 16 x 28m | 448m² | — | — | 8 | 1 | 6 | 5 | 6 | — | 8 | 8 | 7 | 2 | — | — | — |
| **Sub Total 28m Deep Allotments** | | | **23** | **5** | **35** | **19** | **31** | **34** | **48** | **56** | **72** | **64** | **53** | **60** | **31** | **42** | **56** |
| **30m Deep Allotments** | | | | | | | | | | | | | | | | | |
| Villa Allotment | 10.5 x 30m | 315m² | — | 5 | 1 | 4 | 3 | 4 | — | — | — | — | — | — | — | — | — |
| Premium Villa Allotment | 12.5 x 30m | 375m² | 8 | 7 | 15 | 6 | 9 | 11 | 2 | — | — | — | 3 | — | 14 | — | 4 |
| Courtyard Allotment | 14 x 30m | 420m² | 13 | 10 | 12 | 11 | 10 | 5 | 12 | — | — | — | 9 | — | 9 | — | — |
| Premium Courtyard Allotment | 16 x 30m | 480m² | 7 | 3 | 3 | 2 | 6 | 3 | 1 | — | — | — | 1 | — | — | — | — |
| Traditional Allotment | 20 x 30m | 600m² | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Sub Total 30m Deep Allotments** | | | **31** | **25** | **31** | **23** | **28** | **23** | **15** | **—** | **—** | **—** | **13** | **—** | **23** | **—** | **4** |
| **32m Deep Allotments** | | | | | | | | | | | | | | | | | |
| Villa Allotment | 10.5 x 32m | 336m² | 1 | 4 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Premium Villa Allotment | 12.5 x 32m | 400m² | 8 | 10 | — | — | — | 1 | — | — | — | — | — | — | — | — | — |
| Courtyard Allotment | 14 x 32m | 448m² | 8 | 10 | — | 2 | 1 | 3 | — | — | — | — | 1 | — | — | — | — |
| Traditional Allotment | 20 x 32m | 640m² | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — |
| Premium Traditional Allotment | 22 x 32m | 704m² | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Sub Total 32m Deep Allotments** | | | **17** | **24** | **—** | **3** | **1** | **4** | **—** | **—** | **—** | **—** | **1** | **—** | **—** | **—** | **—** |
| **Lifestyle Allotments** | | | | | | | | | | | | | | | | | |
| Lifestyle Allotment | n/a | 800 - 1999m² | 1 | — | — | 1 | — | — | — | — | — | — | — | — | 5 | — | — |
| Premium Lifestyle Allotment | n/a | 2000m² + | 1 | — | — | 5 | — | — | 4 | 9 | — | — | — | — | 5 | — | — |
| **Sub Total Lifestyle Allotments** | | | **2** | **—** | **—** | **6** | **—** | **—** | **4** | **9** | **—** | **—** | **—** | **—** | **10** | **—** | **—** |
| | | | | | | | | | | | | | | | | | |
| **Total Residential Allotments** | | | **73** | **54** | **66** | **51** | **60** | **61** | **67** | **65** | **72** | **64** | **67** | **60** | **64** | **42** | **60** |
| | | | | | | | | | | | | | | | | | |
| **Super Lots** | | | | | | | | | | | | | | | | | |
| Service Allotments | | | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

| Residential Allotments | Stage 16 | Stage 17 | Stage 18 | Stage 19A | Stage 19B | Stage 20 | Stage 21 | Stage 22A | Stage 22B | Stage 22C | Stage 23A | Stage 23B | Stage 24 | Stage 25 | Stage 26 | Stage 27 | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | Lots | % |
| **28m Deep Allotments** | | | | | | | | | | | | | | | | | | |
| Villa Allotment | — | 2 | 3 | — | 1 | 4 | 1 | — | 1 | 2 | — | 1 | — | — | — | 2 | **39** | **2.5%** |
| Premium Villa Allotment | 17 | 9 | 16 | 4 | 4 | 21 | 19 | 6 | 8 | 7 | 7 | 3 | 20 | 6 | — | 23 | **463** | **29.6%** |
| Courtyard Allotment | 21 | 3 | 3 | 4 | 11 | 9 | 14 | 1 | 5 | 8 | 2 | 8 | 6 | 1 | 10 | 20 | **389** | **24.9%** |
| Premium Courtyard Allotment | — | — | — | — | 1 | 2 | 1 | 2 | — | 3 | 1 | — | 1 | — | — | 9 | **71** | **4.5%** |
| **Sub Total 28m Deep Allotments** | **38** | **14** | **22** | **8** | **17** | **36** | **35** | **9** | **14** | **20** | **10** | **12** | **27** | **7** | **10** | **54** | **962** | **61.5%** |
| **30m Deep Allotments** | | | | | | | | | | | | | | | | | | |
| Villa Allotment | — | 4 | 4 | — | 7 | — | — | — | — | — | — | — | — | — | 1 | — | **33** | **2.1%** |
| Premium Villa Allotment | 13 | 24 | 31 | — | 11 | 5 | — | — | 5 | 5 | — | 14 | 6 | 15 | 17 | 3 | **228** | **14.6%** |
| Courtyard Allotment | 3 | 11 | 20 | — | 5 | 5 | — | — | 6 | 2 | — | 13 | 7 | 15 | 12 | 3 | **193** | **12.3%** |
| Premium Courtyard Allotment | — | 5 | — | — | 1 | — | — | — | — | — | — | 3 | — | 1 | 2 | — | **38** | **2.4%** |
| Traditional Allotment | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **3** | **0.2%** |
| **Sub Total 30m Deep Allotments** | **16** | **44** | **55** | **—** | **24** | **10** | **—** | **—** | **11** | **7** | **—** | **30** | **13** | **31** | **32** | **6** | **495** | **31.6%** |
| **32m Deep Allotments** | | | | | | | | | | | | | | | | | | |
| Villa Allotment | — | — | — | — | — | — | — | — | — | — | — | 6 | — | — | — | — | **11** | **0.7%** |
| Premium Villa Allotment | — | 4 | — | — | — | — | — | — | — | 1 | — | 6 | — | — | — | — | **30** | **1.9%** |
| Courtyard Allotment | — | 5 | — | — | — | — | — | — | — | 1 | — | 2 | — | 2 | — | — | **35** | **2.2%** |
| Traditional Allotment | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **1** | **0.1%** |
| Premium Traditional Allotment | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **—** | **0.0%** |
| **Sub Total 32m Deep Allotments** | **—** | **9** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **2** | **—** | **14** | **—** | **2** | **—** | **—** | **77** | **4.9%** |
| **Lifestyle Allotments** | | | | | | | | | | | | | | | | | | |
| Lifestyle Allotment | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **7** | **0.4%** |
| Premium Lifestyle Allotment | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | **24** | **1.5%** |
| **Sub Total Lifestyle Allotments** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **31** | **2.0%** |
| | | | | | | | | | | | | | | | | | | |
| **Total Residential Allotments** | **54** | **67** | **77** | **8** | **41** | **46** | **35** | **9** | **25** | **29** | **10** | **56** | **40** | **40** | **42** | **60** | **1565** | **100%** |
| | | | | | | | | | | | | | | | | | | |
| **Super Lots** | | | | | | | | | | | | | | | | | | |
| Service Allotments | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | |

PLAN REF: 132965 – 27
Rev No: M
DATE: 15 JULY 2021
CLIENT: AVID
DRAWN BY: JC
CHECKED BY: PHE
Not to Scale @ A1

# COVELLA
**PLAN OF SUBDIVISION**
**ULTIMATE OVERALL DEVELOPMENT STATISTICS**
**COMBINED APPLICATIONS**

AVID Property Group

URBAN DESIGN
Level 4 HQ South
520 Wickham Street
PO Box 1559
Fortitude Valley QLD 4006
T +61 7 3539 9500
W rpsgroup.com

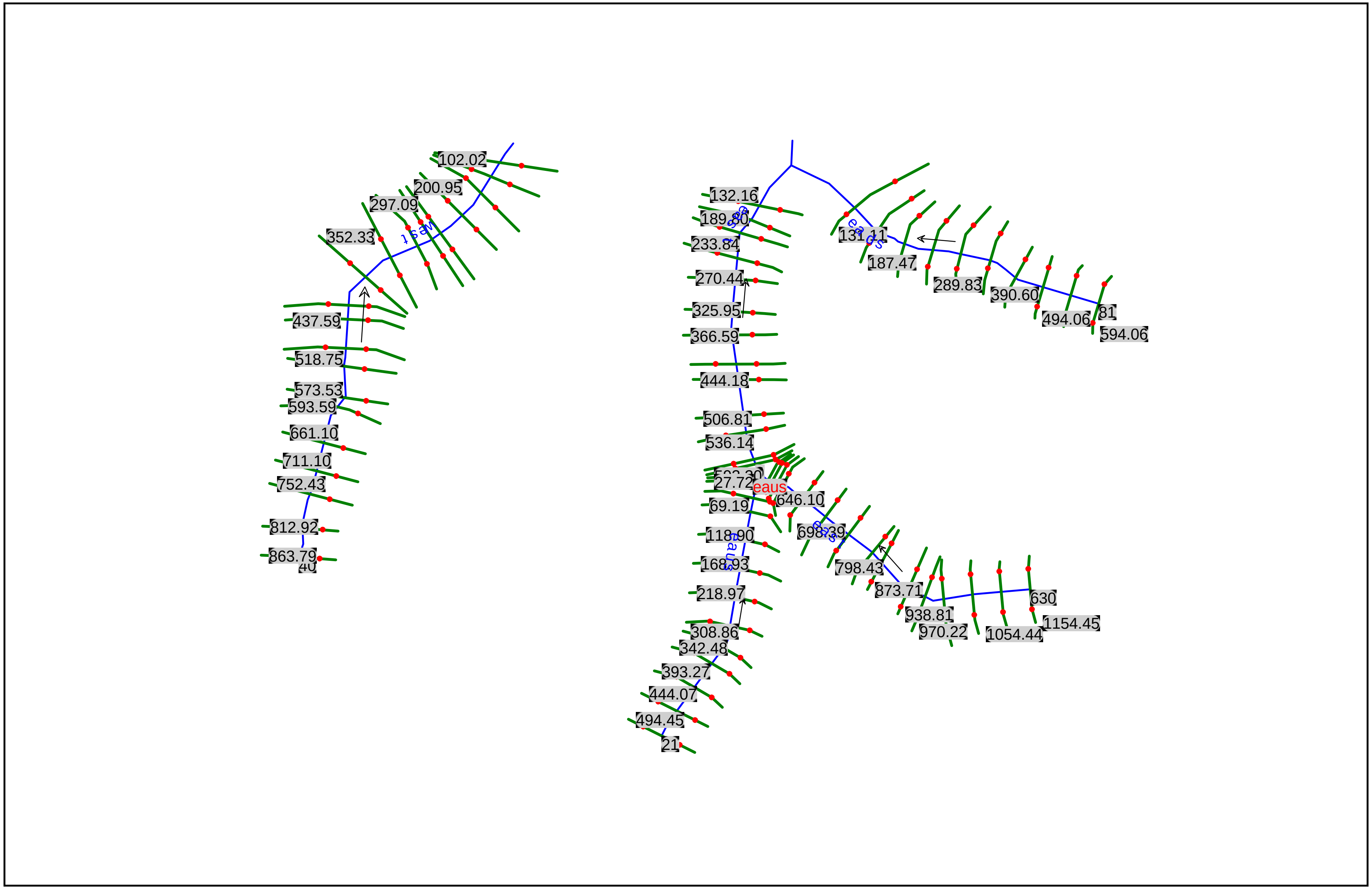


rps

TEVIOT VILLAGE CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION -

# Appendix B HEC RAS Summary

VILLA GREEN PTY LTD



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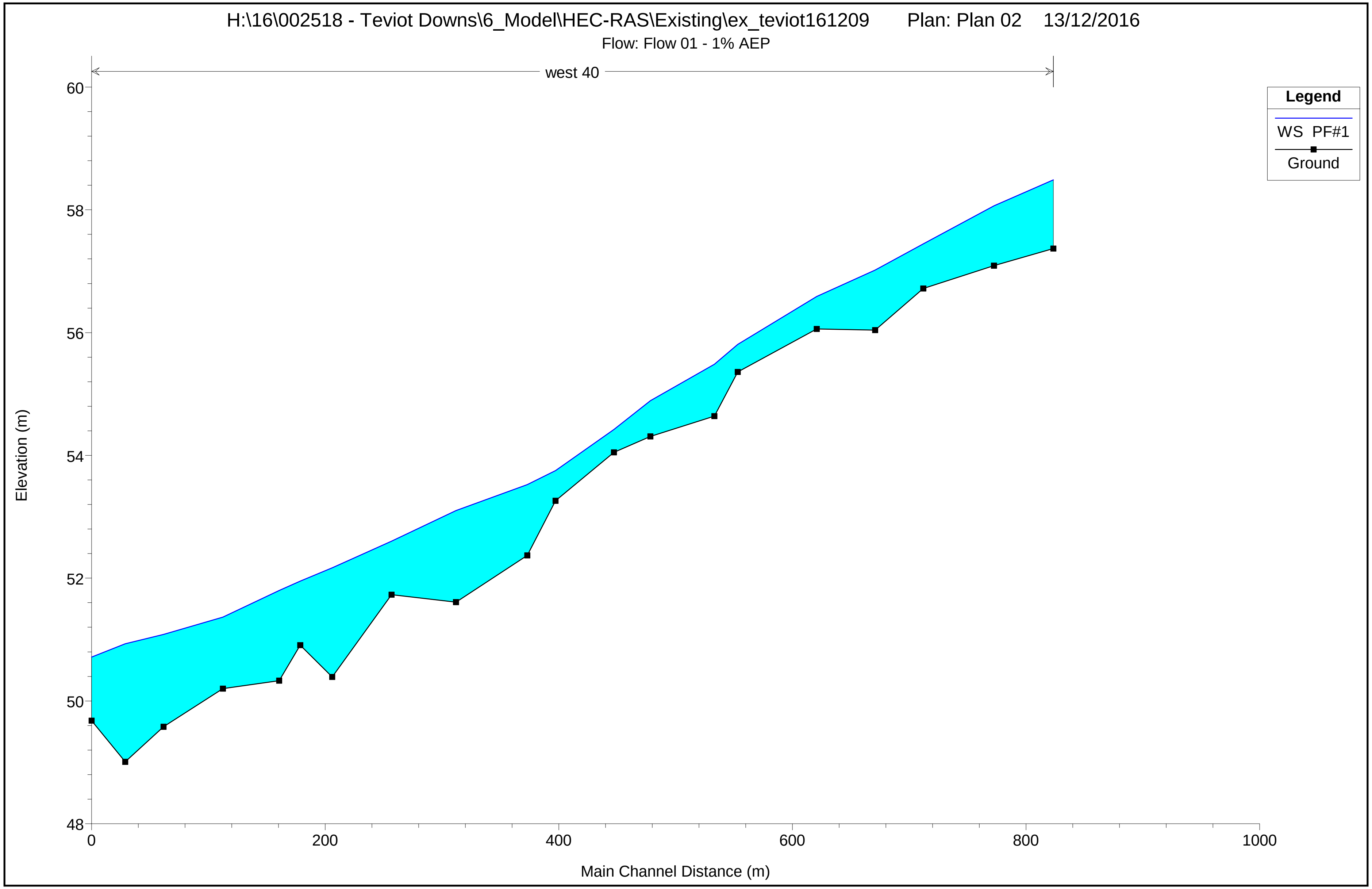

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Ground
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54
52
50
48
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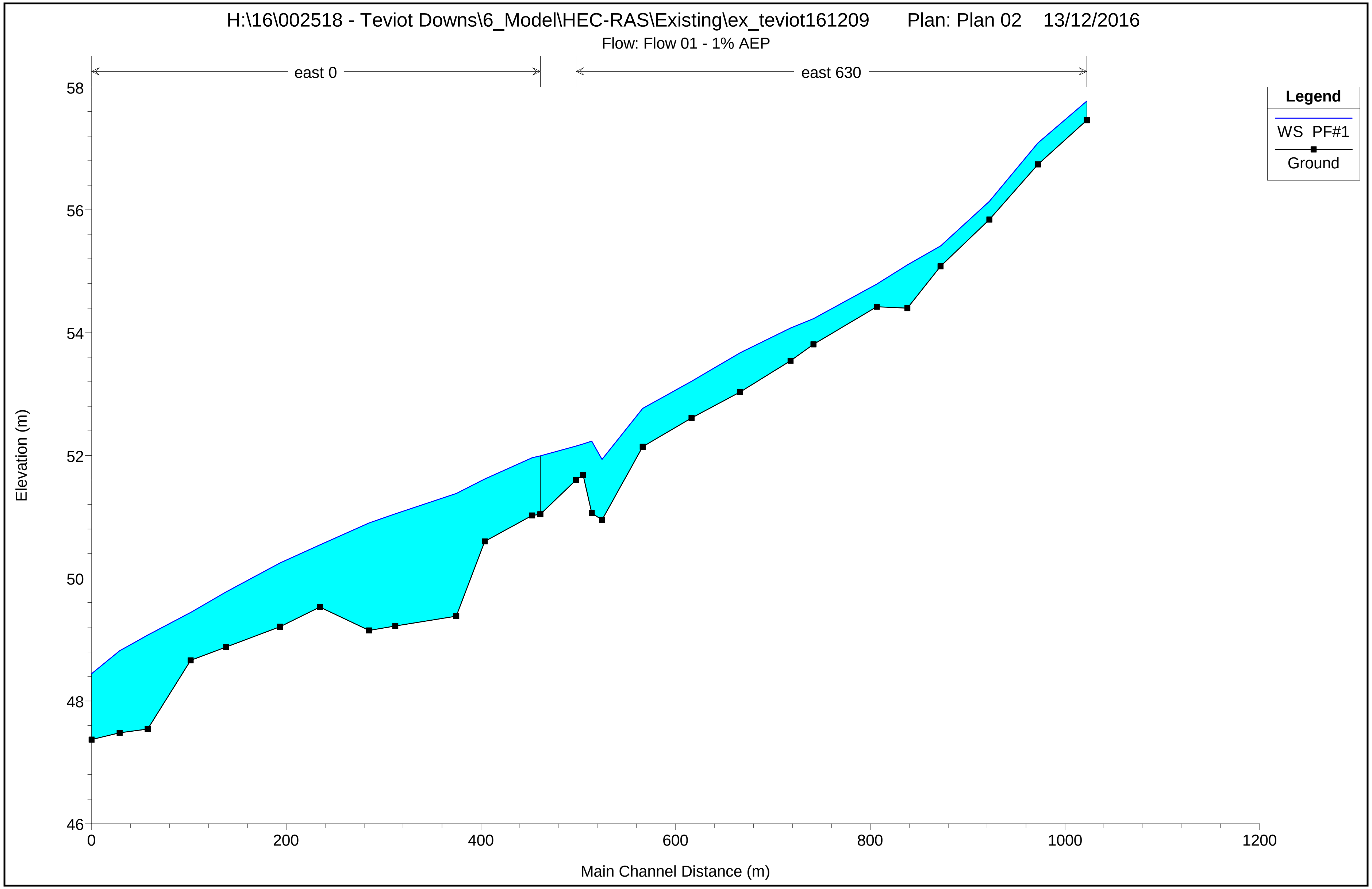
200
400
600
800
1000
Main Channel Distance (m)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WS PF#1
Ground
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46
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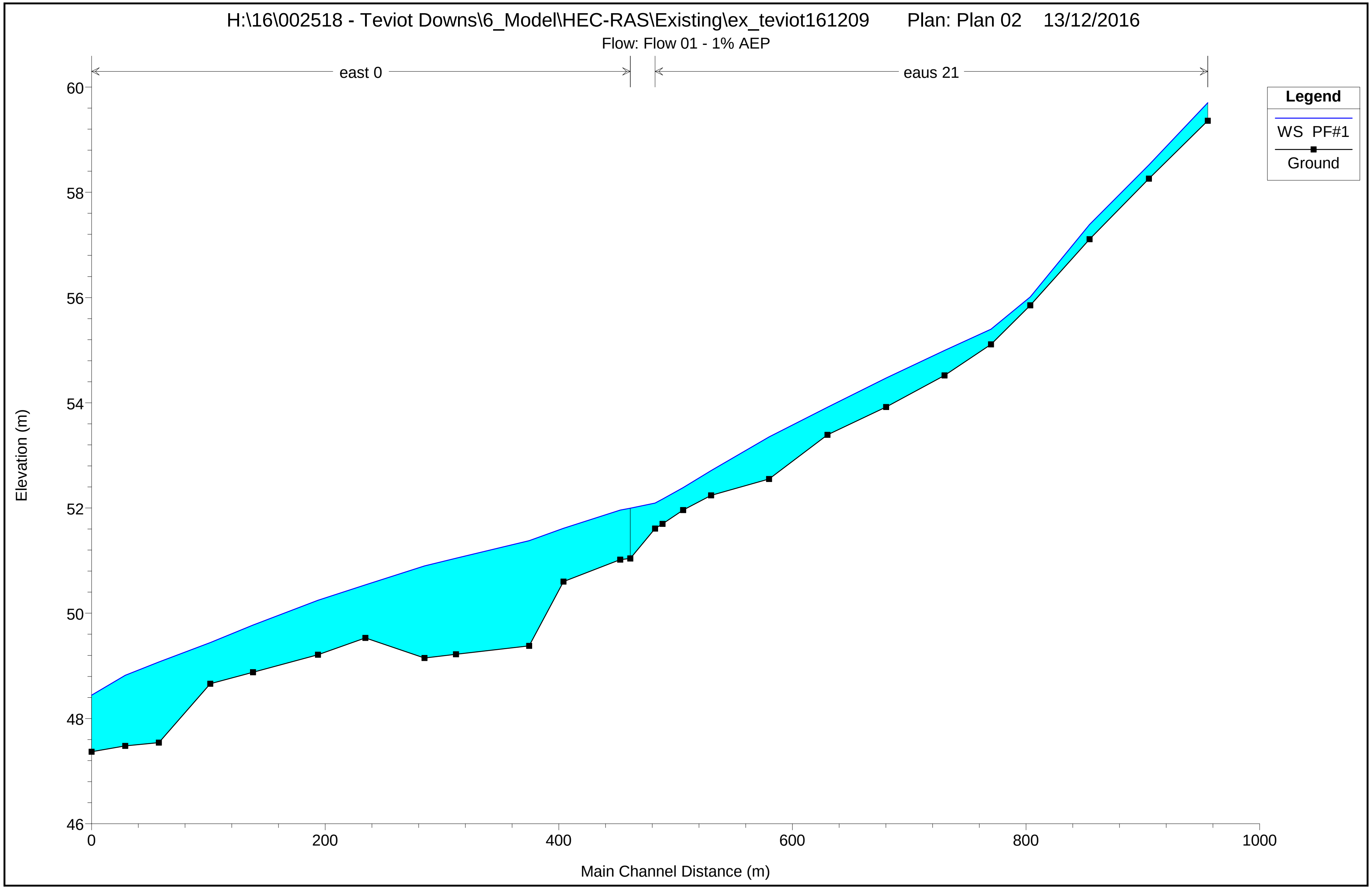
600
800
1000
1200
Main Channel Distance (m)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WS PF#1
Ground
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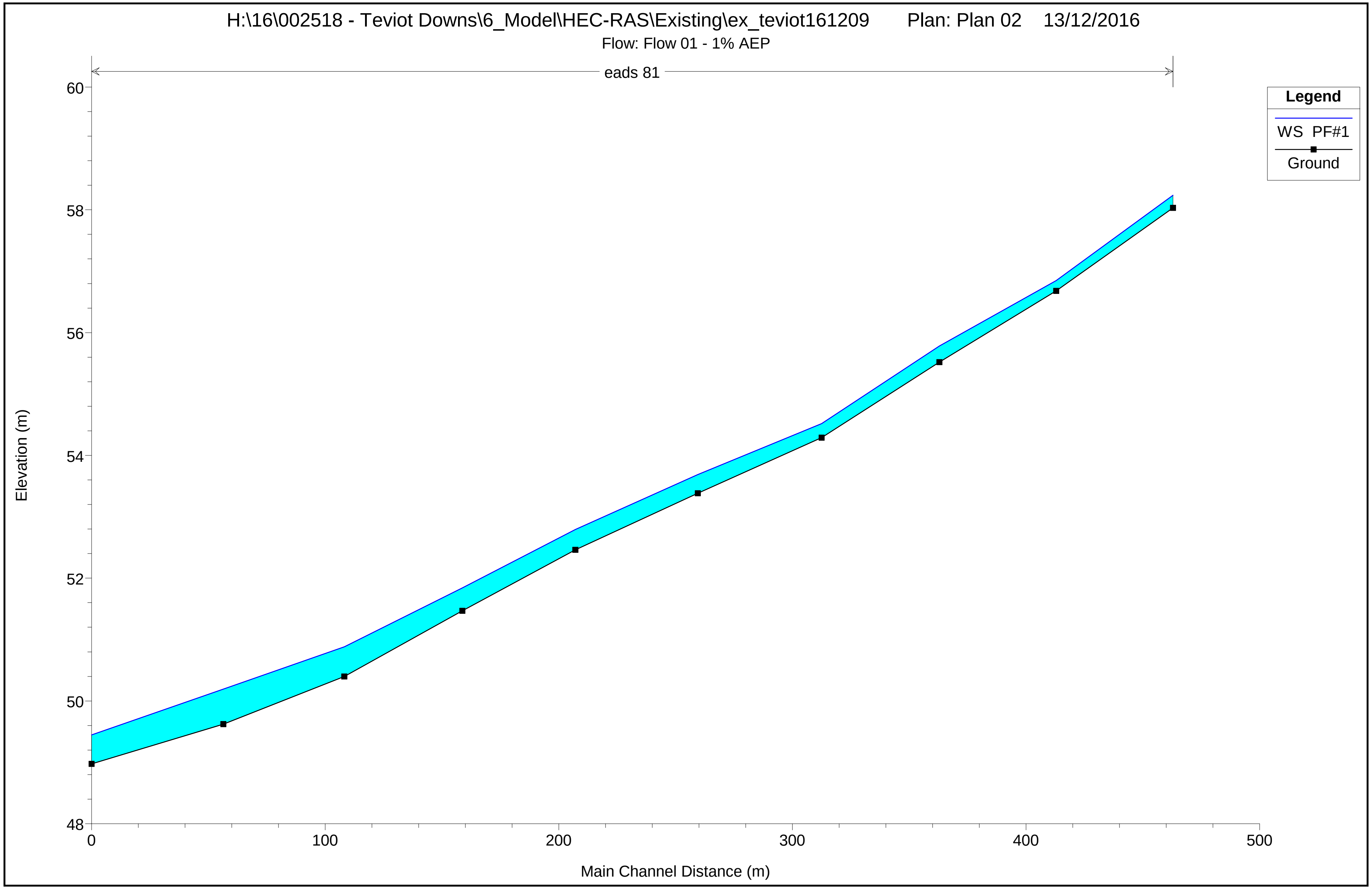
58
56
54
52
50
48
46
0
200
400
600
800
1000
Main Channel Distance (m)



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Legend
WS PF#1
Ground
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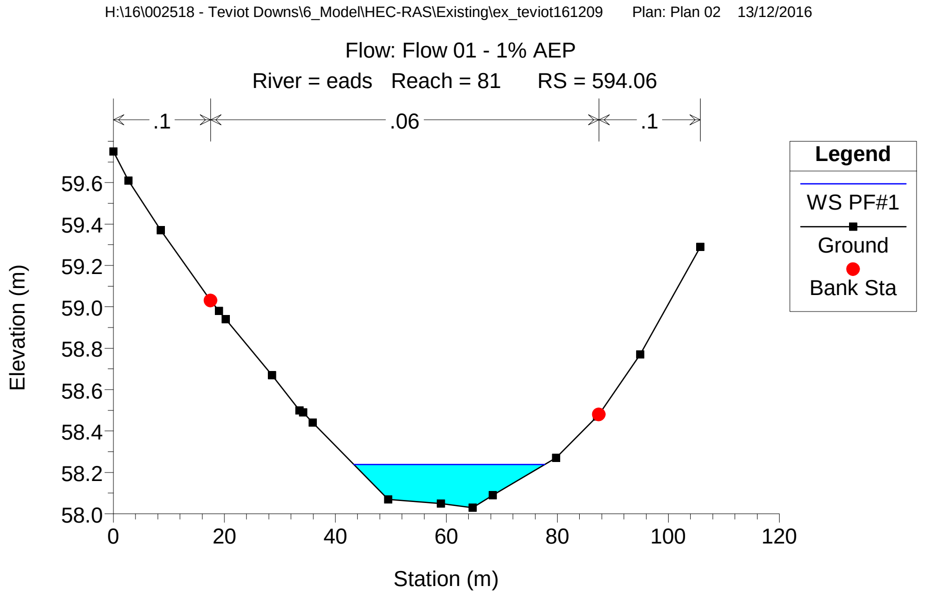
58
56
54
52
50
48
0
100
200
300
400
500
Main Channel Distance (m)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.06
.1
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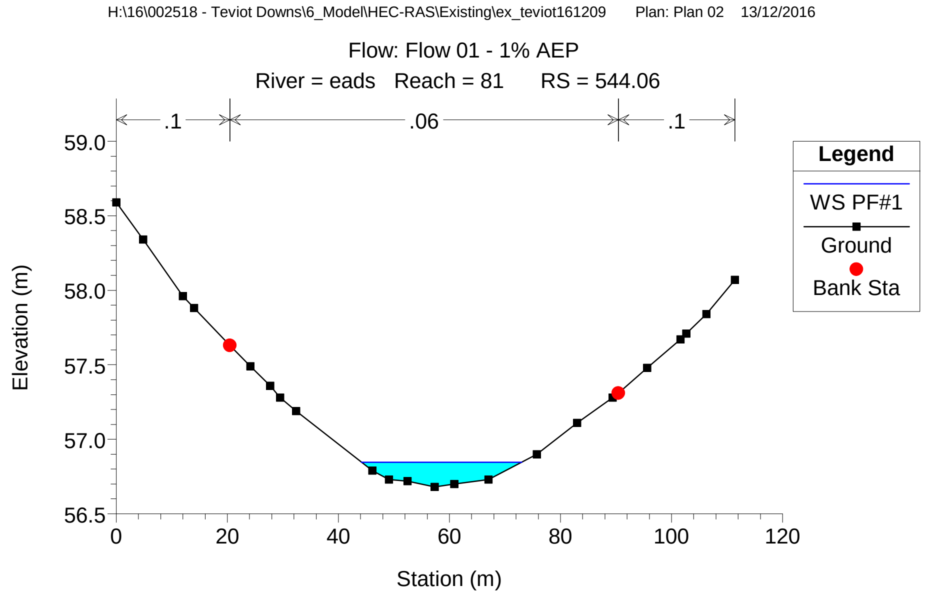
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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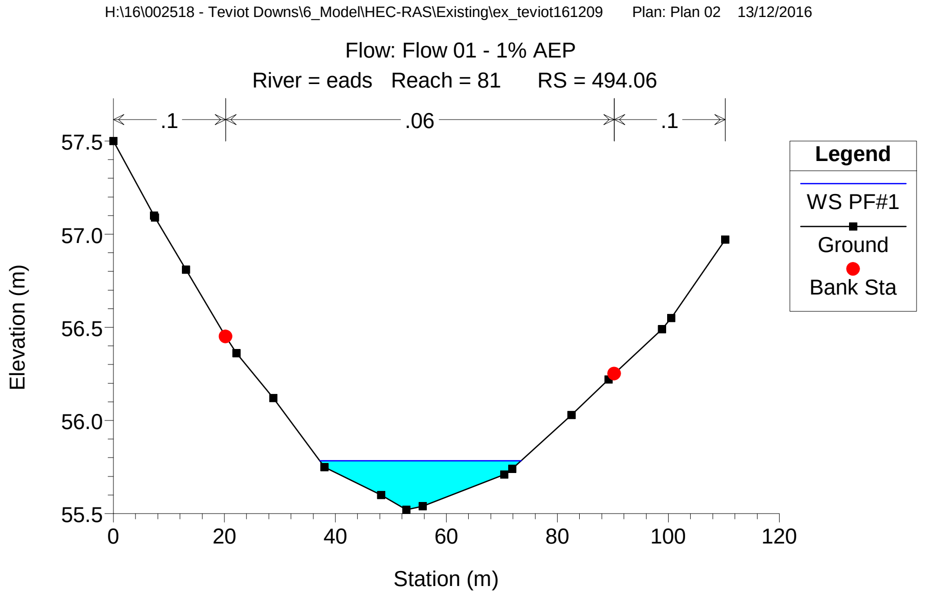
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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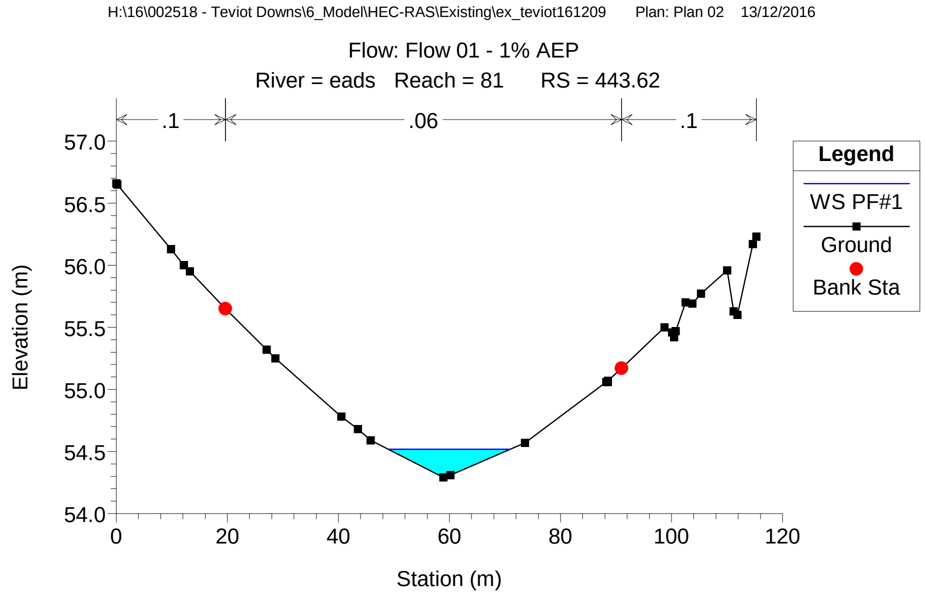
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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.06
.1
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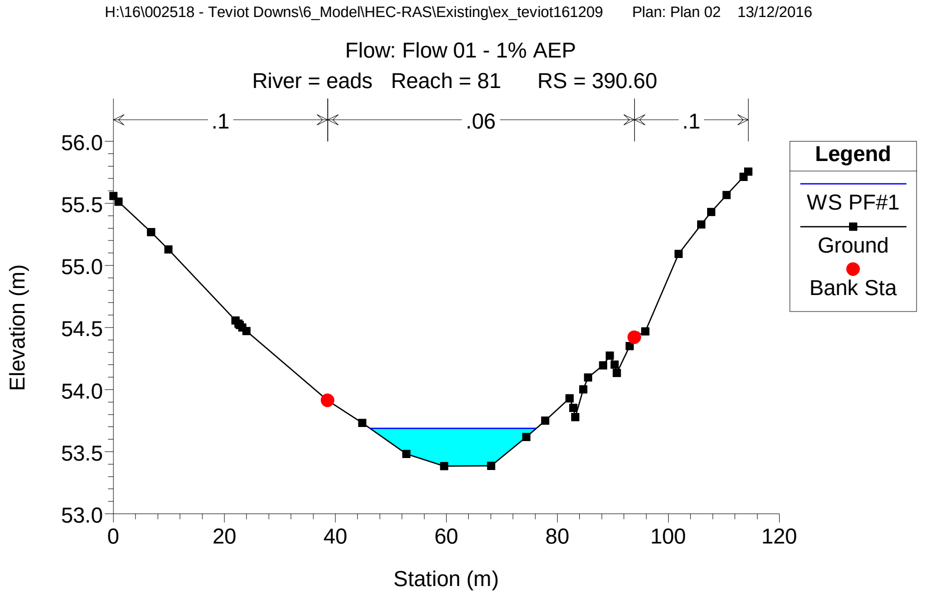
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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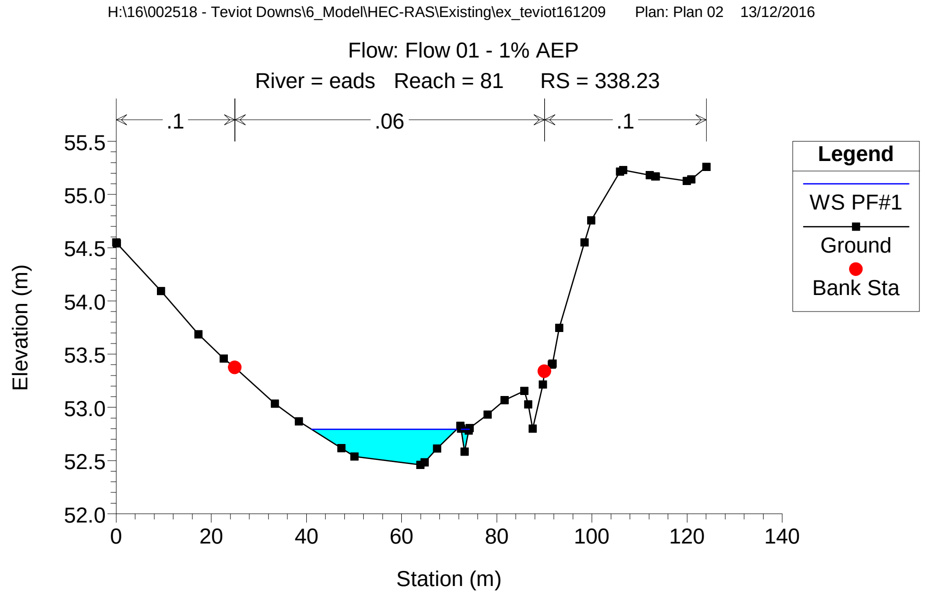
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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.06
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Elevation (m)
Station (m)
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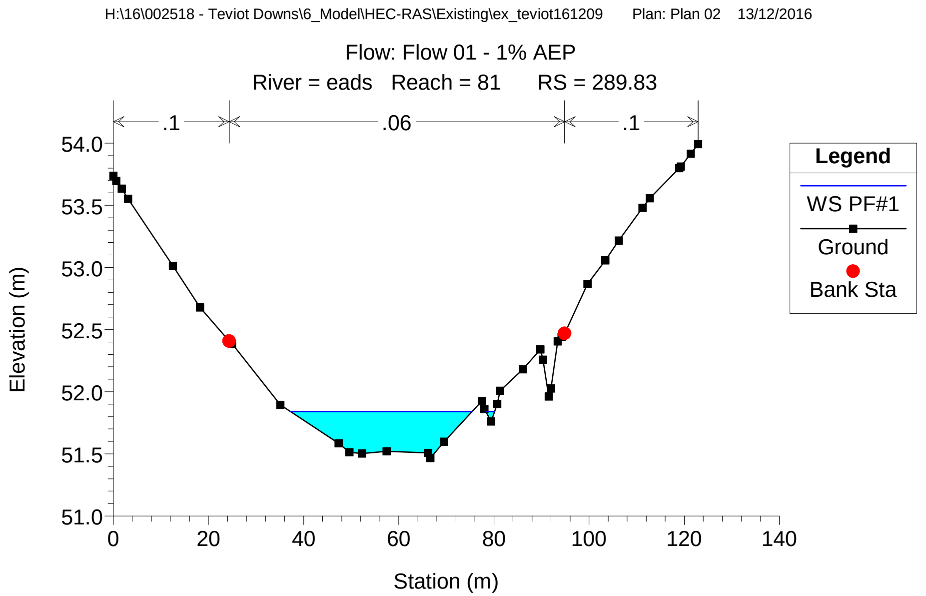
WS PF#1
Ground
Bank Sta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Elevation (m)
Station (m)
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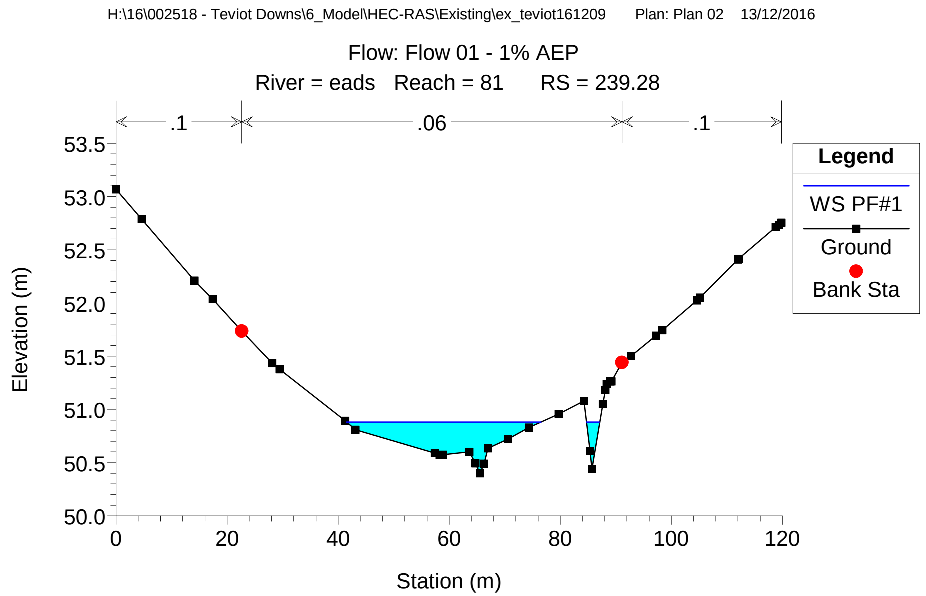
Ground
Bank Sta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.06
.1
Elevation (m)
Station (m)
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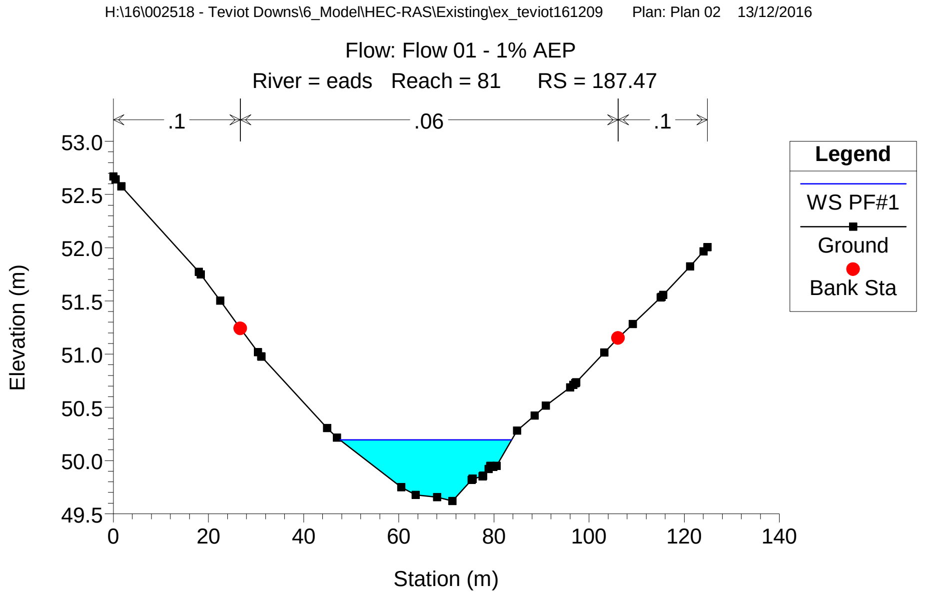
WS PF#1
Ground
Bank Sta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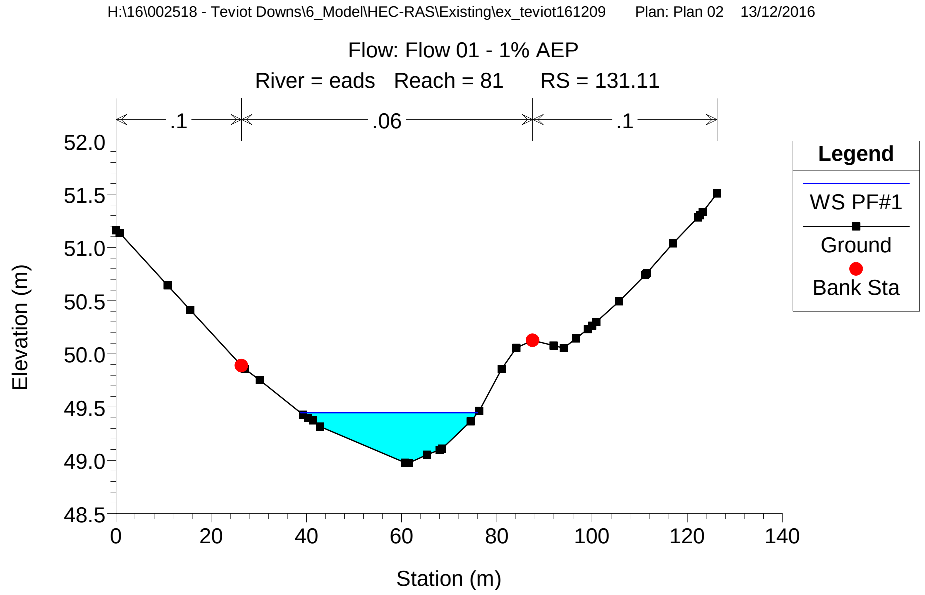
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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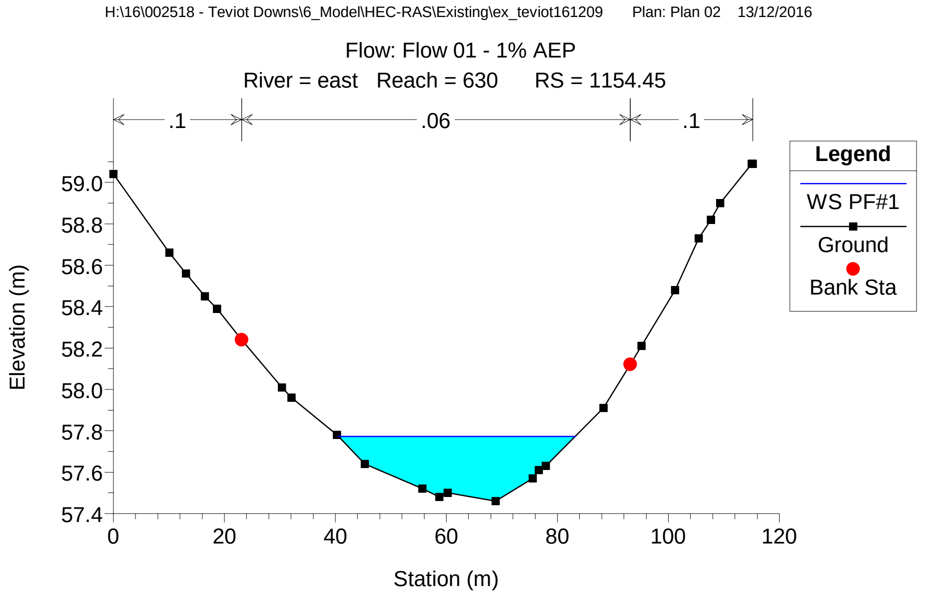
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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Station (m)
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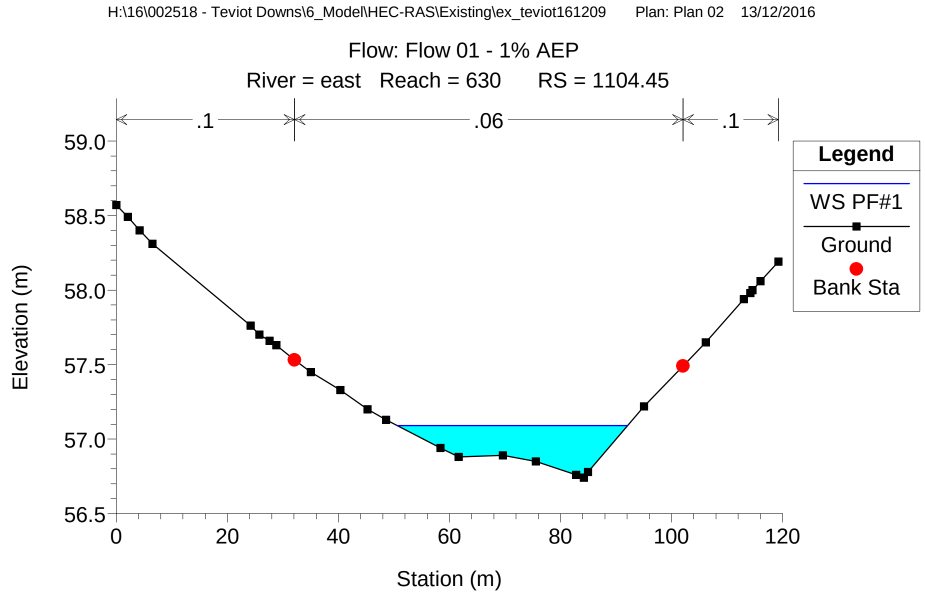
WS PF#1
Ground
Bank Sta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.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

