PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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Queensland Government

Jimboomba Celestino Master Planning

Concept Stormwater Management Plan

Prepared by Calibre Consulting
Prepared for Celestino Pty Ltd

April 2017

B13343.W-02B
Original
Water & Environment

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EXECUTIVE SUMMARY

Calibre Consulting (Qld) Pty Ltd has been engaged to prepare this *Concept Stormwater Management Plan* for the proposed Jimboomba Celestino development within the Greater Flagstone Priority Development Area (PDA). This report addresses total water cycle management, stormwater quality, stormwater quantity, and local flood management for the site.

Utilising hydrological and hydraulic model software packages, the extents of the west-east drainage corridor has been determined. Subsequently, the flood immunity levels for habitable floor levels, sport fields and parks have been nominated based on the local and regional flood levels. This achieves the local flooding requirements.

The regional hydrological and hydraulic analyses presented in a separate report titled *Flood Investigation Report* (Report No. B13343.W-01) demonstrate that site areas discharging directly to Logan River do not require peak flow mitigation. However, for site areas discharging into adjacent properties or road reserves, peak flow management is required. As such, the following peak flow management strategies are proposed for site areas discharging into adjacent properties or road reserves:

- Onsite detention for development areas discharging to Teviot Road;
- Appropriately sized drainage infrastructure for development areas discharging through the downstream context plan area. Downstream owner consent is being sought.
- Appropriately sized swale for the development area discharging into the road and the drainage reserve behind MacKenzie Road.

The above strategies ensure that the development does not result in adverse impacts to downstream or adjacent properties with respect to peak flows.

For stormwater quality and total water cycle management, a strategy comprising bioretention systems, a wetland, and some rainwater tanks is proposed. Rainwater Tanks are proposed only for the medium density residential, commercial and school area discharging to Teviot Road. Runoff collected in these rainwater tanks and the wetland are proposed to be used for toilet flushing and sports field irrigation.

MUSIC modelling demonstrates the effectiveness in achieving the required water quality objectives under the *State Planning Policy* (2014) and the SEQ Water *Development Guidelines*. The re-use from rainwater tanks provide a total water cycle management solution and reduces the frequency of discharge to adjoining areas.

A recreational water play area, such as a pool, is also proposed, however it is not considered to be a Stormwater Quality Improvement Device (SQID). Nonetheless it is proposed to re-use stormwater for topping up the water play area. The top-up stormwater will be adequately treated to a level suitable for primary human contact, prior to entering the water play area.

Water level analyses for the wetland and the water play area demonstrate the viability of stormwater harvesting and water level fluctuations.

Site areas discharging directly to Logan River do not require peak flow mitigation and consequently this also achieves the waterway stability management requirement as the 63% Annual Exceedance Probability (AEP) peak flow will not adversely impact Logan River. This is because the timing of the local peak flows are different to the timing of the regional peak flows.

For site areas discharging into adjacent properties or road reserves, waterway stability management is proposed to be achieved via 63% AEP peak flow mitigation.

Care will be taken during construction activities to ensure existing creek and river embankments are not adversely disturbed. Any disturbed areas will be restabilised. Erosion and sediment control measures will be provided during all construction activities. Measures will consist of, but not limited to, diversion drains, temporary sediment basins, silt fences, and shakedown services.

A Dispersive Soil Management Plan will be provided by a suitably qualified geotechnical consultant during the subsequent ROL application phase. This will define the overall erosion hazard and soil dispersion risk of the site soils and provide over-arching principles to ensure that earthworks do not cause land degradation or soil erosion during the construction phases. If

identified, appropriate dispersive soil and subsoil control measures, such as using non-dispersive topsoil material, compaction of back fill and soil treatment with agricultural gypsum, can be provided.

In summary, the high level analyses and strategies presented in this report demonstrate there are solutions for managing stormwater and local flooding associated with the development. Further analyses of these strategies will be undertaken for the specific development layouts at subsequent Reconfiguration Of Lot (ROL) applications.

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

Following submission of Issue A of this report for master planning approval, Economic Development Queensland (EDQ) have provided an Information Request (*Summary of Flood Investigation and Stormwater Management Review* document dated January 2017). The current issue (B) of this report has been updated to address items outlined in EDQ's Information Request. This has not resulted in any significant changes to the proposed strategies or analysis provided in the original report. Only minor updates to the wording and presentation of management measures have been provided. A summary of Calibre Consulting's responses are provided in *Responses to EDQ Information Request* letter (Ref No. **B13343.W.10L.AMP.cm.docx** dated 20 April 2017) submitted in conjunction with this updated report.

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1 INTRODUCTION

Calibre Consulting (Qld) Pty Ltd has been engaged to prepare this *Concept Stormwater and Flood Management Plan* for the proposed Jimboomba Celestino master plan development within the Greater Flagstone Priority Development Area (PDA). The proposed context plan layout is shown in **Appendix A**. This plan identifies the area that is proposed to be developed by Celestino Pty Ltd. For clarity and consistency, only the land being developed by Celestino Pty Ltd will herein be referred to as the 'site', while the entire context plan area will be referred to as such.

The Preliminary Approval (PA) application for the proposed context plan is being submitted to Economic Development Queensland (EDQ, previously known as the Urban Land Development Authority, ULDA). This report addresses total water cycle management, stormwater quality, stormwater quantity, and flood management for the site.

1.1 UPDATES FOR ISSUE B

Since submission of Issue A of this report for master planning approval, Economic Development Queensland (EDQ) have provided an Information Request (*Summary of Flood Investigation and Stormwater Management Review* document dated January 2017). This issue (B) of the report has been updated to address items outlined in EDQ's Information Request. The following letter has been provided in conjunction with this report to summarise our responses to EDQ's Information Request.

- Calibre Consulting's *Responses to EDQ Information Request* letter (Ref No. **B13343.W.10L.AMP.cm.docx** dated 20 April 2017) – provides an itemized summary of response to EDQ's Information Request (dated January 2017).

Further to EDQ's Information Request, Seqwater has provided an information request letter (*Seqwater Advice Letter,* Ref No. F16/4958 dated 16 January 2016). Item 2 of this letter required further information for stormwater management. This has been addressed in Calibre Consulting's *Responses to Seqwater Advice Letter* (Ref No. **B13343.W.09L.AMP.cm.docx** dated 16 March 2017). A copy of this document is provided in **Appendix F**.

A summary of the updates made to the body of this report are provided below:

- *Site Characteristics (**Section 2**)* – No change. Details as per Issue A.
- *Local Flooding (**Section 3**)* – In response to Item C-1, wording in this section has been added to highlight that analysis and flood immunity levels provided are preliminary only and will be updated during ROL stages when the layout is determined.
- *Stormwater Quantity (**Section 4**)* – This section has been updated in response to stormwater quantity items (D-1 to D-8).
- *Stormwater Quality (**Section 5**)* – No change. Details as per Issue A. The semi-offline nature of the proposed wetland has been highlighted on plans provided in **Appendix G** to address Item E-2. Assessment of the sensitivity of removal of rainwater tanks to meeting overall stormwater quality objectives to address Item E-1 is provided in Calibre Consulting's *Response to EDQ IR.* A MUSIC layout has been provided in **Appendix D**.
- *Water Level Analyses (**Section 6**)* – Wording in this section has been added in response to Item E-2 and F-1, highlighting that details in relation to the proposed wetland and water play area are indicative only. Further details will be provided during ROL applications.
- *Waterway Stability Management (**Section 7**)* - This section has been updated in response to Item D-2.
- ***Section 8** to **10*** – No Change. Details as per Issue A.