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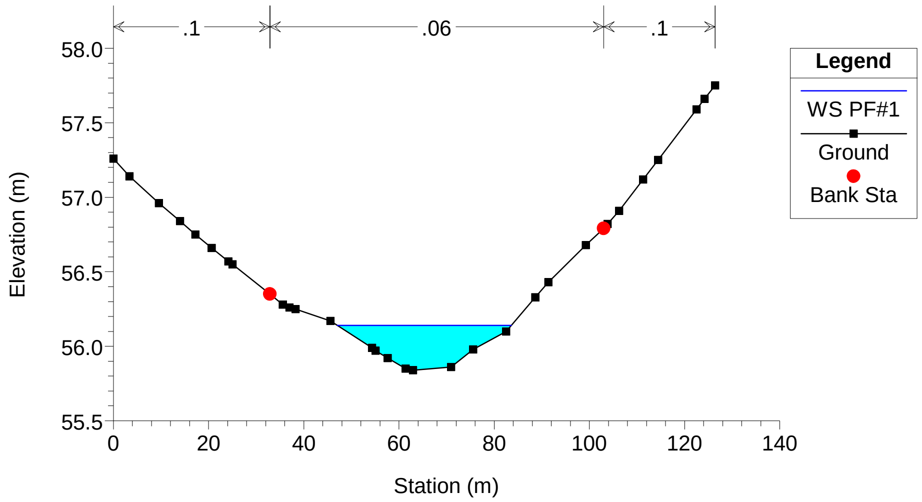


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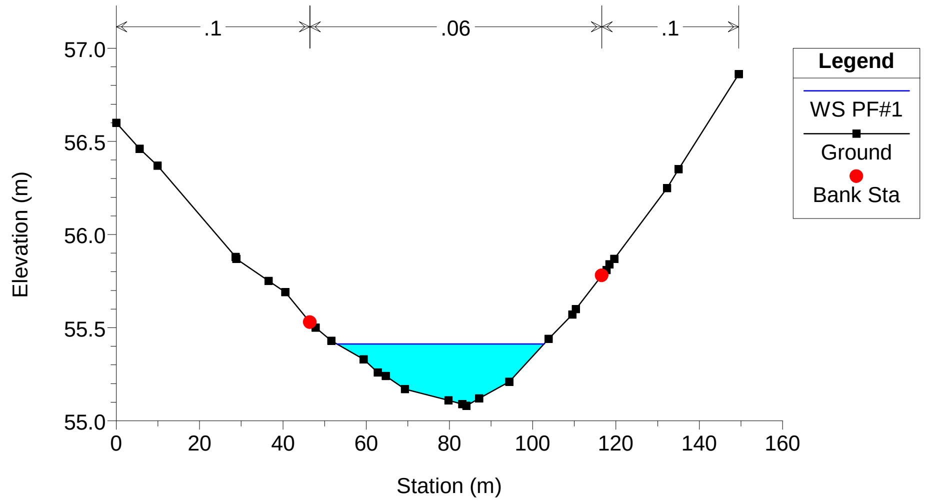


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Flow: Flow 01 - 1% AEP

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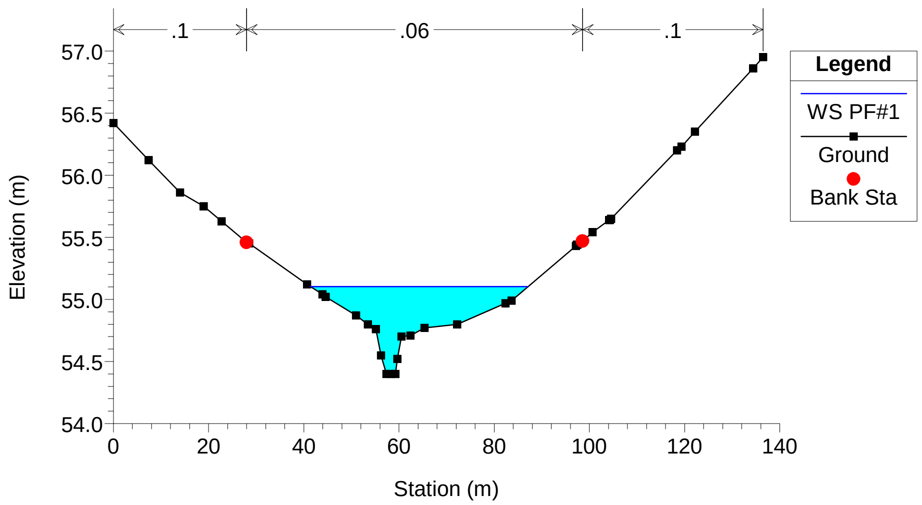


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Flow: Flow 01 - 1% AEP

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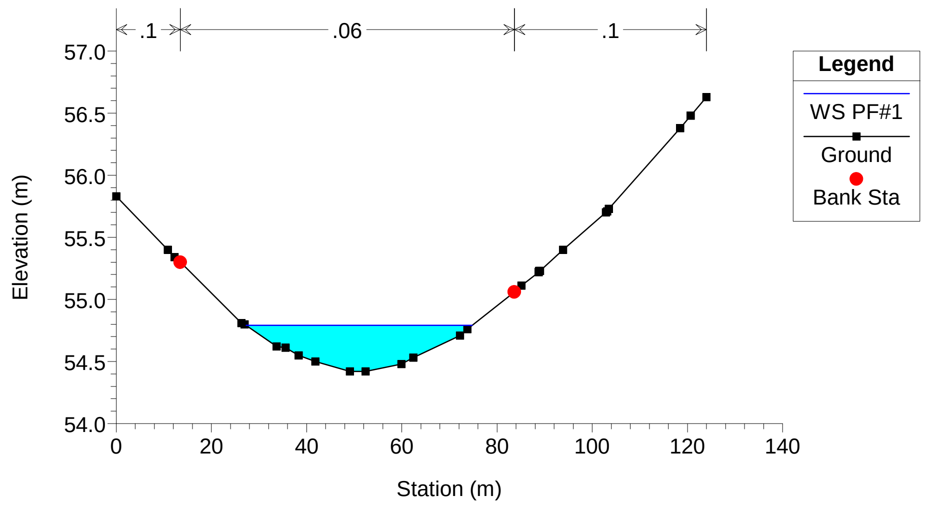

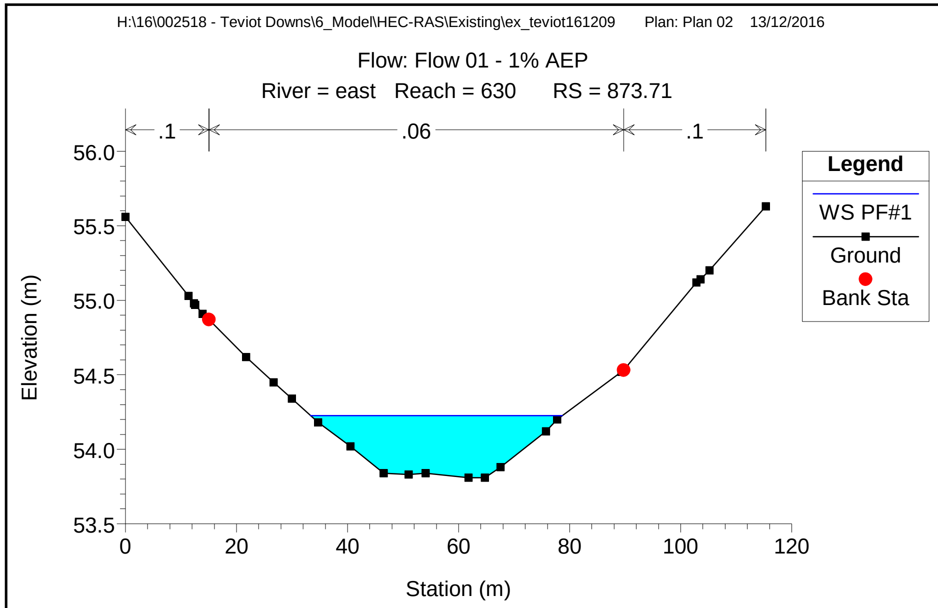
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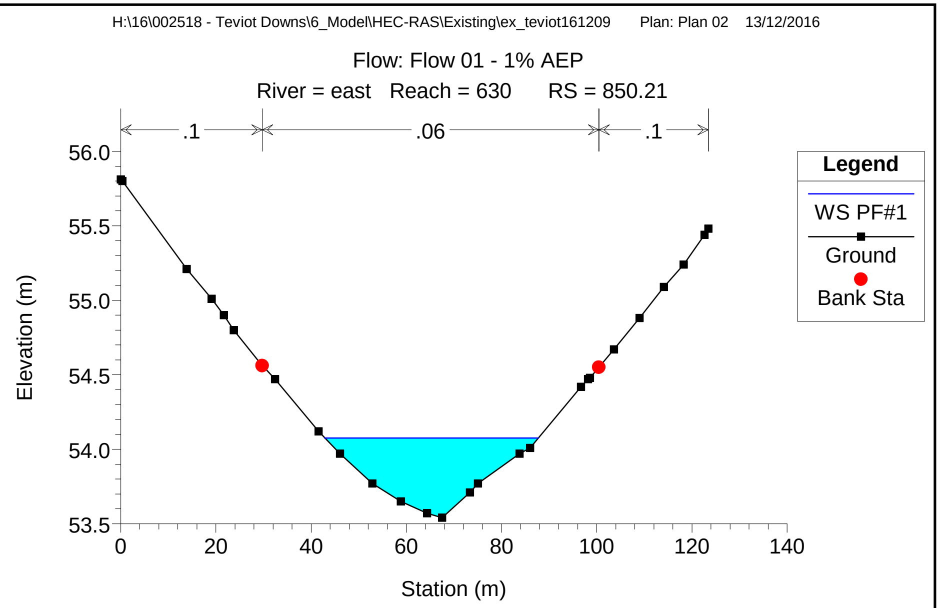
.1
.06
.1
Elevation (m)
56.0
55.5
55.0
54.5
54.0
53.5
0
20
40
60
80
100
120
Station (m)
Legend
WS PF#1
Ground
Bank Sta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.06
.1
Elevation (m)
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55.5
55.0
54.5
54.0
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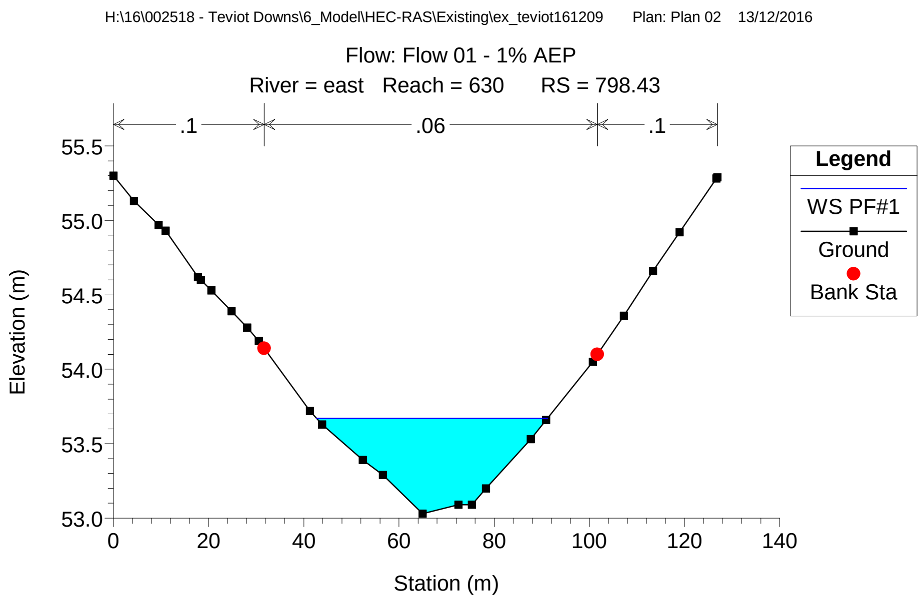
Station (m)
Legend
WS PF#1
Ground
Bank Sta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.06
.1
Elevation (m)
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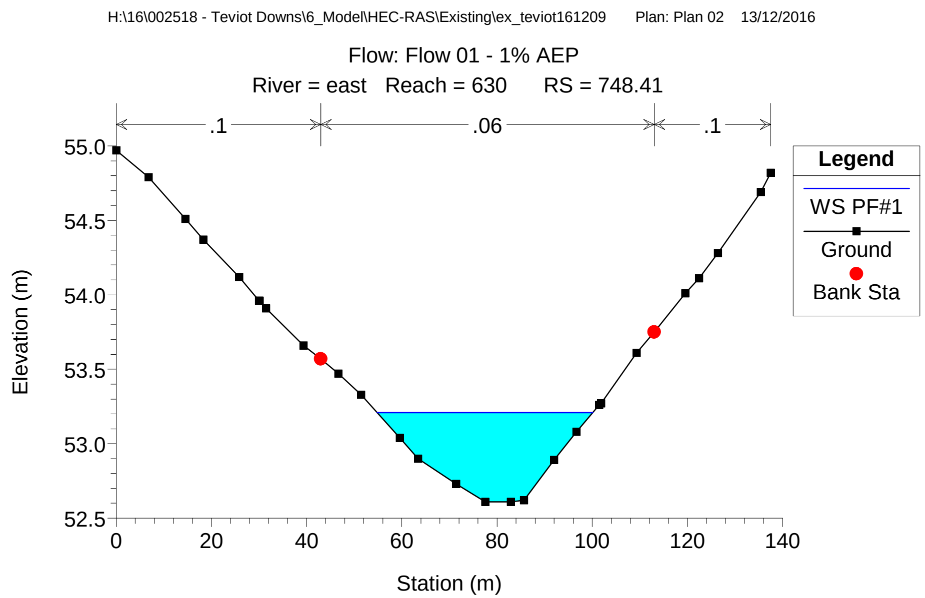
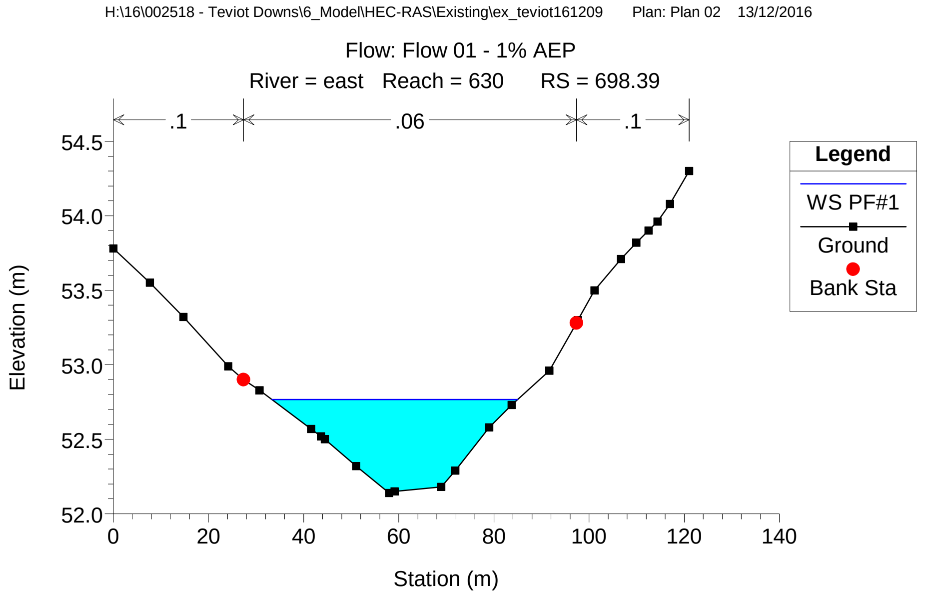
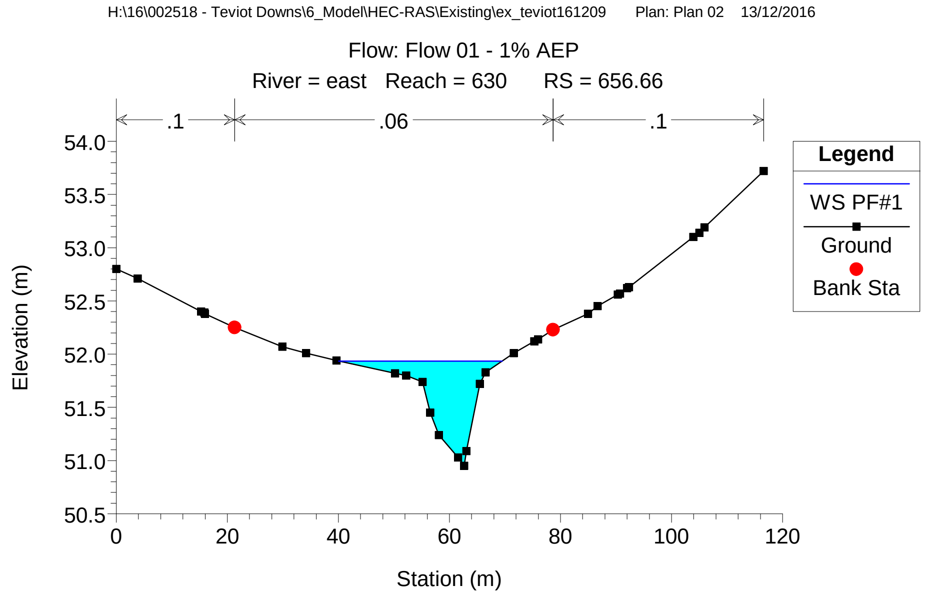
55.0
54.5
54.0
53.5
53.0
0
20
40
60
80
100
120
140
Station (m)
Legend
WS PF#1
Ground
Bank Sta

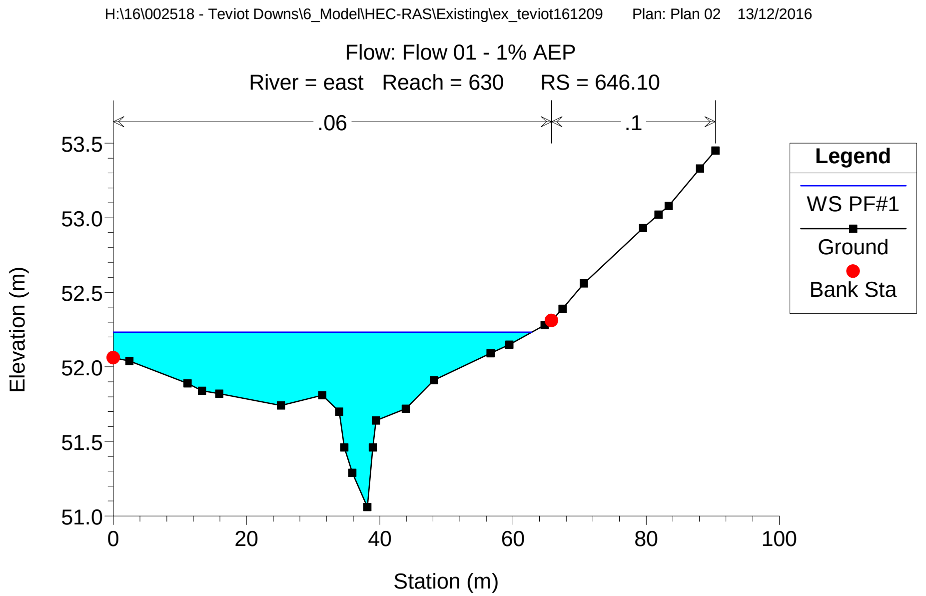

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 748.41
.1
.06
.1
Elevation (m)
55.0
54.5
54.0
53.5
53.0
52.5
0
20
40
60
80
100
120
140
Station (m)
Legend
WS PF#1
Ground
Bank Sta



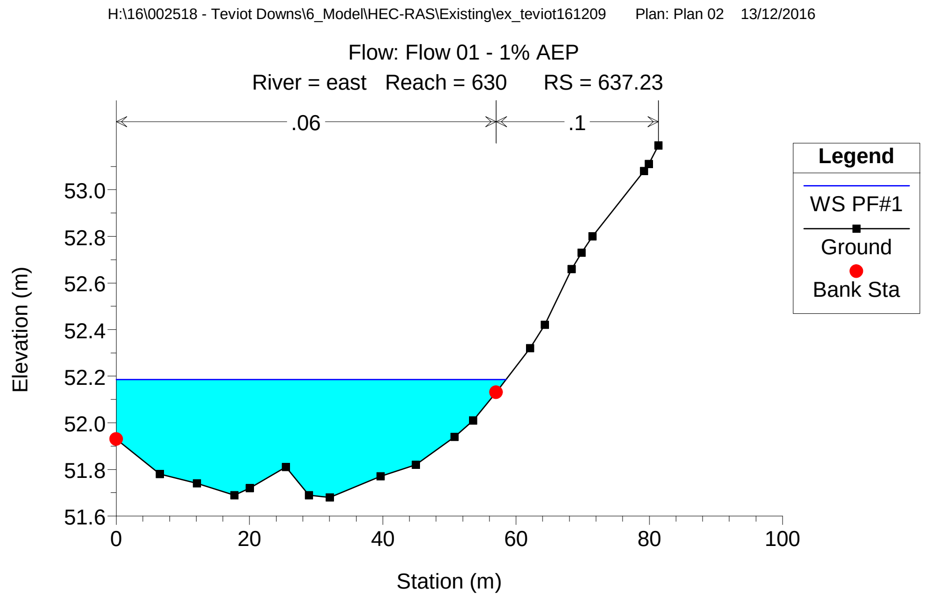
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 698.39
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)

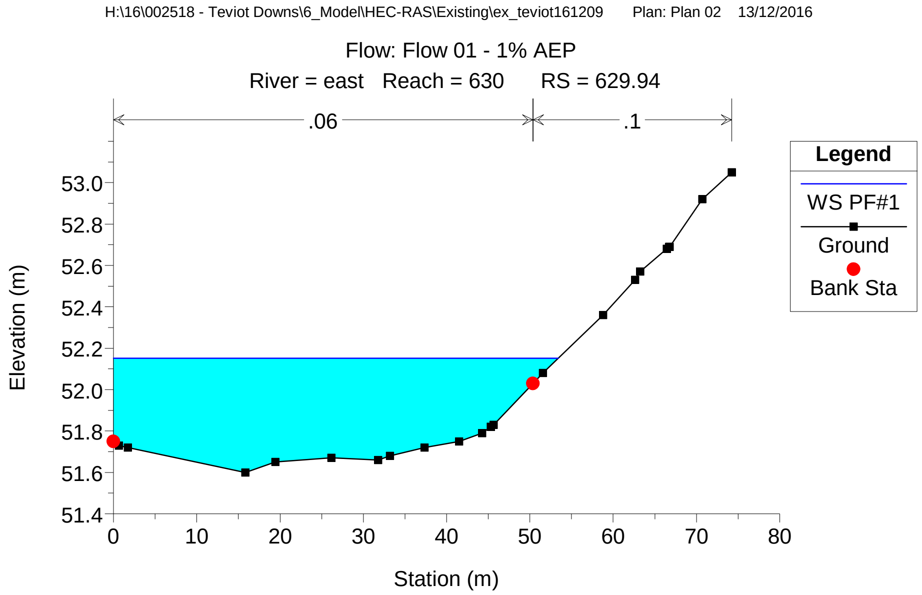
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 656.66
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 646.10
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 637.23
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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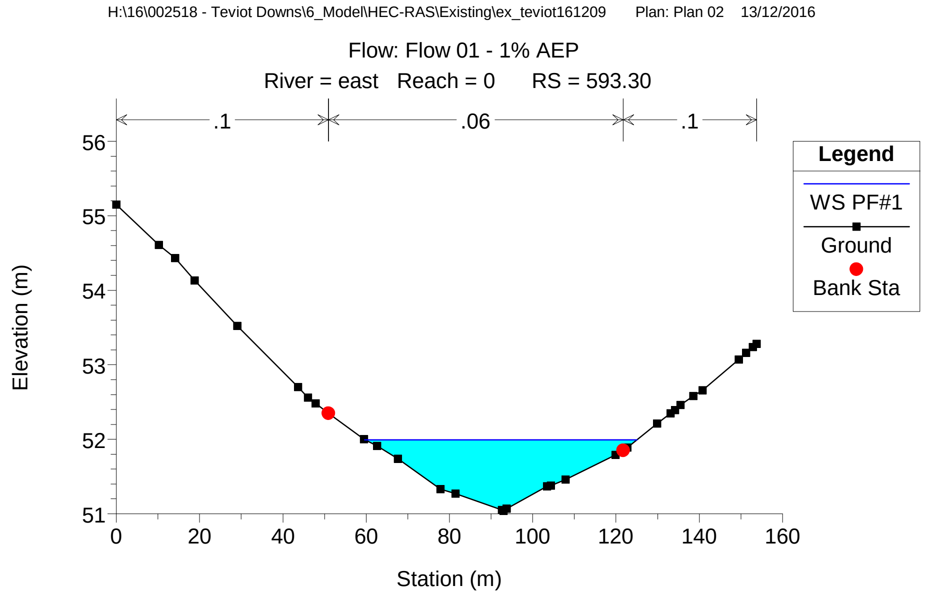
Flow: Flow 01 - 1% AEP
River = east Reach = 630 RS = 629.94
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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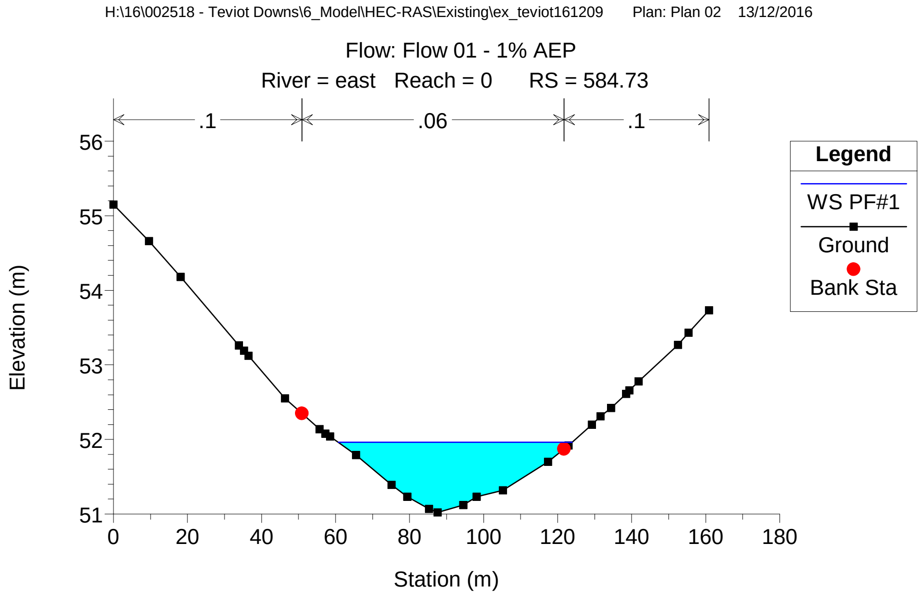
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 593.30
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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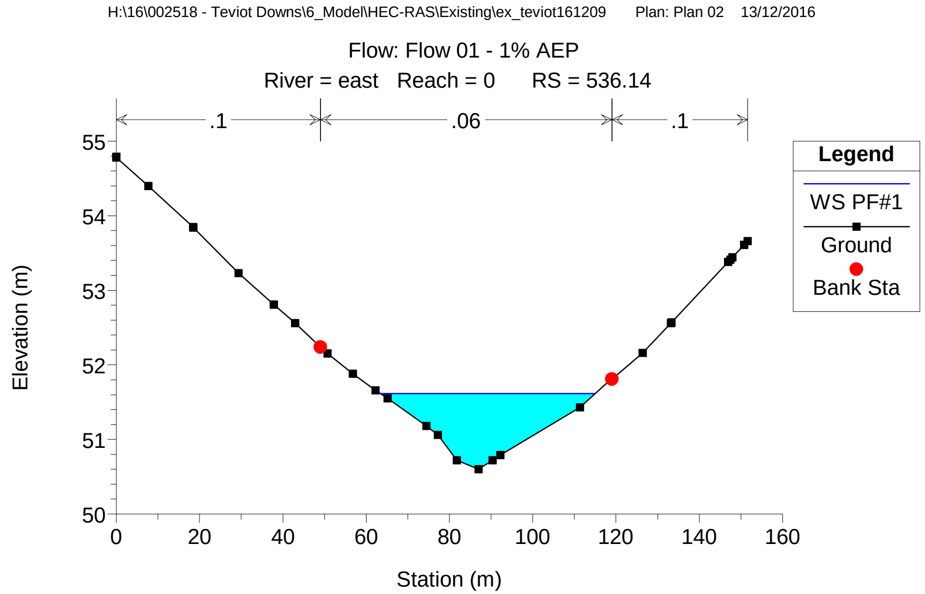
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 584.73
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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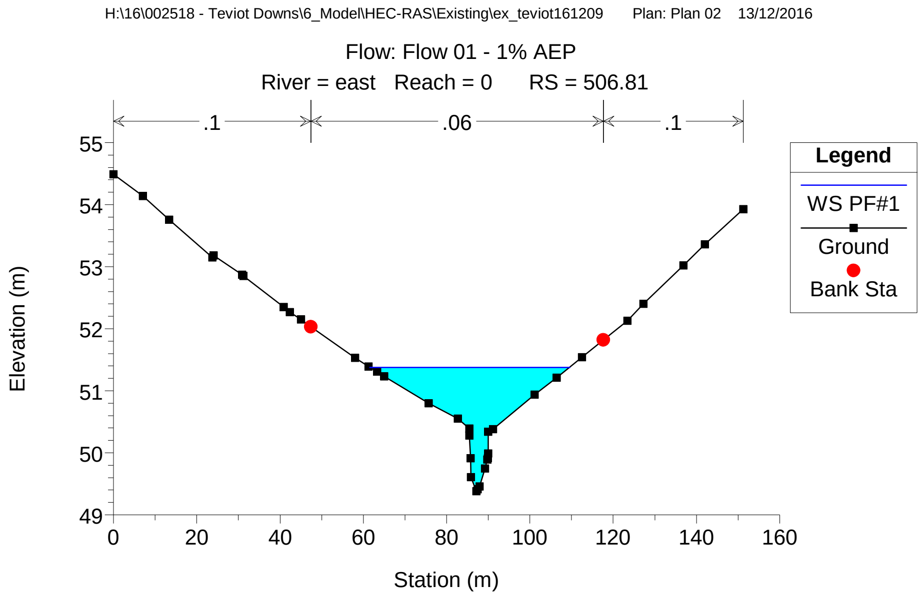
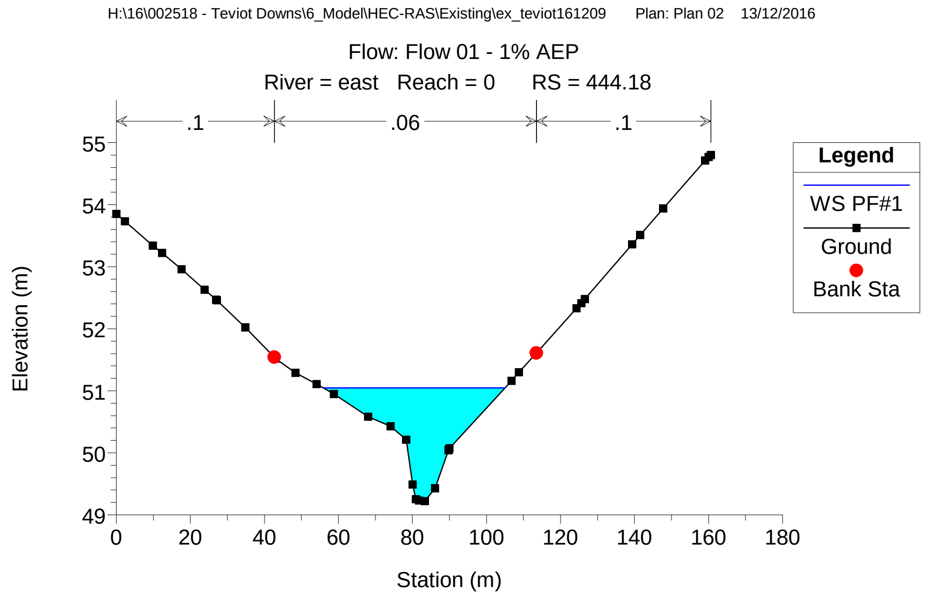
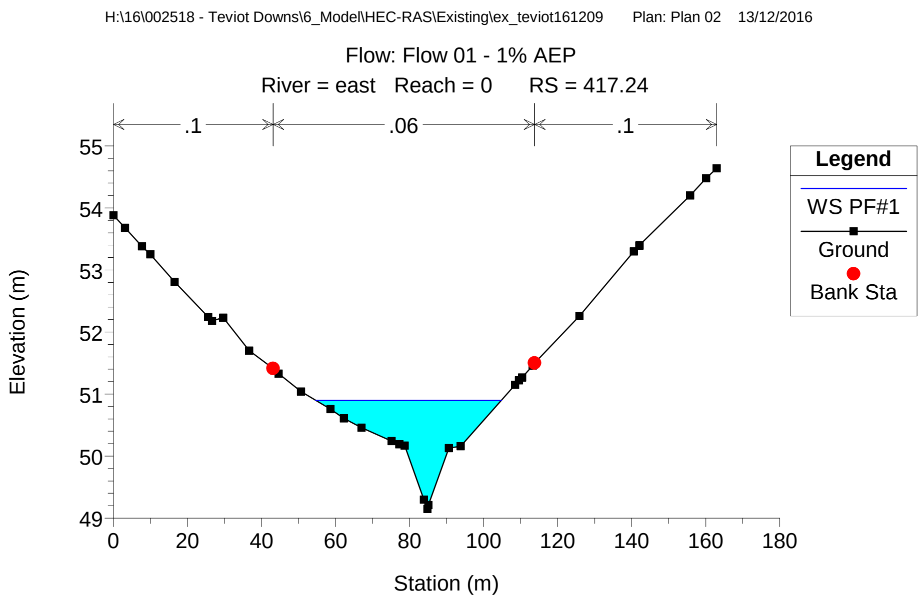
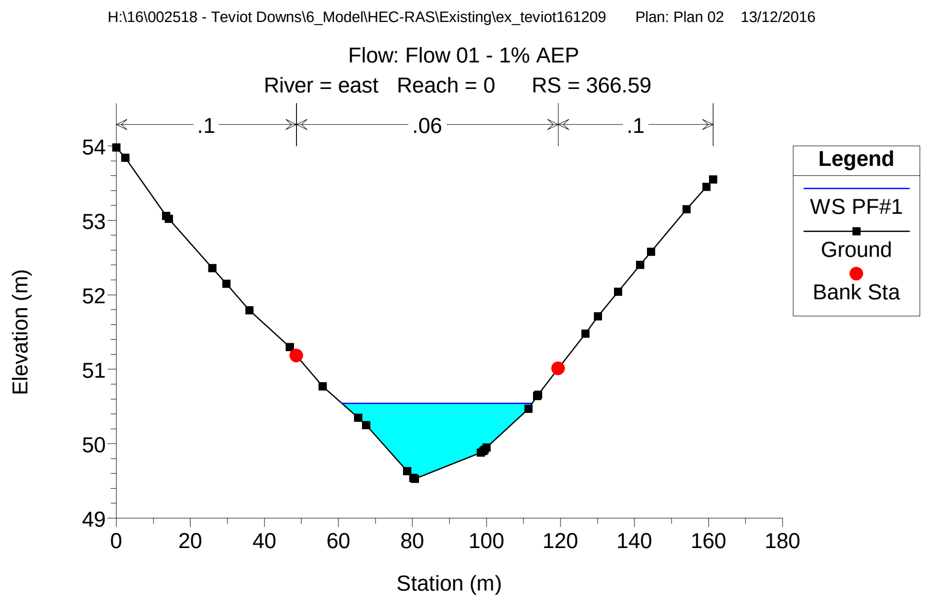
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 536.14
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 506.81
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 444.18
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 417.24
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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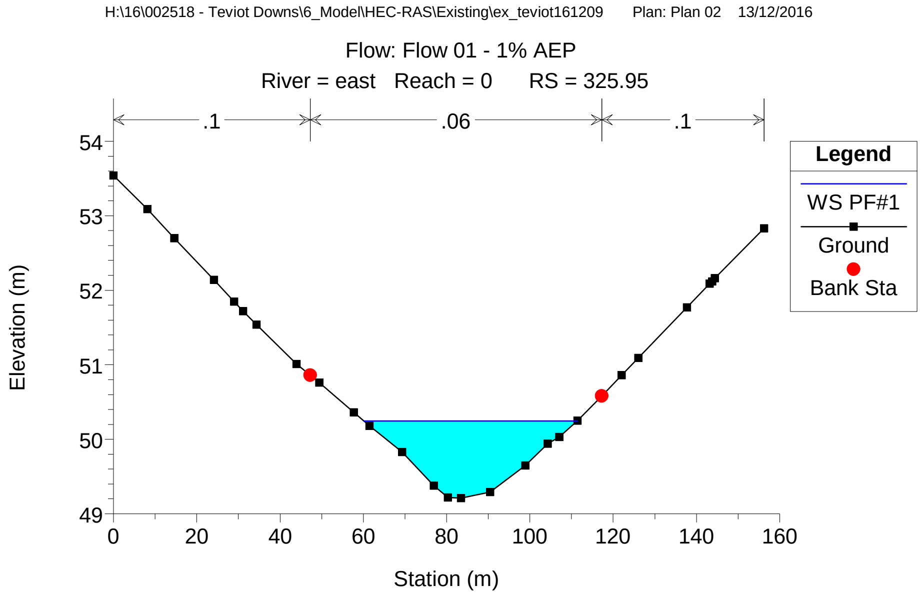
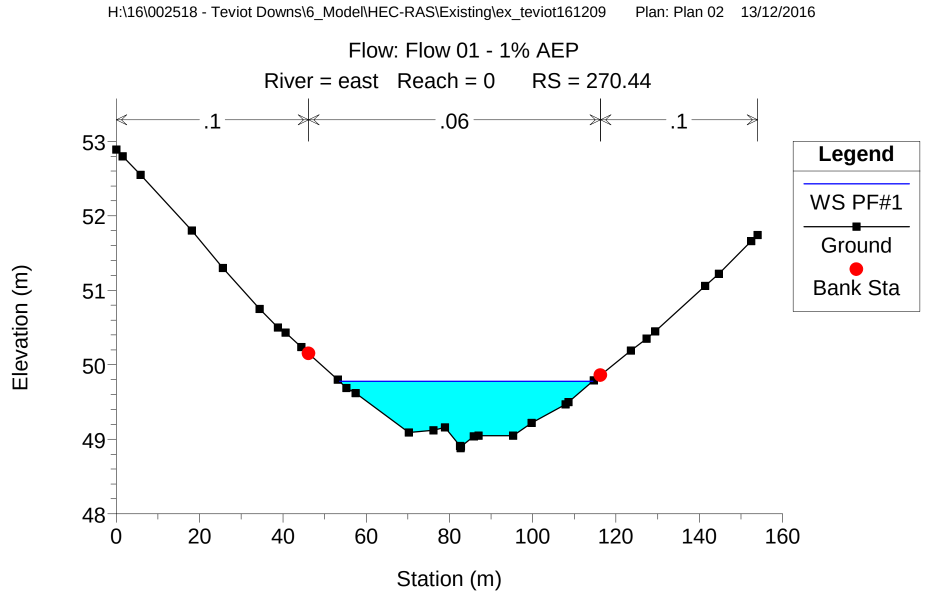
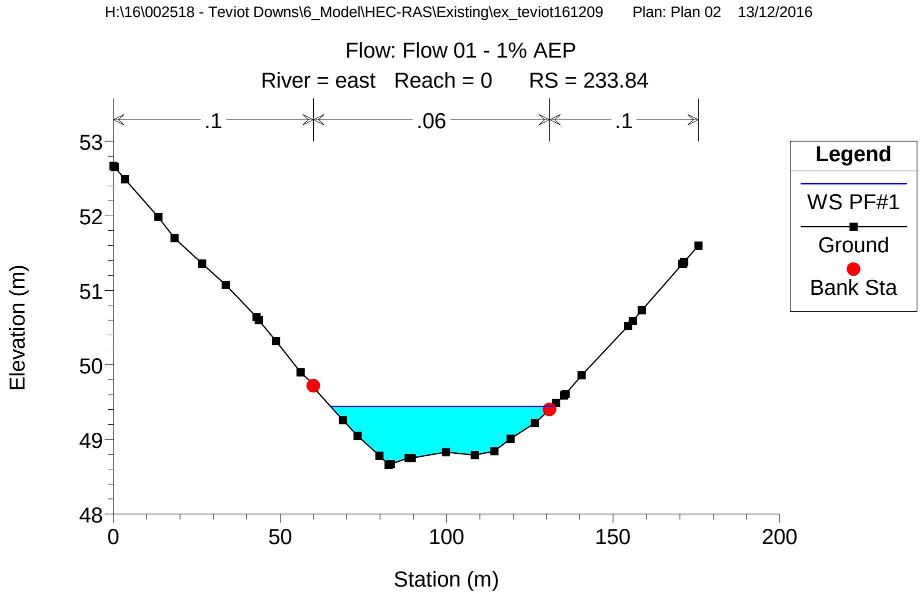
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 366.59
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta



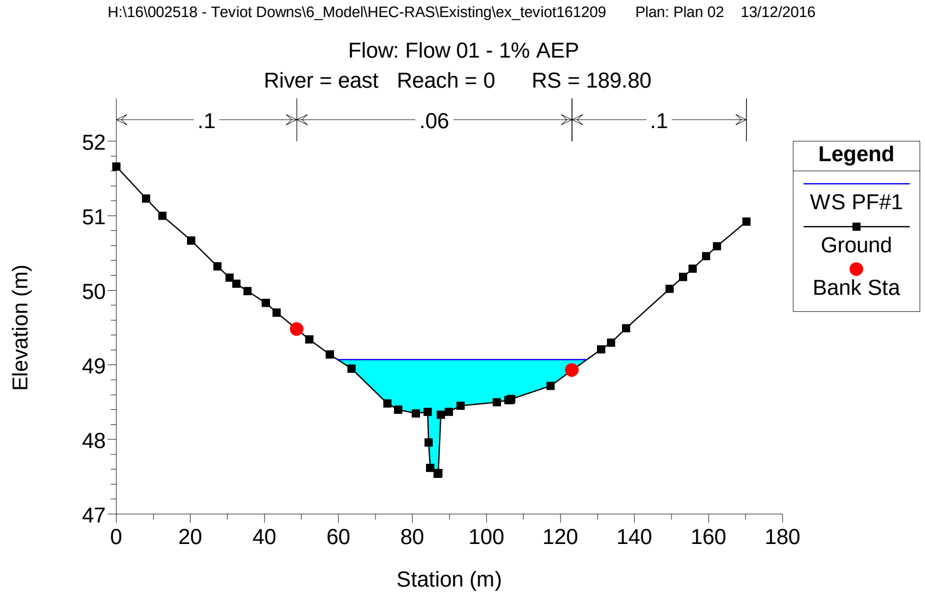
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 325.95
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

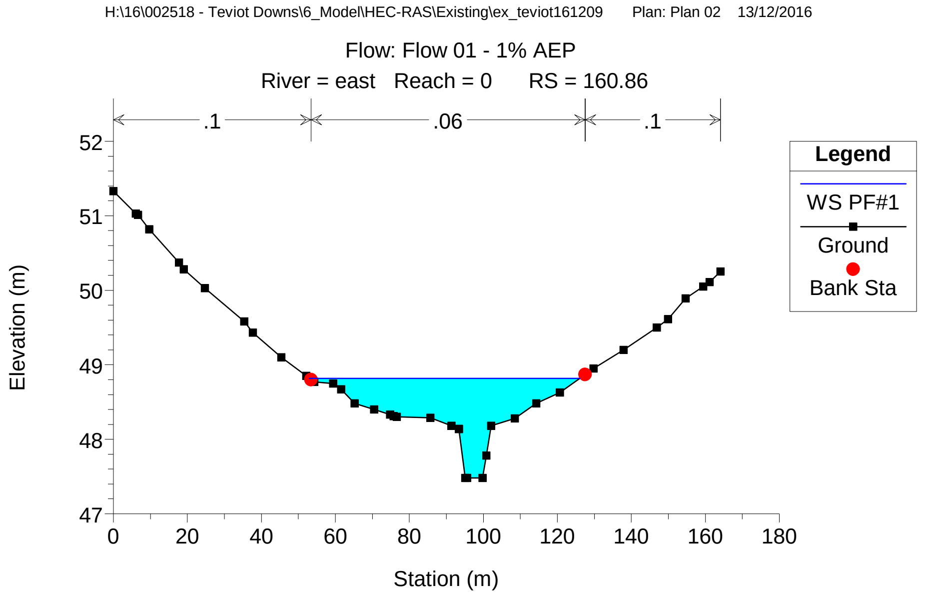
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 270.44
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

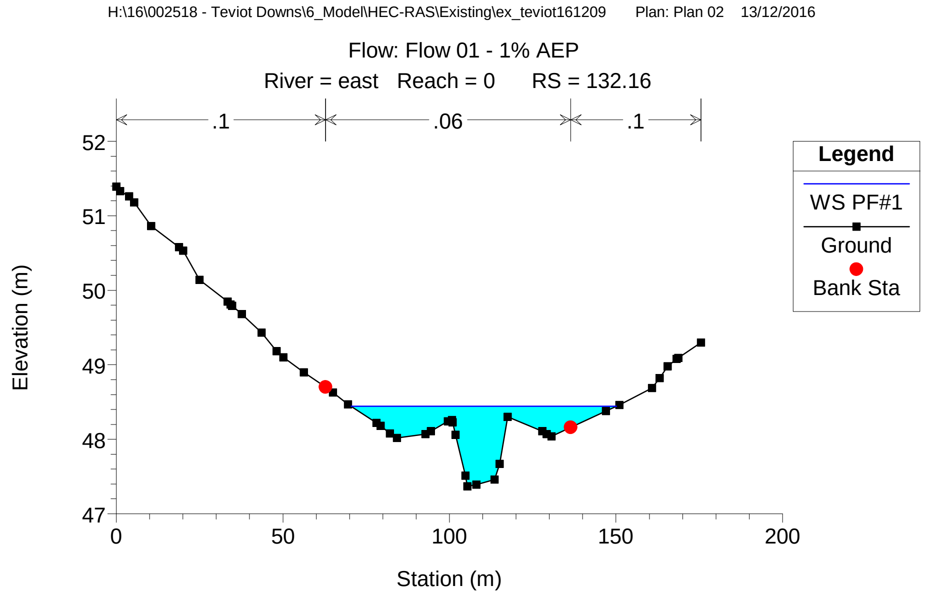



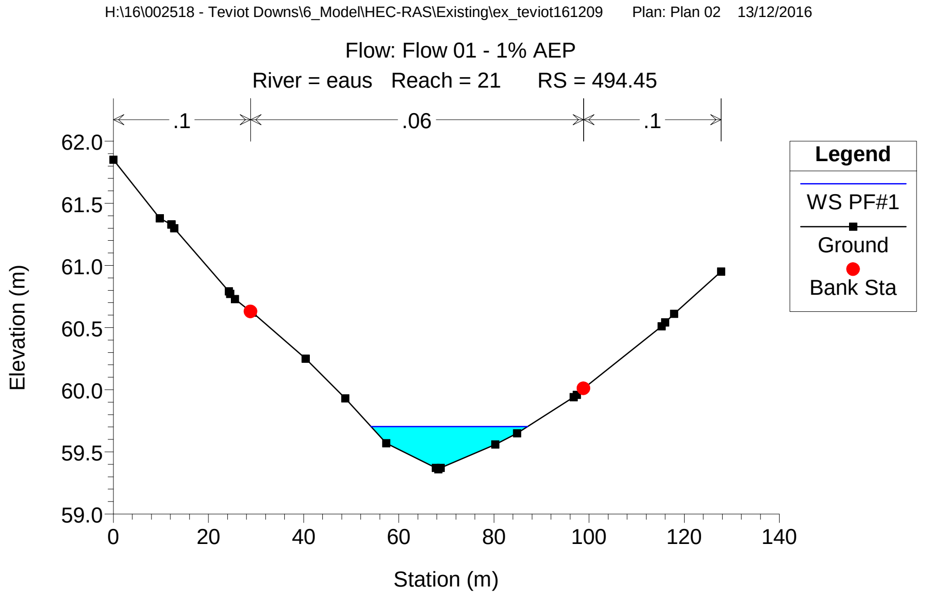
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 233.84
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

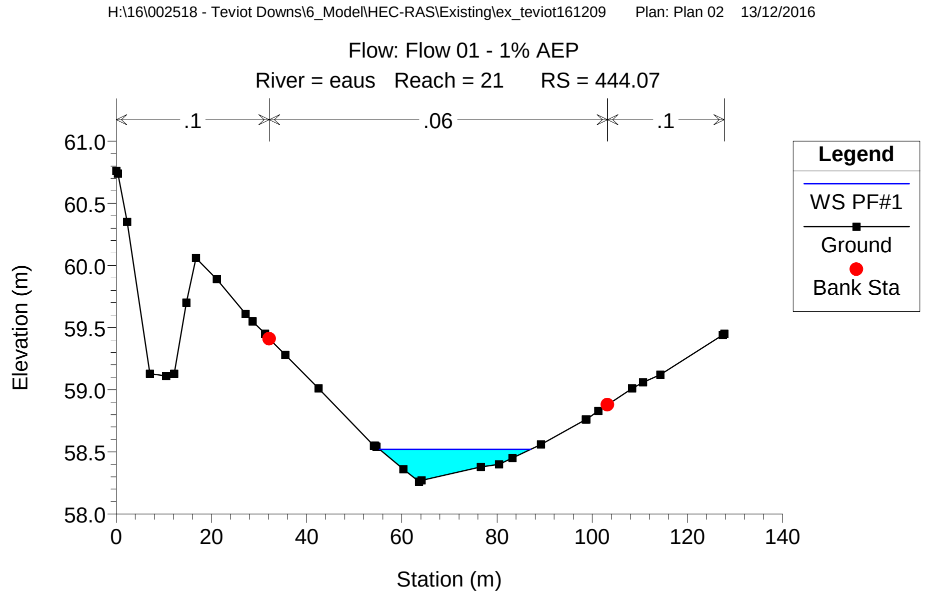



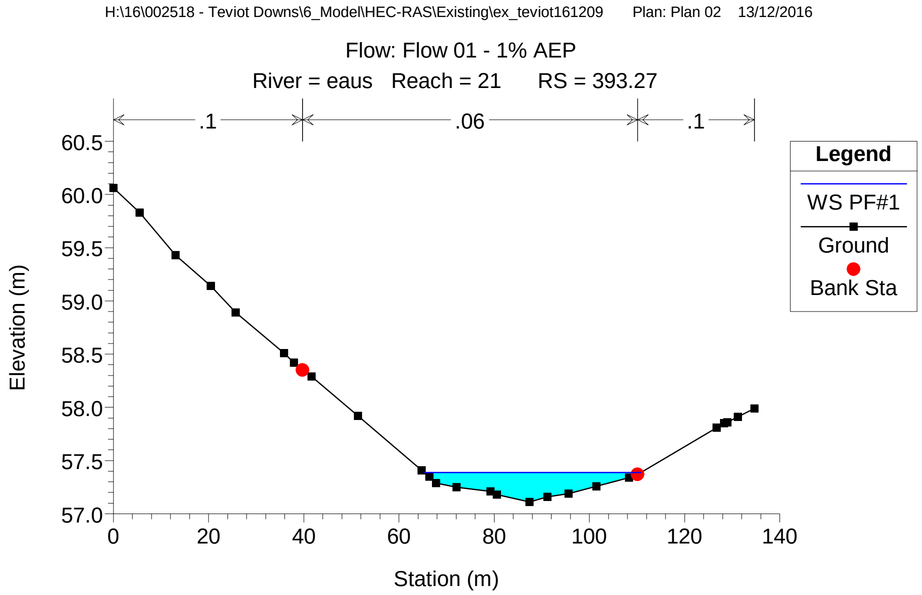
H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 189.80
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

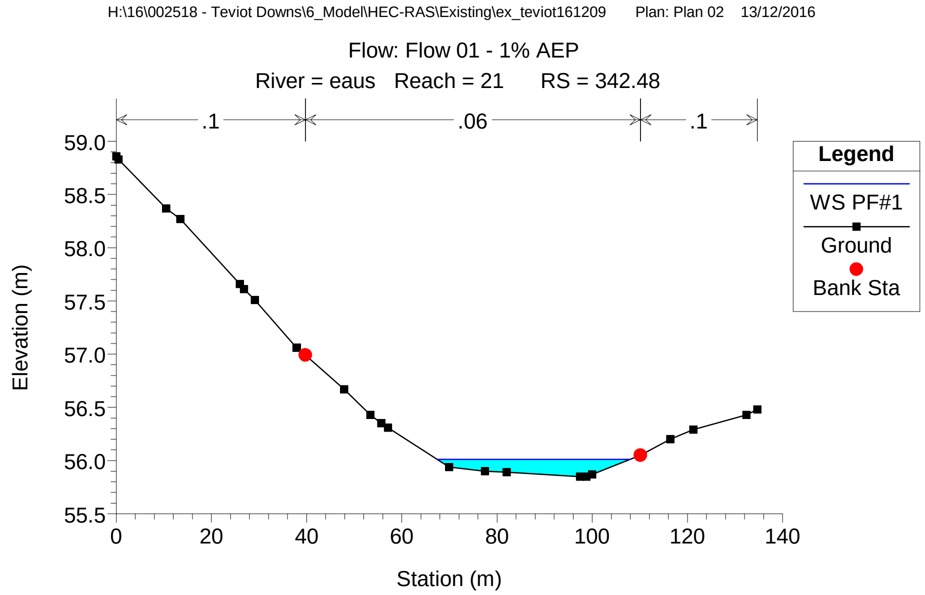

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 160.86
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = east Reach = 0 RS = 132.16
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 494.45
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 444.07
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 393.27
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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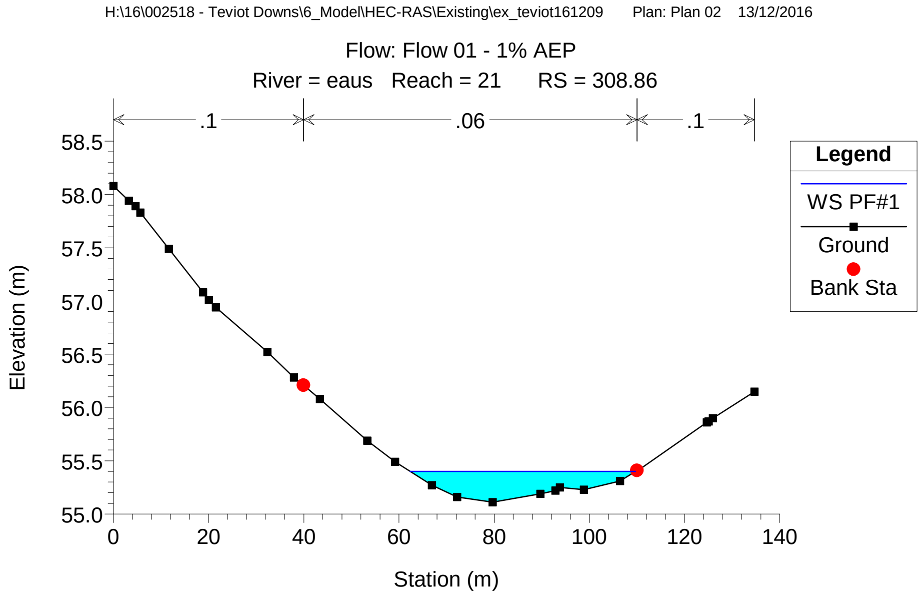
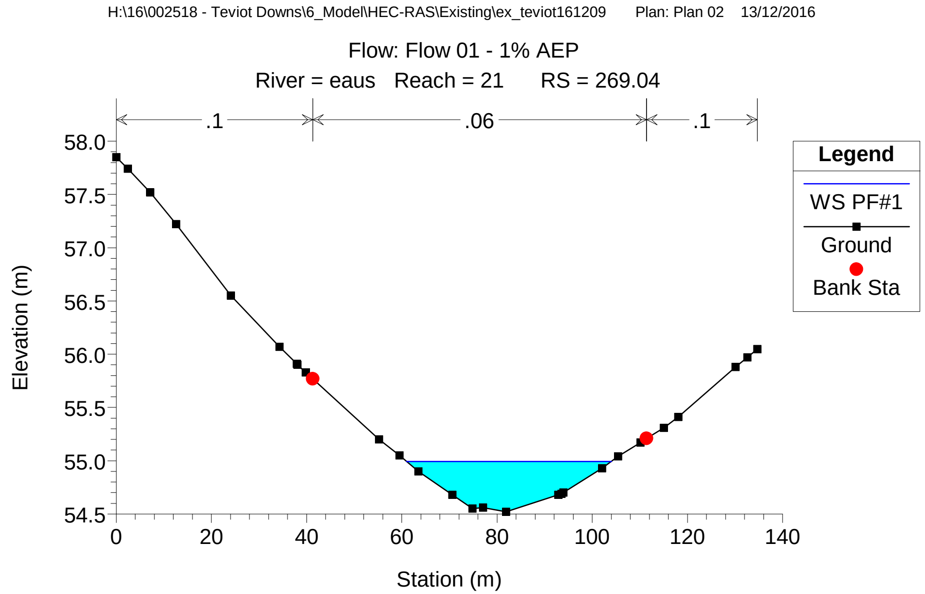
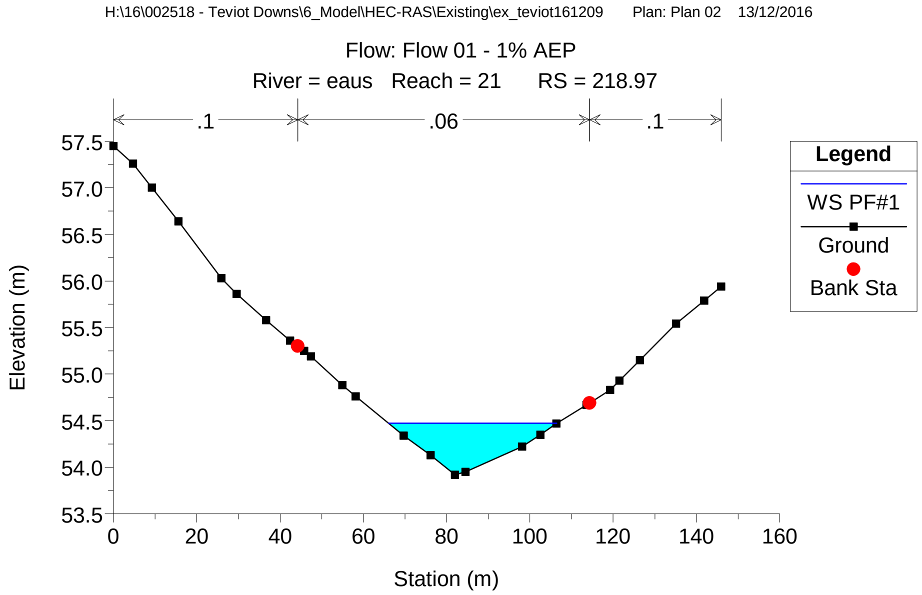
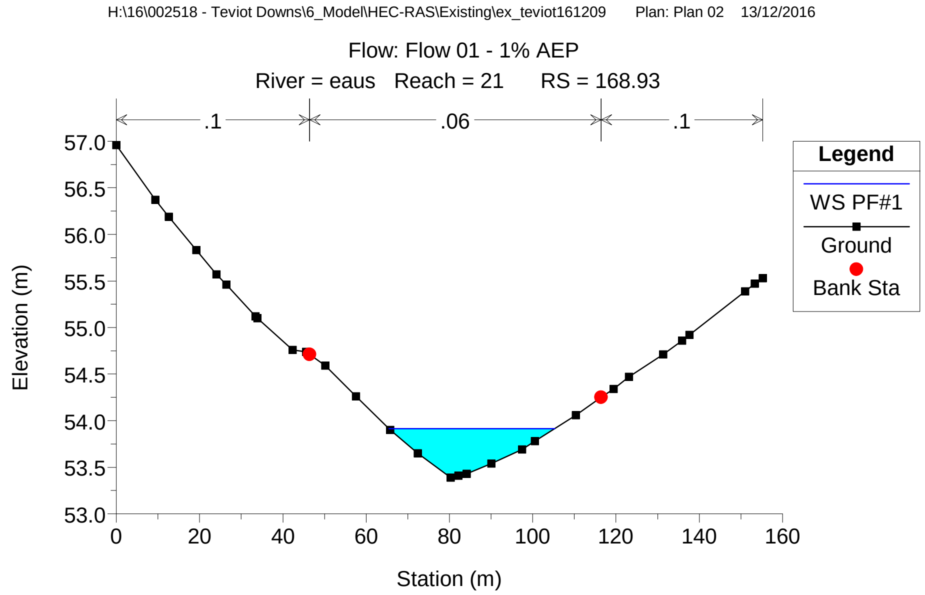
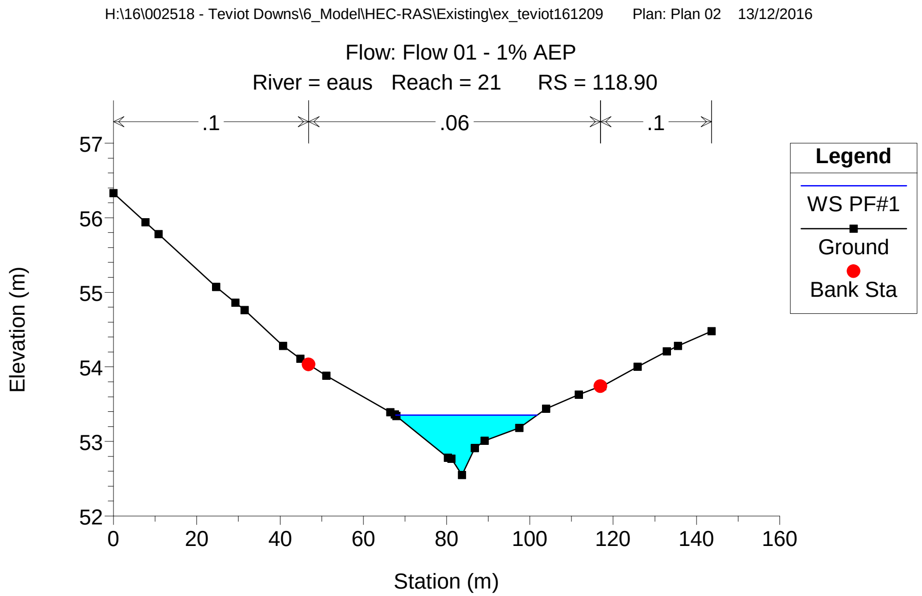
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 342.48
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)

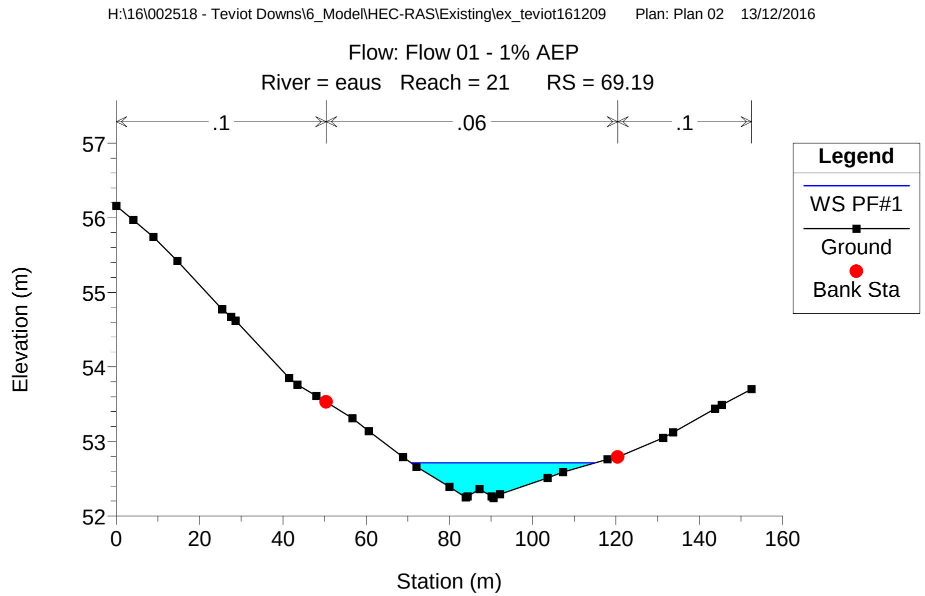

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 308.86
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 269.04
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 218.97
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 168.93
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 118.90
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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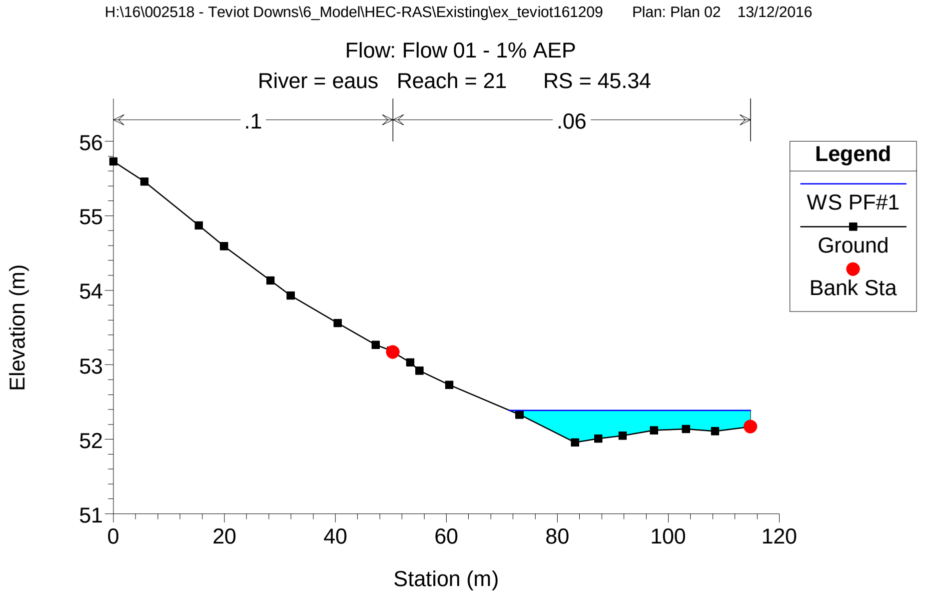
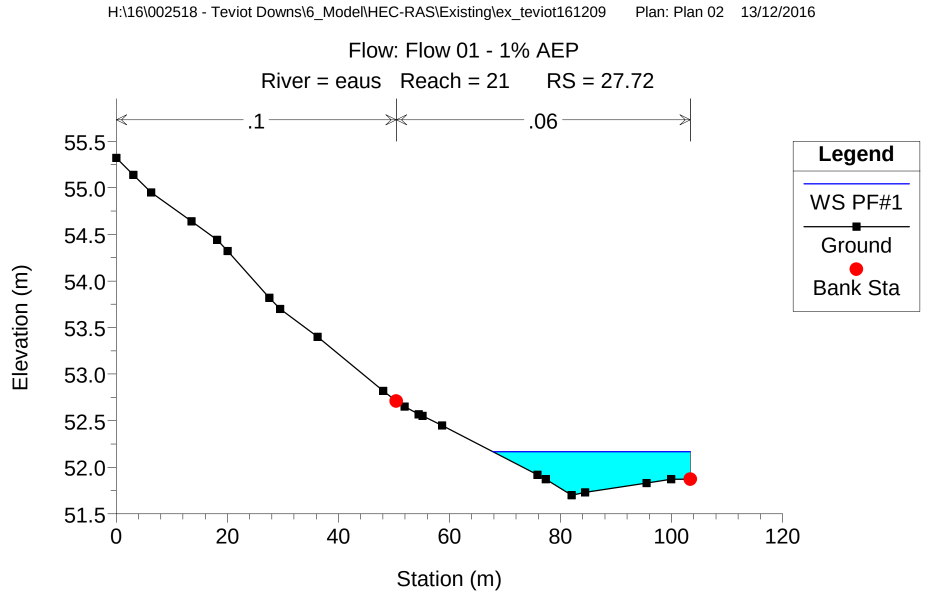
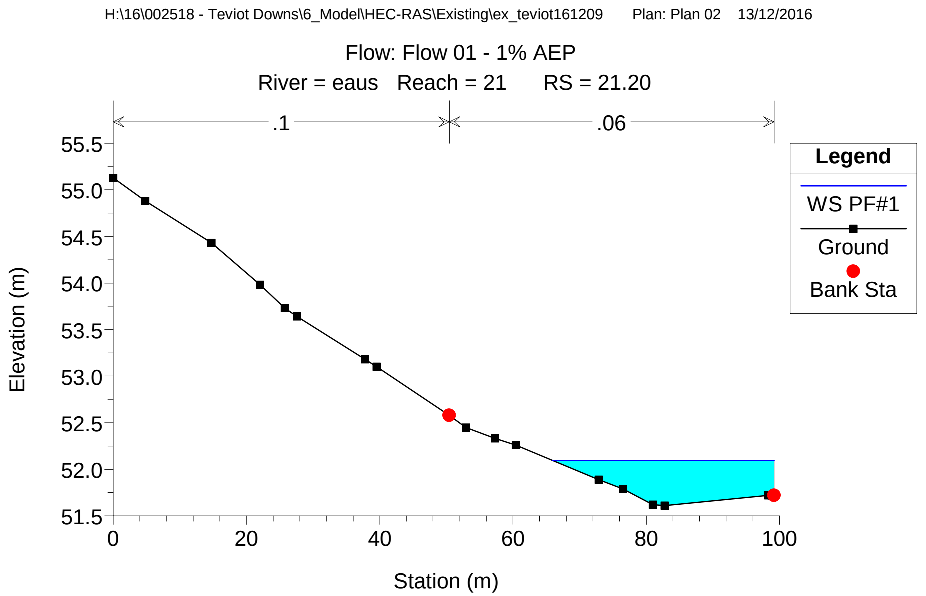
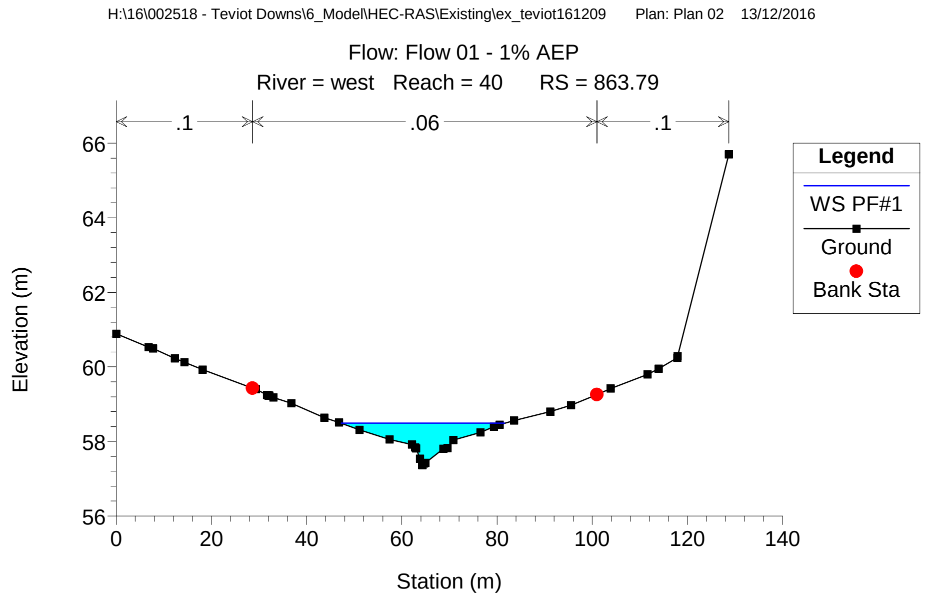
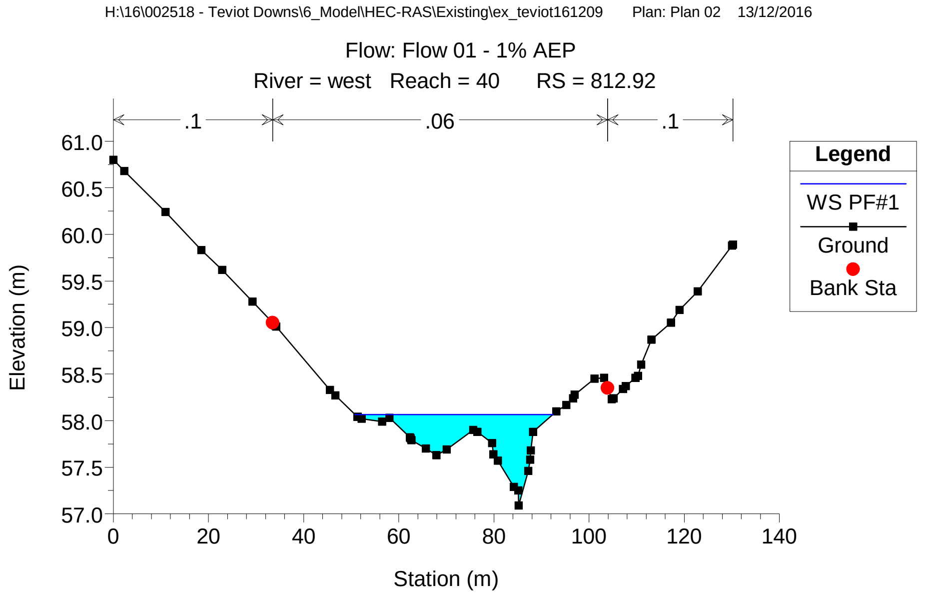
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 69.19
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

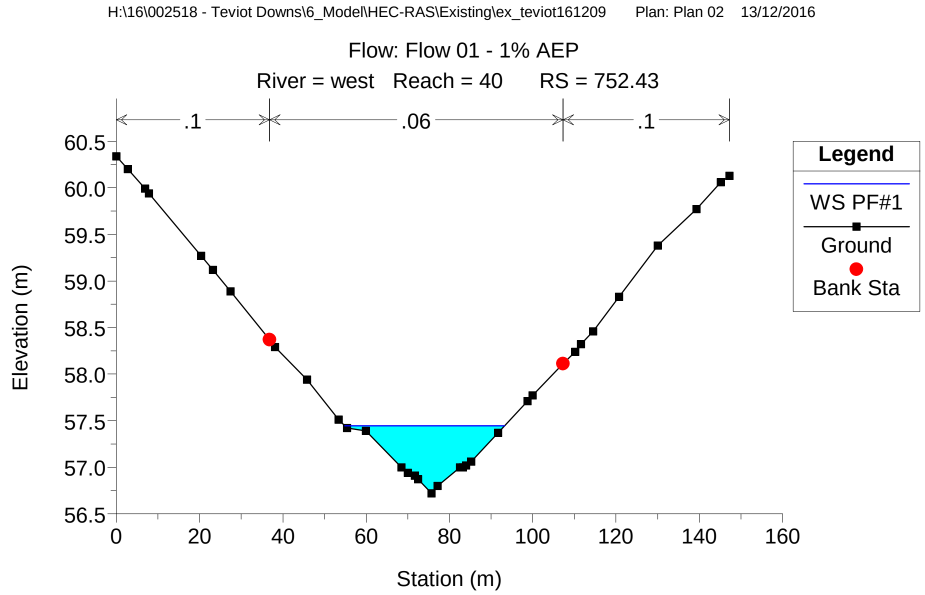

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 45.34
.1
.06
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

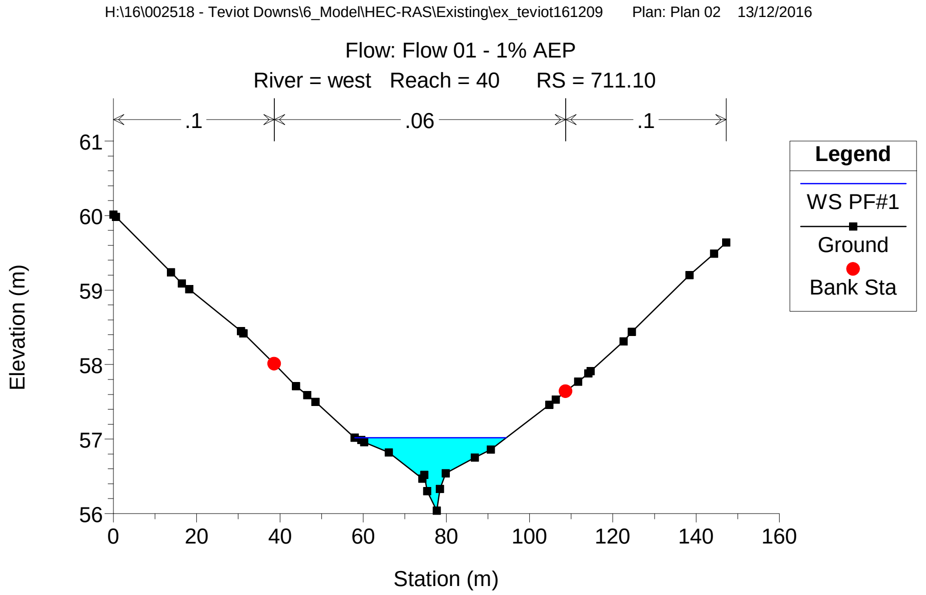

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 27.72
.1
.06
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

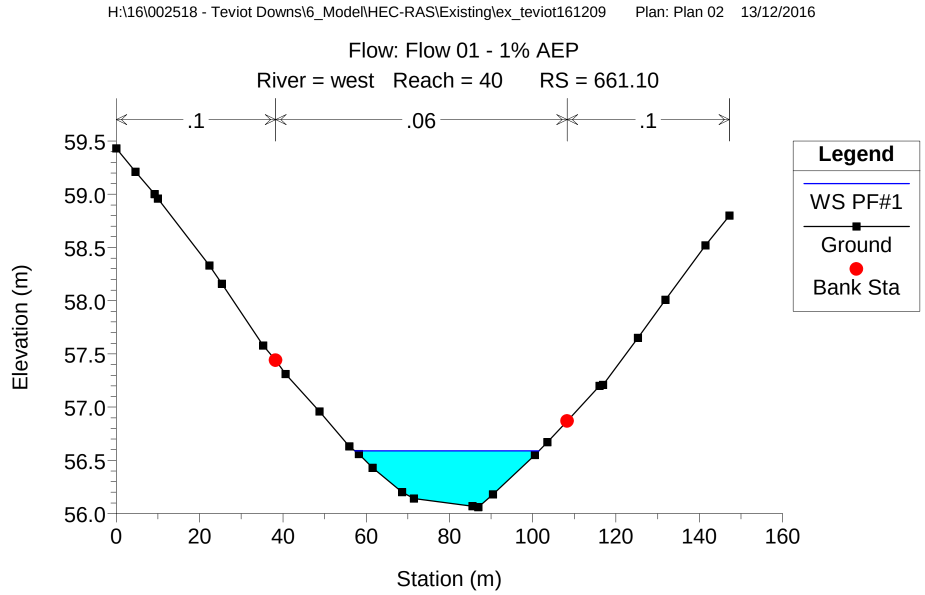

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = eaus Reach = 21 RS = 21.20
.1
.06
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

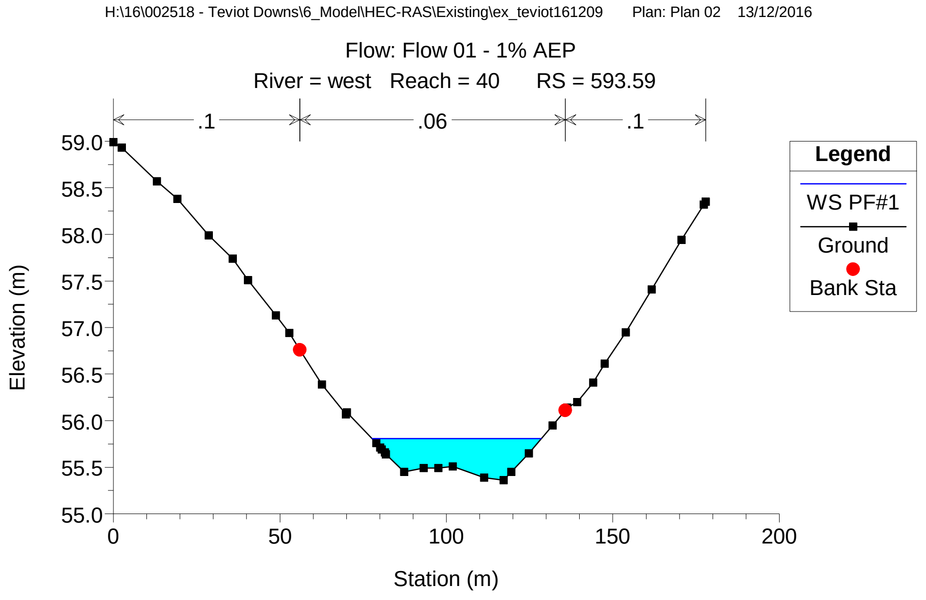

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 863.79
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 812.92
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)
61.0
60.5
60.0
59.5
59.0
58.5
58.0
57.5
57.0
0
20
40
60
80
100
120
140


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 752.43
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)
60.5
60.0
59.5
59.0
58.5
58.0
57.5
57.0
56.5
0
20
40
60
80
100
120
140
160


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 711.10
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)
61
60
59
58
57
56
0
20
40
60
80
100
120
140
160