Other than the abovementioned updates, the Executive Summary, this Introduction and the Conclusion (**Section 11**) no other changes have been made to this report.

1.2 OBJECTIVES

The objectives of the analyses presented in this report are presented below. Please note that the regional hydrological and hydraulic analyses is presented in the *Flood Investigation Report* (Report No. B13343.W-01)

- Determine the extents of the west-east drainage corridor required;

- Determine appropriate flood immunity levels for areas adjacent to the west-east drainage corridor;
- 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 a stormwater quality management strategy to ensure that the development achieves all Water Quality Objectives (WQOs) required under the *State Planning Policy* (*SPP*, 2014) and also address SEQ Water *Development Guidelines* (June 2012) objectives;
- Determine strategies to achieve a total water cycle management solution via roofwater and stormwater harvesting;
- Achieve waterway stability management required under the *SPP* (2014);
- Management of the frequency of outflows to adjoining sites; and
- Provide preliminary strategies for managing erosion and sedimentation, bank stability, and dispersive soils during construction and post-construction of the development.

1.3 SCOPE OF WORKS

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

- Local Flooding
  - Undertake analyses to determine the pre-development local flood conditions through west-east drainage path for the 20%, 10%, 5%, and 1% AEP storm events;
  - Develop a defined drainage corridor for the west-east drainage path;
  - Undertake analyses to determine the post-development local flood conditions for the 20%, 10%, 5%, and 1% AEP storm events;
  - Undertake a sensitivity scenario with a higher Manning's n value; and
  - Nominate flood immunity levels in accordance with the relevant EDQ guidelines;
- Stormwater Quantity
  - Determine the lawful points of discharge for the site under pre- and post-development conditions;
  - Undertake analysis to determine which discharge points require 1% Annual Exceedance Probability (AEP) storm event peak flow mitigation; and
  - Develop a strategy to achieve the required peak flow mitigation.
- Stormwater Quality & Total Water Cycle Management:
  - Develop a stormwater quality and total water cycle management strategies incorporating Stormwater Quality Improvement Devices (SQIDs); and
  - Model the SQIDs using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to determine their effectiveness in achieving the identified Water Quality Objectives (WQOs).
- A water level analyses for the wetland and the water play area to demonstrate the viability of stormwater harvesting (for the wetland) and water level fluctuations for both water bodies.
- Waterway Stability Management
  - Determine which discharge points require 63% AEP peak flow mitigation; and
  - Develop strategies to achieve the peak flow mitigation to achieve the waterway stability management requirement.
- Undertake analyses to demonstrate that the frequency of outflows to adjoining areas will not be adverse in the post-development conditions.
- Provide preliminary commentary regarding erosion & sediment control, bank stability and the dispersive soils management.

All analyses have been undertaken generally in accordance with the following documents:

- *UDA Development Approval for MCU DEV2012/244* dated 12 September 2012 for 72 Riverbend Blvd, Cedar Grove;
- *UDA Development Approval for MCU DEV2012/312* dated 21 November 2012 for 368 Bushman Dr, Jimboomba;
- *Greater Flagstone Urban Development Area Development Scheme* dated October 2011;
- *EDQ Guideline 12 Park Planning* (May 2015);
- *EDQ Guideline 13 Engineering Standards* (May 2015);
- *EDQ Guideline 14 Environmental Values & Sustainable Resource Use* (May 2015);
- *EDQ Guideline 15 Protection from Flood and Storm* (May 2015); and
- SEQ Water *Development Guidelines* (June 2012).

The stormwater and local flooding management strategies for areas outside of the site, but still within the context plan area are discussed in **Section 10**.

2 SITE CHARACTERISTICS

2.1 LOCATION

The site is located in Logan City Council (LCC) local government area and comprise multiple existing land parcels, namely:

- Lot 101, 102, 105, and 106 on SP254145; and
- Lot 800 on SP247625.

Figure 2-1 provides an aerial image of the site area which comprise approximately 514ha.

The site is bound by Teviot Road to the north-west, Logan River to the east, and private properties in other directions.