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 661.10
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)
59.5
59.0
58.5
58.0
57.5
57.0
56.5
56.0
0
20
40
60
80
100
120
140
160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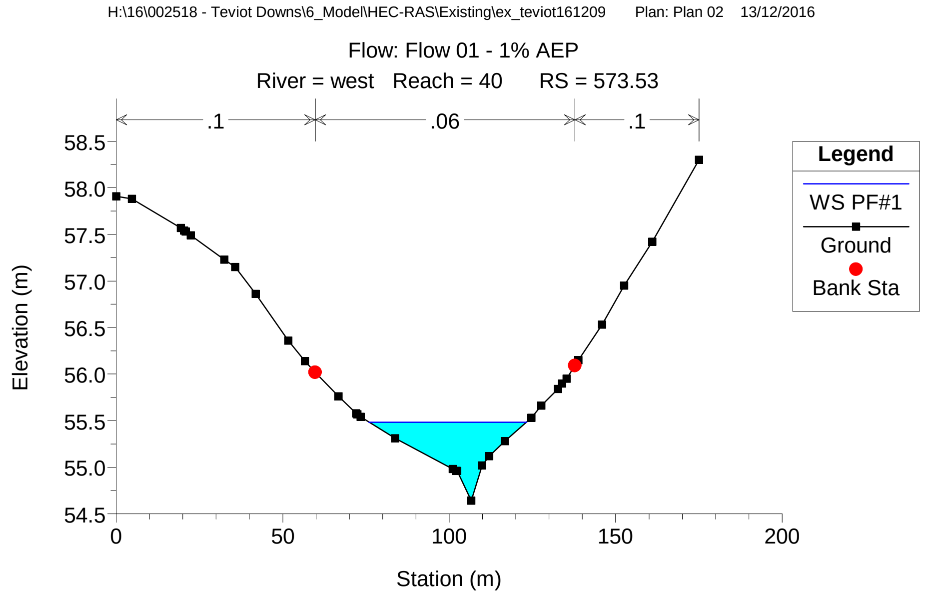
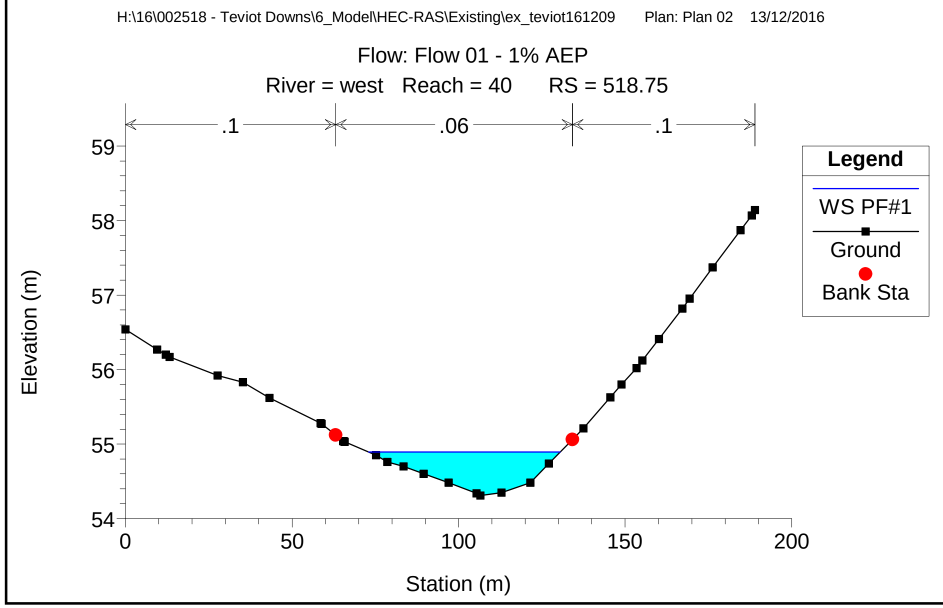
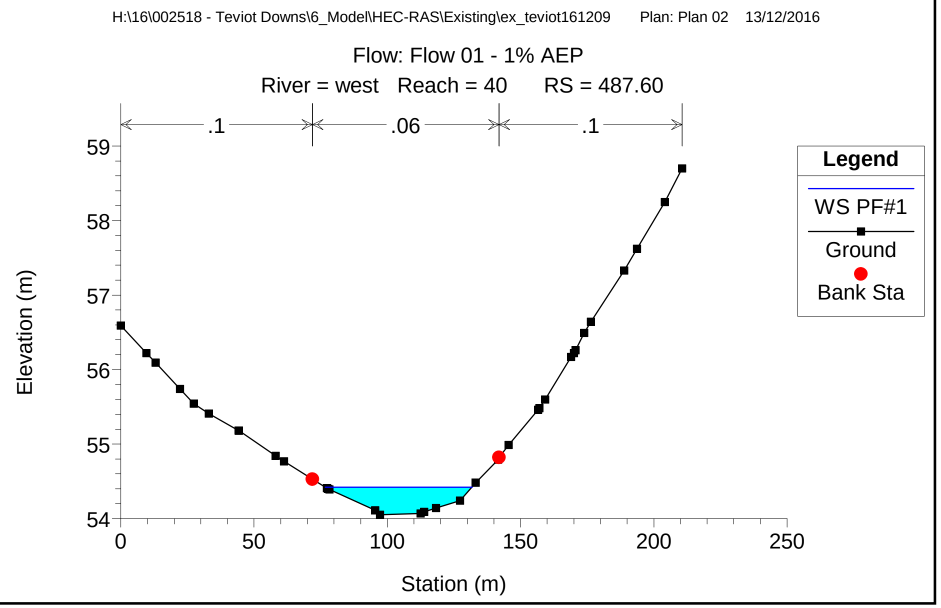
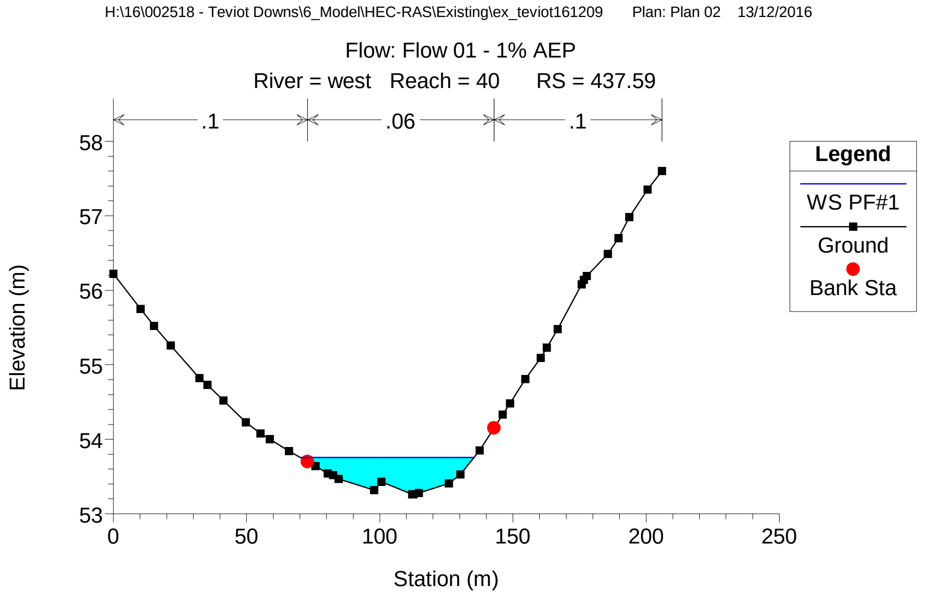
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 593.59
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 573.53
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 518.75
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 487.60
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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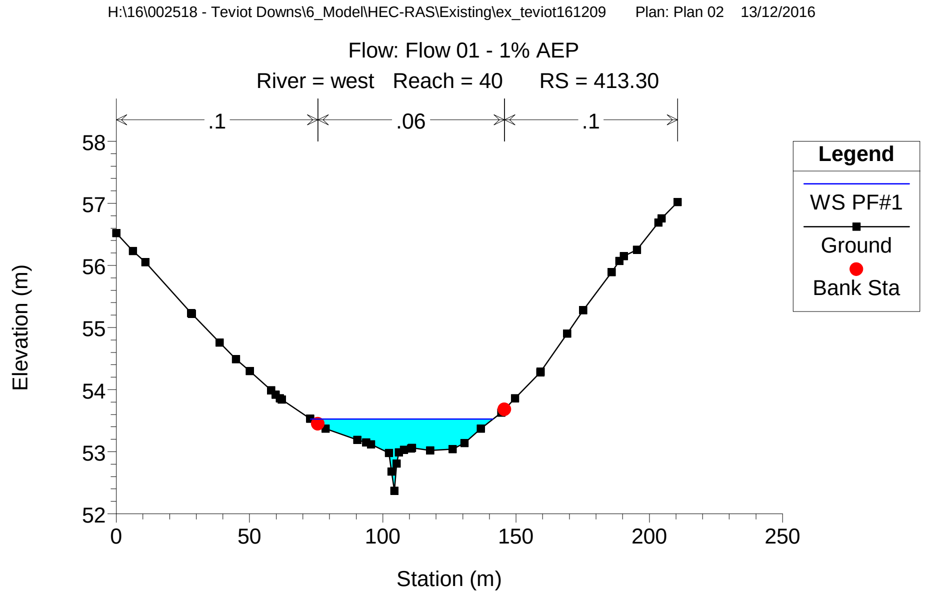
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 437.59
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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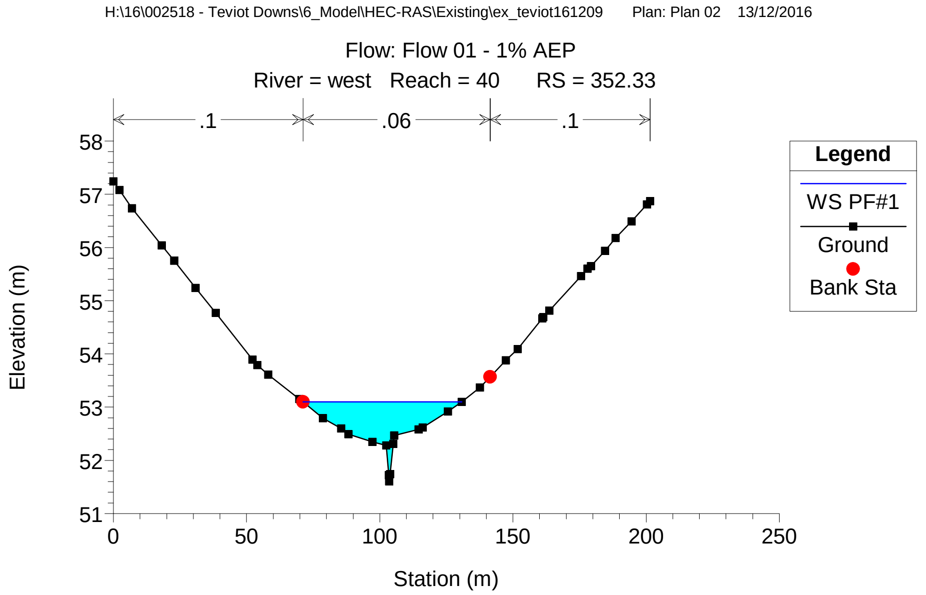
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 413.30
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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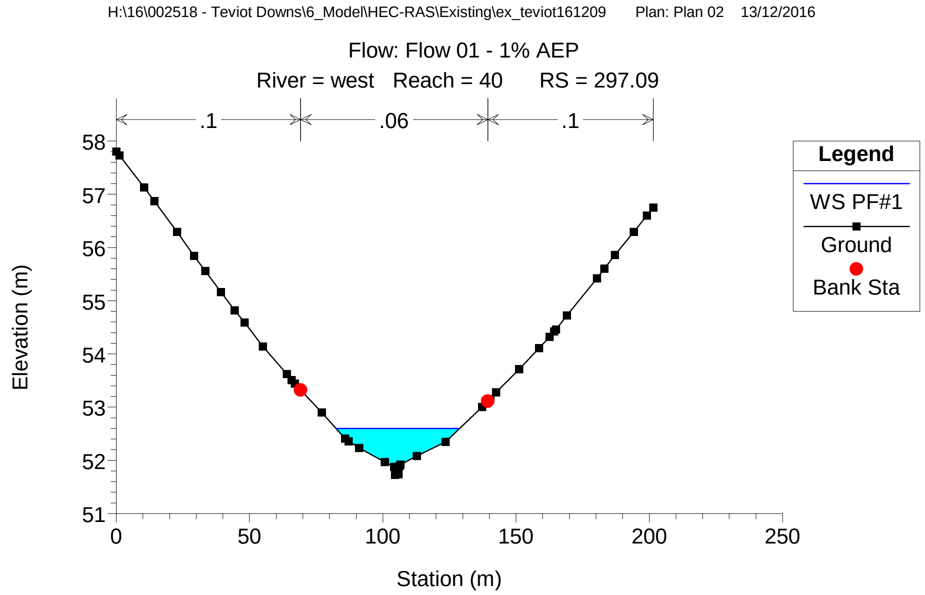
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 352.33
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)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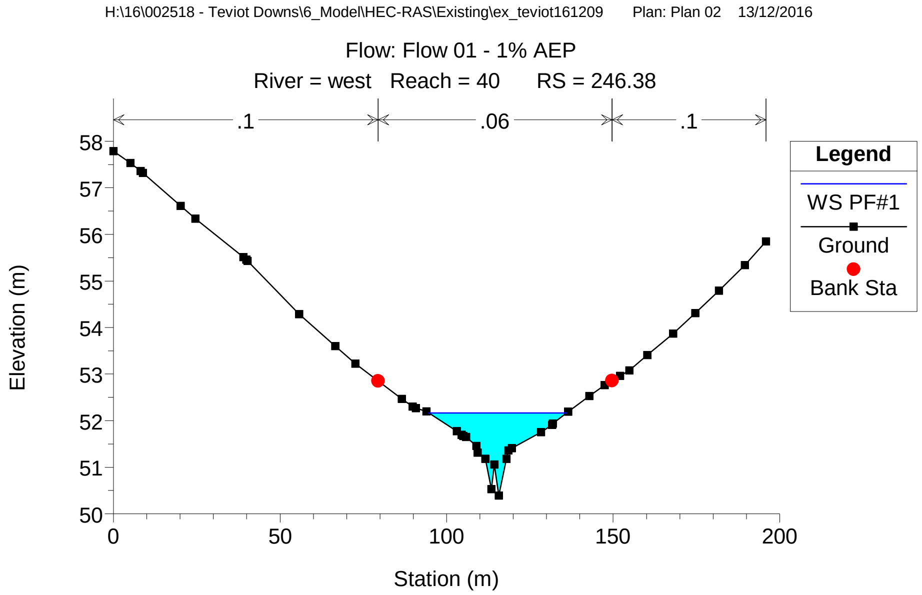
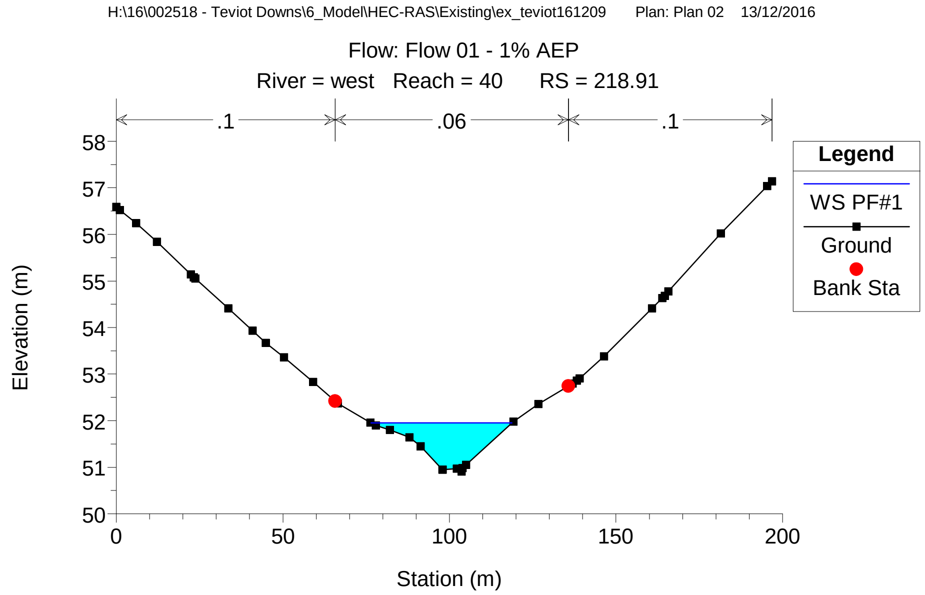
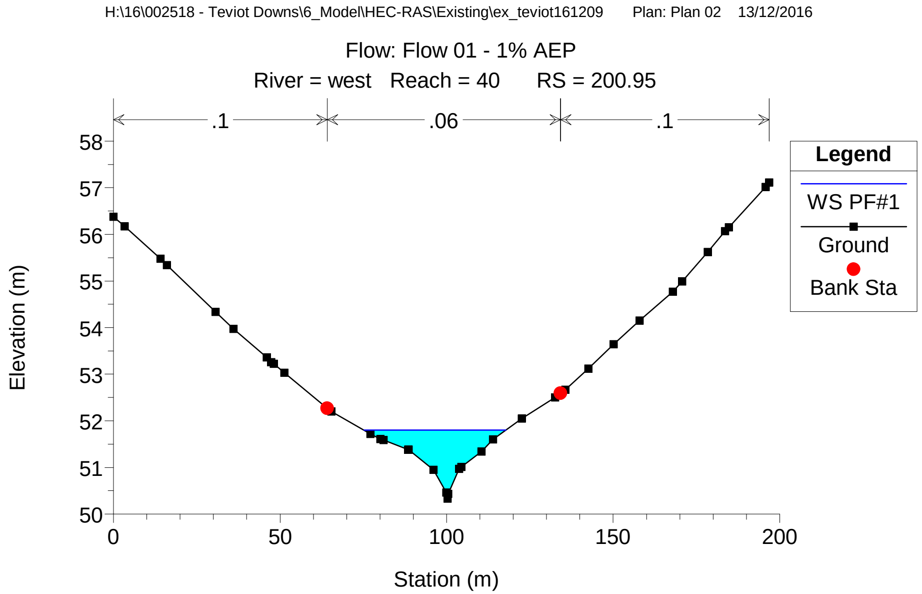
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 297.09
.1
.06
.1
Legend
WS PF#1
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 246.38
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 218.91
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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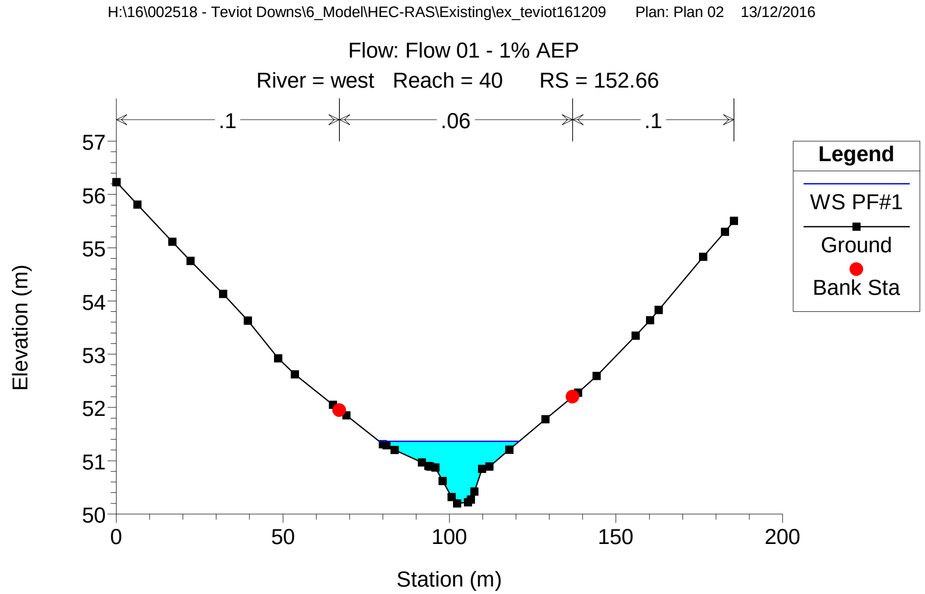
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 200.95
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta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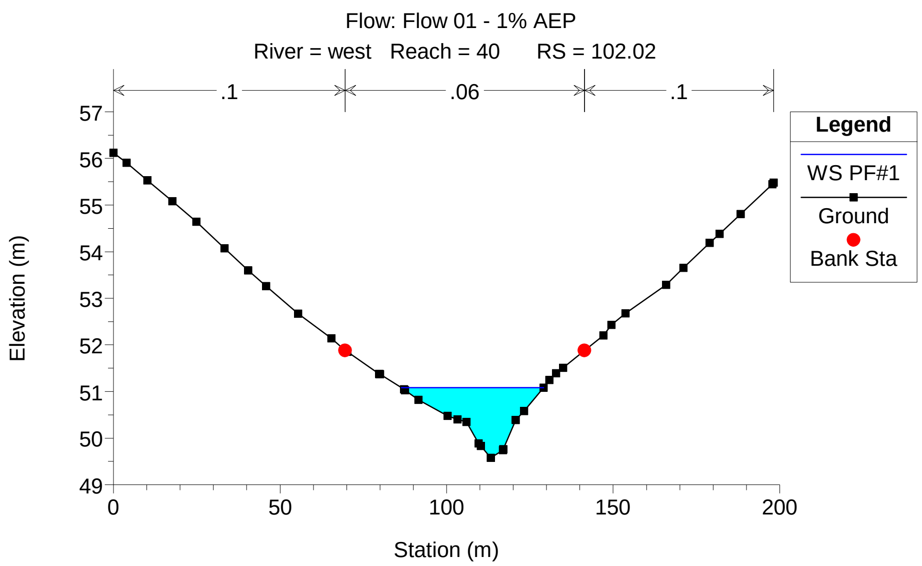
Flow: Flow 01 - 1% AEP
River = west Reach = 40 RS = 152.66
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS PF#1
Ground
Bank Sta

H:\16\002518 - Teviot Downs\6_Model\HEC-RAS\Existing\ex_teviot161209 Plan: Plan 02 13/12/2016

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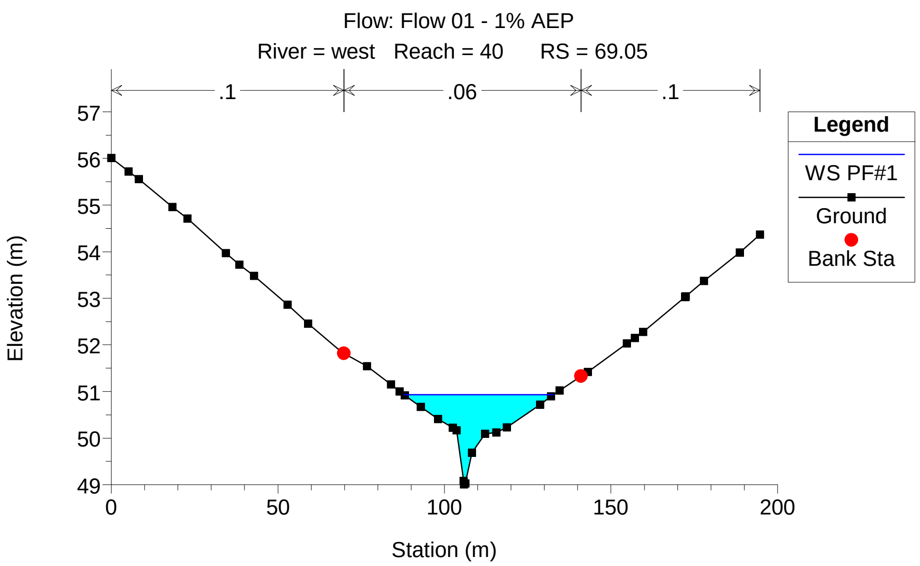


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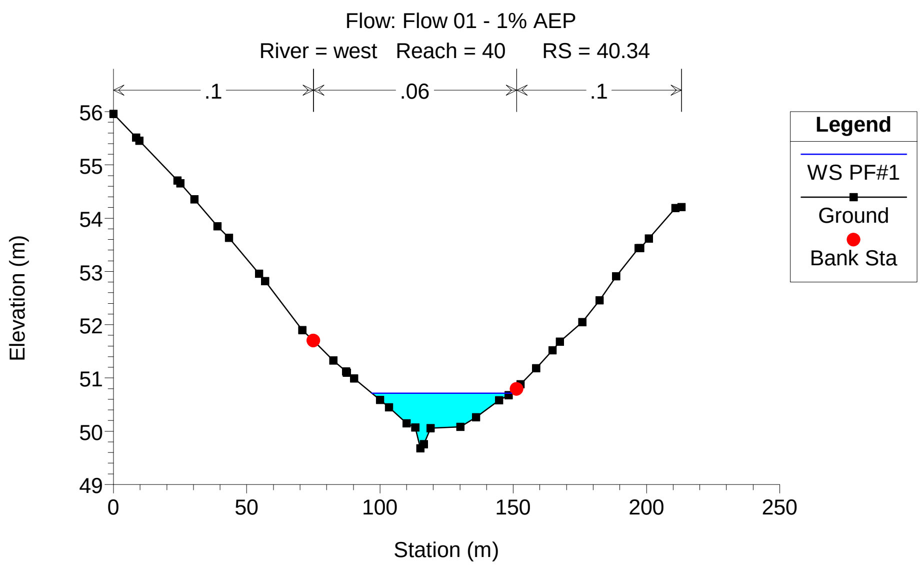
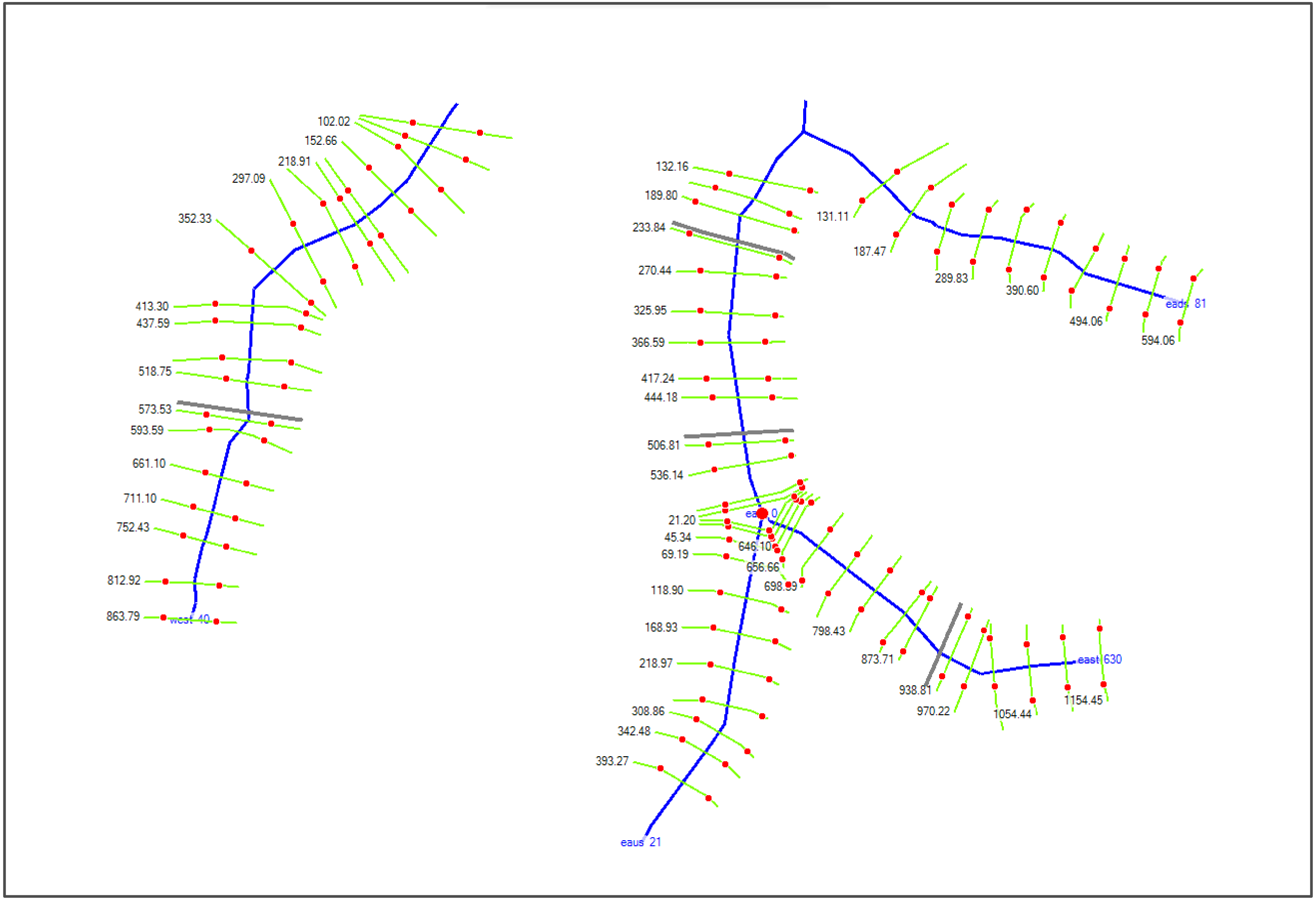


**HEC-RAS** **Plan: Existing 1% AEP**

| River | Reach | River Sta | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m3/s) | (m) | (m) | (m) | (m) | (m/m) | (m/s) | (m2) | (m) | |
| West | 0 | 864 | 9.89 | 57.37 | 58.49 | 58.19 | 58.51 | 0.01 | 0.70 | 14.21 | 34.33 | 0.35 |
| West | 0 | 813 | 9.89 | 57.09 | 58.07 | 57.90 | 58.10 | 0.01 | 0.82 | 12.13 | 41.60 | 0.48 |
| West | 0 | 752 | 9.89 | 56.72 | 57.44 | 57.22 | 57.47 | 0.01 | 0.76 | 13.06 | 38.36 | 0.41 |
| West | 0 | 711 | 9.89 | 56.04 | 57.02 | 56.84 | 57.05 | 0.01 | 0.85 | 11.63 | 36.34 | 0.48 |
| West | 0 | 661 | 9.89 | 56.06 | 56.59 | 56.38 | 56.61 | 0.01 | 0.66 | 14.94 | 44.24 | 0.36 |
| West | 0 | 594 | 14.49 | 55.36 | 55.81 | 55.70 | 55.85 | 0.02 | 0.97 | 14.92 | 50.75 | 0.57 |
| West | 0 | 574 | 14.49 | 54.64 | 55.48 | 55.34 | 55.53 | 0.01 | 0.95 | 15.17 | 47.32 | 0.54 |
| West | 0 | 519 | 14.49 | 54.31 | 54.89 | 54.70 | 54.92 | 0.01 | 0.75 | 19.44 | 57.47 | 0.41 |
| West | 0 | 488 | 14.49 | 54.05 | 54.42 | 54.36 | 54.48 | 0.03 | 1.08 | 13.47 | 55.08 | 0.69 |
| West | 0 | 438 | 14.49 | 53.26 | 53.75 | 53.59 | 53.78 | 0.01 | 0.72 | 20.27 | 65.18 | 0.40 |
| West | 0 | 413 | 21.59 | 52.37 | 53.53 | 53.34 | 53.56 | 0.01 | 0.85 | 25.44 | 68.44 | 0.44 |
| West | 0 | 352 | 21.59 | 51.61 | 53.10 | 52.79 | 53.13 | 0.01 | 0.76 | 28.58 | 59.64 | 0.35 |
| West | 0 | 297 | 21.59 | 51.73 | 52.60 | 52.44 | 52.66 | 0.01 | 1.11 | 19.45 | 46.38 | 0.55 |
| West | 0 | 246 | 21.59 | 50.39 | 52.17 | 51.77 | 52.21 | 0.01 | 0.90 | 24.11 | 41.41 | 0.37 |
| West | 0 | 219 | 21.59 | 50.91 | 51.95 | 51.64 | 52.00 | 0.01 | 1.01 | 21.34 | 42.28 | 0.45 |
| West | 0 | 201 | 21.59 | 50.33 | 51.80 | 51.48 | 51.85 | 0.01 | 0.97 | 22.30 | 42.62 | 0.43 |
| West | 0 | 153 | 21.59 | 50.20 | 51.37 | 51.09 | 51.42 | 0.01 | 1.03 | 20.93 | 42.13 | 0.47 |
| West | 0 | 102 | 23.47 | 49.58 | 51.09 | 50.57 | 51.12 | 0.00 | 0.81 | 28.89 | 42.67 | 0.32 |
| West | 0 | 69 | 23.47 | 49.01 | 50.93 | 50.50 | 50.97 | 0.01 | 0.86 | 27.33 | 44.78 | 0.35 |
| West | 0 | 40 | 23.47 | 49.68 | 50.72 | 50.48 | 50.77 | 0.01 | 0.98 | 23.84 | 52.42 | 0.47 |
| East | 21 | 494 | 4.22 | 59.36 | 59.70 | 59.62 | 59.73 | 0.01 | 0.67 | 6.28 | 32.96 | 0.49 |
| East | 21 | 444 | 4.22 | 58.26 | 58.52 | 58.49 | 58.56 | 0.04 | 0.92 | 4.58 | 31.78 | 0.77 |
| East | 21 | 393 | 4.22 | 57.11 | 57.39 | 57.31 | 57.40 | 0.01 | 0.59 | 7.16 | 45.42 | 0.47 |
| East | 21 | 342 | 4.22 | 55.85 | 56.01 | 56.00 | 56.06 | 0.06 | 0.96 | 4.42 | 40.46 | 0.92 |
| East | 21 | 309 | 4.22 | 55.11 | 55.40 | 55.30 | 55.41 | 0.01 | 0.50 | 8.45 | 47.32 | 0.38 |
| East | 21 | 269 | 9.21 | 54.52 | 54.99 | 54.84 | 55.02 | 0.01 | 0.74 | 12.48 | 43.03 | 0.44 |
| East | 21 | 219 | 9.21 | 53.92 | 54.47 | 54.31 | 54.50 | 0.01 | 0.76 | 12.05 | 40.31 | 0.45 |
| East | 21 | 169 | 9.21 | 53.39 | 53.91 | 53.77 | 53.95 | 0.01 | 0.79 | 11.63 | 39.81 | 0.47 |
| East | 21 | 119 | 9.21 | 52.55 | 53.35 | 53.18 | 53.39 | 0.01 | 0.82 | 11.17 | 33.96 | 0.46 |
| East | 21 | 69 | 9.21 | 52.24 | 52.71 | 52.60 | 52.75 | 0.02 | 0.83 | 11.12 | 44.15 | 0.53 |
| East | 21 | 45 | 9.21 | 51.96 | 52.39 | 52.27 | 52.42 | 0.01 | 0.77 | 11.91 | 43.47 | 0.47 |
| East | 21 | 28 | 9.21 | 51.70 | 52.17 | 52.03 | 52.20 | 0.01 | 0.84 | 10.99 | 35.55 | 0.48 |
| East | 21 | 21 | 9.21 | 51.61 | 52.10 | 51.93 | 52.13 | 0.01 | 0.82 | 11.25 | 33.22 | 0.45 |
| East | 630 | 1154 | 5.47 | 57.46 | 57.77 | 57.67 | 57.79 | 0.01 | 0.64 | 8.60 | 42.69 | 0.45 |
| East | 630 | 1104 | 5.47 | 56.74 | 57.09 | 57.00 | 57.11 | 0.02 | 0.68 | 8.01 | 41.45 | 0.50 |
| East | 630 | 1054 | 5.47 | 55.84 | 56.14 | 56.08 | 56.17 | 0.02 | 0.83 | 6.61 | 36.51 | 0.62 |
| East | 630 | 1004 | 5.47 | 55.08 | 55.41 | 55.30 | 55.43 | 0.01 | 0.56 | 9.75 | 49.77 | 0.40 |
| East | 630 | 970 | 7.62 | 54.40 | 55.10 | 54.95 | 55.12 | 0.01 | 0.63 | 12.17 | 45.80 | 0.39 |
| East | 630 | 939 | 7.62 | 54.42 | 54.79 | 54.68 | 54.82 | 0.01 | 0.69 | 11.09 | 47.48 | 0.45 |
| East | 630 | 874 | 7.62 | 53.81 | 54.23 | 54.05 | 54.24 | 0.01 | 0.59 | 12.88 | 45.33 | 0.35 |
| East | 630 | 850 | 7.62 | 53.54 | 54.08 | 53.88 | 54.09 | 0.01 | 0.57 | 13.25 | 44.91 | 0.34 |
| East | 630 | 798 | 14.24 | 53.03 | 53.67 | 53.46 | 53.70 | 0.01 | 0.79 | 17.94 | 48.48 | 0.42 |
| East | 630 | 748 | 14.24 | 52.61 | 53.21 | 53.01 | 53.25 | 0.01 | 0.85 | 16.76 | 45.26 | 0.45 |
| East | 630 | 698 | 14.24 | 52.14 | 52.77 | 52.54 | 52.80 | 0.01 | 0.76 | 18.62 | 51.61 | 0.41 |
| East | 630 | 657 | 14.24 | 50.95 | 51.94 | 51.94 | 52.08 | 0.05 | 1.68 | 8.50 | 29.43 | 1.00 |
| East | 630 | 646 | 14.24 | 51.06 | 52.23 | 51.97 | 52.25 | 0.00 | 0.58 | 24.56 | 62.81 | 0.30 |
| East | 630 | 637 | 14.24 | 51.68 | 52.19 | 51.97 | 52.21 | 0.01 | 0.65 | 22.01 | 58.51 | 0.33 |
| East | 630 | 630 | 14.24 | 51.60 | 52.15 | 51.90 | 52.17 | 0.00 | 0.63 | 22.62 | 53.40 | 0.30 |
| East | 109 | 593 | 23.45 | 51.04 | 51.99 | 51.62 | 52.02 | 0.00 | 0.70 | 33.64 | 65.41 | 0.31 |
| East | 109 | 585 | 23.45 | 51.02 | 51.96 | 51.58 | 51.99 | 0.00 | 0.69 | 33.85 | 63.12 | 0.30 |
| East | 109 | 536 | 29.56 | 50.60 | 51.62 | 51.36 | 51.68 | 0.01 | 1.10 | 26.92 | 51.65 | 0.49 |
| East | 109 | 507 | 29.56 | 49.38 | 51.38 | 50.98 | 51.43 | 0.01 | 0.99 | 29.80 | 48.00 | 0.40 |
| East | 109 | 444 | 29.56 | 49.22 | 51.05 | 50.47 | 51.09 | 0.00 | 0.86 | 34.18 | 49.06 | 0.33 |
| East | 109 | 417 | 29.56 | 49.15 | 50.90 | 50.50 | 50.95 | 0.01 | 0.95 | 31.06 | 50.10 | 0.39 |
| East | 109 | 367 | 29.56 | 49.53 | 50.54 | 50.22 | 50.59 | 0.01 | 1.01 | 29.22 | 51.34 | 0.43 |
| East | 109 | 326 | 29.56 | 49.21 | 50.25 | 49.88 | 50.30 | 0.01 | 0.97 | 30.44 | 51.34 | 0.40 |
| East | 109 | 270 | 33.17 | 48.88 | 49.78 | 49.54 | 49.84 | 0.01 | 1.07 | 31.12 | 60.76 | 0.48 |
| East | 109 | 234 | 33.17 | 48.66 | 49.44 | 49.19 | 49.49 | 0.01 | 0.99 | 33.54 | 66.70 | 0.44 |
| East | 109 | 190 | 33.17 | 47.54 | 49.07 | 48.81 | 49.12 | 0.01 | 0.98 | 33.95 | 67.29 | 0.43 |
| East | 109 | 161 | 33.76 | 47.48 | 48.82 | 48.56 | 48.87 | 0.01 | 0.98 | 34.49 | 73.04 | 0.45 |
| East | 109 | 132 | 33.76 | 47.37 | 48.44 | 48.31 | 48.51 | 0.02 | 1.20 | 29.57 | 79.71 | 0.59 |
| East | 81 | 594 | 2.69 | 58.03 | 58.24 | 58.18 | 58.25 | 0.02 | 0.58 | 4.67 | 34.38 | 0.50 |
| East | 81 | 544 | 2.69 | 56.68 | 56.85 | 56.83 | 56.88 | 0.05 | 0.86 | 3.15 | 28.84 | 0.83 |
| East | 81 | 494 | 2.69 | 55.52 | 55.78 | 55.71 | 55.80 | 0.01 | 0.51 | 5.32 | 36.24 | 0.42 |
| East | 81 | 444 | 2.69 | 54.29 | 54.52 | 54.52 | 54.58 | 0.07 | 1.06 | 2.54 | 22.00 | 1.00 |
| East | 81 | 391 | 2.69 | 53.38 | 53.69 | 53.54 | 53.70 | 0.01 | 0.43 | 6.20 | 29.93 | 0.31 |
| East | 81 | 338 | 6.85 | 52.46 | 52.79 | 52.74 | 52.85 | 0.03 | 1.03 | 6.68 | 32.18 | 0.72 |
| East | 81 | 290 | 6.85 | 51.47 | 51.84 | 51.73 | 51.87 | 0.01 | 0.74 | 9.23 | 40.02 | 0.49 |
| East | 81 | 239 | 6.85 | 50.40 | 50.88 | 50.82 | 50.92 | 0.03 | 0.92 | 7.49 | 37.40 | 0.65 |
| East | 81 | 187 | 9.79 | 49.62 | 50.19 | 50.01 | 50.23 | 0.01 | 0.79 | 12.38 | 36.07 | 0.43 |
| East | 81 | 131 | 9.79 | 48.97 | 49.45 | 49.35 | 49.50 | 0.02 | 0.97 | 10.14 | 37.20 | 0.59 |



102.02
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593.59
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752.43
812.92
863.79
west 40
132.16
189.80
233.84
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eaus 21
131.11
187.47
289.83
390.60
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970.22
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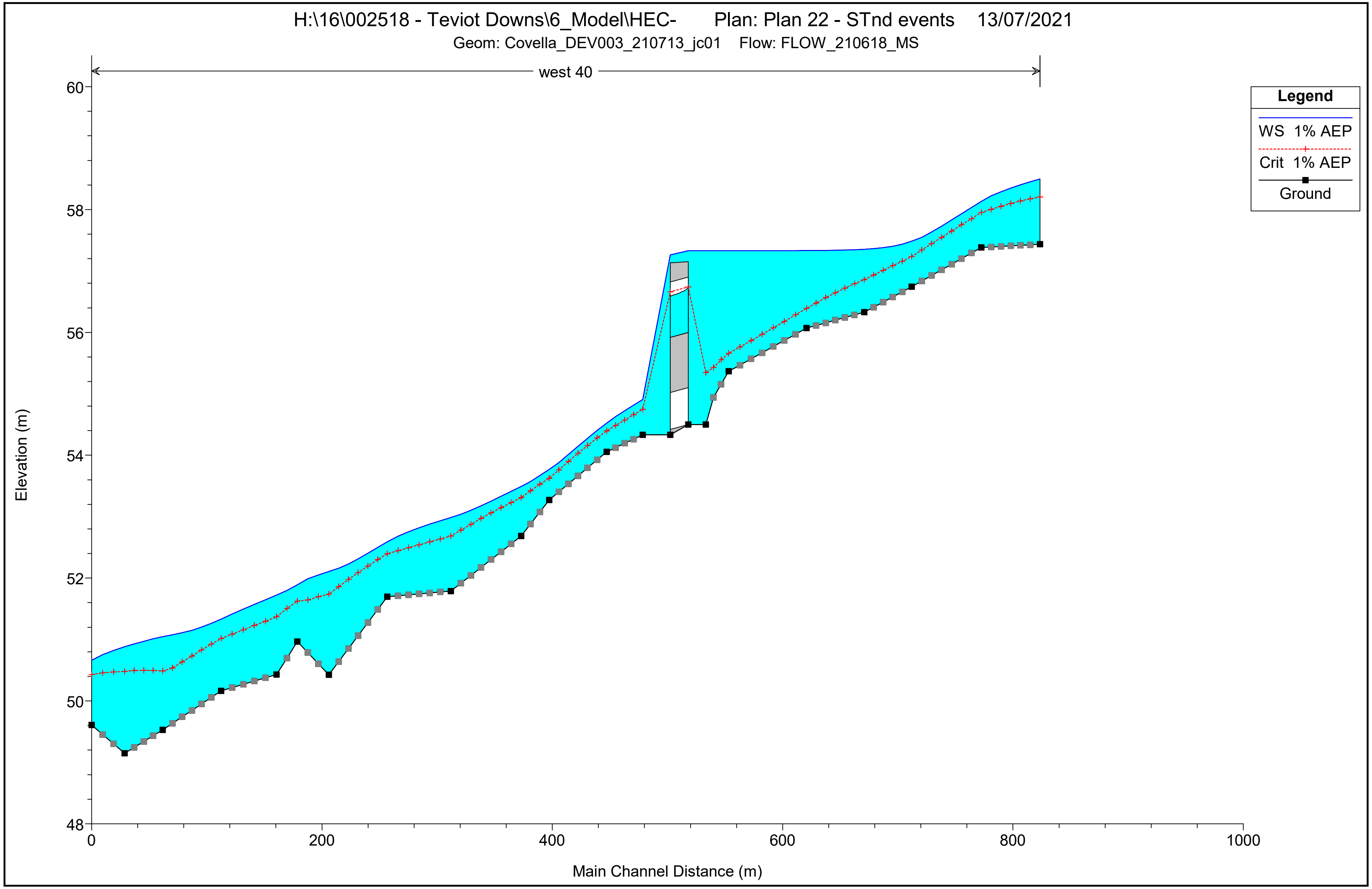
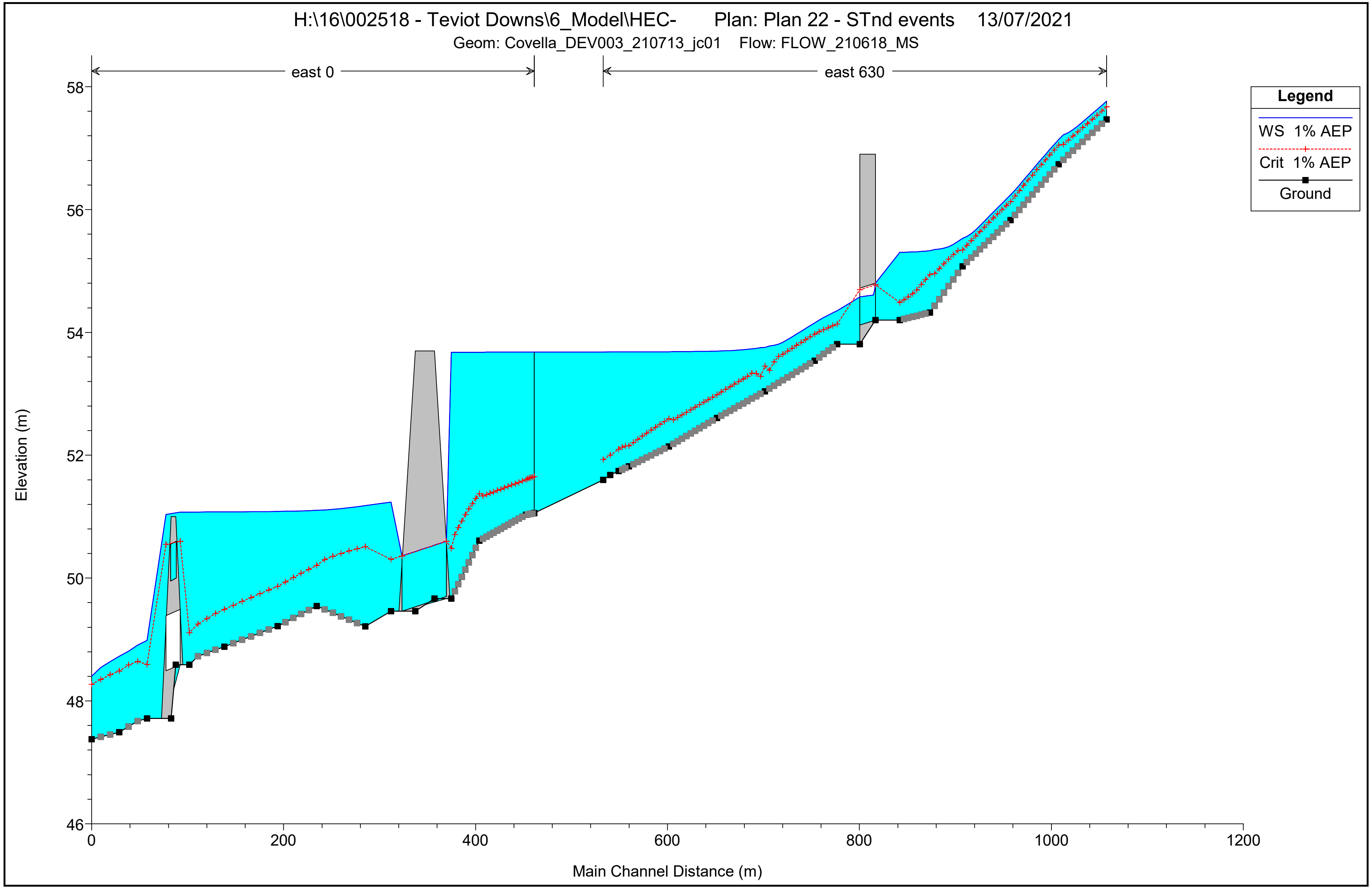
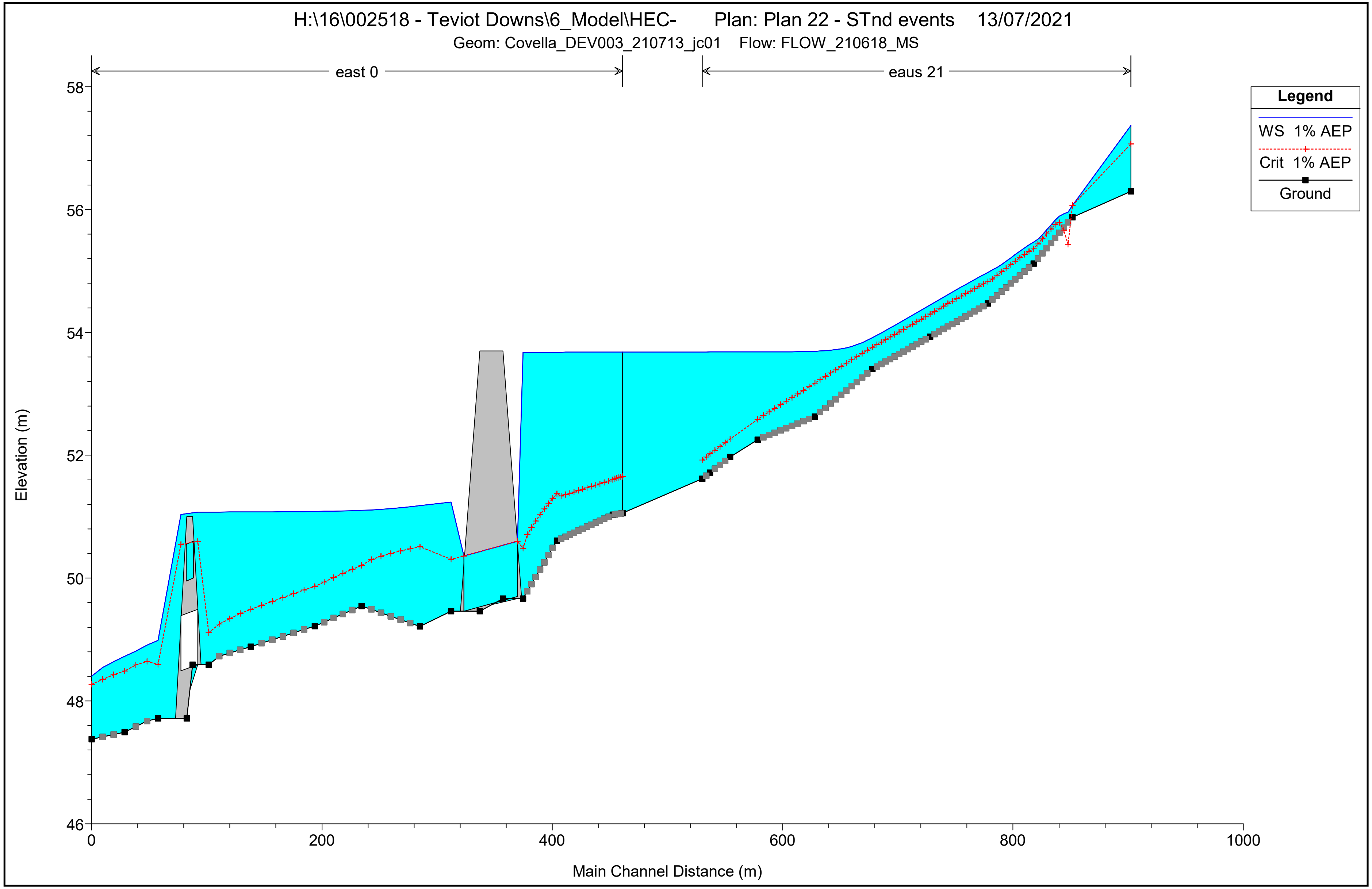
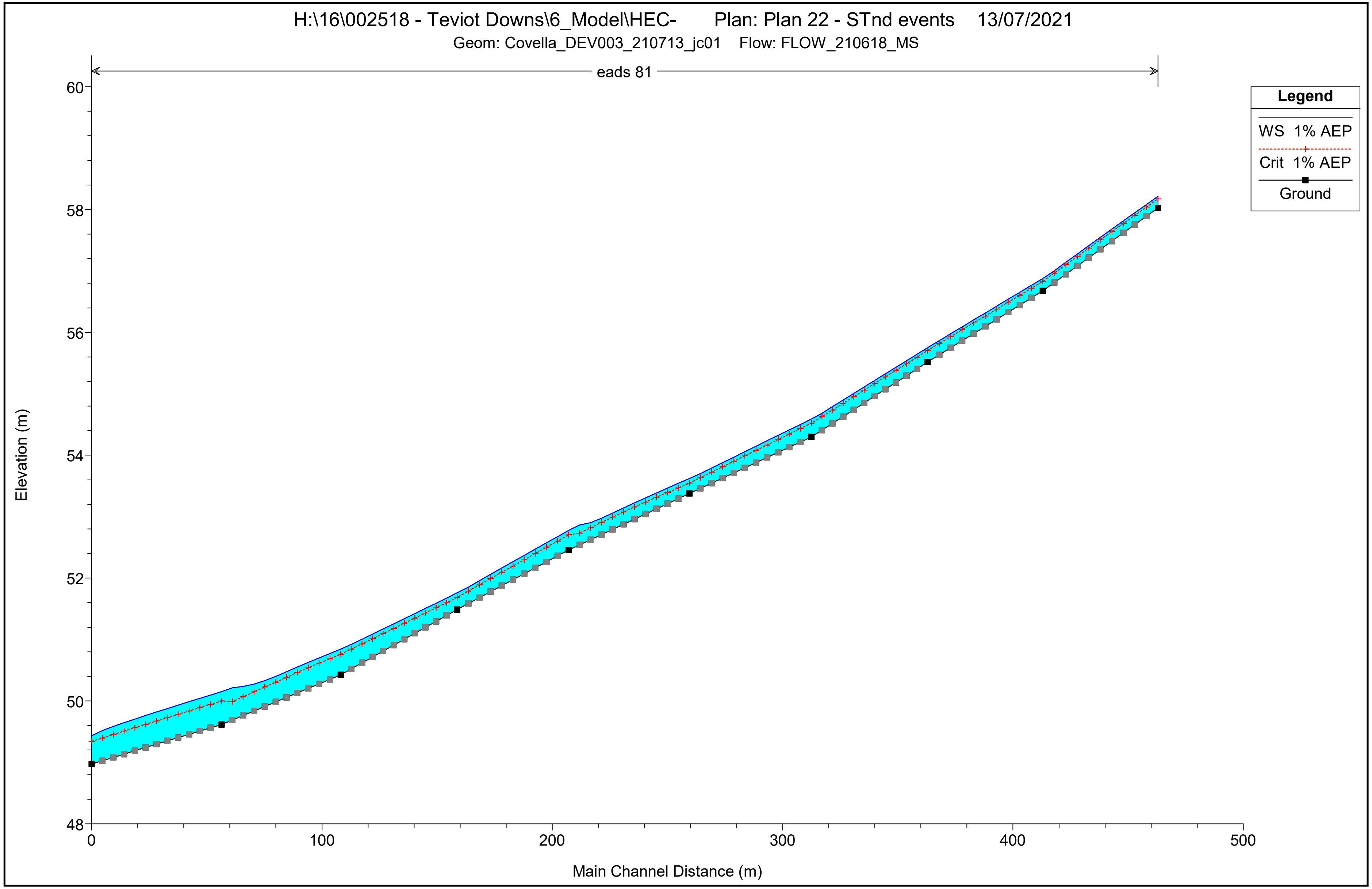
east 630

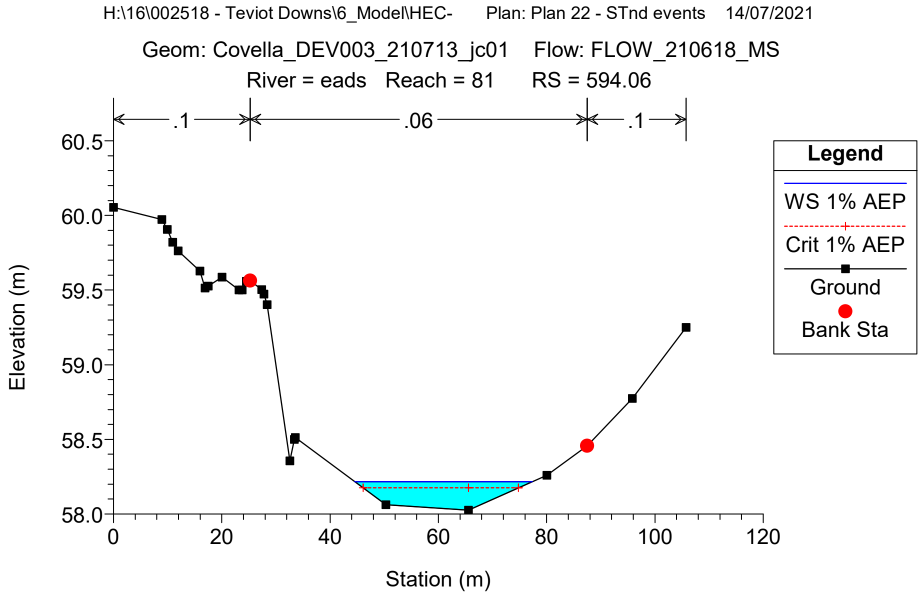

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events
13/07/2021
Geom: Covella_DEV003_210713_jc01
Flow: FLOW_210618_MS
west 40
Legend
WS 1% AEP
Crit 1% AEP
Ground
Elevation (m)
Main Channel Distance (m)
60
58
56
54
52
50
48
0
200
400
600
800
1000


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 13/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
east 0
east 630
Legend
WS 1% AEP
Crit 1% AEP
Ground
Elevation (m)
58
56
54
52
50
48
46
0
200
400
600
800
1000
1200
Main Channel Distance (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 13/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
east 0
eaus 21
Legend
WS 1% AEP
Crit 1% AEP
Ground
Elevation (m)
Main Channel Distance (m)
58
56
54
52
50
48
46
0
200
400
600
800
1000



H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 13/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
eads 81
Legend
WS 1% AEP
Crit 1% AEP
Ground
Elevation (m)
Main Channel Distance (m)
60
58
56
54
52
50
48
0
100
200
300
400
500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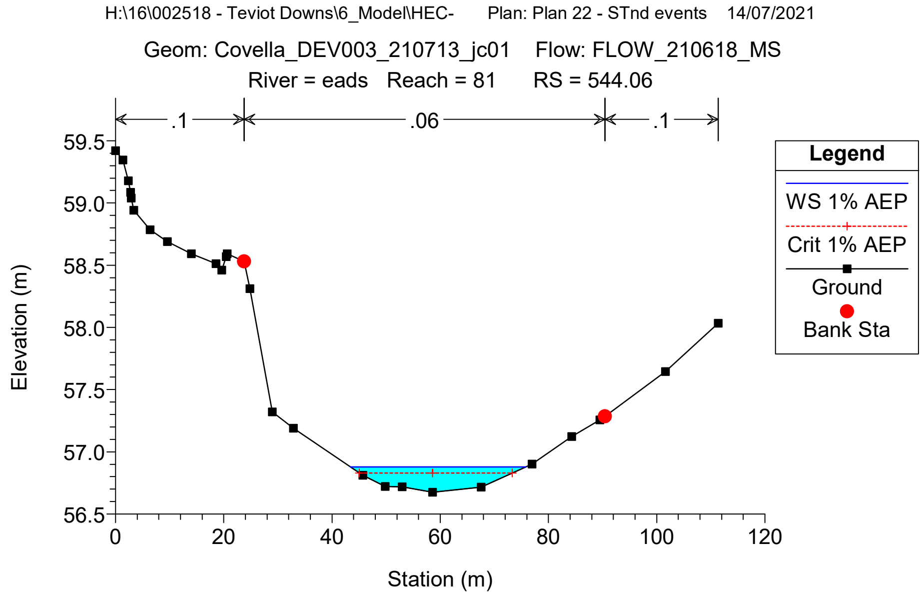
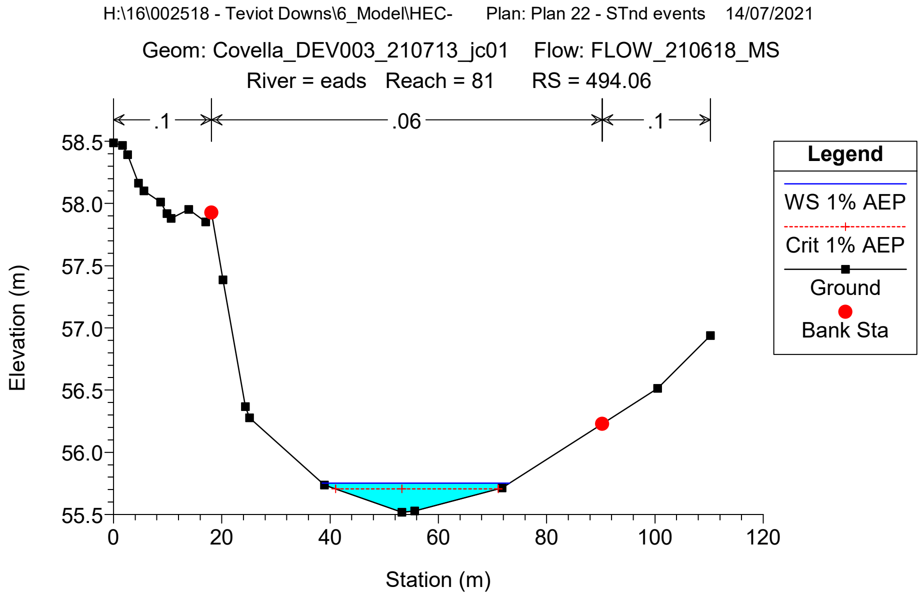
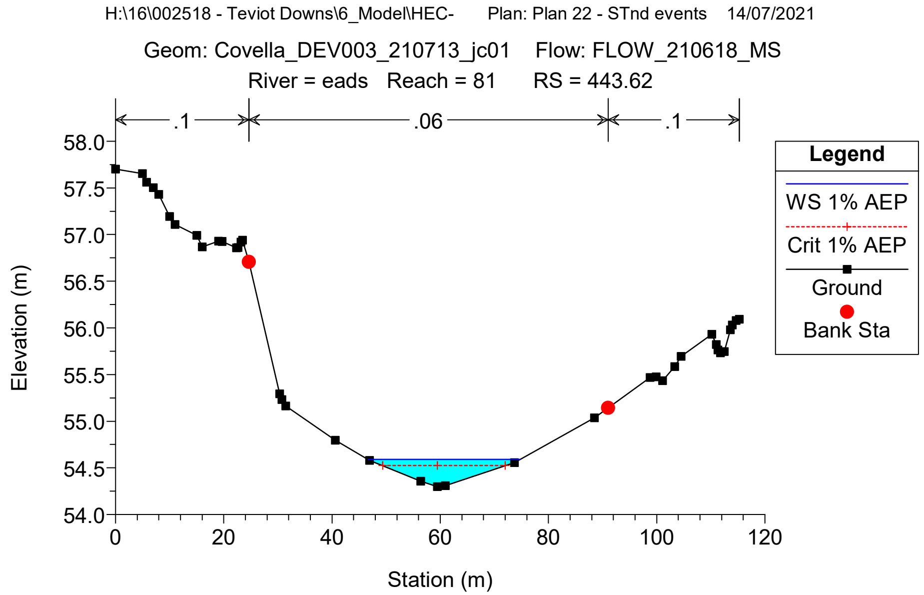
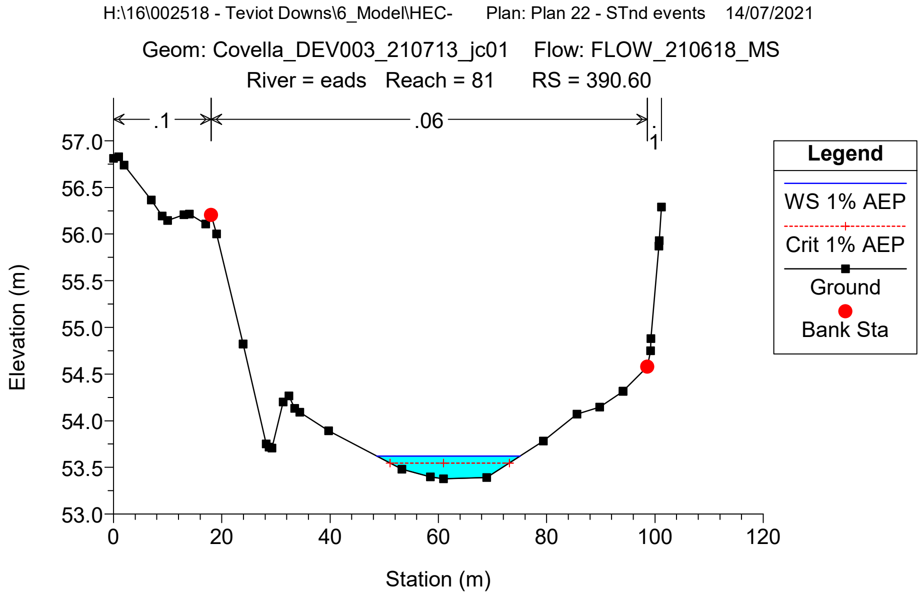
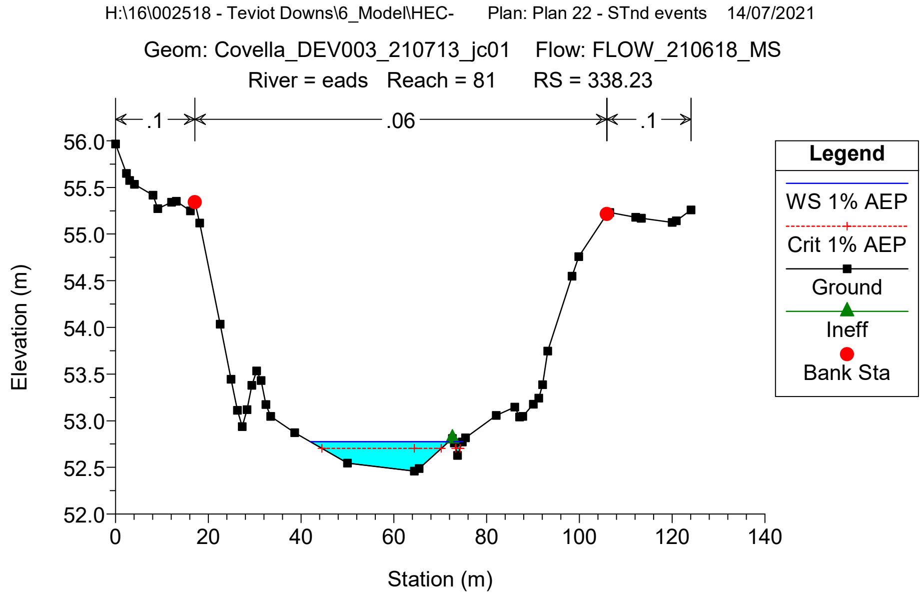
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 594.06
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

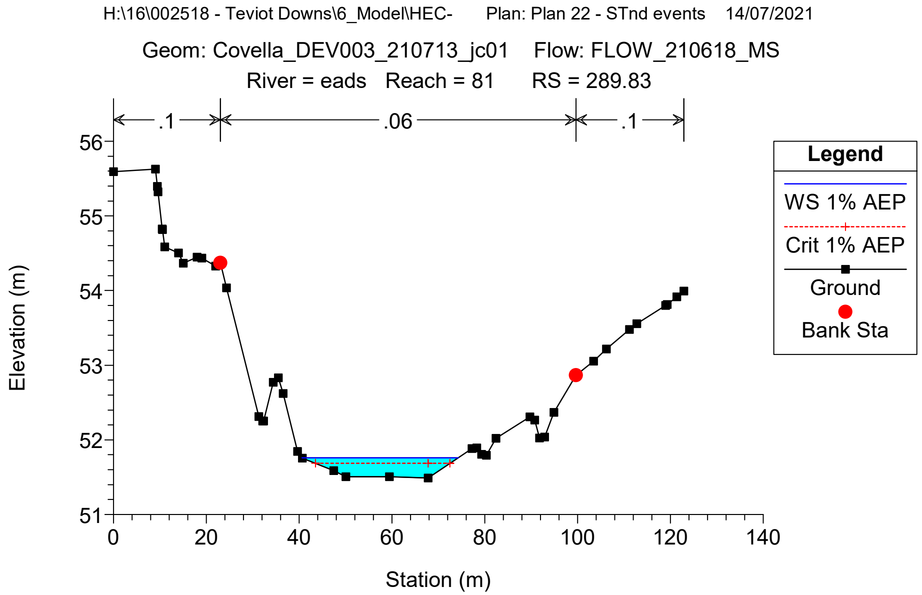

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 544.06
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 494.06
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 443.62
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 390.60
.1
.06
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 338.23
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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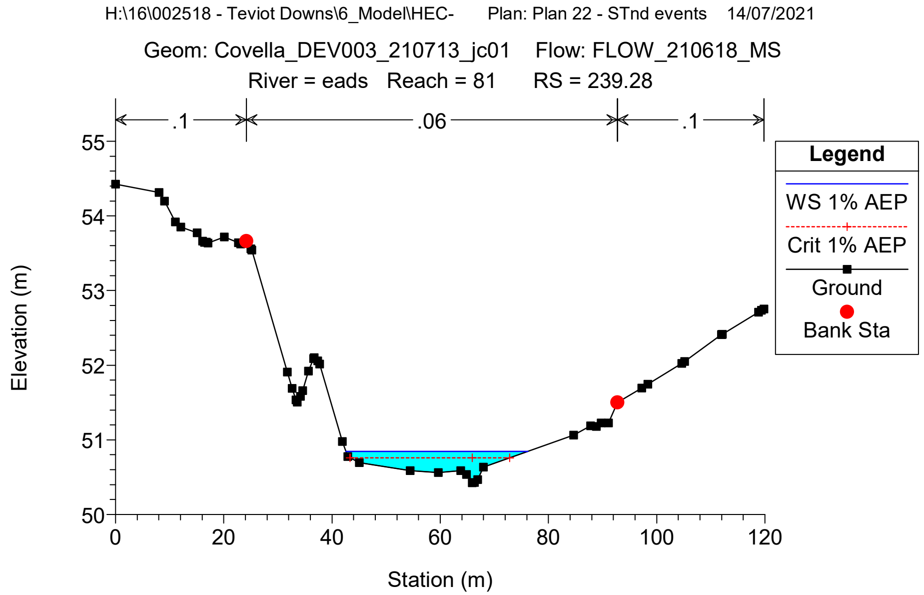
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 289.83
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)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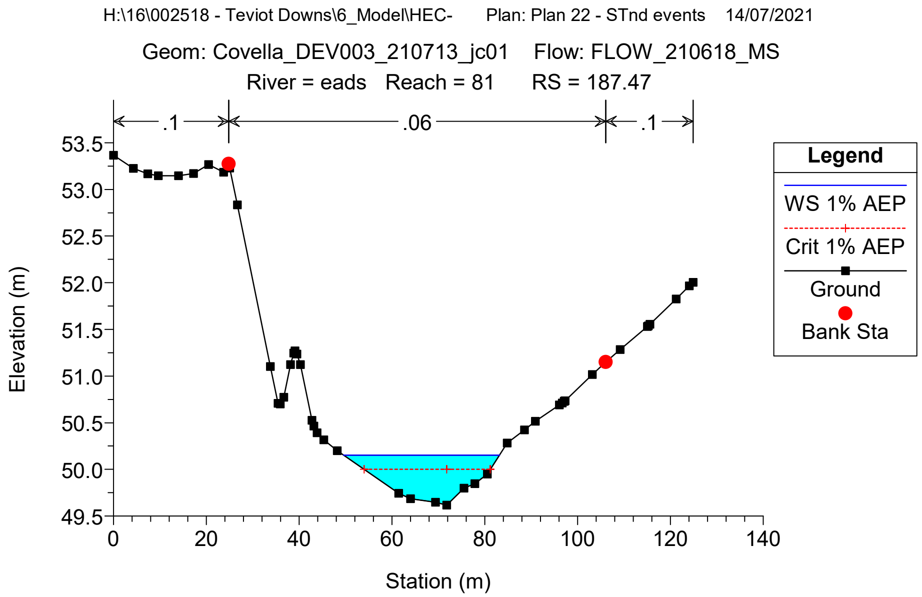
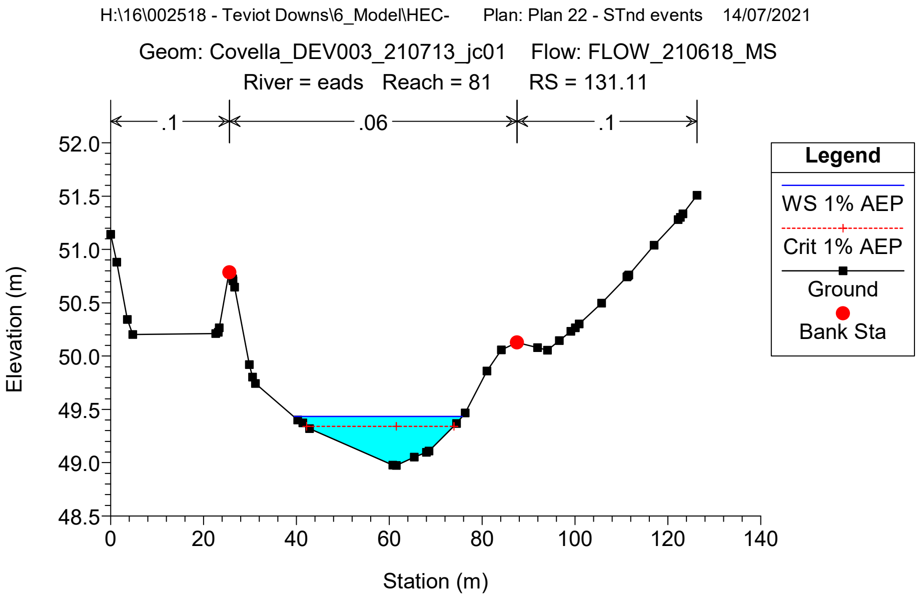
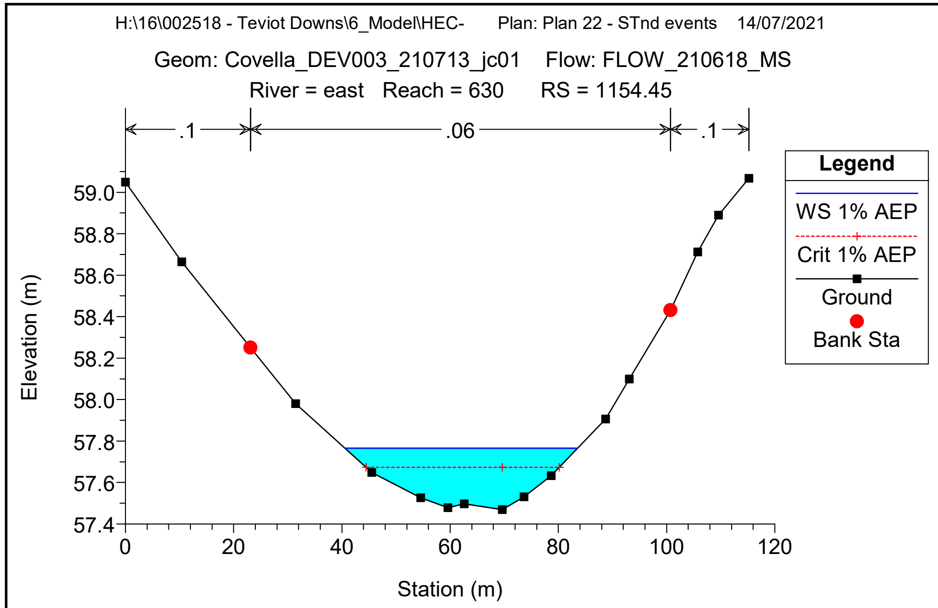
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 239.28
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

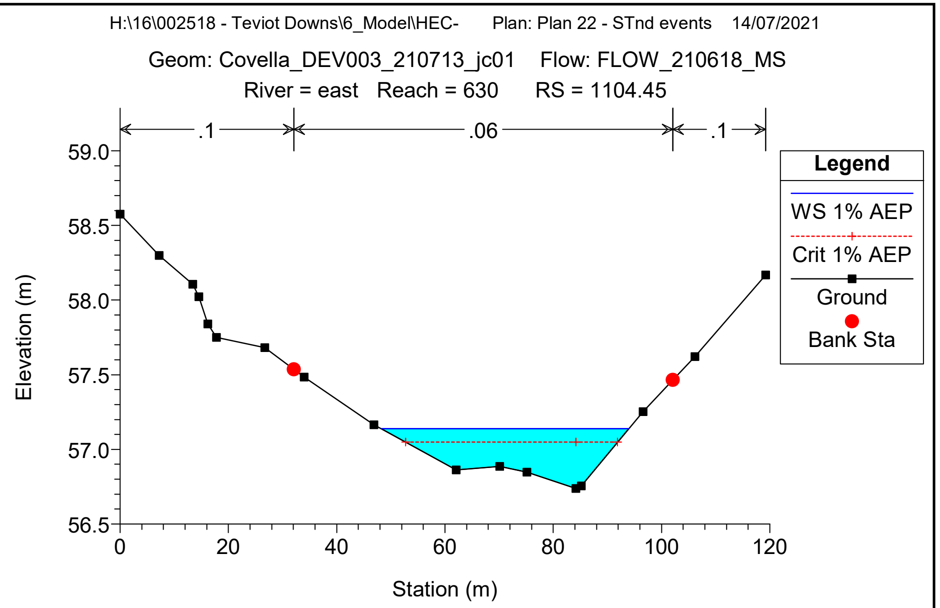


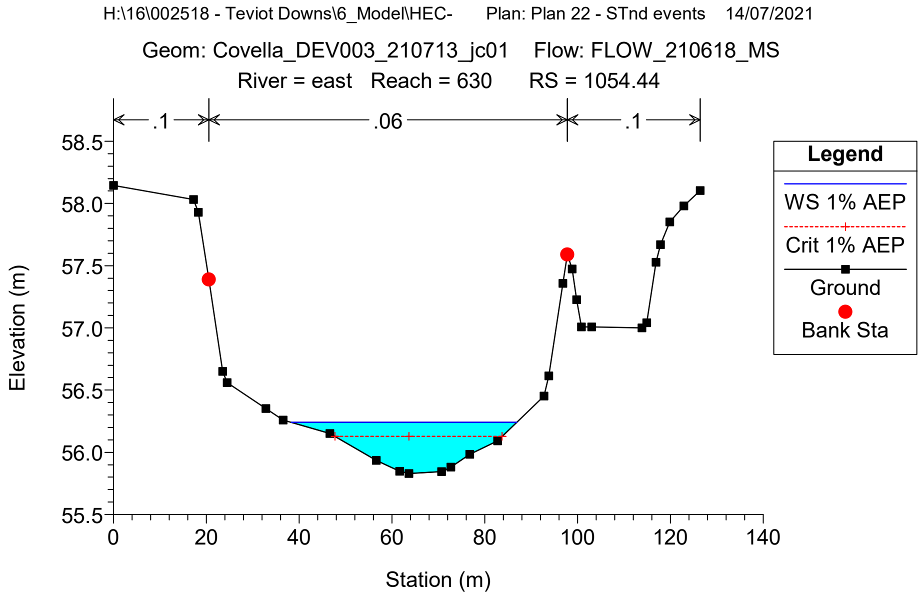
H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 187.47
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

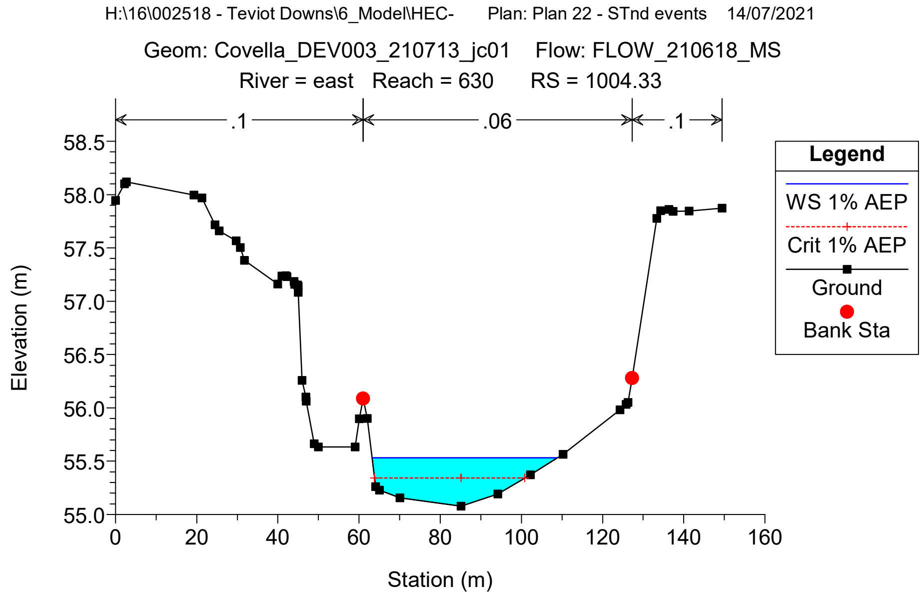



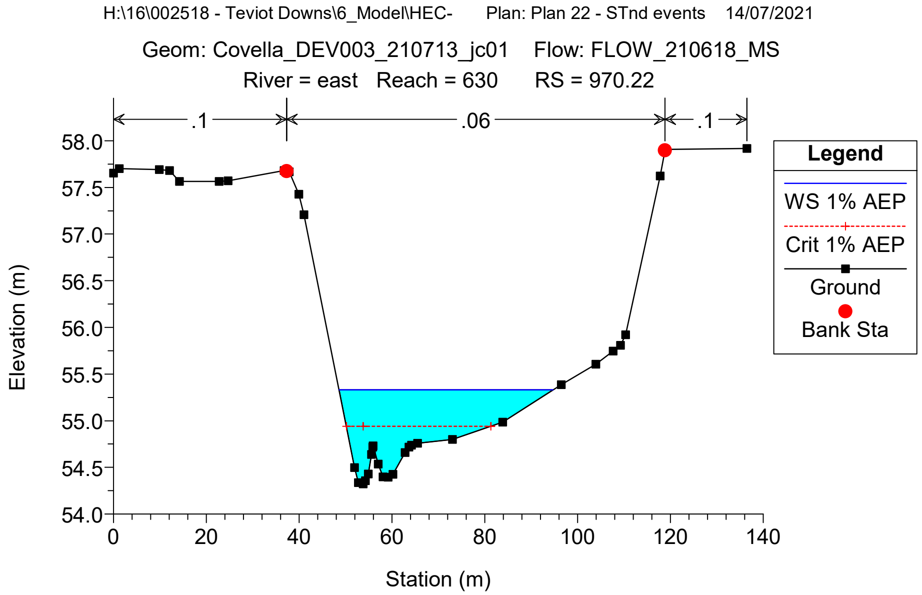
H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eads Reach = 81 RS = 131.11
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

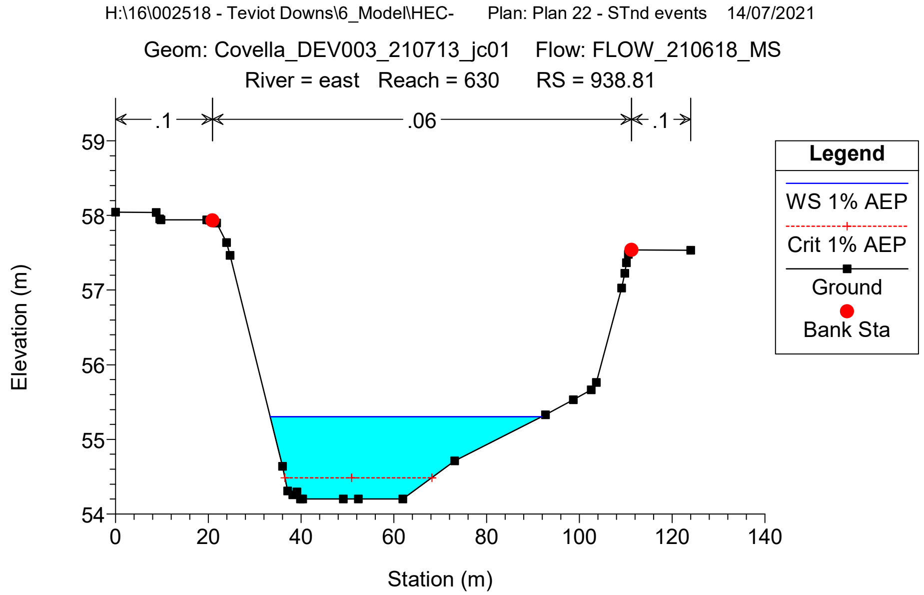

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 1154.45
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

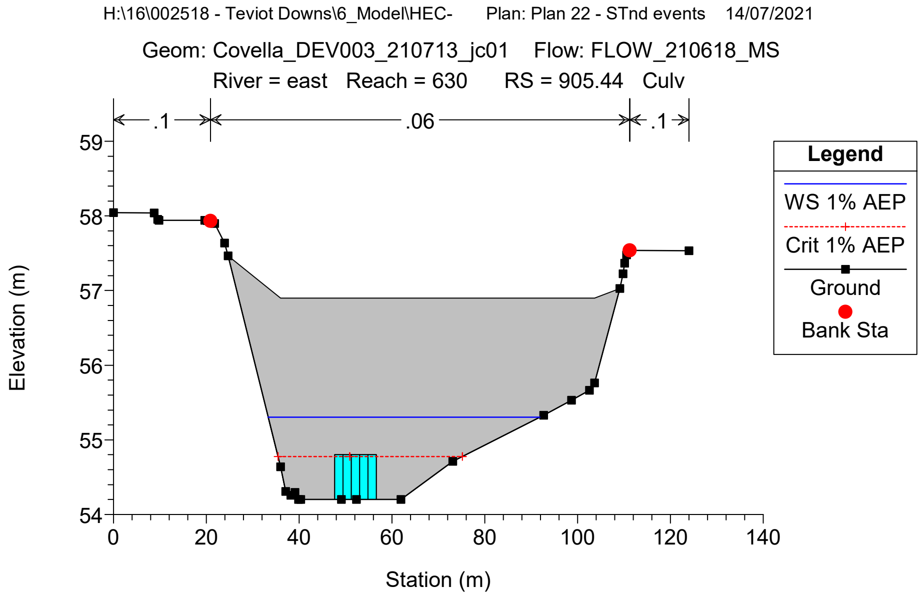

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 1104.45
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

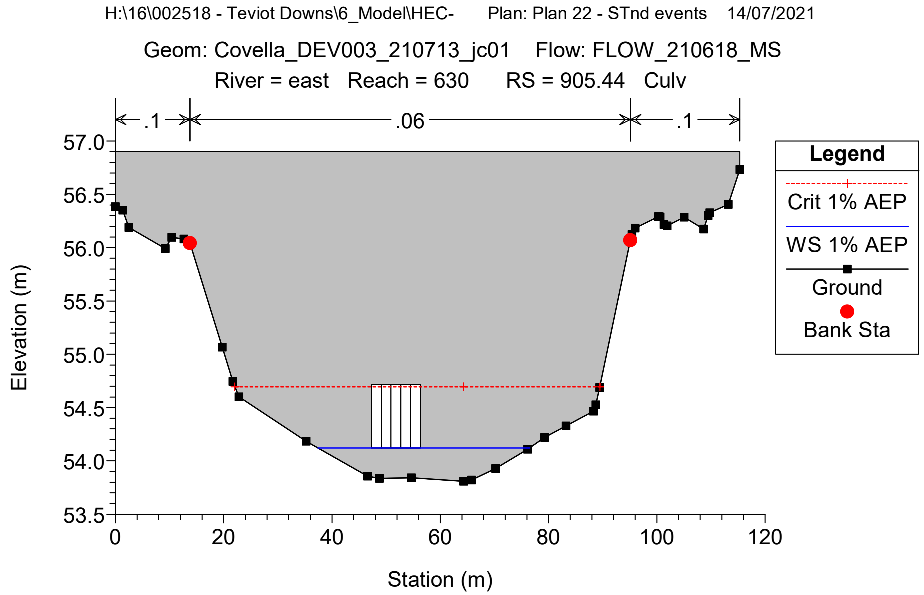

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 1054.44
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

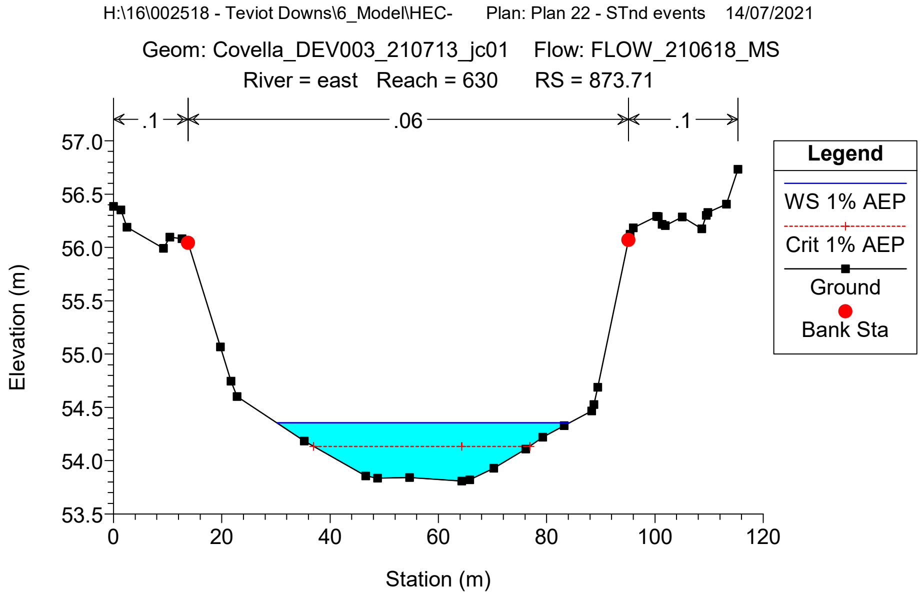

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 1004.33
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