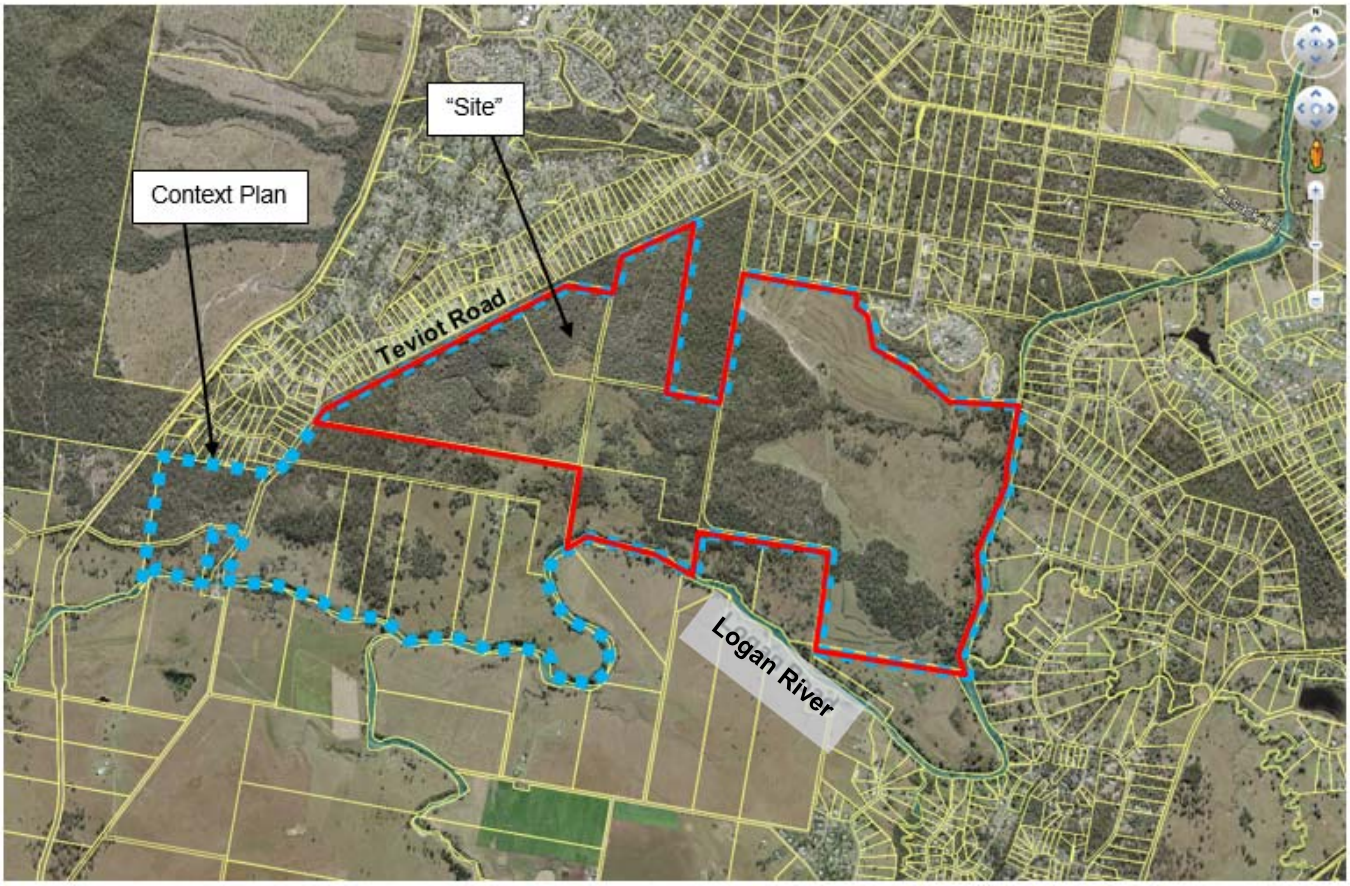

Figure 2-1: Site Location (Source: Google Earth)

2.2 LAND USE

The existing site is undeveloped with large areas already cleared. The cleared areas are currently being used as grazing land.

The proposed development will change the land use to predominately urban residential, with open space areas, parks, sports fields, district centres and a school.

2.3 EXISTING TOPOGRAPHY, DRAINAGE & FLOODING

The existing topography of the site varies from RL 70m AHD in south-western corner, down to levels in the order of 25m AHD along the eastern side adjacent to Logan River. The eastern portion of the site is affected by flooding from Logan River. Refer to **Section 3.3** for the river flood levels.

The site, under existing conditions, predominately falls from west to east, however there are multiple other discharge points for the site. There are a number of local gullies within the site that connects to the main west-east drainage path. **Figure 2.2** below presents an image on the main west-east drainage path on site.

Figure 2-2: Existing Gully on Site

There are no municipal drainage infrastructure on site nor private underground stormwater pipes. The runoff under existing conditions will follow the topography and discharge into either the river, Teviot Road or adjacent properties.

3 LOCAL FLOODING

This local flooding investigation is undertaken to determine Existing and Developed Scenario peak flows and flood levels along the main west to east drainage path through the site. Flood conditions determined in this local analysis have been used for sizing preliminary corridor widths and for outlining development constraints. Note that the flood immunity levels for the development provided in **Section 3.3** are indicative only and are subject to further refinement to be undertaken during Reconfiguration of Lot (ROL) application phases.

This section of the report does not address site's stormwater quantity (i.e. peak flow management). Refer to **Section 4** for peak flow management for development site area not discharging directly to Logan River.

The regional hydrological and hydraulic analyses presented in the *Flood Investigation Report* (Report No. **B13343.W-01**) demonstrates that the development areas discharging directly to Logan River do not create adverse impacts with respect to peak flow or flood level increases.

The XP-RAFTS modelling for this local analysis is independent of the LCC's regional model used for the regional analyses in the *Flood Investigation Report* (Report No. **B13343.W-01**) because:

a) The regional model has been set up for the larger scale regional catchments. Using the same parameters for the site, which is small compared to the regional model sub-catchments, is not appropriate.

b) Only the 10% to 1% AEP hydrological models were provided by LCC. No regional models were provided for smaller storm events.

c) LCC supplied XP-RAFTS models (10% to 1% AEPs) were set up using catchment dependent local storms for durations of 1 hour and above. This is because the scale of the regional catchment would not warrant the analyses of shorter duration storms. This is not the case for the local analyses. Shorter duration storms produce the critical peak flows in the local analyses.

d) The regional models utilised 15 minute routing increments, which is not suitable for a local model with shorter duration storms.

Since the previous issue (A) of this report, the only change to this section (**Section 3**) is the following:

- **Section 3.3** Flood Immunity – **Section 3.3** has been updated to highlight that the analysis undertaken is preliminary. Flood immunity levels are therefore indicative only and will be refined during the following Reconfiguration of Lot (ROL) application phases. This addresses the Local Flooding Item C-1 of EDQ's *Information Request*.

3.1 HYDROLOGY

3.1.1 RATIONAL METHOD CALCULATION

The Rational Method calculation has been undertaken to determine the peak flow rates along the main west to east drainage path through the site for verification of the XP-RAFTS model. Refer to Drawing No. **B13343.W-SK03** in **Appendix G** for the Existing Scenario catchment delineation.

The Rational Method calculation was undertaken to calibrate the XP-RAFTS runoff routing model for the site hydrological analyses. **Table 3-1** presents the Rational Method catchment parameters adopted.

Table 3-1: Rational Method Calculation

Catchment Name	Catchment Area (ha)	C_{10}	Tc (minutes)
U	369.69	0.59	81

The time of concentration (Tc) was calculated using the Friend's overland sheet flow equation and the channelised flow travel time generally in accordance with the *QUDM* (2013). The runoff coefficient (C_{10}) was calculated using *Table 4.5.3* and *4.5.4* of the *QUDM* (2013). The $^{1}I_{10}$ for the regional is 61.9mm/hr. The Intensity-Frequency-Duration (IFD) data was sourced from the Bureau of Meteorology (BOM) for the Riverbend site.

The calculated peak flows are presented in **Table 3-2**. Refer to **Appendix B** for further details of the Rational Method.

Table 3-2: Rational Method Peak Flows

AEP	Peak Flow (m^3/s)
63%	14.25
39%	19.45
20%	27.56
10%	32.67
5%	39.52
2%	50.87
1%	59.23

3.1.2 EXISTING SCENARIO MODELLING

The XP-RAFTS runoff routing has been undertaken for the site hydrological analyses. The Rational Method peak flows have been used for model verification.

3.1.2.1 CATCHMENT DATA

The following catchment data has been adopted for Existing Scenario XP-RAFTS modelling. A zero fraction impervious value was conservatively adopted for all sub-catchments. Refer to Drawing No. **B13343.W-SK03** in **Appendix G** for the catchment delineation.

Table 3-3: Existing Scenario Catchment Data

Catchment Name	Catchment Area (ha)	Fraction Impervious	Vectored Slope	Pervious Manning's n
U1	31.64	0%	3.6	0.06
U2	13.36	0%	3.6	0.06
U3	16.25	0%	3.6	0.06
U4	33.47	0%	3.6	0.06
U5	4.93	0%	3.6	0.06
U6	17.03	0%	3.6	0.06
U7	43.54	0%	3.6	0.06
U8	45.87	0%	3.6	0.06
U9	25.82	0%	3.6	0.06
U10	26.12	0%	3.6	0.06
U11	15.73	0%	3.6	0.06
U12	9.40	0%	3.6	0.06

Catchment Name	Catchment Area (ha)	Fraction Impervious	Vectored Slope	Pervious Manning's n
U13	56.54	0%	3.6	0.06
U14	30.00	0%	3.6	0.06
Total	**369.69**	**0%**	**3.6**	**0.06**

3.1.2.2 INITIAL AND CONTINUING LOSS

Table 3-4: Initial and Continuing Loss

Surface Type	Initial Loss (mm)	Continuing Loss (mm/hr)
Pervious	10	2
Impervious	0	0.5

3.1.2.3 BX FACTOR

The default storage coefficient (Bx) of 1 was adopted.

3.1.2.4 RAINFALL DATA

The rainfall intensities were adopted as per "LL2" of the LCC supplied regional XP-RAFTS model. Refer to **Table 3-5**.

Table 3-5: IFD Data

Duration	39% AEP	2% AEP
1 hour	44.7614	84.2404
12 hour	7.7337	14.7176
72 hour	2.32104	4.96639

The following geographical factors were also adopted:

- Location skew: 0.137321
- F2: 4.39444
- F50: 17.1769

3.1.2.5 EXISTING PEAK FLOWS

The Existing Scenario results from the XP-RAFTS model at the downstream end of west-east drainage corridor are presented below. They have been compared against the peak flow rates calculated using the Rational Method calculation.

Table 3-6: Existing Scenario XP-RAFTS Peak Flow

AEP	XP-RAFTS Peak Flow (m^3/s)	Rational Method Peak Flow (m^3/s)	Variance
63%	14.12	14.25	-1%
39%	20.91	19.45	8%
20%	29.24	27.56	6%

AEP	XP-RAFTS Peak Flow (m^3/s)	Rational Method Peak Flow (m^3/s)	Variance
10%	34.38	32.67	5%
5%	41.49	39.52	5%
2%	50.02	50.87	-2%
1%	57.08	59.23	-4%

The results demonstrate that XP-RAFTS peak flows are generally within 4 to 6% of the Rational Method peak flows. Only the 39% AEP peak flows have an 8% variance. The average variance over all the standard AEPs is 3%. Therefore the abovementioned XP-RAFTS model parameters have been adopted for the Developed Scenario also.

3.1.3 DEVELOPED SCENARIO MODELLING

The following catchment data has been adopted for Developed Scenario XP-RAFTS modelling. An 80% fraction impervious value was adopted for all sub-catchments. This is considered to be a conservative assumption and will likely be less once detailed layouts are developed. Refer to Drawing No. **B13343.W-SK09** in **Appendix G** for the Developed Scenario catchment delineation.

Table 3-7: Developed Scenario Catchment Data

Catchment	Catchment Area (ha)	Fraction Impervious	Vectored Slope (%)	Pervious Manning's n	Impervious Manning's n
U1	31.64	80%	3.6	0.06	0.015
U2	13.36	80%	3.6	0.06	0.015
U3	16.25	80%	3.6	0.06	0.015
U4	33.15	80%	3.6	0.06	0.015
U5	4.96	80%	3.6	0.06	0.015
U6	22.48	80%	3.6	0.06	0.015
U7	56.01	80%	3.6	0.06	0.015
U8	27.61	80%	3.6	0.06	0.015
U9	25.82	80%	3.6	0.06	0.015
U10	26.12	80%	3.6	0.06	0.015
U11	15.73	80%	3.6	0.06	0.015
U12	9.40	80%	3.6	0.06	0.015
U13	56.54	80%	3.6	0.06	0.015
U14	30.00	80%	3.6	0.06	0.015
Total	**369.06**	**80%**	**3.6**	**0.06**	**0.015**

All other XP-RAFTS parameters such as the rainfall data, losses and the Bx factor were as per the Existing Scenario.

3.1.4 DEVELOPED PEAK FLOWS

The Developed Scenario results at the downstream end of west-east drainage corridor are presented below.

Table 3-8: Developed Scenario XP-RAFTS Peak Flows

AEP	XP-RAFTS Peak Flow (m³/s)
63%	27.73
39%	36.56
20%	47.54
10%	54.20
5%	63.15
2%	73.47
1%	82.46

3.2 HYDRAULICS

Hydraulic analyses using HEC-RAS one-dimensional steady state flood modelling were undertaken to determine the flooding conditions along the waterway for the following scenarios. HEC-RAS modelling was undertaken for the following scenarios:

- Existing Scenario 20%, 10%, 5% and 1% AEP;
- Developed Scenario 20%, 10%, 5% and 1% AEP; and
- Sensitivity Scenario with High Manning's n (0.15) and 1% AEP.

3.2.1 EXISTING SCENARIO

3.2.1.1 GEOMETRY DATA

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

A Manning's n value of 0.06 was adopted for the entire length of the modelled drainage path. A Manning's n value of 0.06 represents "*low grass, trees at 6m spacing, few shrubs, vegetation easy to walk through*" (BCC *Natural Channel Design Guidelines* 2003). Drawings Numbered **B13343.W-SK04** and **SK05** presents the HEC-RAS cross section locations.

3.2.1.2 PEAK FLOW INPUT

The Existing Scenario peak flow rates at various points along the drainage corridor was obtained from the XP-RAFTS model. **Table 3-9** presents the Existing Scenario peak flow rates utilised for HEC-RAS analyses. Drawings Numbered **B13343.W-SK04** and **SK05** presents the HEC-RAS cross section locations.

Table 3-9: Existing Scenario Peak Flows

HEC-RAS Cross Section	1% AEP (m³/s)
4093	6.89
3850	10.16
3597	13.76
3238	20.14
3185	20.92
2983	23.79
2283	30.43

HEC-RAS Cross Section	1% AEP (m³/s)
1866	37.31
1554	40.87
1209	44.17
1040	45.82
656	46.67
389	54.39
214	57.08

3.2.1.3 BOUNDARY CONDITIONS

The following boundary conditions were adopted for the HEC-RAS model

- Upstream: Normal depth friction slope of 0.78%; and
- Downstream: Tail Water Level of 26.25m AHD (10% AEP river flood level).