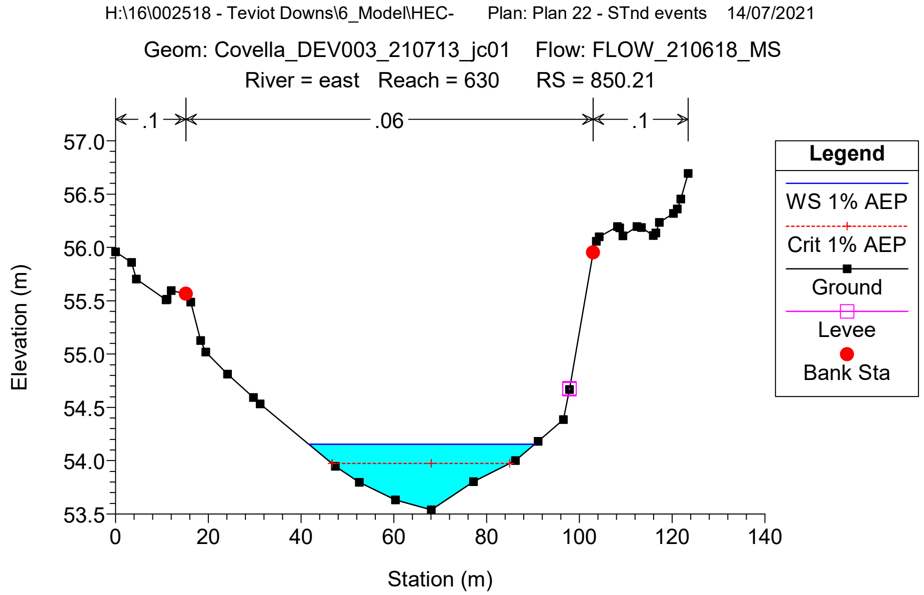

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 970.22
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

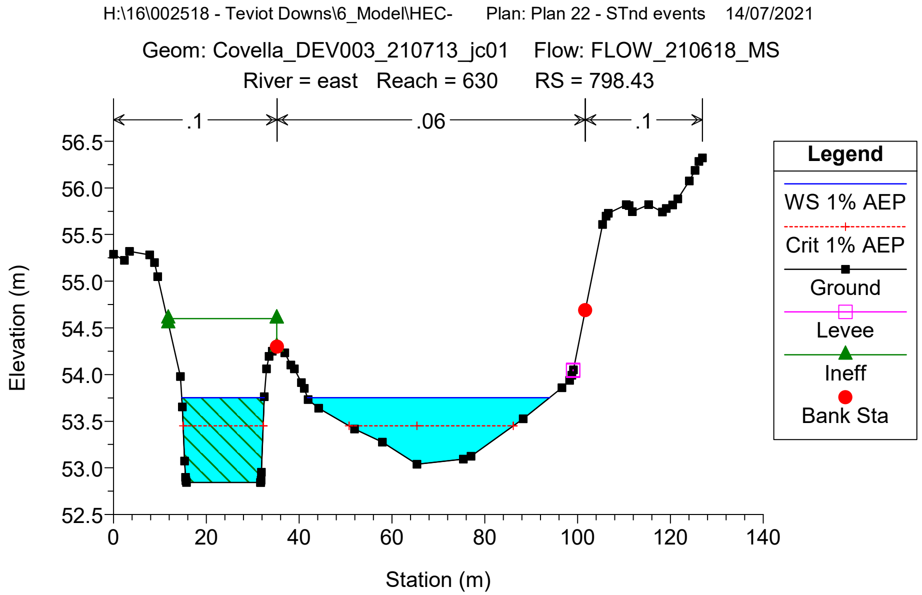

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 938.81
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

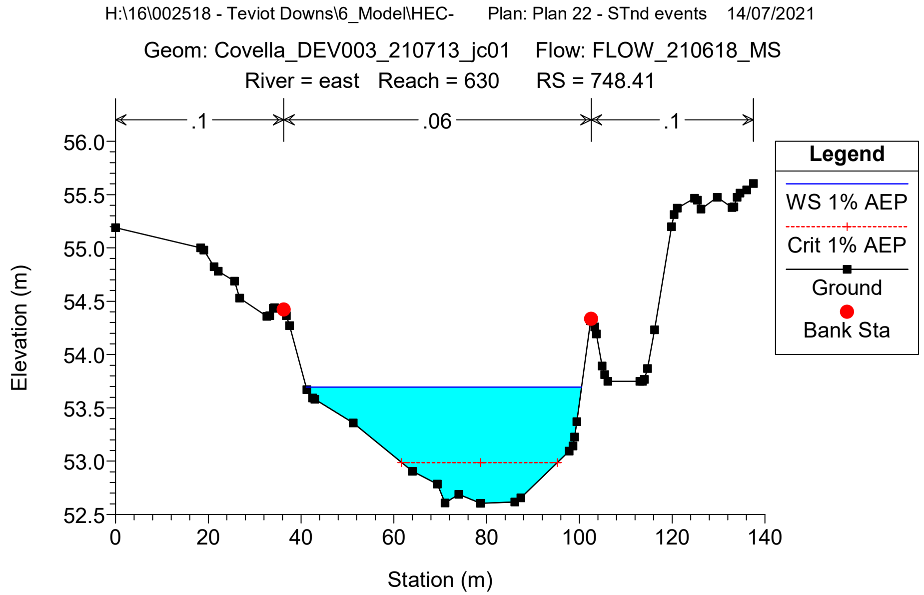

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 905.44 Culv
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

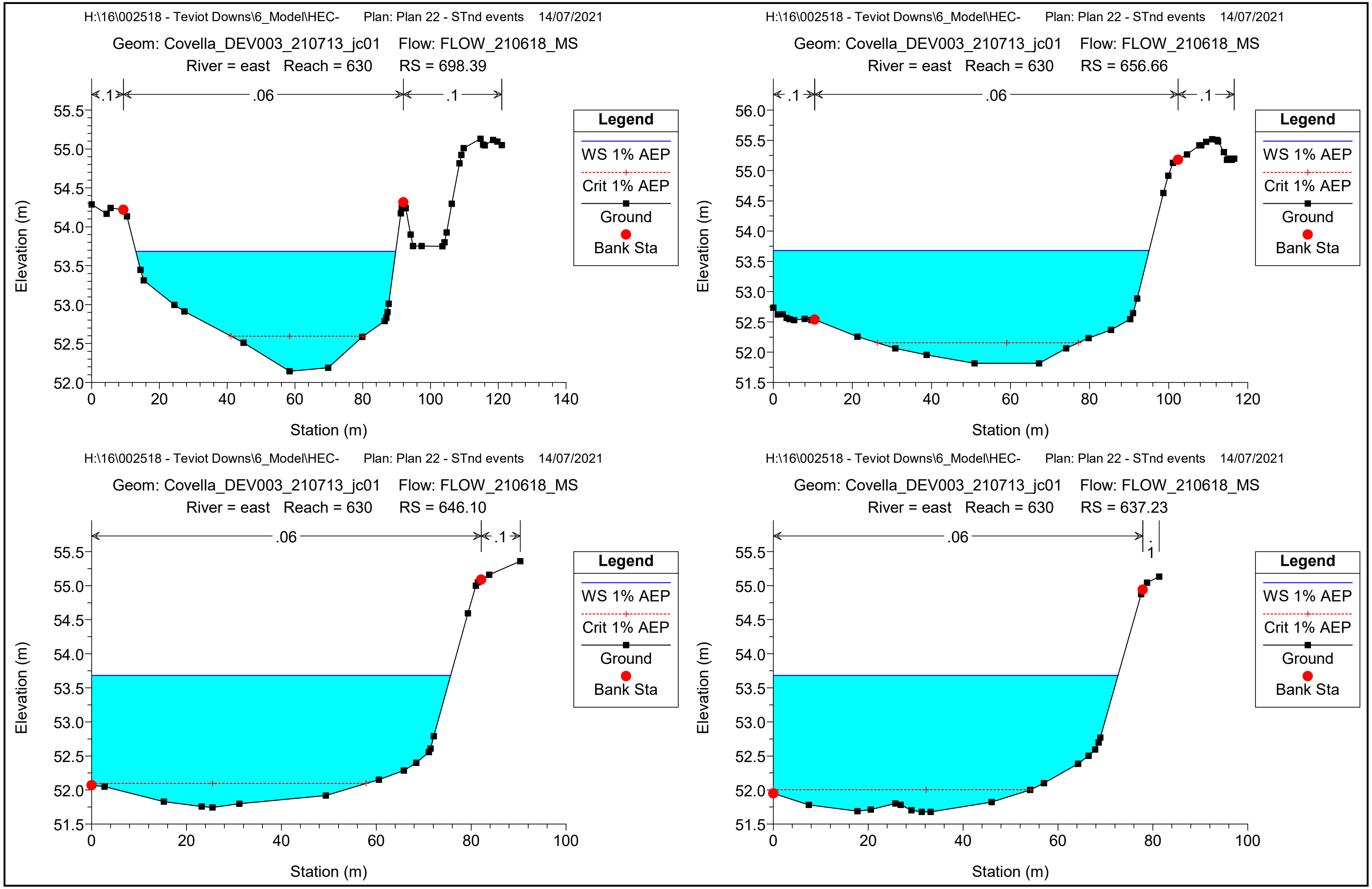

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 905.44 Culv
.1
.06
.1
Legend
Crit 1% AEP
WS 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 873.71
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 850.21
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 798.43
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)

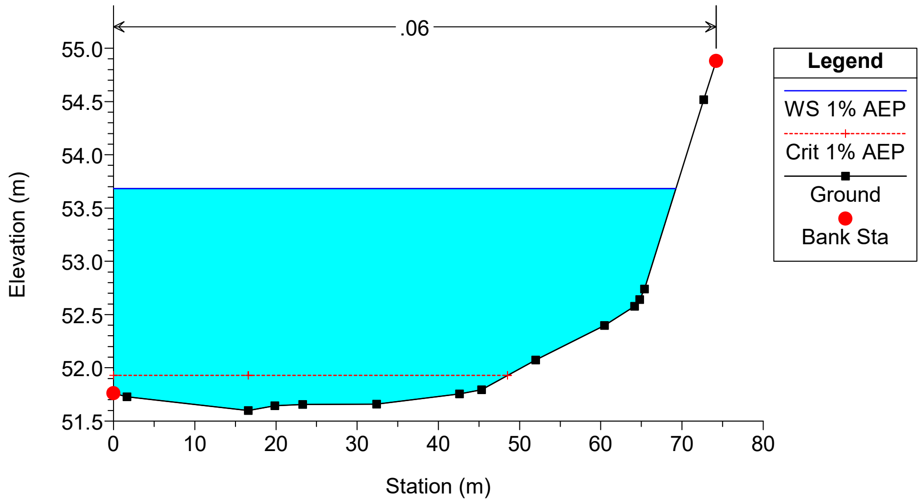

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 748.41
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

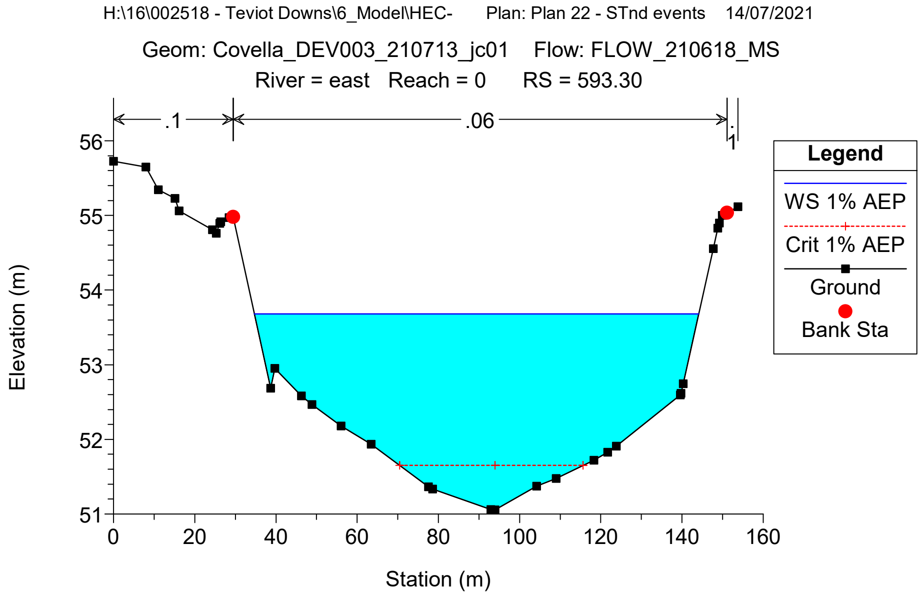

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 698.39
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 656.66
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 646.10
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 630 RS = 637.23
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta

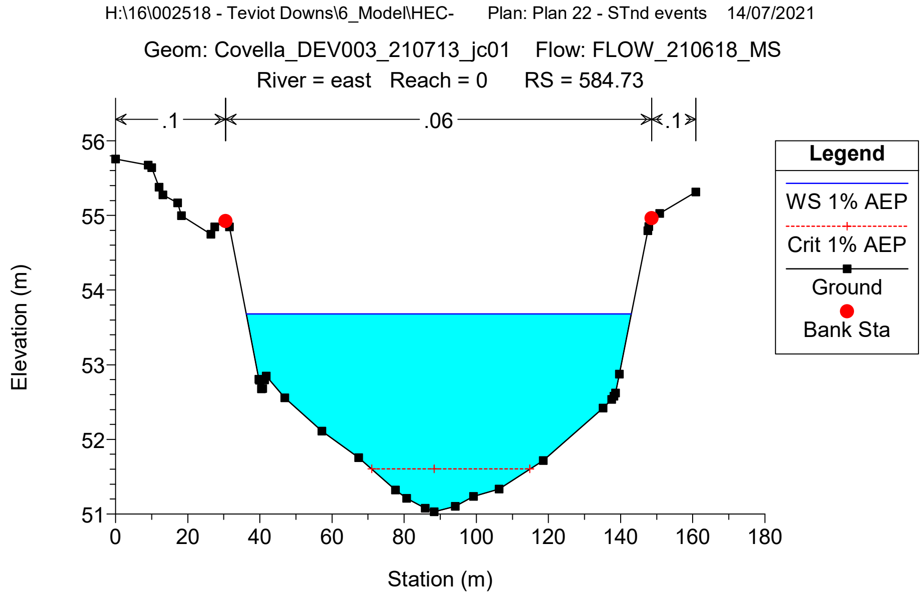
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021

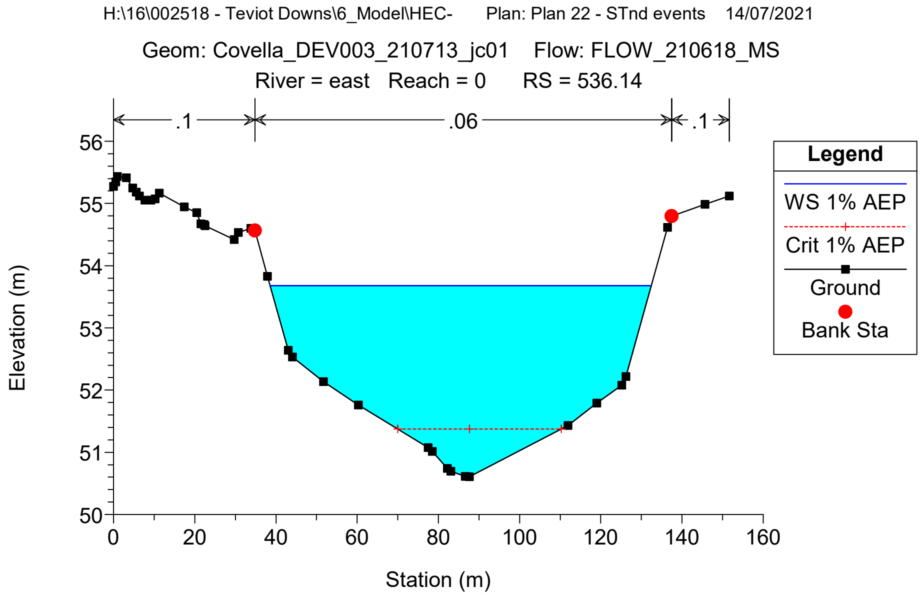
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS

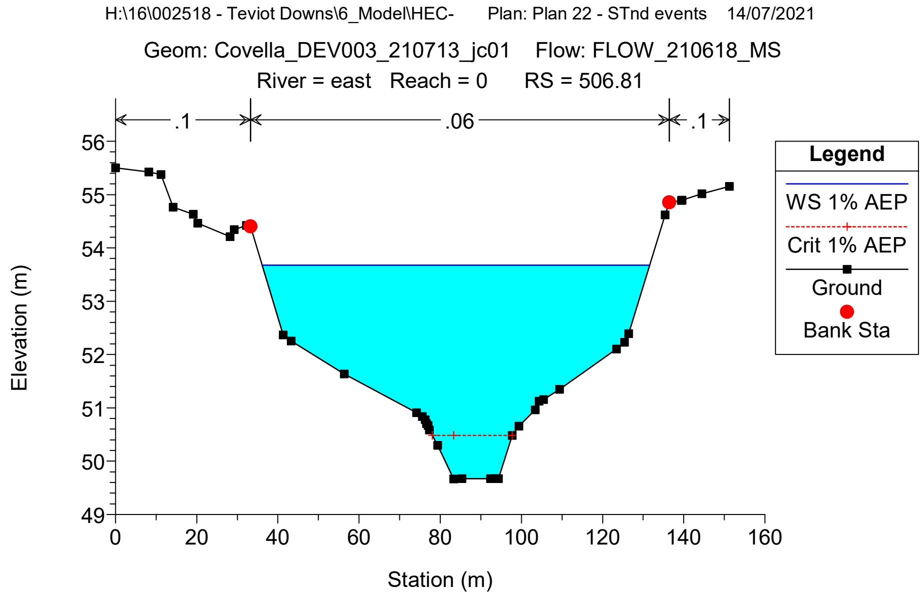
River = east Reach = 630 RS = 629.94

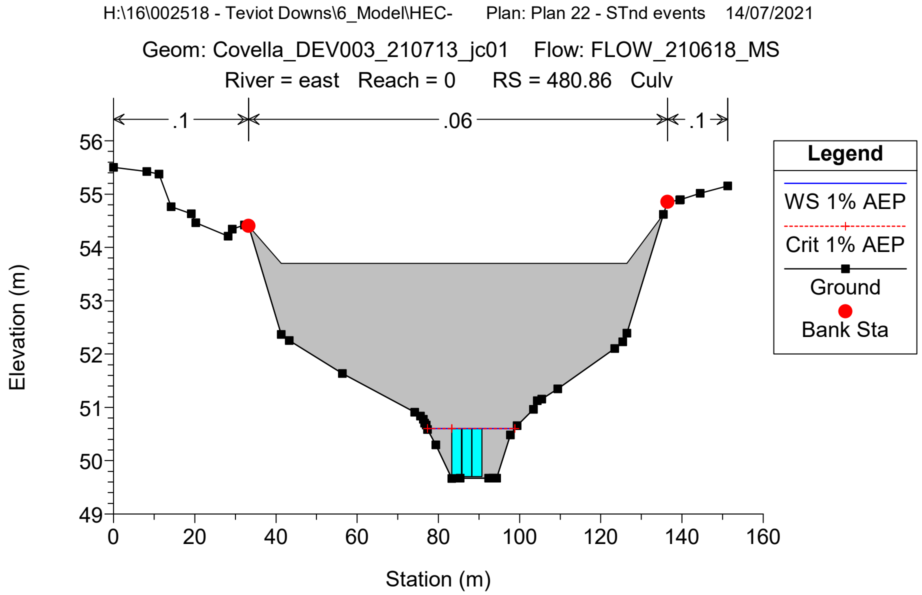


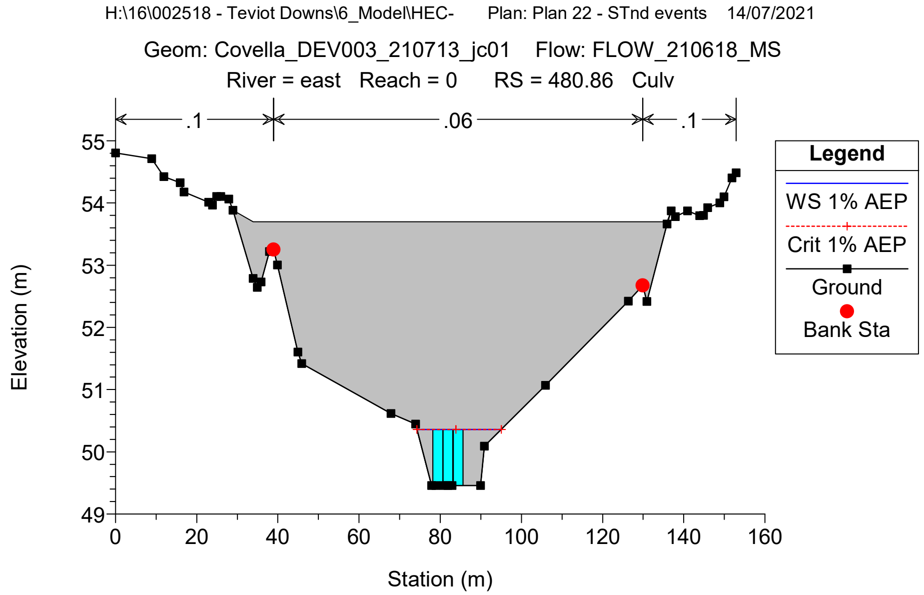

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 593.30
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
56
55
54
53
52
51
0
20
40
60
80
100
120
140
160

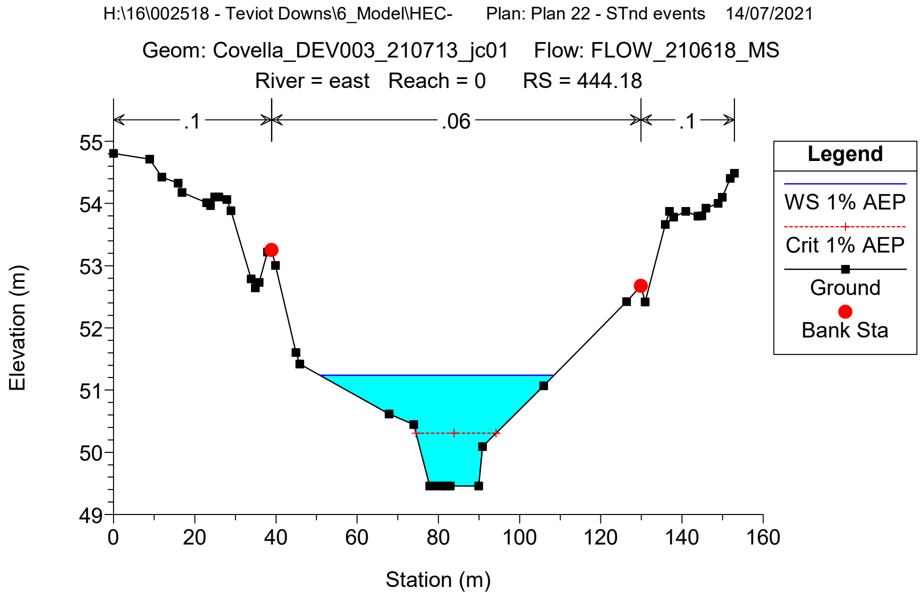

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 584.73
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
56
55
54
53
52
51
0
20
40
60
80
100
120
140
160
180

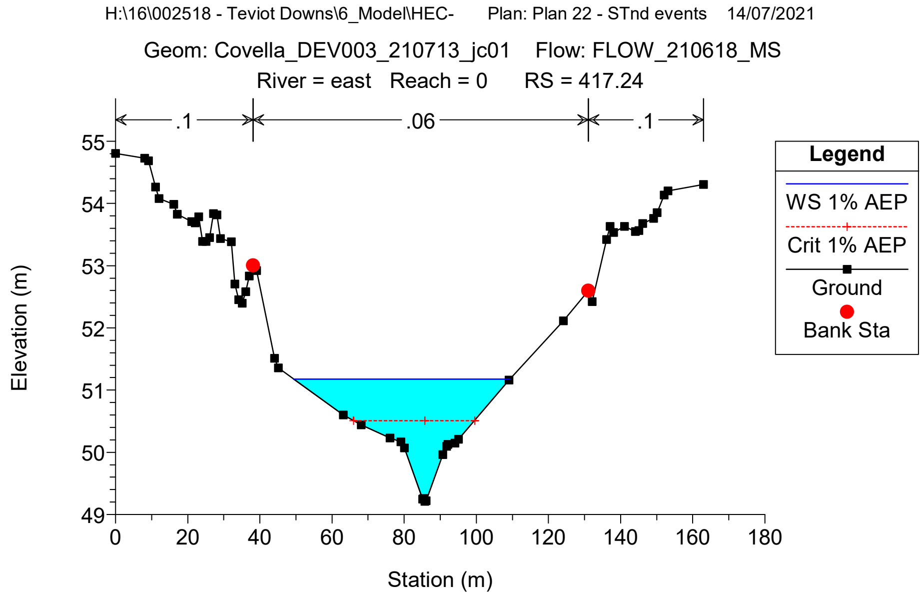

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 536.14
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
56
55
54
53
52
51
50
0
20
40
60
80
100
120
140
160

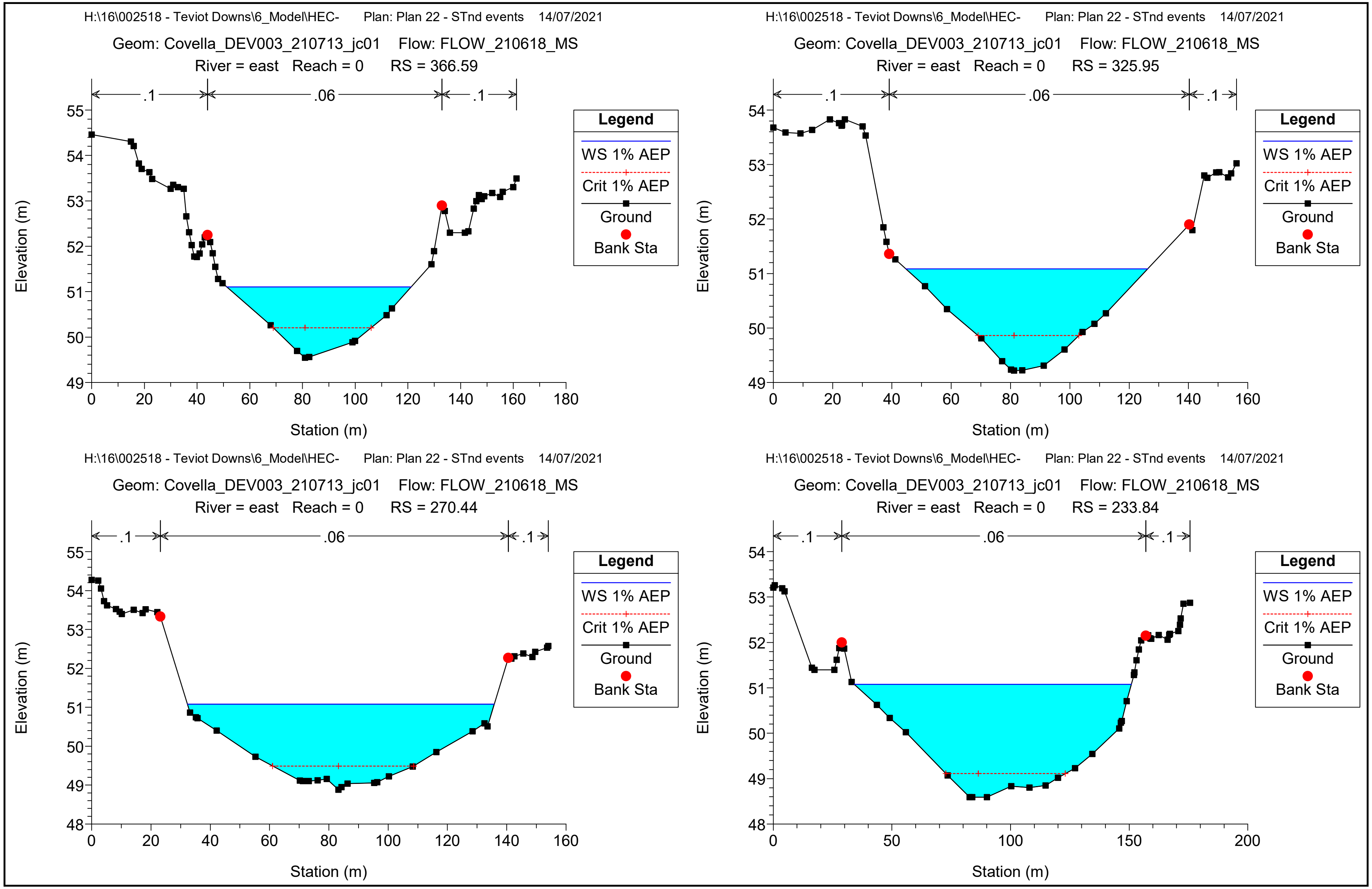

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 506.81
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
56
55
54
53
52
51
50
49
0
20
40
60
80
100
120
140
160


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 480.86 Culv
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

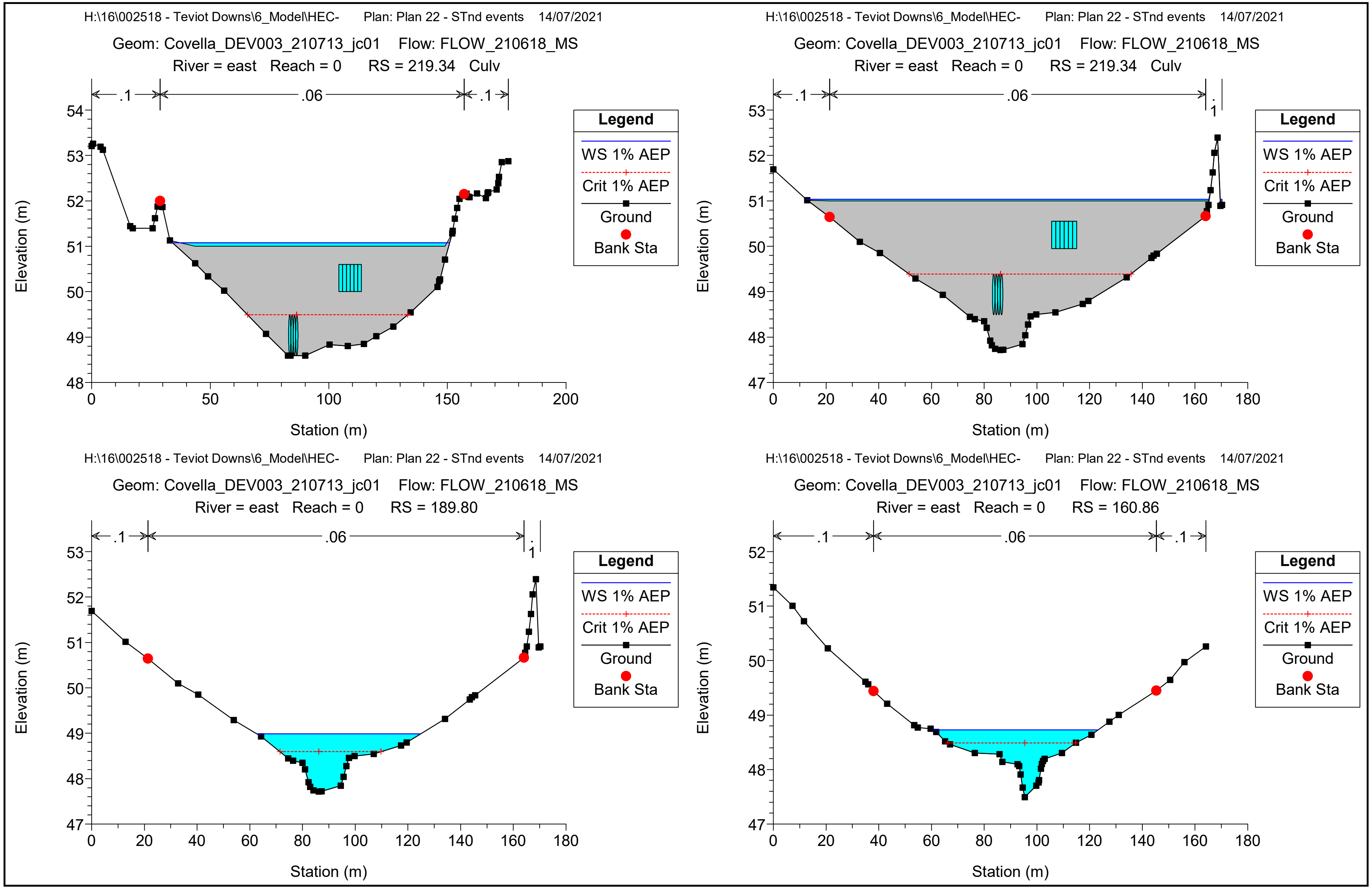

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 480.86 Culv
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 444.18
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 417.24
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)



H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 366.59
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 325.95
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 270.44
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 233.84
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)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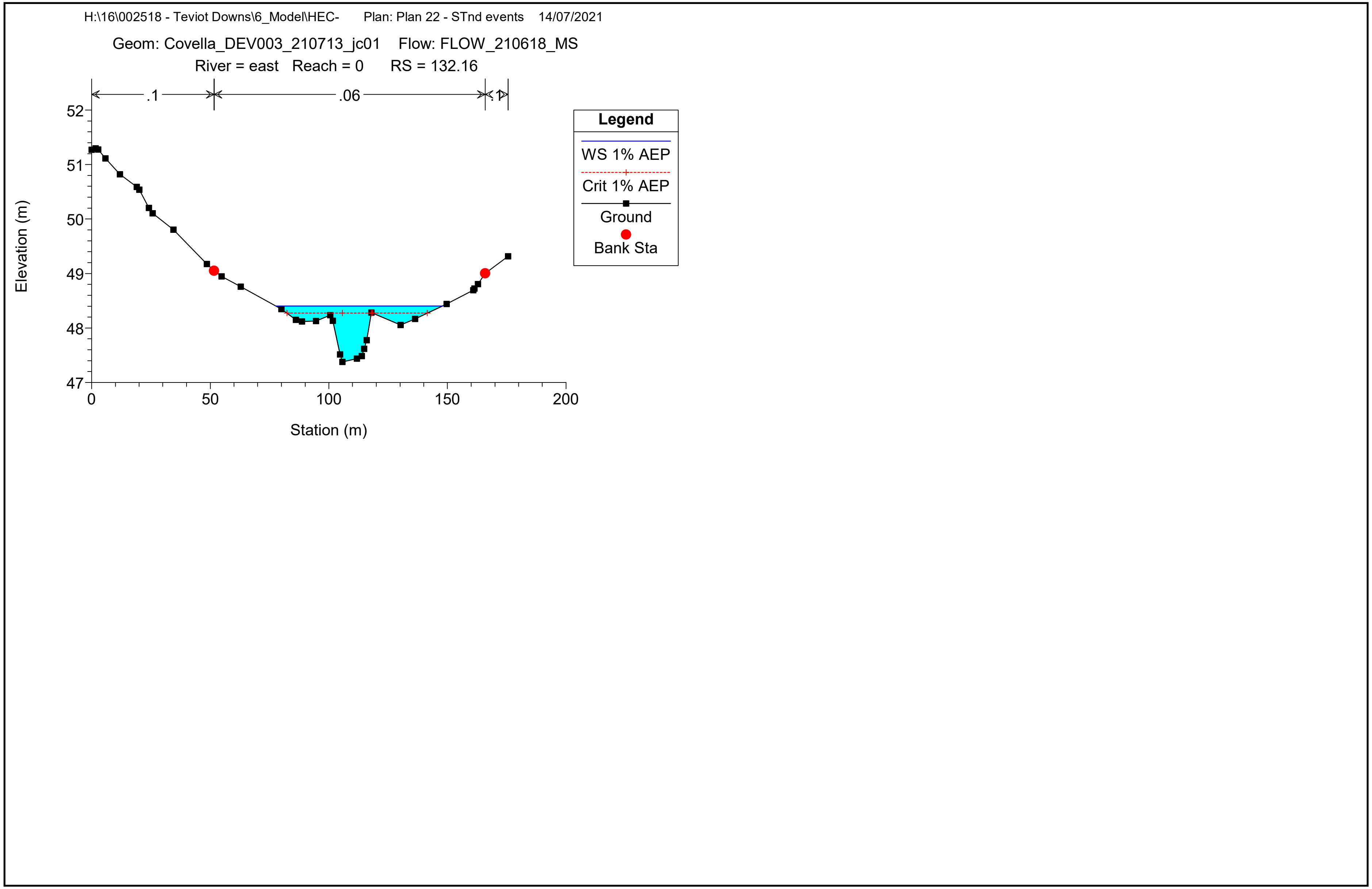
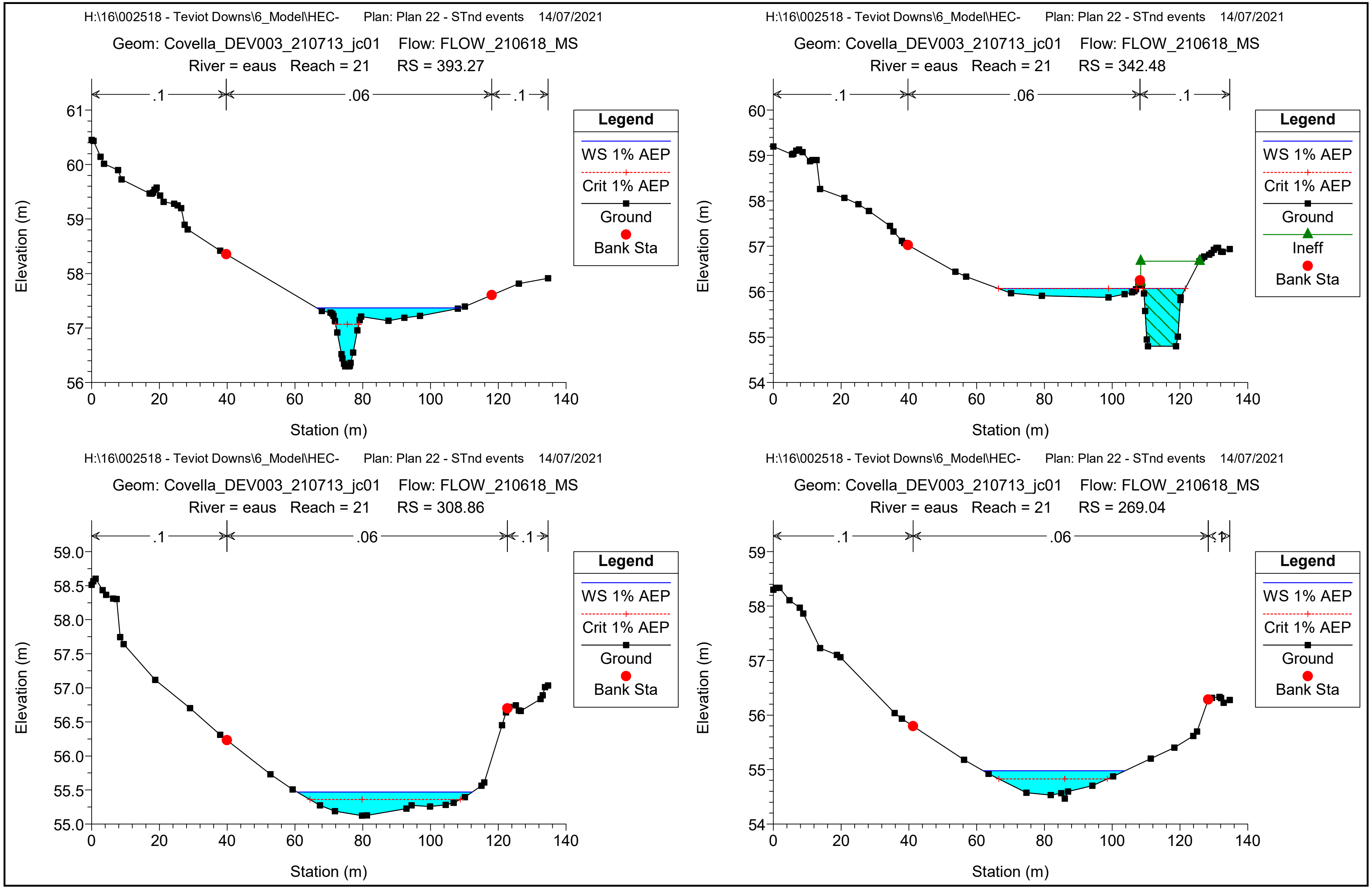
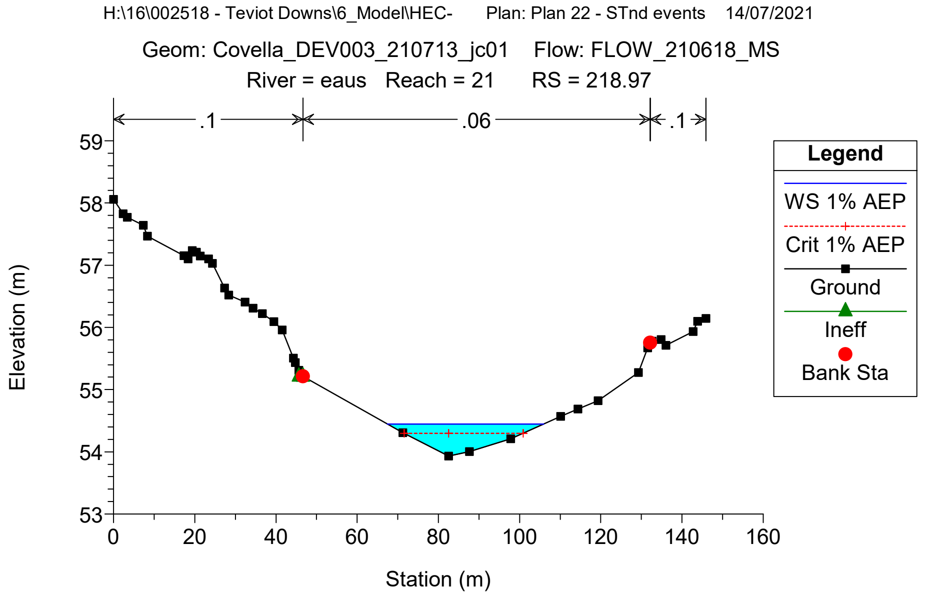
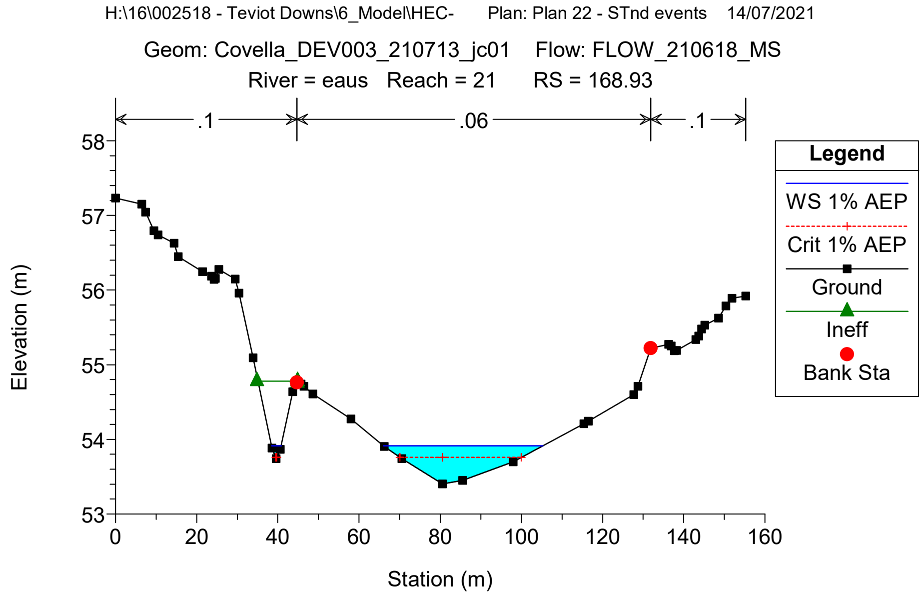
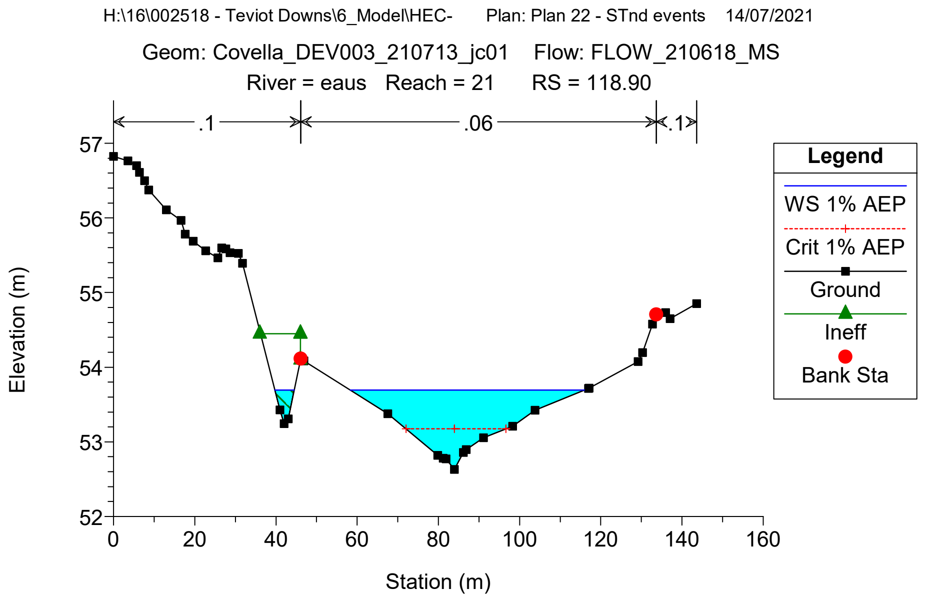
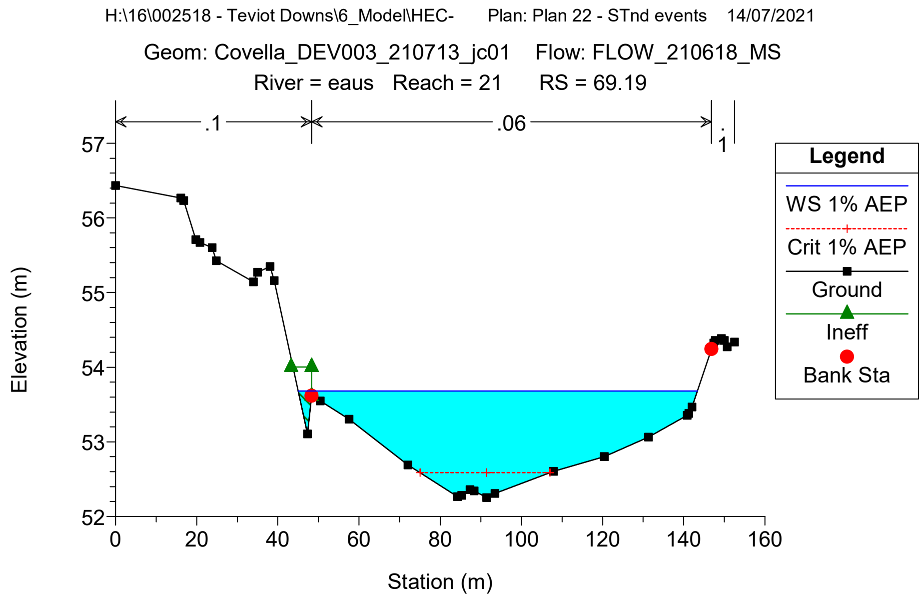
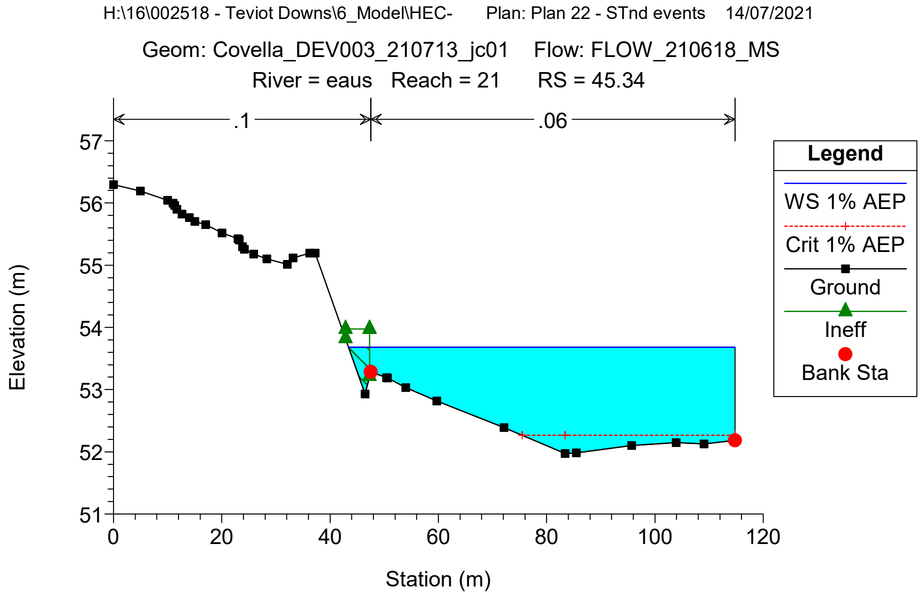
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 219.34 Culv
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 219.34 Culv
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 189.80
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 160.86
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)