3.2.1.4 EXISTING LOCAL FLOOD RESULTS

The 1% AEP flood conditions along the drainage path for the Existing Scenario are presented in **Table 3-10.** Further HEC-RAS result details are provided in **Appendix C** and the Existing Scenario 1% AEP flood extent is shown on Drawing No. **B13343.W-SK04** and **SK05** in **Appendix G.**

Table 3-10: Existing Scenario 1% AEP Local Flood Conditions

HEC-RAS Cross Section	Flood Level (m AHD)	Maximum Flood Depth (m)	Average Velocity (m/s)	Depth-Velocity Product (m²/s)
4093	48.56	0.56	0.87	0.49
4034	47.62	0.45	0.81	0.36
3983	46.99	0.67	0.96	0.64
3922	46.46	0.49	0.67	0.33
3850	45.22	0.38	1.13	0.43
3790	44.43	0.59	0.51	0.30
3741	43.72	0.51	1.00	0.51
3665	43.24	0.79	0.88	0.70
3597	42.80	0.52	0.79	0.41
3490	41.71	0.62	0.65	0.40
3392	40.76	0.45	0.85	0.38
3305	40.02	0.48	0.69	0.33
3238	39.52	0.79	0.88	0.70
3185	39.20	0.68	1.07	0.73
3155	38.97	1.08	0.73	0.79
3134	38.65	0.91	1.86	1.69
3073	38.03	0.70	0.70	0.49
2983	36.60	0.69	2.16	1.49
2820	35.77	1.61	0.82	1.32
2670	34.75	1.29	1.46	1.88

HEC-RAS Cross Section	Flood Level (m AHD)	Maximum Flood Depth (m)	Average Velocity (m/s)	Depth-Velocity Product (m²/s)
2554	34.19	1.64	0.67	1.10
2463	33.61	1.48	0.75	1.11
2376	33.26	2.06	1.13	2.33
2283	32.91	1.78	1.25	2.23
2171	31.80	1.07	1.10	1.18
2142	31.38	1.19	0.66	0.79
2013	30.10	1.26	1.10	1.39
1866	29.79	1.71	0.99	1.69
1748	29.49	1.99	1.28	2.55
1687	29.16	2.00	1.02	2.04
1662	28.95	1.87	0.88	1.65
1638	28.84	2.41	0.73	1.76
1618	28.77	2.33	1.35	3.15
1554	28.48	1.94	1.06	2.06
1497	28.05	1.78	0.90	1.60
1460	27.79	1.70	0.77	1.31
1370	27.36	1.78	0.79	1.41
1209	26.70	2.03	0.47	0.95
1129	26.43	2.11	0.21	0.44
1040	26.31	2.62	0.16	0.42
864	26.28	3.13	0.11	0.34
656	26.26	4.06	0.14	0.57
526	26.26	4.77	0.12	0.57
389	26.26	5.78	0.23	1.33
290	26.26	6.20	0.25	1.55
214	26.25	6.73	0.87	5.86
121	26.25	7.54	0.81	6.11

3.2.2 DEVELOPED SCENARIO

3.2.2.1 GEOMETRY DATA

The upstream cross section 4093 to 3922 has been deleted from the Developed Scenario model. This is because the flows from catchment U1 and U2 will be conveyed into the drainage corridor via multiple urban drainage (underground and pipe networks). Refer to Drawing No. **B13343.W-SK10**.

All cross sections downstream of 3922 have not changed from the Existing Scenario, except “obstructions” were utilised to present proposed filling for the development.

There are three road crossings through the drainage path, however these have not been incorporated in the HEC-RAS model at this master planning stage. It is recommended that these crossings are conceptually sized during the subsequent DA phases to convey 1% AEP Developed Scenario peak flows. Appropriate design blockage factors should be incorporated in accordance with the *QUDM* (2013) and other relevant guidelines.

3.2.2.2 PEAK FLOW INPUT

The Developed Scenario peak flow rates at various points along the drainage corridor was obtained from the XP-RAFTS model. **Table 3-11** presents the Developed Scenario peak flow rates utilised for HEC-RAS analyses. Drawings Numbered **B13343.W-SK10** and **SK11** present the HEC-RAS cross section locations.

It is noted that 63% AEP peak flow mitigation is proposed upstream of HEC-RAS cross section 1866. This has not been modelled in XP-RAFTS and thus not incorporated when determining the peak flow rates presented below. This is considered acceptable for this master planning investigations, since 63% AEP peak flow mitigation is expected to have no significant impact to larger AEP peak flows. Refer to **Section 7.4** for discussion regarding 63% AEP peak flow mitigation.

Table 3-11: Developed Scenario Peak Flows

HEC-RAS Cross Section	20% AEP (m^3/s)	10% AEP (m^3/s)	5% AEP (m^3/s)	1% AEP (m^3/s)
3850	16.33	18.51	21.46	26.58
3597	17.68	19.96	23.17	29.53
3238	21.76	24.68	28.69	37.04
3185	22.38	25.49	29.68	38.36
2983	24.71	28.16	32.82	42.79
2283	29.80	33.97	39.49	50.66
1866	33.72	38.30	44.49	55.81
1554	37.33	42.36	49.30	63.34
1209	40.30	45.80	53.33	68.98
1040	41.90	47.64	55.49	72.00
656	42.78	48.63	56.63	73.57
389	46.73	53.20	62.01	81.46
214	47.54	54.20	63.15	82.46

3.2.2.3 BOUNDARY CONDITIONS

Boundary condition for the Existing Scenario has been adopted for the Developed Scenario.

3.2.2.4 DEVELOPED LOCAL FLOOD RESULTS

The 1% AEP flood conditions along the drainage path for the Developed Scenario are presented in **Table 3-12.** Further HEC-RAS result details, including flood levels for the 20%, 10% and 5% AEPs are provided in **Appendix C.**

Table 3-12: Developed Scenario 1% AEP Local Flood Conditions

HEC-RAS Cross Section	Flood Level (m AHD)	Maximum Flood Depth (m)	Average Velocity (m/s)	Depth-Velocity Product (m^2/s)
3850	45.87	0.89	1.38	1.23
3790	44.86	1.16	0.97	1.13
3741	44.10	0.77	1.46	1.12
3665	43.61	0.94	1.21	1.14
3597	43.05	0.81	1.36	1.10
3490	42.03	1.09	0.90	0.98

HEC-RAS Cross Section	Flood Level (m AHD)	Maximum Flood Depth (m)	Average Velocity (m/s)	Depth-Velocity Product (m^2/s)
3392	41.12	1.51	0.92	1.39
3305	40.67	1.85	0.80	1.48
3238	40.48	2.09	1.18	2.47
3185	40.37	2.14	1.27	2.72
3155	40.25	1.39	2.70	3.75
3134	40.14	1.21	1.29	1.56
3073	39.08	2.16	0.92	1.99
2983	37.12	1.86	1.57	2.92
2820	36.32	2.05	0.97	1.99
2670	35.33	1.86	1.32	2.46
2554	34.59	2.32	0.85	1.97
2463	33.99	1.94	1.02	1.98
2376	33.52	1.28	1.43	1.83
2283	33.07	1.36	1.54	2.09
2171	32.01	1.58	1.17	1.85
2142	31.56	2.02	0.79	1.60
2013	30.42	2.27	1.18	2.68
1866	30.10	2.30	1.01	2.32
1748	29.77	2.21	1.16	2.56
1687	29.46	2.72	1.07	2.91
1662	29.29	2.59	1.00	2.59
1638	29.15	2.15	0.84	1.81
1618	29.03	2.09	1.15	2.40
1554	28.69	2.04	0.93	1.90
1497	28.36	2.08	0.94	1.96
1460	28.13	2.33	0.92	2.14
1370	27.66	2.28	1.23	2.80
1209	27.00	2.69	0.74	1.99
1129	26.60	3.17	0.37	1.17
1040	26.38	4.08	0.33	1.35
864	26.32	4.79	0.21	1.01
656	26.28	5.79	0.26	1.51
526	26.28	6.21	0.25	1.55
389	26.27	6.74	0.36	2.43
290	26.27	7.54	0.36	2.71
214	26.26	1.05	1.27	1.33
121	26.25	0.81	1.20	0.97

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

- Local flooding is contained within the site; and
- Appropriate flood immunity will be provided for the development.

The culvert crossings are to be sized during subsequent DA application phases. It is recommended that the culverts are modelled in a hydraulic software package to confirm the sizing during subsequent ROL application phases.

3.2.3 SENSITIVITY SCENARIO

A Sensitivity Scenario with a higher Manning's n value of 0.15 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 3-12.**

Table 3-13: Sensitivity Scenario 1% AEP Local Flood Levels

HEC-RAS Cross Section	Flood Level (m AHD)
3850	46.33
3790	45.31
3741	44.70
3665	44.17
3597	43.62
3490	42.59
3392	41.83
3305	41.45
3238	41.23
3185	41.08
3155	40.95
3134	40.81
3073	39.20
2983	37.80
2820	36.95
2670	35.99
2554	35.17
2463	34.56
2376	34.05
2283	33.53
2171	32.52
2142	32.19
2013	31.33
1866	30.87
1748	30.39
1687	30.00
1662	29.82
1638	29.64
1618	29.50
1554	29.15
1497	28.86
1460	28.65
1370	28.24
1209	27.60

HEC-RAS Cross Section	Flood Level (m AHD)
1129	27.22
1040	26.84
864	26.59
656	26.43
526	26.39
389	26.36
290	26.33
214	26.30
121	26.25

The above flood levels will be utilised for to confirm the appointment of freeboard (500mm) above the 1% AEP Developed Scenario local flood levels for habitable floor levels adjacent to the west-east drainage path.

As mentioned previously, there are three road crossings through the drainage path, which have not been incorporated in the HEC-RAS model at this master planning stage. It is recommended that culvert blockage scenarios are also investigated during the subsequent DA phases. Appropriate sensitivity blockage factors should be incorporated in accordance with the *QUDM* (2013) and other relevant guidelines.

3.3 FLOOD IMMUNITY

3.3.1 FLOOD IMMUNITY STANDARDS

Tables 3-14 to **3-16** provide details of flood immunity levels for the development. These are preliminary only and subject to refinement to occur during subsequent ROL application phases. 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 3-14: Flood Immunity Standards

Floor Type	Flood Immunity Standard
Habitable Floor	Greater of: • 1% AEP + 500mm or • Sensitivity Scenario
District Sports Park Buildings	1% AEP
District Sports Park Sports Fields	5% AEP
Recreation Park Buildings	1% AEP
Recreation Park [1]	20% AEP

[1] 30% of the recreation park area can be below 20% AEP flood level

While LCC's *Flood Hazard Overlay Code* (2015) only specifies freeboard requirements to habitable floor levels, allotment ground levels will be provided above the greater of 1% AEP + 300mm or sensitivity scenario flood levels.

Both the regional and local flood levels have been considered for nominating the flood immunity standards. **Table 3-15** presents the Logan River flood levels at the downstream end of the west-east waterway corridor.

Table 3-15: Logan River Flood Levels

AEP	Logan River Flood Level (m AHD)
20%	Not known
10%	26.25
5%	28.25
1%	30.85

Note that the Logan River flood levels vary around the perimeter of the site. Refer to the *Flood Investigation Report* (Report No. **B13343.W-01**) for flood levels around the perimeter of the site.

3.3.2 FLOOD IMMUNITY LEVELS

The minimum flood immunity level along the west-east drainage corridor are presented in **Table 3-16.** These are based on the minimum flood immunity standards presented in **Table 3-14.** Flood immunity levels are preliminary only and subject to further refinement to occur during subsequent ROL application phases.

Table 3-16: Minimum Flood Immunity Levels

HEC-RAS Cross Section	Minimum Habitable Floor Levels (m AHD)	Minimum Building Levels associated with Park (m AHD)	Minimum District Sports Park RL (m AHD)	Minimum Recreation Park RL (m AHD)
3850	46.37	45.87	45.78	45.67
3790	45.36	44.86	44.80	44.74
3741	44.70	44.1	44.01	43.90
3665	44.17	43.61	43.50	43.39
3597	43.62	43.05	42.95	42.85
3490	42.59	42.03	41.93	41.82
3392	41.83	41.12	41.01	40.93
3305	41.45	40.67	40.50	40.34
3238	41.23	40.48	40.28	40.08
3185	41.08	40.37	40.17	39.97
3155	40.95	40.25	40.06	39.87
3134	40.81	40.14	39.95	39.76
3073	39.58	39.08	38.93	38.79
2983	37.80	37.12	36.98	36.85
2820	36.95	36.32	36.20	36.04
2670	35.99	35.33	35.12	34.78
2554	35.17	34.59	34.41	34.21
2463	34.56	33.99	33.86	33.64
2376	34.05	33.52	33.40	33.24
2283	33.57	33.07	32.97	32.87
2171	32.52	32.01	31.89	31.77
2142	32.19	31.56	31.47	31.40
2013	**31.35**	**30.85**	30.24	30.04
1866	**31.35**	**30.85**	29.93	29.72
1748	**31.35**	**30.85**	29.62	29.43

HEC-RAS Cross Section	Minimum Habitable Floor Levels (m AHD)	Minimum Building Levels associated with Park (m AHD)	Minimum District Sports Park RL (m AHD)	Minimum Recreation Park RL (m AHD)
1687	**31.35**	**30.85**	29.32	29.11
1662	**31.35**	**30.85**	29.13	28.89
1638	**31.35**	**30.85**	29.00	28.78
1618	**31.35**	**30.85**	28.89	28.72
1554	**31.35**	**30.85**	28.59	28.44
1497	**31.35**	**30.85**	**28.25**	27.99
1460	**31.35**	**30.85**	**28.25**	27.73
1370	**31.35**	**30.85**	**28.25**	27.25
1209	**31.35**	**30.85**	**28.25**	26.68
1129	**31.35**	**30.85**	**28.25**	26.40
1040	**31.35**	**30.85**	**28.25**	26.30
864	**31.35**	**30.85**	**28.25**	26.27
656	**31.35**	**30.85**	**28.25**	26.26
526	**31.35**	**30.85**	**28.25**	26.26
389	**31.35**	**30.85**	**28.25**	26.26
290	**31.35**	**30.85**	**28.25**	**26.25**
214	**31.35**	**30.85**	**28.25**	**26.25**
121	**31.35**	**30.85**	**28.25**	**26.25**

Future development within and adjacent to the west-east drainage corridor is required to achieve adequate flood immunity. The above provides preliminary flood immunity levels associated with the development. Bold text denotes levels governed by regional flooding.

Please note that the Logan River flood levels vary around the perimeter of the site. Refer to the *Flood Investigation Report* (Report No. **B13343.W-01**) for flood immunity levels around the perimeter of the site.