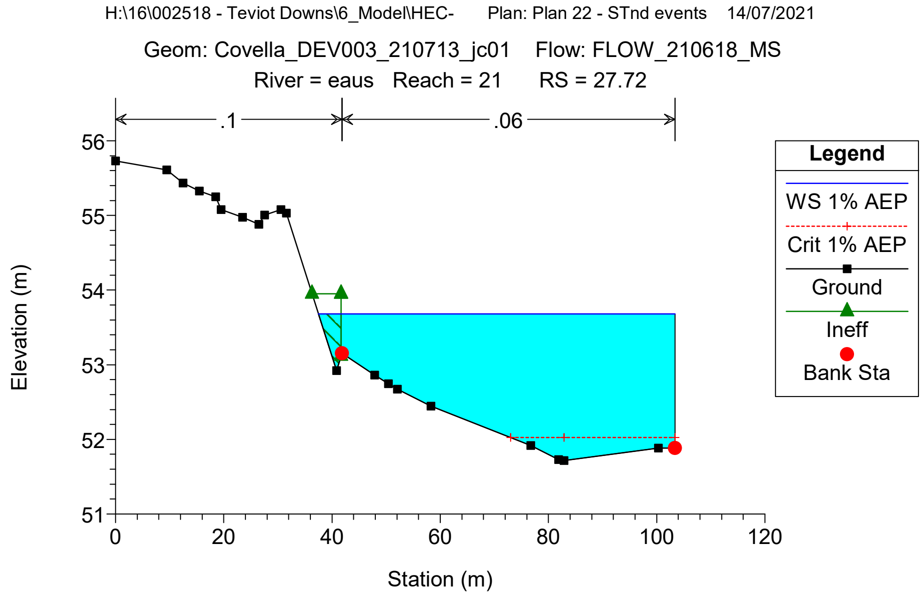

H:\16\002518 - Teviot Downs\6_Model\HEC-
Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = east Reach = 0 RS = 132.16
.1
.06
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta



H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 393.27
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 342.48
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 308.86
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 269.04
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 218.97
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 168.93
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 118.90
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 69.19
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 45.34
.1
.06
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta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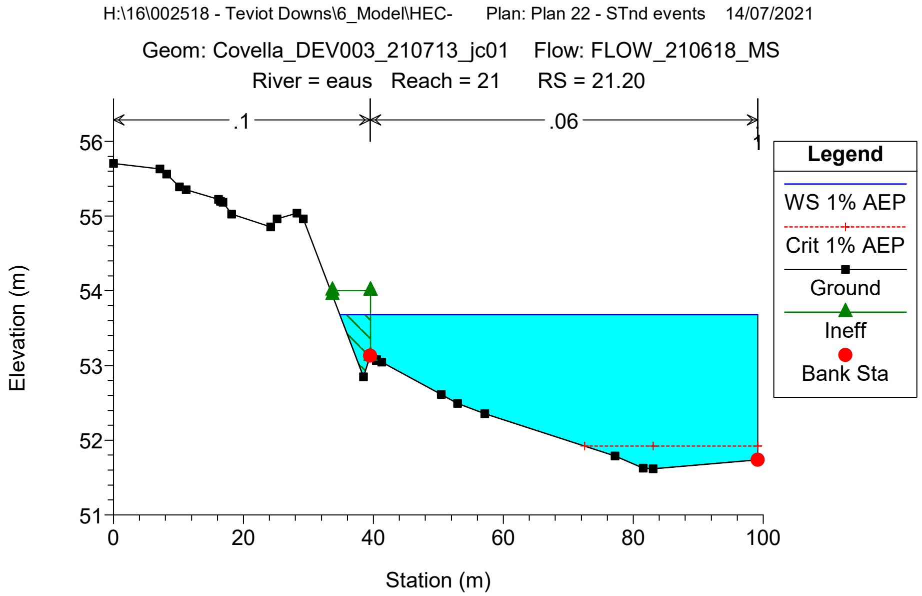
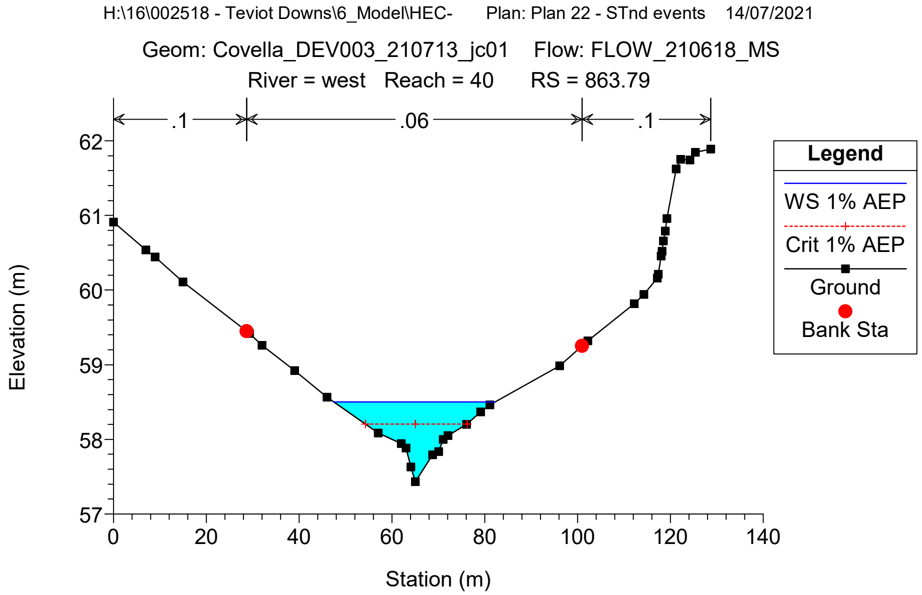
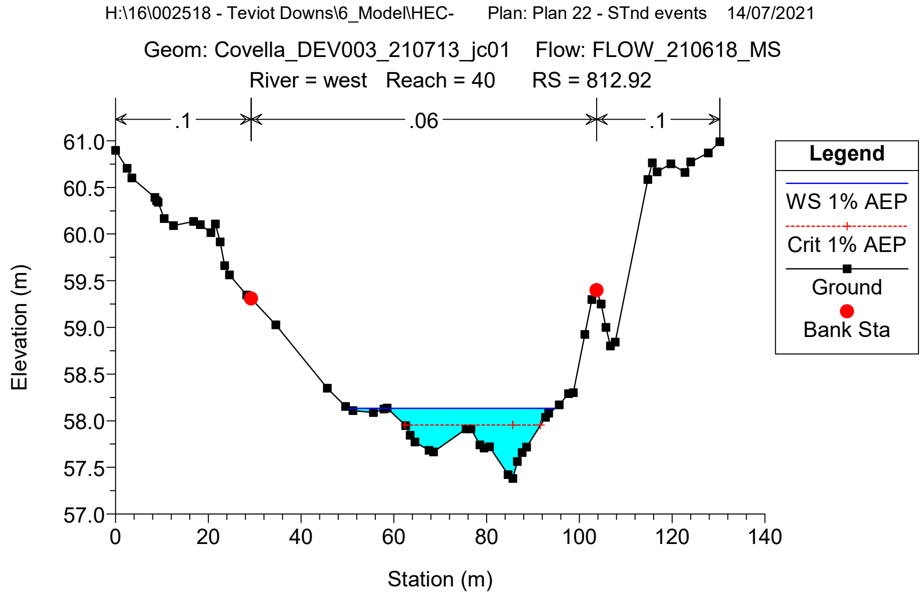
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 27.72
.1
.06
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = eaus Reach = 21 RS = 21.20
.1
.06
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-    Plan: Plan 22 - STnd events    14/07/2021
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 863.79
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta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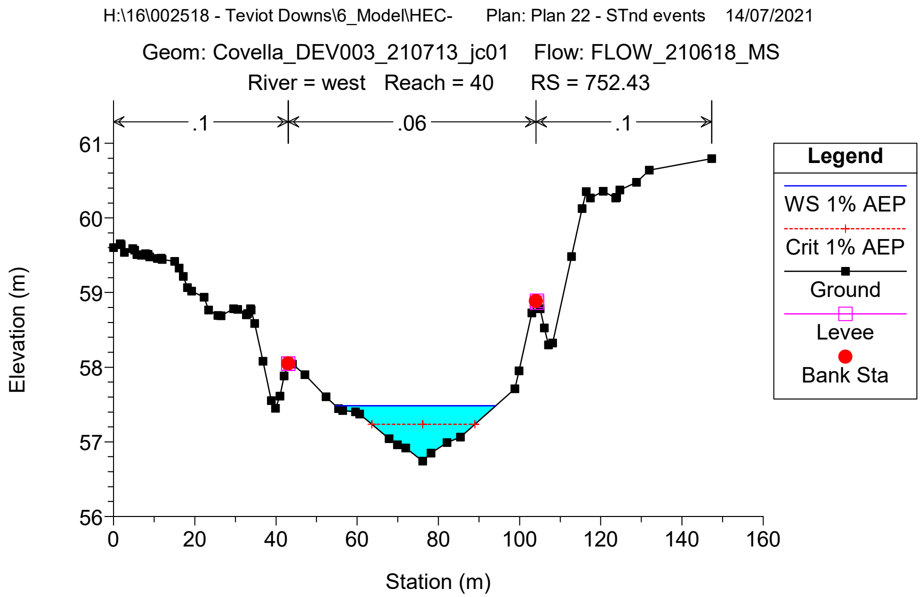
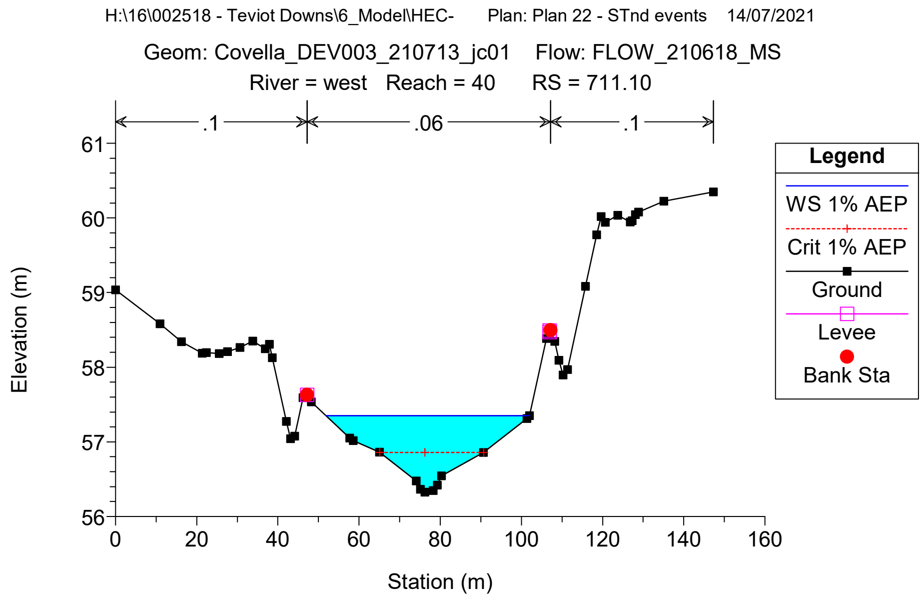
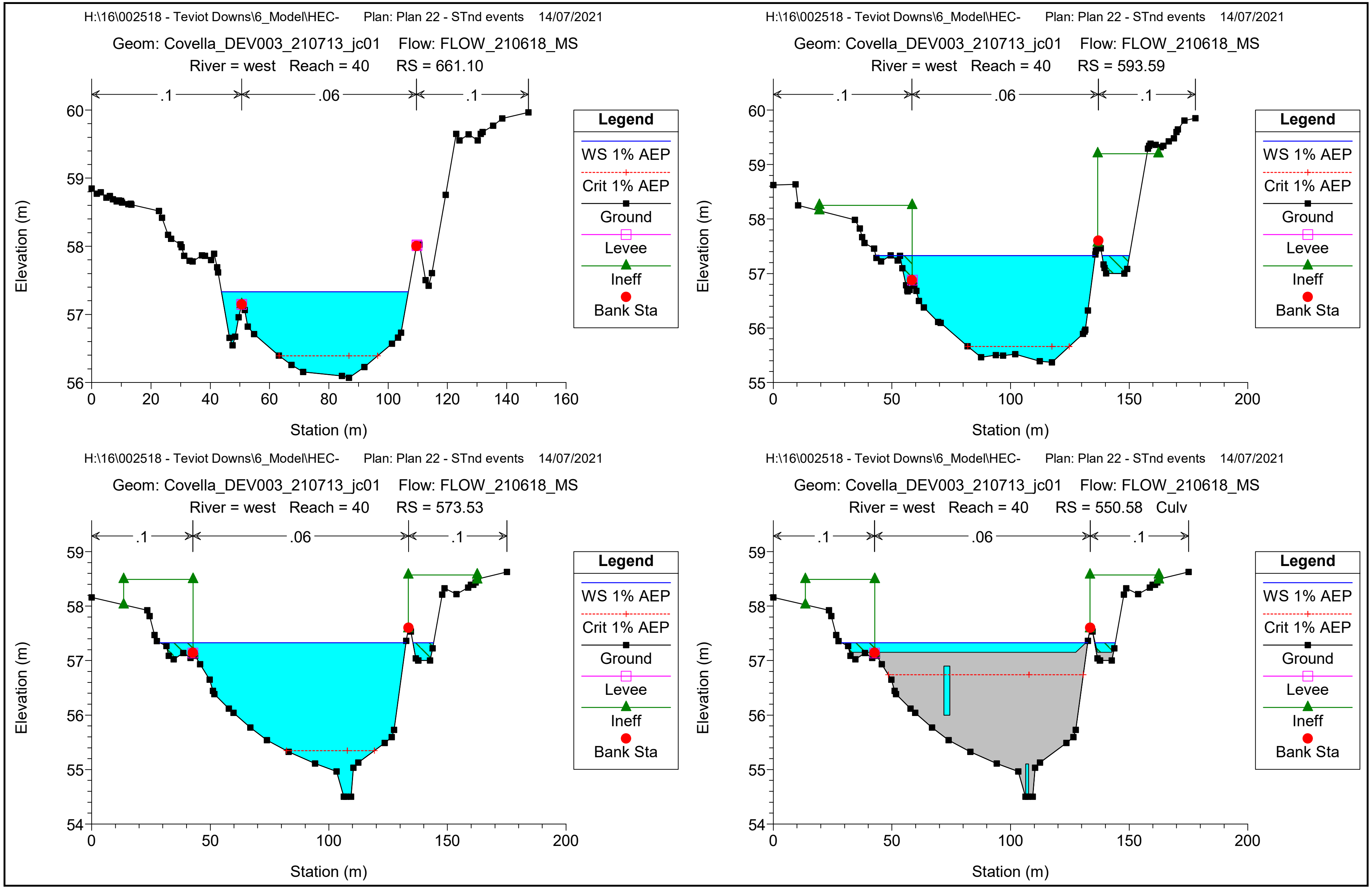
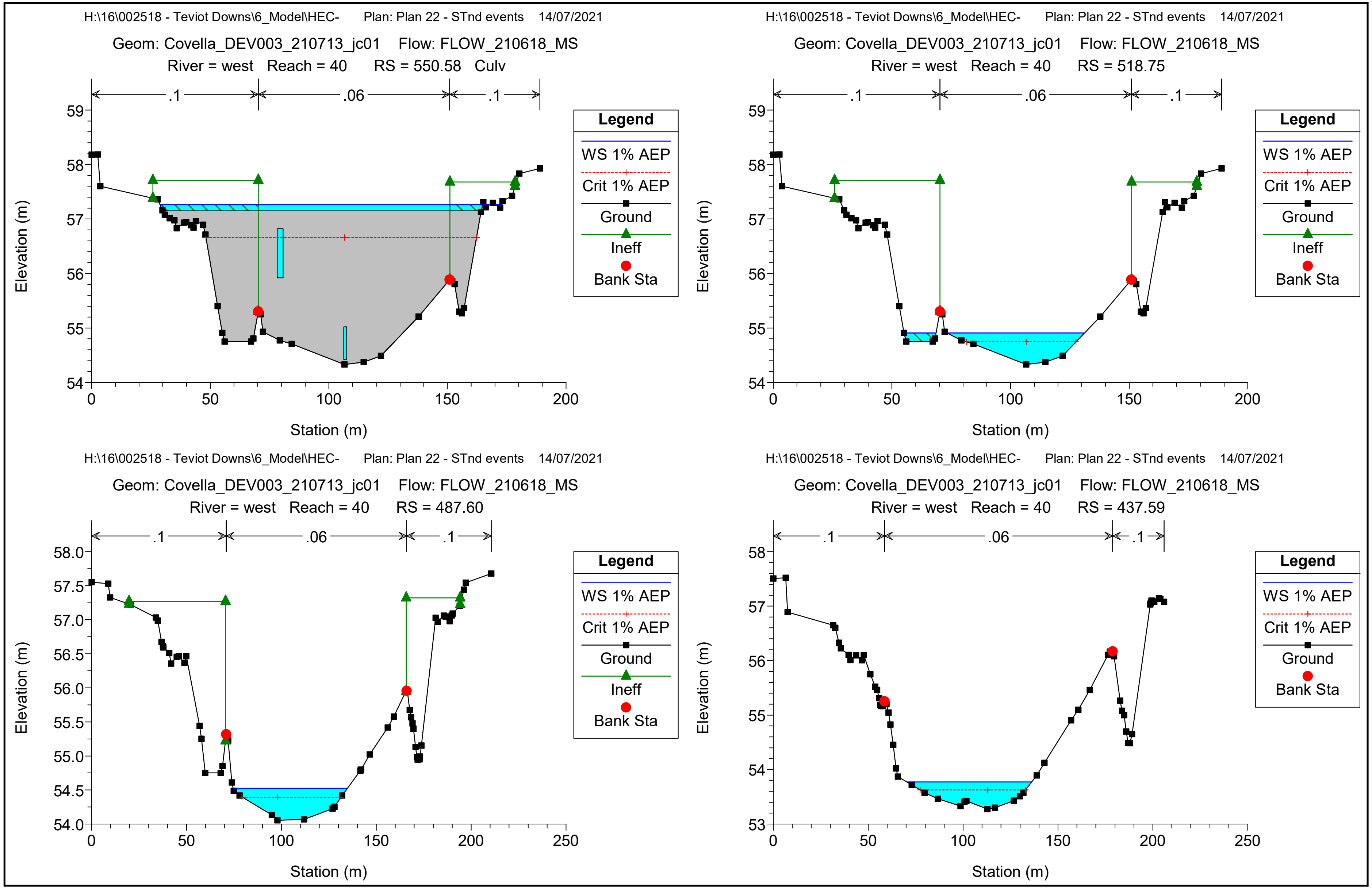
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 812.92
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-    Plan: Plan 22 - STnd events    14/07/2021
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 752.43
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Levee
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC-    Plan: Plan 22 - STnd events    14/07/2021
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 711.10
.1
.06
.1
Elevation (m)
Station (m)
Legend
WS 1% AEP
Crit 1% AEP
Ground
Levee
Bank Sta


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 661.10
Legend
WS 1% AEP
Crit 1% AEP
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 593.59
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 573.53
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 550.58 Culv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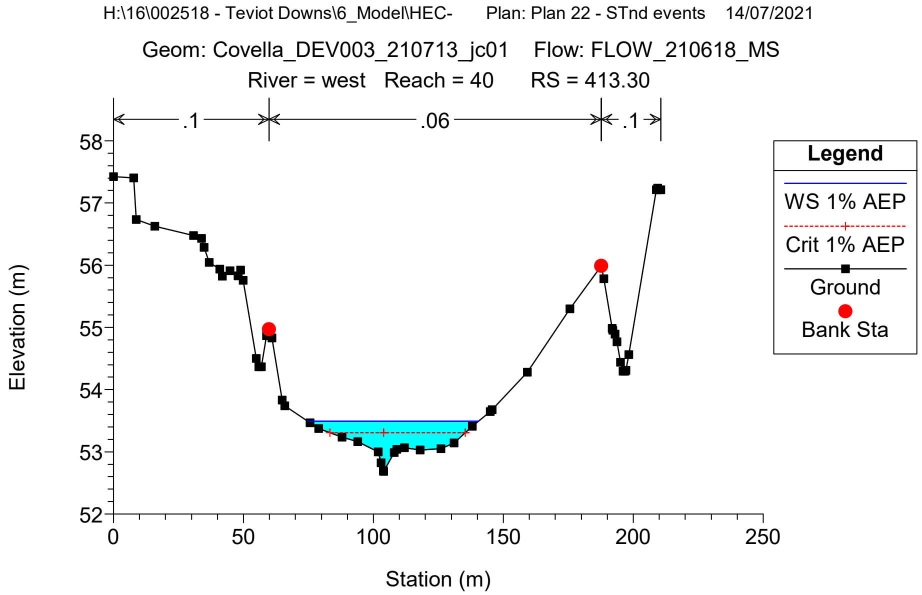
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 550.58 Culv
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 518.75
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 487.60
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 437.59
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)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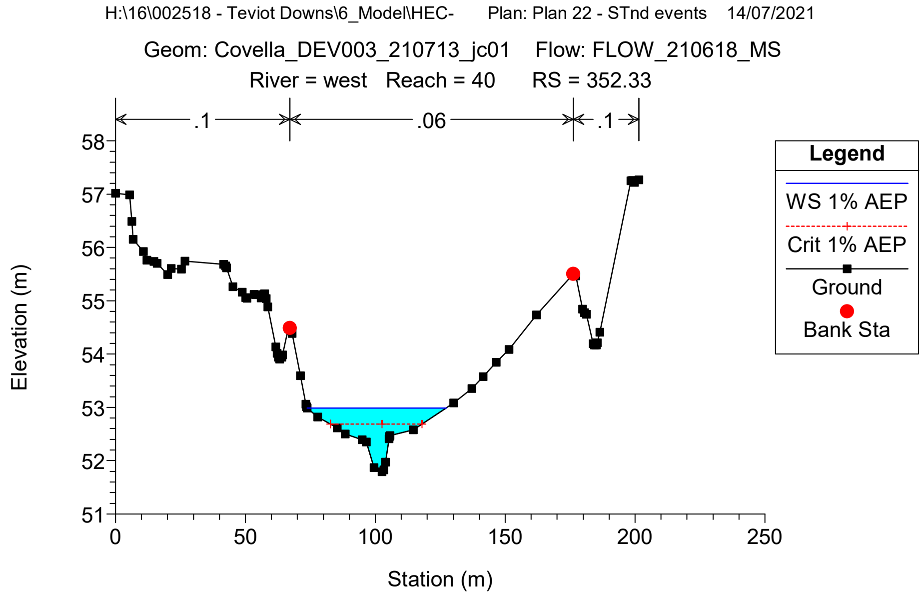
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 413.30
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)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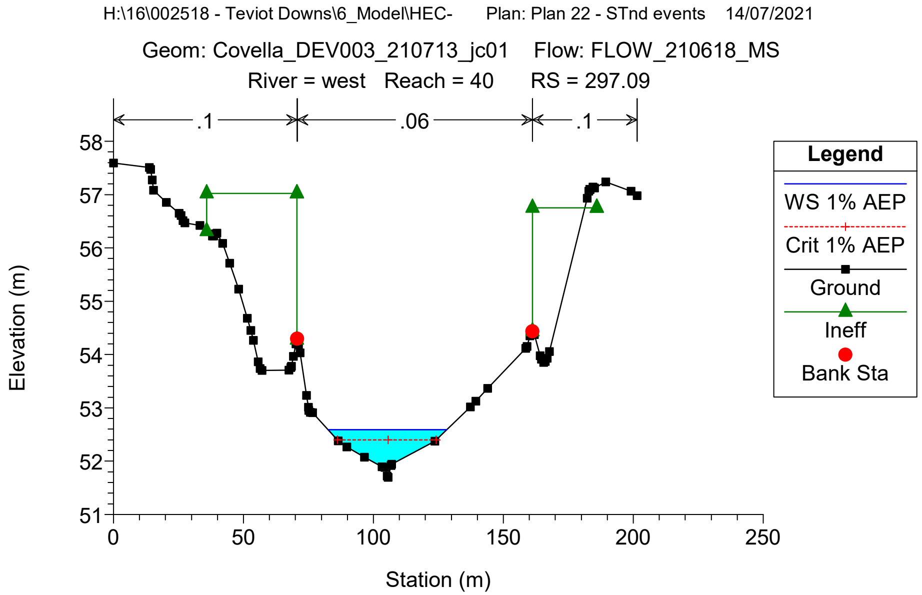
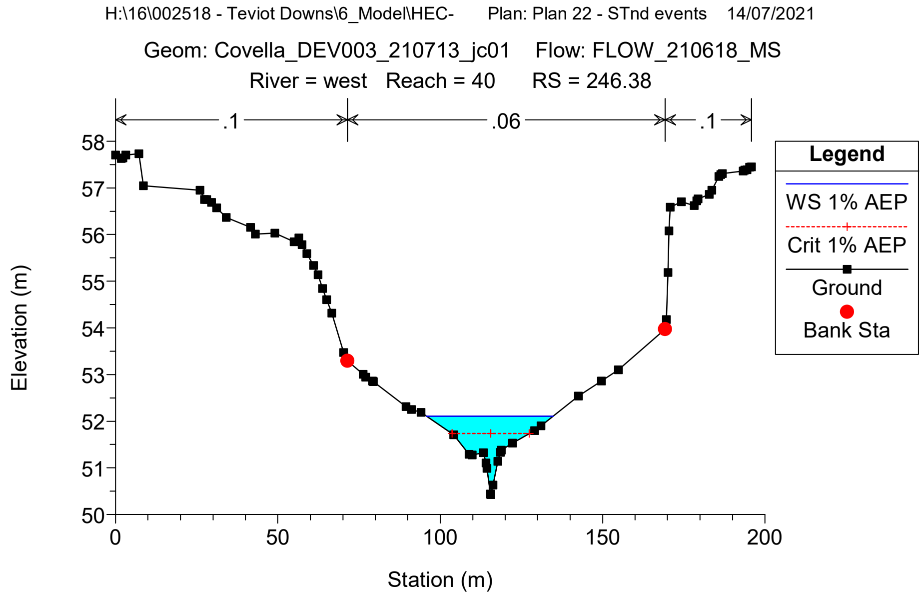
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 352.33
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-    Plan: Plan 22 - STnd events    14/07/2021
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 297.09
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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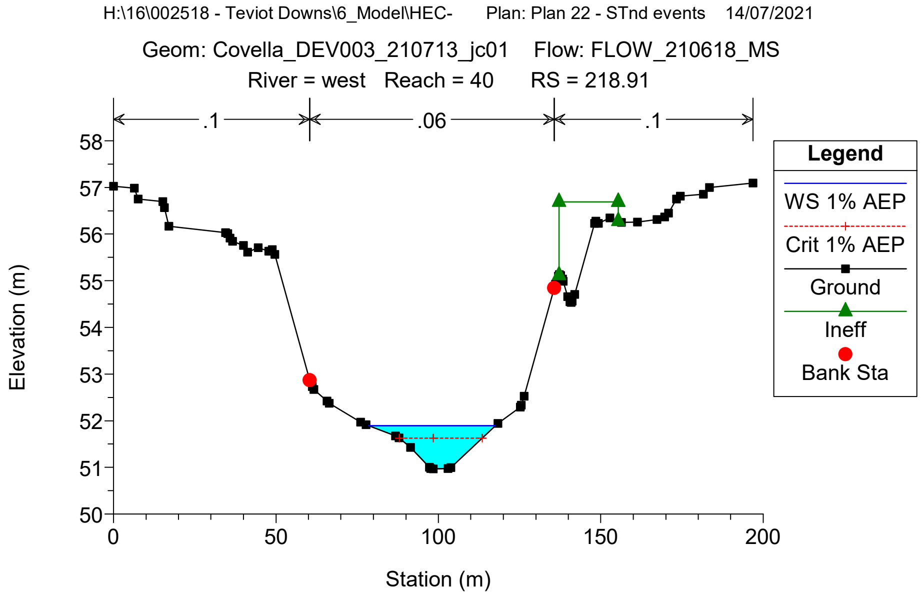
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 246.38
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)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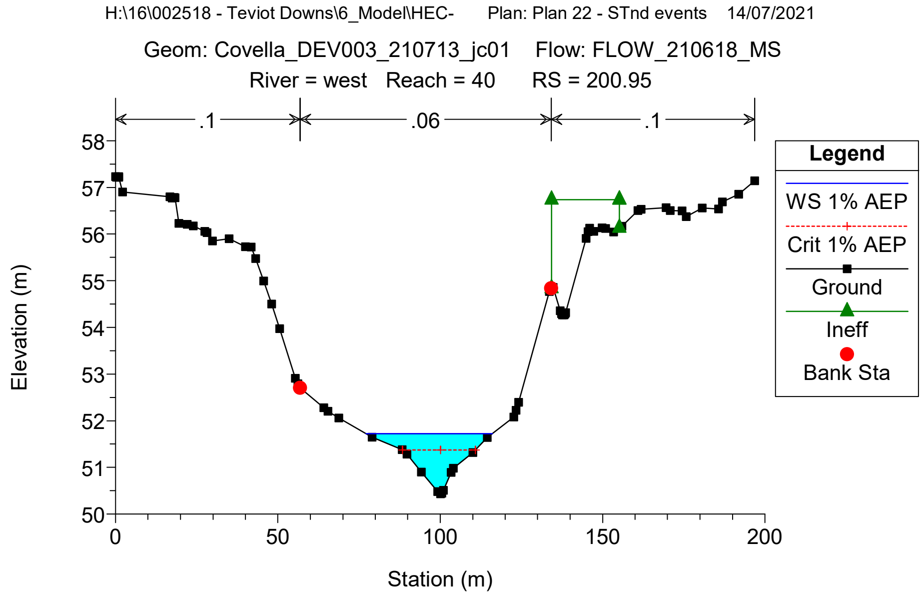
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 218.91
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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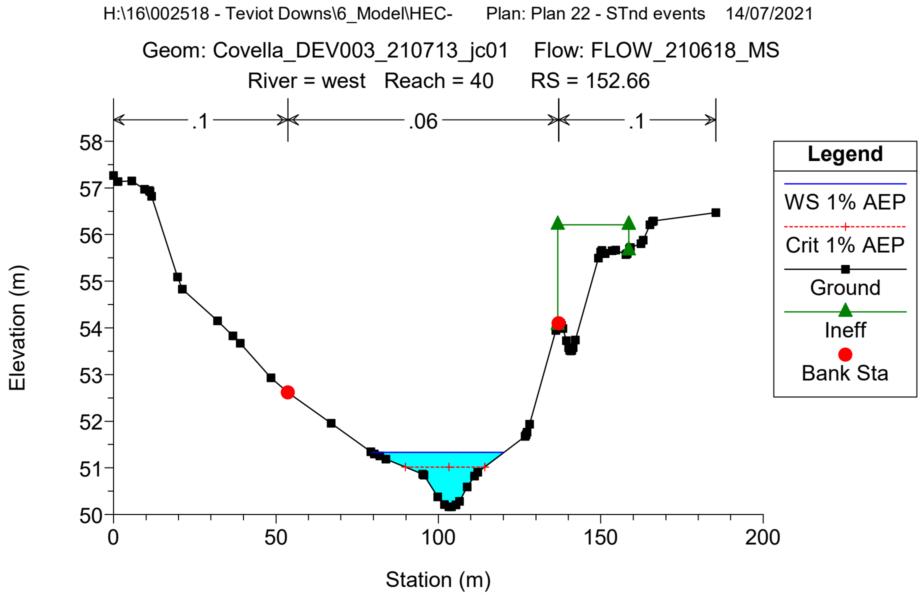
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 200.95
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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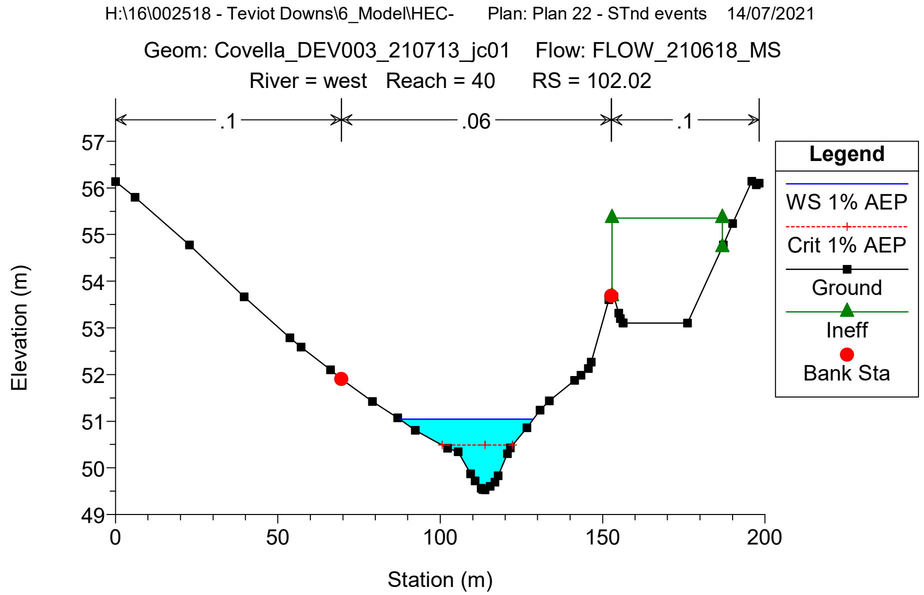
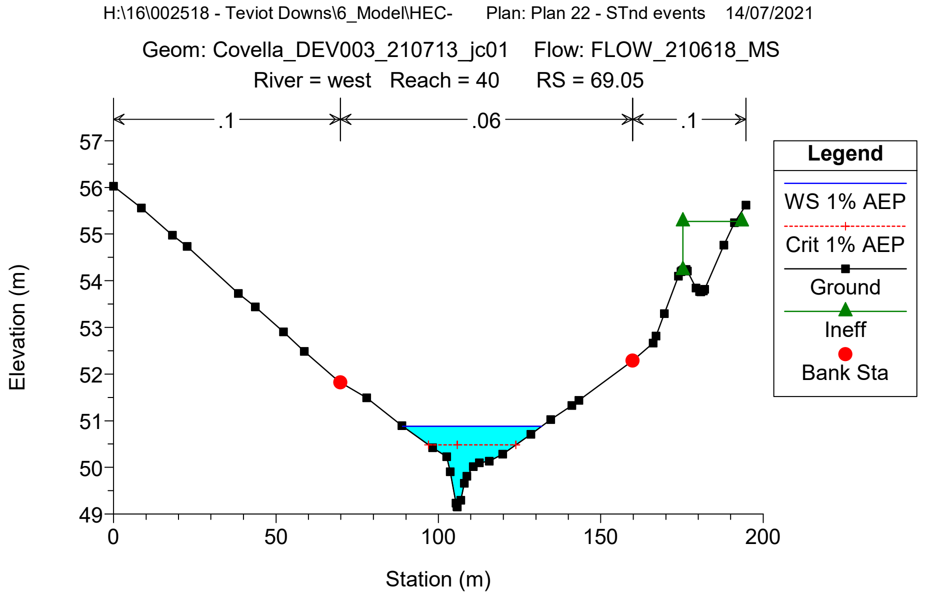
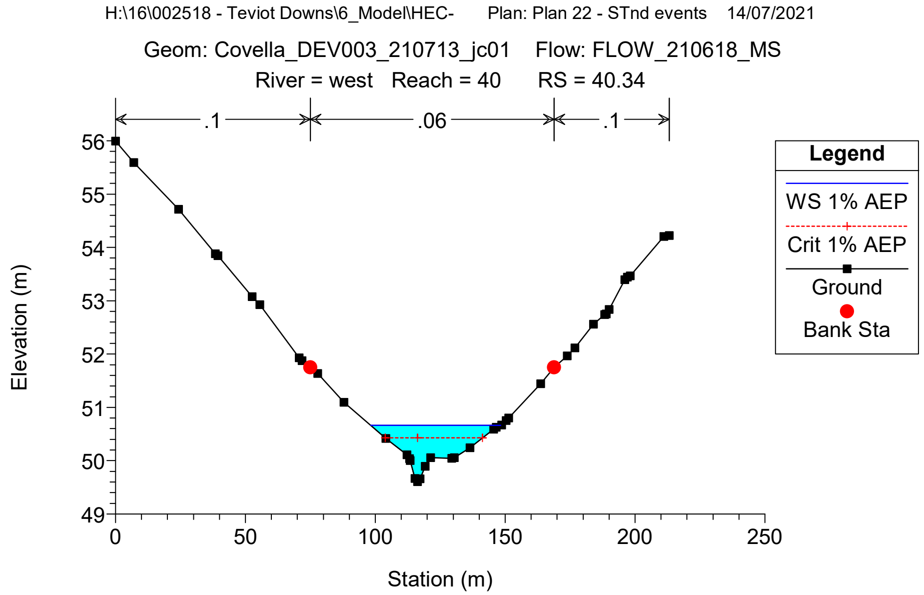
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 152.66
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC-    Plan: Plan 22 - STnd events    14/07/2021
Geom: Covella_DEV003_210713_jc01    Flow: FLOW_210618_MS
River = west    Reach = 40    RS = 102.02
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 69.05
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
57
56
55
54
53
52
51
50
49
0
50
100
150
200


H:\16\002518 - Teviot Downs\6_Model\HEC- Plan: Plan 22 - STnd events 14/07/2021
Geom: Covella_DEV003_210713_jc01 Flow: FLOW_210618_MS
River = west Reach = 40 RS = 40.34
.1
.06
.1
Legend
WS 1% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
56
55
54
53
52
51
50
49
0
50
100
150
200
250