4 STORMWATER QUANTITY

The XP-RAFTS hydrological modelling has also been undertaken for the stormwater quantity analyses, also referred to as peak flow management of the site. The subsequent sections investigate the peak flow discharges around the external perimeter of the site and provide strategies for managing adverse impacts, namely:

- A peak flow management strategy for Catchments J, K and L discharging to Logan River via adjacent land in the context plan;
- A peak flow management strategy for Catchments M, N and O discharging to Teviot Road; and
- A peak flow management strategy for Catchment P discharging to a local road reserve prior to entering the drainage reserve behind Mackenzie Road.

Refer to Drawing No. **B13343.W-SK09** for the development scenario catchment plan. The regional hydrological and hydraulic analyses presented in the *Flood Investigation Report* (Report No. **B13343.W-01**) demonstrate that the development areas discharging directly to Logan River do not create adverse impacts with respect to peak flow increases or the maximum flood level increases. Therefore, no 1% AEP peak flow mitigation measures are proposed for site catchments discharging directly into Logan River (i.e. Catchments A, B, C, D, G, H, I, S, T and V in Drawing No. **B13343.W-SK09**). For waterway stability management of local gullies prior to Logan River, management of scour such as energy dissipaters and rock protection will be provided at discharge points. Further details are provided in **Section 7**.

Since the previous issue (A) of this report the following updates have been made to this section to address Item D-4 and D-7 of EDQ's *Information Request* (January 2017):

- *Peak Flow Mitigation (**Section 4.3**)* – This section has been updated to address Item D-4 and D-7. Detention basin sizes for Catchment J, K and L have been incorporated. It is to be noted that if/when discharge approval from the downstream property is granted, requirement for detention mitigation will be removed as specified in the Information Request Item.

4.1 EXISTING SCENARIO

4.1.1 CATCHMENT DATA

The following site catchments have been modelled in the local XP-RAFTS model. A zero fraction impervious value was conservatively adopted for all sub-catchments. Refer to Drawing No. **B13343.W-SK03** in **Appendix G** for the catchments.

Table 4-1: Existing Scenario Catchment Data

Catchment	Catchment Area (ha)	Fraction Impervious	Vectored Slope	Pervious Surface Manning's n
A	16.33	0%	4.72	0.06
B	19.22	0%	4.72	0.06
C	13.53	0%	4.72	0.06
D	13.77	0%	4.72	0.06
V	8.76	0%	4.72	0.06
G	4.33	0%	4.72	0.06
H	13.70	0%	4.72	0.06
I	4.52	0%	4.72	0.06
J	1.44	0%	3.54	0.06

Catchment	Catchment Area (ha)	Fraction Impervious	Vectored Slope	Pervious Surface Manning's n
K	3.77	0%	3.54	0.06
L	5.56	0%	3.54	0.06
M	19.04	0%	4.51	0.06
N	14.92	0%	4.51	0.06
O	9.96	0%	4.51	0.06
P	17.67	0%	3.60	0.06
S	18.82	0%	3.60	0.06
T	8.38	0%	3.60	0.06

4.1.2 XP-RAFTS MODEL PARAMETERS

All XP-RAFTS model parameters for the Existing Scenario, such as loss values, Bx factor, rainfall etc are as per those presented in **Section 3.1.2)**

4.1.3 EXISTING PEAK FLOWS

The Existing Scenario peak flow rates discharging to the perimeter of the site are presented in **Table 4-2.**

Table 4-2: Existing Scenario Peak Flows

Catchment	Existing Scenario						
	63% AEP Peak Flow (m^3/s)	39% AEP Peak Flow (m^3/s)	20% AEP Peak Flow (m^3/s)	10% AEP Peak Flow (m^3/s)	5% AEP Peak Flow (m^3/s)	2% AEP Peak Flow (m^3/s)	1% AEP Peak Flow (m^3/s)
A	0.93	1.45	2.14	2.57	3.16	3.89	4.57
B	1.07	1.64	2.42	2.89	3.57	4.44	5.22
C	0.80	1.25	1.86	2.24	2.73	3.34	3.90
D	0.81	1.26	1.88	2.27	2.77	3.39	3.95
V	0.32	0.50	0.74	0.89	1.09	1.33	1.54
G	0.81	1.26	1.88	2.26	2.76	3.38	3.94
H	0.33	0.52	0.76	0.91	1.14	1.38	1.60
I	0.12	0.18	0.26	0.31	0.38	0.47	0.54
J	**0.25**	**0.38**	**0.58**	**0.70**	**0.87**	**1.07**	**1.24**
K	**0.34**	**0.54**	**0.80**	**0.96**	**1.17**	**1.46**	**1.69**
L	**1.04**	**1.59**	**2.35**	**2.81**	**3.48**	**4.33**	**5.09**
M	**0.85**	**1.32**	**1.97**	**2.36**	**2.89**	**3.55**	**4.15**
N	**0.61**	**0.97**	**1.42**	**1.71**	**2.12**	**2.57**	**2.98**
O	**0.89**	**1.35**	**2.01**	**2.41**	**2.96**	**3.69**	**4.33**
P	**0.94**	**1.43**	**2.10**	**2.52**	**3.09**	**3.87**	**4.57**
S	0.48	0.75	1.12	1.34	1.66	2.05	2.40
T	0.57	0.89	1.29	1.57	1.95	2.36	2.74

The catchments highlighted in **bold** are those that discharge into adjacent private properties or road reserves. The other site catchments discharge directly into the Logan River or adjacent drainage reserves. No peak flow mitigation measures are proposed for those catchments.

4.2 DEVELOPED SCENARIO

4.2.1 CATCHMENT DATA

The following site catchments have been modelled in the local XP-RAFTS model for the Developed Scenario. An 80% fraction impervious value was conservatively adopted for all sub-catchments. Refer to Drawing No. **B13343.W-SK09** in **Appendix E** for the catchment delineation.

Table 4-3: Developed Scenario Catchment Data

Catchment	Catchment Area (ha)	Fraction Impervious	Vectored Slope	Pervious Surface Manning's n	Pervious Surface Manning's n
A	16.33	80%	4.72	0.06	0.015
B	19.22	80%	4.72	0.06	0.015
C	13.53	80%	4.72	0.06	0.015
D	13.77	80%	4.72	0.06	0.015
V	8.76	80%	4.72	0.06	0.015
G	4.33	80%	4.72	0.06	0.015
H	13.70	80%	4.72	0.06	0.015
I	4.52	80%	4.72	0.06	0.015
J	1.44	80%	3.54	0.06	0.015
K	3.77	80%	3.54	0.06	0.015
L	5.56	80%	3.54	0.06	0.015
M	17.20	80%	4.51	0.06	0.015
N	17.38	80%	4.51	0.06	0.015
O	10.60	80%	4.51	0.06	0.015
P	17.67	80%	3.60	0.06	0.015
S	18.82	80%	3.60	0.06	0.015
T	8.38	80%	3.60	0.06	0.015