**HEC-RAS** **Plan: Developed Mitigated 1% AEP**

| River | Reach | River Sta | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m3/s) | (m) | (m) | (m) | (m) | (m/m) | (m/s) | (m2) | (m) | |
| west | 40 | 864 | 9.84 | 57.43 | 58.50 | 58.20 | 58.52 | 0.01 | 0.69 | 14.27 | 34.66 | 0.34 |
| west | 40 | 813 | 9.84 | 57.38 | 58.13 | 57.95 | 58.16 | 0.01 | 0.77 | 12.70 | 44.28 | 0.46 |
| west | 40 | 752 | 9.84 | 56.74 | 57.48 | 57.23 | 57.51 | 0.01 | 0.69 | 14.25 | 39.52 | 0.37 |
| west | 40 | 711 | 9.84 | 56.33 | 57.35 | 56.86 | 57.36 | 0.00 | 0.38 | 25.66 | 50.20 | 0.17 |
| west | 40 | 661 | 9.84 | 56.07 | 57.33 | 56.39 | 57.33 | 0.00 | 0.18 | 56.74 | 63.05 | 0.06 |
| west | 40 | 594 | 9.84 | 55.37 | 57.33 | 55.66 | 57.33 | 0.00 | 0.08 | 120.41 | 103.92 | 0.02 |
| west | 40 | 574 | 17.54 | 54.50 | 57.33 | 55.35 | 57.33 | 0.00 | 0.11 | 154.36 | 112.36 | 0.03 |
| west | 40 | 551 | Culvert | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| west | 40 | 519 | 17.54 | 54.33 | 54.91 | 54.75 | 54.95 | 0.01 | 0.89 | 19.74 | 71.41 | 0.49 |
| west | 40 | 488 | 17.54 | 54.06 | 54.52 | 54.40 | 54.57 | 0.01 | 0.92 | 19.05 | 60.14 | 0.52 |
| west | 40 | 438 | 17.54 | 53.27 | 53.77 | 53.63 | 53.81 | 0.01 | 0.85 | 20.75 | 65.64 | 0.48 |
| west | 40 | 413 | 17.54 | 52.68 | 53.49 | 53.31 | 53.52 | 0.01 | 0.78 | 22.63 | 65.64 | 0.42 |
| west | 40 | 352 | 17.54 | 51.79 | 52.99 | 52.68 | 53.02 | 0.01 | 0.73 | 23.92 | 53.54 | 0.35 |
| west | 40 | 297 | 17.54 | 51.70 | 52.59 | 52.40 | 52.63 | 0.01 | 0.94 | 18.64 | 45.66 | 0.47 |
| west | 40 | 246 | 17.54 | 50.43 | 52.11 | 51.74 | 52.14 | 0.01 | 0.84 | 20.81 | 39.10 | 0.37 |
| west | 40 | 219 | 19.69 | 50.97 | 51.89 | 51.62 | 51.95 | 0.01 | 1.06 | 18.53 | 39.00 | 0.49 |
| west | 40 | 201 | 19.69 | 50.43 | 51.72 | 51.37 | 51.77 | 0.01 | 0.96 | 20.47 | 38.93 | 0.42 |
| west | 40 | 153 | 19.69 | 50.16 | 51.33 | 51.02 | 51.38 | 0.01 | 0.98 | 20.15 | 40.66 | 0.44 |
| west | 40 | 102 | 21.82 | 49.53 | 51.05 | 50.49 | 51.08 | 0.00 | 0.78 | 28.05 | 41.19 | 0.30 |
| west | 40 | 69 | 21.82 | 49.15 | 50.88 | 50.48 | 50.92 | 0.01 | 0.88 | 24.87 | 42.79 | 0.37 |
| west | 40 | 40 | 21.82 | 49.61 | 50.66 | 50.43 | 50.71 | 0.01 | 0.97 | 22.39 | 50.01 | 0.47 |
| eaus | 21 | 393 | 7.28 | 56.30 | 57.37 | 57.07 | 57.39 | 0.01 | 0.72 | 10.17 | 42.37 | 0.47 |
| eaus | 21 | 342 | 7.28 | 55.87 | 56.07 | 56.07 | 56.14 | 0.07 | 1.22 | 5.99 | 53.31 | 1.01 |
| eaus | 21 | 309 | 7.28 | 55.12 | 55.47 | 55.36 | 55.49 | 0.01 | 0.64 | 11.41 | 51.73 | 0.43 |
| eaus | 21 | 269 | 8.10 | 54.47 | 54.98 | 54.83 | 55.00 | 0.01 | 0.70 | 11.55 | 41.84 | 0.43 |
| eaus | 21 | 219 | 8.10 | 53.93 | 54.45 | 54.30 | 54.47 | 0.01 | 0.75 | 10.86 | 38.44 | 0.45 |
| eaus | 21 | 169 | 8.10 | 53.40 | 53.91 | 53.76 | 53.94 | 0.01 | 0.72 | 11.22 | 41.58 | 0.43 |
| eaus | 21 | 119 | 8.10 | 52.63 | 53.69 | 53.17 | 53.70 | 0.00 | 0.31 | 26.07 | 62.34 | 0.15 |
| eaus | 21 | 69 | 8.10 | 52.25 | 53.68 | 52.59 | 53.68 | 0.00 | 0.10 | 82.46 | 98.33 | 0.03 |
| eaus | 21 | 45 | 8.10 | 51.97 | 53.68 | 52.26 | 53.68 | 0.00 | 0.09 | 87.85 | 71.38 | 0.03 |
| eaus | 21 | 28 | 8.10 | 51.72 | 53.68 | 52.02 | 53.68 | 0.00 | 0.09 | 92.44 | 65.90 | 0.02 |
| eaus | 21 | 21 | 8.10 | 51.62 | 53.68 | 51.92 | 53.68 | 0.00 | 0.09 | 93.14 | 64.35 | 0.02 |
| east | 630 | 1154 | 5.47 | 57.47 | 57.77 | 57.67 | 57.79 | 0.01 | 0.65 | 8.36 | 42.99 | 0.47 |
| east | 630 | 1104 | 8.78 | 56.74 | 57.14 | 57.05 | 57.17 | 0.02 | 0.83 | 10.60 | 45.75 | 0.55 |
| east | 630 | 1054 | 8.78 | 55.83 | 56.24 | 56.13 | 56.27 | 0.02 | 0.78 | 11.27 | 48.53 | 0.52 |
| east | 630 | 1004 | 8.78 | 55.08 | 55.53 | 55.34 | 55.55 | 0.01 | 0.61 | 14.43 | 45.59 | 0.35 |
| east | 630 | 970 | 12.32 | 54.32 | 55.33 | 54.94 | 55.35 | 0.00 | 0.53 | 23.14 | 46.11 | 0.24 |
| east | 630 | 939 | 12.32 | 54.20 | 55.30 | 54.49 | 55.31 | 0.00 | 0.28 | 44.00 | 58.55 | 0.10 |
| east | 630 | 905 | Culvert | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| east | 630 | 874 | 13.54 | 53.81 | 54.35 | 54.13 | 54.38 | 0.01 | 0.70 | 19.29 | 54.02 | 0.38 |
| east | 630 | 850 | 13.54 | 53.54 | 54.15 | 53.97 | 54.19 | 0.01 | 0.81 | 16.81 | 48.61 | 0.44 |
| east | 630 | 798 | 13.54 | 53.04 | 53.75 | 53.45 | 53.77 | 0.00 | 0.61 | 22.18 | 70.02 | 0.30 |
| east | 630 | 748 | 13.24 | 52.61 | 53.70 | 52.99 | 53.70 | 0.00 | 0.31 | 42.42 | 59.39 | 0.12 |
| east | 630 | 698 | 17.70 | 52.14 | 53.68 | 52.59 | 53.69 | 0.00 | 0.22 | 81.49 | 76.73 | 0.07 |
| east | 630 | 657 | 17.70 | 51.82 | 53.68 | 52.16 | 53.68 | 0.00 | 0.13 | 142.90 | 95.06 | 0.03 |
| east | 630 | 646 | 17.70 | 51.74 | 53.68 | 52.10 | 53.68 | 0.00 | 0.14 | 125.18 | 75.67 | 0.04 |
| east | 630 | 637 | 17.70 | 51.68 | 53.68 | 52.00 | 53.68 | 0.00 | 0.14 | 125.01 | 72.64 | 0.03 |
| east | 630 | 630 | 17.70 | 51.60 | 53.68 | 51.93 | 53.68 | 0.00 | 0.14 | 122.17 | 69.24 | 0.03 |
| east | 0 | 593 | 25.80 | 51.06 | 53.68 | 51.65 | 53.68 | 0.00 | 0.13 | 193.56 | 109.44 | 0.03 |
| east | 0 | 585 | 25.80 | 51.03 | 53.68 | 51.60 | 53.68 | 0.00 | 0.13 | 193.22 | 106.74 | 0.03 |
| east | 0 | 536 | 31.07 | 50.61 | 53.68 | 51.37 | 53.68 | 0.00 | 0.16 | 192.92 | 93.89 | 0.04 |
| east | 0 | 507 | 31.07 | 49.67 | 53.68 | 50.48 | 53.68 | 0.00 | 0.14 | 224.78 | 95.51 | 0.03 |
| east | 0 | 481 | Culvert | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| east | 0 | 444 | 31.07 | 49.46 | 51.24 | 50.31 | 51.26 | 0.00 | 0.65 | 47.59 | 57.64 | 0.23 |
| east | 0 | 417 | 31.07 | 49.21 | 51.18 | 50.51 | 51.20 | 0.00 | 0.67 | 46.45 | 60.09 | 0.24 |
| east | 0 | 367 | 27.42 | 49.54 | 51.10 | 50.21 | 51.11 | 0.00 | 0.44 | 62.64 | 69.96 | 0.15 |
| east | 0 | 326 | 27.42 | 49.22 | 51.08 | 49.86 | 51.09 | 0.00 | 0.32 | 85.58 | 81.58 | 0.10 |
| east | 0 | 270 | 27.42 | 48.88 | 51.08 | 49.49 | 51.08 | 0.00 | 0.19 | 142.80 | 103.42 | 0.05 |
| east | 0 | 234 | 27.42 | 48.59 | 51.08 | 49.11 | 51.08 | 0.00 | 0.15 | 188.42 | 116.79 | 0.04 |
| east | 0 | 219 | Culvert | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| east | 0 | 190 | 28.10 | 47.72 | 48.98 | 48.59 | 49.02 | 0.01 | 0.81 | 34.68 | 62.07 | 0.35 |
| east | 0 | 161 | 25.05 | 47.49 | 48.73 | 48.49 | 48.77 | 0.01 | 0.90 | 27.98 | 62.67 | 0.43 |
| east | 0 | 132 | 25.23 | 47.38 | 48.40 | 48.27 | 48.46 | 0.02 | 1.05 | 24.10 | 70.35 | 0.57 |
| eads | 81 | 594 | 2.88 | 58.03 | 58.22 | 58.18 | 58.24 | 0.03 | 0.69 | 4.18 | 32.73 | 0.62 |
| eads | 81 | 544 | 2.88 | 56.68 | 56.88 | 56.83 | 56.90 | 0.02 | 0.66 | 4.38 | 32.45 | 0.57 |
| eads | 81 | 494 | 2.88 | 55.52 | 55.75 | 55.70 | 55.77 | 0.02 | 0.65 | 4.46 | 34.62 | 0.57 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **eads** | **81** | 444 | 2.88 | 54.30 | 54.59 | 54.52 | 54.61 | 0.02 | 0.65 | 4.40 | 28.02 | 0.53 |
| **eads** | **81** | 391 | 2.88 | 53.38 | 53.62 | 53.55 | 53.64 | 0.02 | 0.65 | 4.46 | 26.51 | 0.50 |
| **eads** | **81** | 338 | 5.08 | 52.46 | 52.78 | 52.70 | 52.81 | 0.02 | 0.84 | 6.08 | 31.75 | 0.59 |
| **eads** | **81** | 290 | 5.08 | 51.49 | 51.76 | 51.68 | 51.79 | 0.02 | 0.77 | 6.64 | 33.67 | 0.55 |
| **eads** | **81** | 239 | 5.08 | 50.43 | 50.85 | 50.76 | 50.87 | 0.02 | 0.72 | 7.01 | 33.62 | 0.51 |
| **eads** | **81** | 187 | 9.09 | 49.62 | 50.15 | 50.00 | 50.19 | 0.01 | 0.84 | 10.78 | 33.56 | 0.48 |
| **eads** | **81** | 131 | 9.09 | 48.97 | 49.43 | 49.34 | 49.48 | 0.02 | 0.95 | 9.60 | 36.24 | 0.59 |

TEVIOT VILLAGE CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION -

# Appendix C MUSIC Summary

VILLA GREEN PTY LTD

## 1. MUSIC NODES DETAILS

| Catchment | Total Area (ha) | Roof (ha) | Road (ha) | Ground (ha) |
|---|---|---|---|---|
| **5A** | 4.933 | 1.333 | 0.573 | 3.027 |
| **5B** | 4.894 | 0.882 | 0.541 | 3.471 |
| **5C** | 6.823 | 1.290 | 0.640 | 4.893 |
| **5D** | 3.545 | 1.376 | 0.268 | 1.901 |
| **6B** | 2.719 | 0.860 | 0.489 | 1.370 |
| **6C** | 6.964 | 2.473 | 1.111 | 3.381 |
| **7B1** | 2.615 | 0.968 | 0.379 | 1.269 |
| **7B2** | 1.638 | 0.667 | 0.247 | 0.724 |
| **7B3** | 2.051 | 0.495 | 0.444 | 1.113 |
| **7B4** | 1.242 | 0.452 | 0.199 | 0.592 |
| **7B5** | 2.829 | 0.946 | 0.517 | 1.366 |
| **9A** | 5.762 | 1.398 | 1.845 | 2.519 |
| **11B** | 11.331 | 3.035 | 3.375 | 4.921 |
| **11C1** | 1.896 | 0.645 | 0.351 | 0.900 |
| **11C2** | 4.303 | 1.591 | 0.863 | 1.849 |
| **11C3** | 5.353 | 1.634 | 0.996 | 2.723 |
| **11D1** | 3.940 | 1.335 | 1.465 | 1.140 |
| **11D2** | 4.700 | 1.462 | 1.731 | 1.507 |
| **11D3** | 3.425 | 1.076 | 1.304 | 1.045 |
| **12B1** | 2.200 | 0.774 | 0.380 | 1.047 |
| **12B3** | 3.254 | 1.204 | 0.568 | 1.481 |
| **12B4** | 1.612 | 0.581 | 0.267 | 0.764 |
| **14B** | 3.420 | 1.290 | 0.434 | 1.696 |
| **14C** | 5.437 | 2.066 | 1.461 | 1.910 |
| **20B1** | 3.125 | 1.097 | 0.558 | 1.470 |
| **20B2** | 5.304 | 1.935 | 0.809 | 2.560 |
| **21A** | 2.052 | 0.430 | 0.343 | 1.279 |
| **TOTAL** | **107.365** | **33.291** | **22.158** | **51.917** |

Note: Roof area of each lot is based on 215m$^2$.

## 2. MUSIC TREATMENT NODES DETAILS

### a. End-of-line Bioretention Basin

| MUSIC Catchment | Filter Area ($m^2$) | Filter Depth (mm) | Saturated Hydraulic Conductivity (mm/hr) | TN Content of Filter Media (mg/kg) | Orthophosphate Content of Filter Media (mg/kg) |
|---|---|---|---|---|---|
| **5A** | 700 | 400 | 200 | 400 | 30 |
| **5C** | | | | | |
| **5B** | 330 | 500 | 200 | 400 | 30 |
| **5D** | | | | | |
| **6B** | 1000 | 500 | 200 | 400 | 30 |
| **6C** | | | | | |
| **7B1** | 810 | 400 | 200 | 400 | 30 |
| **7B2** | | | | | |
| **7B3** | | | | | |
| **7B4** | | | | | |
| **7B5** | | | | | |
| **11C1** | 526 | 400 | 200 | 400 | 30 |
| **11C2** | 365 | 400 | 200 | 400 | 30 |
| **11C3** | 735 | 400 | 200 | 400 | 30 |
| **11D1** | 371 | 500 | 200 | 400 | 30 |
| **11D3** | 560 | 500 | 200 | 400 | 30 |
| **12B1** | 350 | 400 | 200 | 400 | 30 |
| **12B3** | | | | | |
| **12B4** | | | | | |
| **14B** | 550 | 400 | 200 | 400 | 30 |
| **14C** | 500 | 400 | 200 | 400 | 30 |
| **20B1** | 350 | 400 | 200 | 400 | 30 |
| **20B2** | | | | | |
| **TOTAL** | **7147** | **NA** | **NA** | **NA** | **NA** |

### b. Bio Swale

| MUSIC Catchment | Total Length (m) | Effective Length (m) | Filter Area ($m^2$) | Filter Depth (mm) | Bed Slope (%) | Base Width (m) | Top Width (m) | Vegetation Height (m) |
|---|---|---|---|---|---|---|---|---|
| **6B** | 125 | 75 | 112.5 | 400 | 1 | 1.5 | 4 | 0.25 |
| **6C** | 45 | 25 | 37.5 | 400 | 1 | 1.5 | 4 | 0.25 |
| **7B1** | 150 | 100 | 100 | 400 | 2.3 | 1 | 4 | 0.25 |
| **7B2** | 290 | 50 | 75 | 400 | 1.6 | 1.5 | 4 | 0.25 |
| **7B3** | 350 | 70 | 105 | 400 | 1.5 | 1.5 | 4 | 0.25 |
| **7B4** | 200 | 145 | 217.5 | 400 | 2.5 | 1.5 | 4 | 0.25 |
| **7B5** | 100 | 25 | 37.5 | 400 | 2.5 | 1.5 | 4 | 0.25 |
| **9A** | 20 | 20 | 0 | 0 | 0.5 | 2 | 7 | 0.05 |
| **11B** | 243 | 243 | 219 | 500/600 | 1 | 1 | 5.8 | 0.05 |
| **12B1** | 110 | 55 | 55 | 400 | 2.2 | 1 | 4 | 0.25 |
| **20B1** | 200 | 100 | 60 | 400 | 2.2 | 0.6 | 4 | 0.25 |
| **20B2** | 250 | 150 | 90 | 400 | 2.2 | 0.6 | 4 | 0.25 |
| **TOTAL** | **2283** | **1158** | **1259** | **NA** | **NA** | **NA** | **NA** | **NA** |

### c. Bio Pod

| MUSIC Catchment | Filter Area ($m^2$) | Filter Depth (mm) | Saturated Hydraulic Conductivity (mm/hr) | TN Content of Filter Media (mg/kg) | Orthophosphate Content of Filter Media (mg/kg) |
|---|---|---|---|---|---|
| **9A** | 359 | 500 | 200 | 400 | 30 |
| **11B** | 459 | 500 | 200 | 400 | 30 |
| **11D1** | 224 | 500 | 200 | 400 | 30 |
| **11D2** | 263 | 500 | 200 | 400 | 30 |
| **11D3** | 37.5 | 500 | 200 | 400 | 30 |
| **12B3** | 224 | 500 | 200 | 400 | 30 |
| **12B4** | 22 | 500 | 200 | 400 | 30 |
| **14C** | 234 | 500 | 200 | 400 | 30 |
| **TOTAL** | **1822.5** | **NA** | **NA** | **NA** | **NA** |

## 3. FRACTION IMPERVIOUS

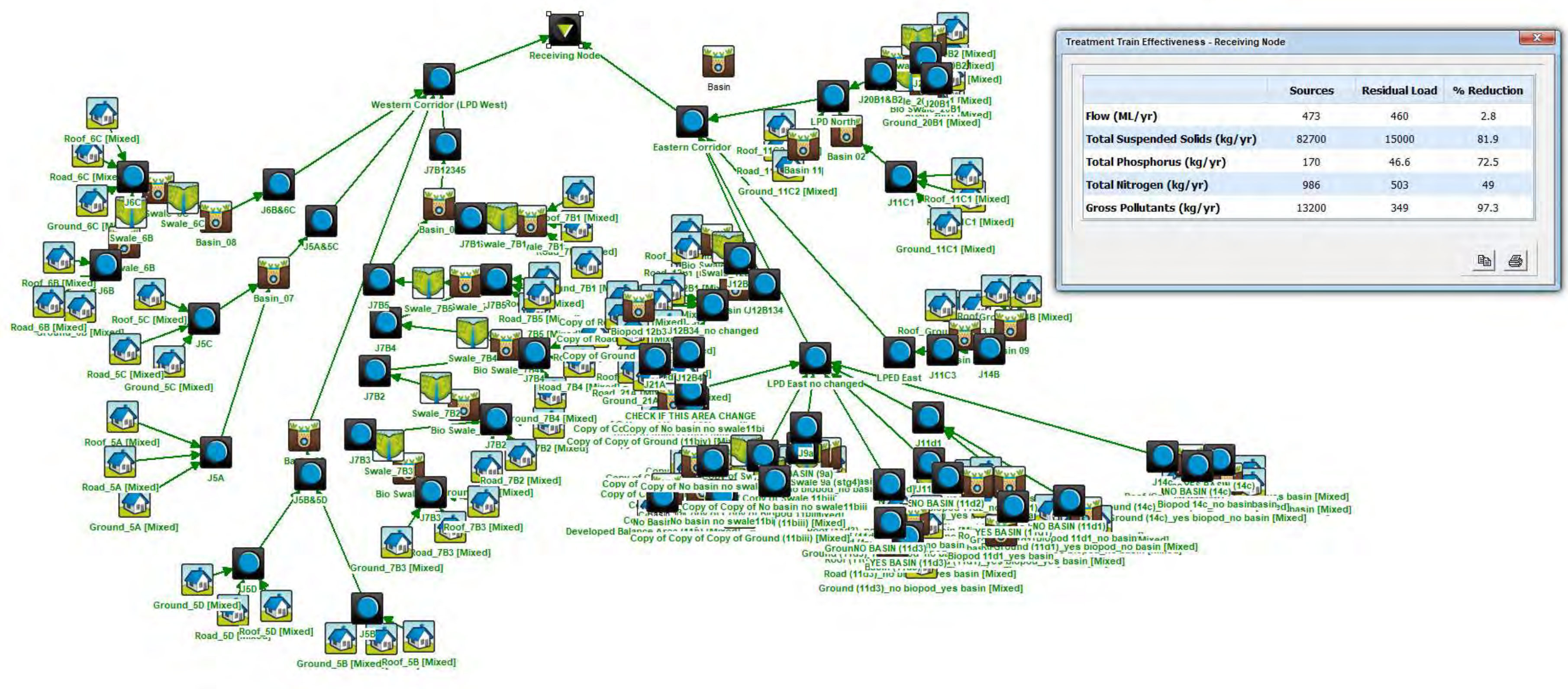
| Land use | Road | Roof | Ground |
|---|---|---|---|
| **Fraction Impervious** | 90% | 100% | 25% |

## 4. MUSIC MODEL LAYOUT

**File:**
21-000066_Covella_20210617_V01.sqz

**Location:**
\\bnenas01.browncan.local\Projects\21\000066 - Covella Masterplanning - B.EW\6_Model\SF\MUSIC\

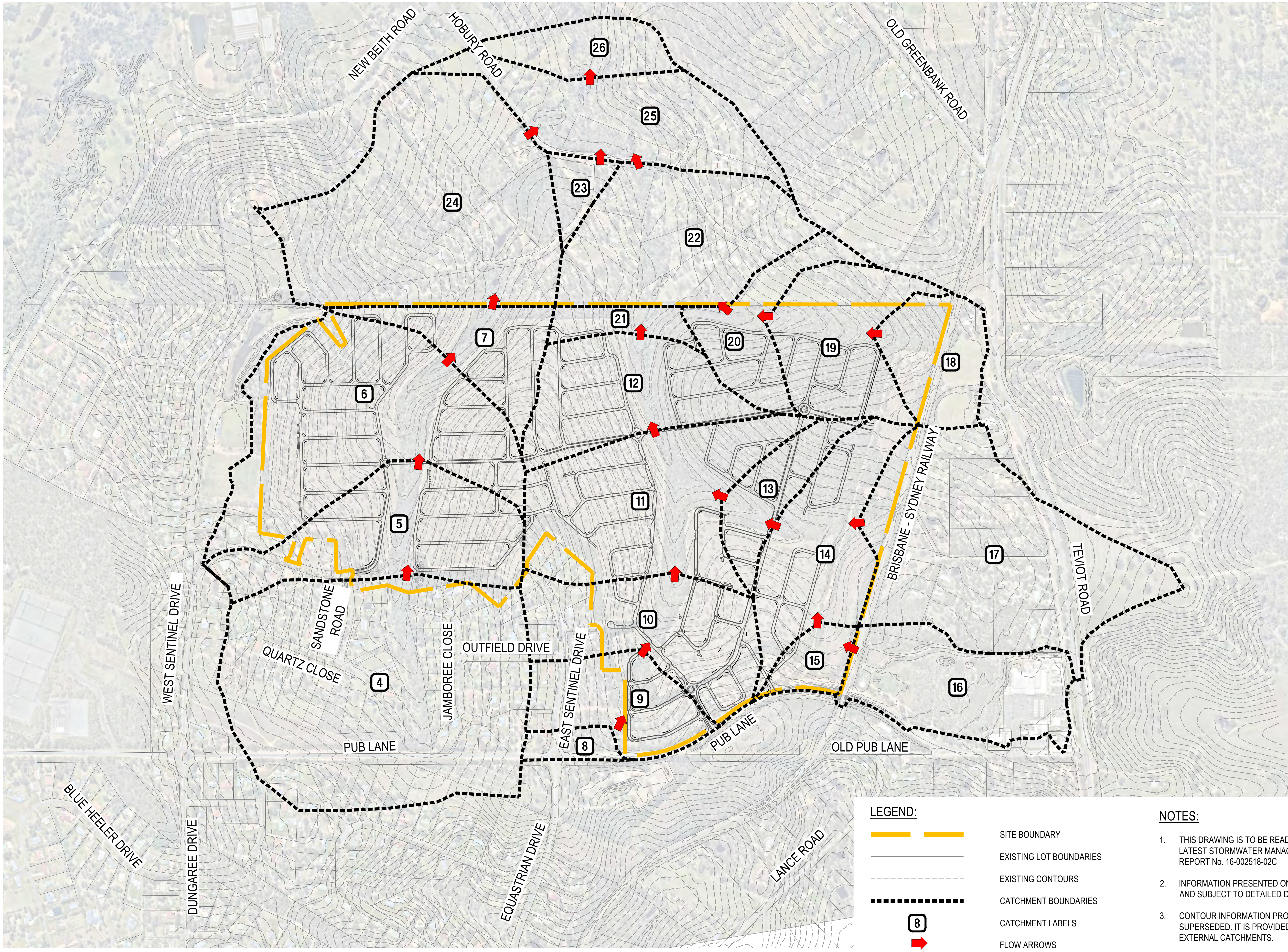
Modeler: Gabriela Bausson & Jingyi Chen & Kevin Clancy



TEVIOT VILLAGE CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION -

# Appendix D Concept Drawings

VILLA GREEN PTY LTD




| CATCHMENT | AREA (ha) |
|---|---|
| 4 | 46.88 |
| 5 | 18.39 |
| 6 | 31.19 |
| 7 | 8.51 |
| 8 | 2.10 |
| 9 | 9.90 |
| 10 | 16.18 |
| 11 | 22.91 |
| 12 | 14.43 |
| 13 | 6.18 |
| 14 | 14.43 |
| 15 | 3.35 |
| 16 | 14.87 |
| 17 | 32.95 |
| 18 | 8.48 |
| 19 | 12.98 |
| 20 | 8.03 |
| 21 | 3.18 |
| 22 | 20.20 |
| 23 | 2.58 |
| 24 | 36.32 |
| 25 | 16.48 |
| 26 | 6.20 |

LEGEND:

- SITE BOUNDARY
- EXISTING LOT BOUNDARIES
- EXISTING CONTOURS
- CATCHMENT BOUNDARIES
- 8 CATCHMENT LABELS
- FLOW ARROWS

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE'S LATEST STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION REPORT No. 16-002518-02C
2. INFORMATION PRESENTED ON THIS DRAWING IS PRELIMINARY ONLY AND SUBJECT TO DETAILED DESIGN.
3. CONTOUR INFORMATION PROVIDED ON THIS DRAWING HAS BEEN SUPERSEDED. IT IS PROVIDED ON THIS DRAWING TO ILLUSTRATE EXTERNAL CATCHMENTS.

FILE: H:\16\002518 - TEVIOT DOWNS\6_MODEL\AUTOCAD\16-002518-SK10.DWG LAST SAVED BY:HUNG TRAN

| REVISION | DATE | ISSUE DETAILS | DRAWN | DESIGN |
|---|---|---|---|---|
| A | 28.11.16 | ORIGINAL ISSUE | SL | KO |
| B | 18.06.21 | UPDATED TITLE BLOCK AND NOTES | HT | DY |
| C | | | | |
| D | | | | |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |

DRAWN

DESIGN

STATUS

ISSUED FOR APPROVAL

APPROVED

SCALE

1:2500 50 0 50 100m A1
1:5000 A3

CLIENT

AVID PROPERTY GROUP PTY LTD

AVID Property Group

calibre
calibregroup.com

©

PROJECT

COVELLA

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

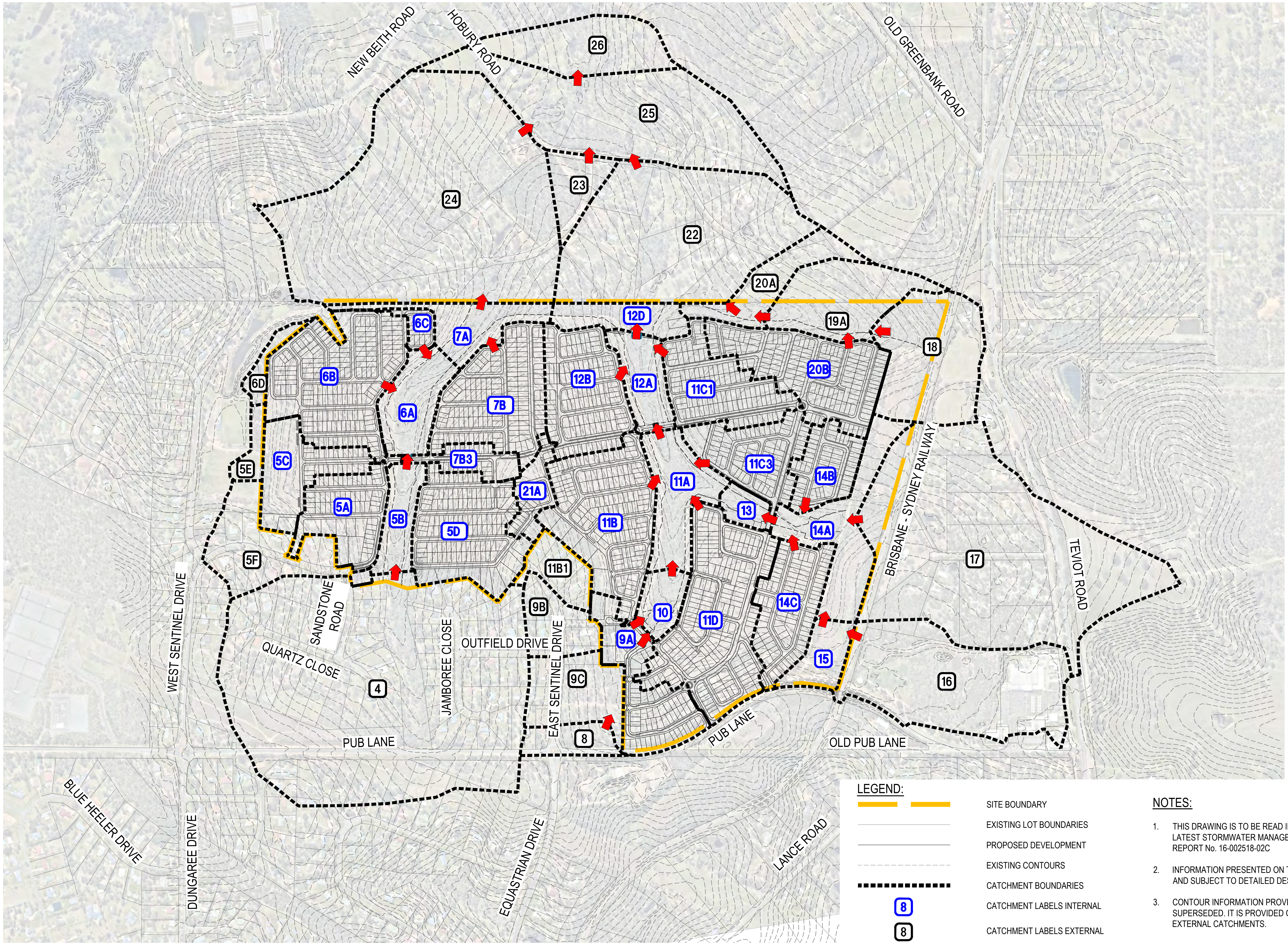
DRAWING TITLE

**CONCEPT STORMWATER MANAGEMENT STRATEGY EXISTING CATCHMENT PLAN**

PROJECT No. 16-002518

DRAWING No. SK10

REVISION B




| CATCHMENT | AREA (ha) |
|---|---|
| 4 | 46.27 |
| 5A | 4.93 |
| 5B | 2.71 |
| 5C | 4.79 |
| 5D | 8.42 |
| 5E | 1.08 |
| 5F | 6.28 |
| 6A | 4.07 |
| 6B | 10.87 |
| 6C | 0.89 |
| 6D | 1.02 |
| 7A | 3.73 |
| 7B | 8.32 |
| 7B3 | 2.05 |
| 8 | 2.10 |
| 9A | 5.86 |
| 9B | 3.23 |
| 9C | 4.94 |
| 10 | 1.94 |
| 11A | 5.05 |
| 11B | 9.93 |
| 11B1 | 2.44 |
| 11C1 | 6.20 |
| 11C3 | 5.35 |
| 11D | 12.18 |
| 12A | 3.19 |
| 12B | 7.07 |
| 12D | 2.82 |
| 13 | 1.18 |
| 14A | 6.37 |
| 14B | 3.42 |
| 14C | 5.53 |
| 15 | 2.38 |
| 16 | 14.87 |
| 17 | 32.95 |
| 18 | 9.22 |
| 19A | 6.56 |
| 20A | 3.92 |
| 20B | 8.43 |
| 21A | 2.05 |
| 22 | 20.20 |
| 23 | 2.58 |
| 24 | 36.32 |
| 25 | 16.48 |
| 26 | 6.20 |

LEGEND:

SITE BOUNDARY

EXISTING LOT BOUNDARIES

PROPOSED DEVELOPMENT

EXISTING CONTOURS

CATCHMENT BOUNDARIES

8 CATCHMENT LABELS INTERNAL

8 CATCHMENT LABELS EXTERNAL

FLOW ARROWS

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE'S LATEST STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION REPORT No. 16-002518-02C
2. INFORMATION PRESENTED ON THIS DRAWING IS PRELIMINARY ONLY AND SUBJECT TO DETAILED DESIGN.
3. CONTOUR INFORMATION PROVIDED ON THIS DRAWING HAS BEEN SUPERSEDED. IT IS PROVIDED ON THIS DRAWING TO ILLUSTRATE EXTERNAL CATCHMENTS.

FILE: H:\16\002518 - TEVIOT DOWNS\6_MODEL\AUTOCAD\16-002518-SK11.DWG LAST SAVED BY:HUNG TRAN

| REVISION | DATE | ISSUE DETAILS | DRAWN | DESIGN |
|---|---|---|---|---|
| A | 28.11.16 | ORIGINAL ISSUE | SL | KO |
| B | 13.12.16 | UPDATED SURVEY AND CATCHMENTS | SL | KO |
| C | 18.06.21 | LAYOUT AND STORMWATER STRATEGY AMENDED | HT | DY |
| D | | | | |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |

DRAWN

DESIGN

STATUS

ISSUED FOR APPROVAL

APPROVED

SCALE

1:5000 100 50 0 100 200m A1
1:10000 A3

CLIENT

AVID PROPERTY GROUP PTY LTD

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PROJECT

COVELLA

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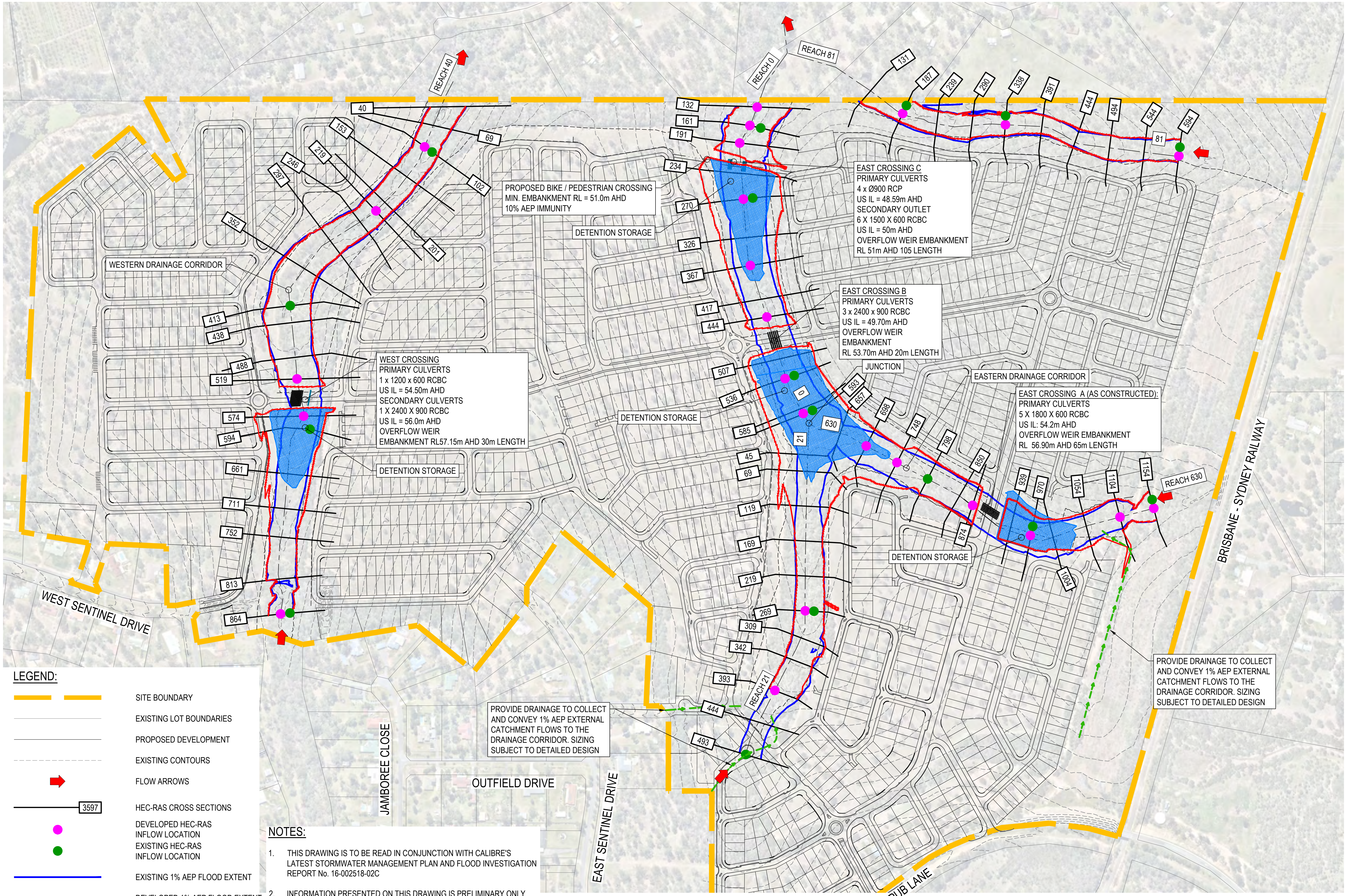
DRAWING TITLE

CONCEPT STORMWATER MANAGEMENT STRATEGY DEVELOPED CATCHMENT PLAN

PROJECT No. 16-002518

DRAWING No. SK11

REVISION C




## LEGEND:

| | |
|---|---|
| | SITE BOUNDARY |
| | EXISTING LOT BOUNDARIES |
| | PROPOSED DEVELOPMENT |
| | EXISTING CONTOURS |
| | FLOW ARROWS |
| 3597 | HEC-RAS CROSS SECTIONS |
| | DEVELOPED HEC-RAS INFLOW LOCATION |
| | EXISTING HEC-RAS INFLOW LOCATION |
| | EXISTING 1% AEP FLOOD EXTENT |
| | DEVELOPED 1% AEP FLOOD EXTENT |

## NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE'S LATEST STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION REPORT No. 16-002518-02C
2. INFORMATION PRESENTED ON THIS DRAWING IS PRELIMINARY ONLY AND SUBJECT TO DETAILED DESIGN.

| REVISION | DATE | ISSUE DETAILS | DRAWN | DESIGN |
|---|---|---|---|---|
| A | 28.11.16 | ORIGINAL ISSUE | SL | KO |
| B | 13.12.16 | UPDATED HEC-RAS MODEL | SL | KO |
| C | 18.06.21 | STORMWATER STRATEGY AND LAYOUT AMENDED | HT | DY |
| D | 22.07.21 | UPDATED HEC-RAS MODELLING | NM | DY |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |

DRAWN

DESIGN

STATUS: ISSUED FOR APPROVAL

APPROVED

SCALE: 1:2500 A1 / 1:5000 A3 — 50 0 50 100m

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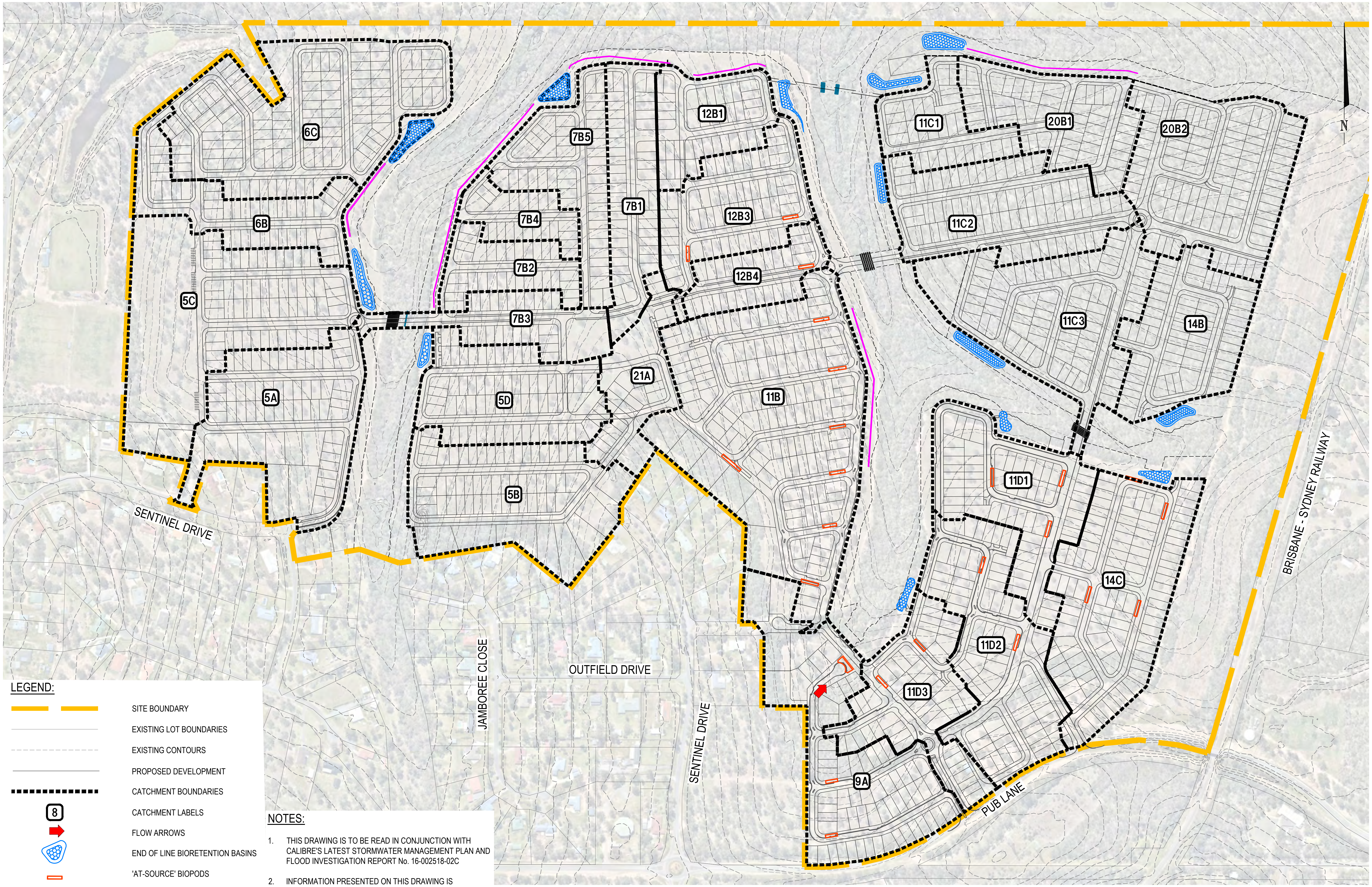
DRAWING TITLE: CONCEPT STORMWATER MANAGEMENT STRATEGY HEC-RAS GENERAL ARRANGEMENT

| PROJECT No. | DRAWING No. | REVISION |
|---|---|---|
| 16-002518 | SK12 | D |




LEGEND:

- SITE BOUNDARY
- EXISTING LOT BOUNDARIES
- EXISTING CONTOURS
- PROPOSED DEVELOPMENT
- CATCHMENT BOUNDARIES
- 8 CATCHMENT LABELS
- FLOW ARROWS
- END OF LINE BIORETENTION BASINS
- 'AT-SOURCE' BIOPODS
- BIO SWALE

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE'S LATEST STORMWATER MANAGEMENT PLAN AND FLOOD INVESTIGATION REPORT No. 16-002518-02C
2. INFORMATION PRESENTED ON THIS DRAWING IS PRELIMINARY ONLY AND SUBJECT TO DETAILED DESIGN.

| REVISION | DATE | ISSUE DETAILS | DRAWN | DESIGN |
|---|---|---|---|---|
| A | 07.12.16 | ORIGINAL ISSUE | SL | DY |
| B | 13.12.16 | UPDATED DRAINAGE STRATEGY | SL | DY |
| C | 18.06.21 | LAYOUT AND DRAINAGE STRATEGY AMENDED | HT | DY |
| D | | | | |
| E | | | | |
| F | | | | |
| G | | | | |
| H | | | | |

DRAWN

DESIGN

STATUS
ISSUED FOR APPROVAL

APPROVED

SCALE
1:2500 50 0 50 100m A1
1:5000 A3

CLIENT
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DRAWING TITLE
CONCEPT STORMWATER QUALITY MANAGEMENT STRATEGY

| PROJECT No. | DRAWING No. | REVISION |
|---|---|---|
| 16-002518 | SK13 | C |

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