4.2.2 XP-RAFTS MODEL PARAMETERS

All XP-RAFTS model parameters for the Developed Scenario such as loss values, Bx factor, rainfall etc are as per those presented in **Section 3.1.3)**

4.2.3 DEVELOPED PEAK FLOWS

The Developed Scenario peak flow rates discharging to the perimeter of the site are presented in **Table 4-4.**

Table 4-4: Developed Scenario Peak Flows

Catchment Name	Developed Scenario						
	63% AEP Peak Flow (m^3/s)	39% AEP Peak Flow (m^3/s)	20% AEP Peak Flow (m^3/s)	10% AEP Peak Flow (m^3/s)	5% AEP Peak Flow (m^3/s)	2% AEP Peak Flow (m^3/s)	1% AEP Peak Flow (m^3/s)
A	4.00	5.20	6.67	7.53	8.76	9.31	10.43
B	4.71	6.11	7.80	8.85	10.31	10.91	12.23
C	3.32	4.33	5.54	6.27	7.26	7.72	8.68
D	3.38	4.41	5.64	6.38	7.38	7.86	8.84
V	2.15	2.83	3.62	4.10	4.75	5.08	5.69
G	1.08	1.40	1.81	2.05	2.39	2.54	2.85
H	3.36	4.38	5.61	6.35	7.35	7.82	8.79
I	1.13	1.46	1.89	2.15	2.50	2.65	2.97
J	**0.37**	**0.48**	**0.61**	**0.68**	**0.79**	**0.86**	**0.97**
K	**0.93**	**1.21**	**1.56**	**1.78**	**2.06**	**2.20**	**2.46**
L	**1.37**	**1.77**	**2.30**	**2.61**	**3.01**	**3.19**	**3.58**
M	**4.22**	**5.47**	**7.00**	**7.92**	**9.21**	**9.78**	**10.94**
N	**4.26**	**5.53**	**7.07**	**8.00**	**9.30**	**9.88**	**11.04**
O	**2.61**	**3.39**	**4.35**	**4.93**	**5.72**	**6.09**	**6.86**
P	**4.34**	**5.59**	**7.15**	**8.05**	**9.33**	**9.96**	**11.13**
S	4.61	5.96	7.60	8.56	9.93	10.59	11.83
T	2.05	2.67	3.43	3.87	4.49	4.77	5.35

The catchments highlighted in **bold** are those that discharge into adjacent private properties or road reserves. The other site catchments discharge directly into the Logan River or existing drainage reserves.

The regional hydrological and hydraulic analyses presented in the *Flood Investigation Report* (Report No. B13343.W-01) demonstrate that the development areas discharging directly to Logan River do not create adverse impacts with respect to peak flow increases or the maximum flood level increases. Therefore, no peak flow mitigation measures are proposed for site catchments discharging directly into Logan River (i.e. Catchments A, B, C, D, G, H, I, S,T and V in Drawing No. **B13343.W-SK09**).

The next section presents conceptual mitigation strategies for managing peak flows for catchments discharging into private properties and road reserves.

4.3 PEAK FLOW MITIGATION

The following peak flow management strategies are proposed for catchments discharging into private properties and road reserves.

- **Catchments M, N & O:** These catchments discharge to Teviot Road and drain through adjoining private properties. It is proposed to provide detention basins for managing peak flows.
- **Catchments J, K & L:** These catchments discharge to adjacent private property to the south (within the overall context plan) and then into Logan River. The regional hydrological and hydraulic modelling presented in the *Flood Investigation Report* (Report No. B13343.W-01) have considered the post-development conditions of these catchments. The results of the regional analyses demonstrate that the development of catchments J, K and L will not cause adverse impacts at Logan River. Therefore, it is proposed to seek downstream owner consent to safely convey the post-development peak flows from catchments J, K and L into Logan River. Future development of the downstream property is to provide adequate drainage infrastructure to convey these upstream flows. In the absence of current written consent from the property owner, detention basins have been sized to mitigate peak flows at the boundary of the site (refer to **Section 4.3.2**). If or when discharge approval is granted the requirement for detention can be removed.
- **Catchment P:** This catchment discharges into a local road reserve and then into private properties. Therefore it is proposed to provide a drainage swale along the road reserve to safely convey the Developed Scenario peak flows from Catchment P into the tributary flooded by Logan River without causing adverse impacts to external residential properties. The regional hydrological and hydraulic modelling presented in the *Flood Investigation Report* (Report No. B13343.W-01) have considered the post-development conditions of this catchment and the results demonstrate that it will not cause adverse impacts at Logan River.

4.3.1 DETENTION BASINS

Peak flows to Teviot Road increase as a result of the site development. Refer to **Table 4-5.**

Table 4-5: Catchments M, N & O Peak Flows

Catchment	1% AEP Existing Peak Flow (m^3/s)	1% AEP Developed Peak Flow (m^3/s)	Variance (m^3/s)
M & N	9.23	21.98	+12.75
O	2.98	6.86	+3.88

For peak flow management, two detention basins are proposed, one for catchments M & N, and another for catchment O. Refer to Drawing No. **B13343.W-SK09** in **Appendix G** for the concept locations for these two detention basins.

Boyd's calculation has been undertaken for preliminary estimation of detention volumes. The runoff volumes were calculated from the hydrographs exported from XP-RAFTS models. **Table 4-6** presents the preliminary detention basin volumes. The preliminary detention basin areas were estimated assuming an average basin depth of 1.5m.

Table 4-6: Preliminary Detention Basin Volumes

Catchment	Preliminary Detention Basin Volume (m^3)	Preliminary Detention Basin Area (m^2)
M & N	21,400	14,250
O	6,050	4,050

The above detention basins can be combined with the bioretention filter areas required for stormwater quality treatment (refer to **Section 5**). Basin O can be incorporated within the future recreational area in the school facility.

The detention basins and outlets are to be conceptually designed and modelled during the subsequent ROL phase. The outlets are to be designed so that the site peak flows discharging from the basins will not be greater than under existing conditions. This will ensure the development does not cause adverse impacts to road drainage or downstream properties.

The frequency of flow low flows discharging to Teviot Road will be limited by the use of rainwater tanks. Refer to **Section 8** for preliminary analyses of flow frequency.

4.3.2 PROVISIONAL BASIN SIZING PRIOR TO DOWNSTREAM OWNER CONSENT

Catchments J, K and L discharge to Logan River via a downstream private property. This downstream private property is external to the site, however it forms part of the overall context plan. Refer to Drawing No. **B13343.W-SK09** in **Appendix G.** Therefore, it is proposed to provide an overall strategy for peak flow management rather than site based at Catchments J, K & L.

The local XP-RAFTS model calculates the following peak flows for Catchments J, K and L.

Table 4-7: Catchments J, K & L Peak Flows

	63% AEP	39% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
Catchment J							
Existing Peak Flow (m^3/s)	0.12	0.18	0.26	0.31	0.38	0.47	0.54
Developed Peak Flow (m^3/s)	0.37	0.48	0.61	0.68	0.79	0.86	0.97
Variance (m^3/s)	*0.25*	*0.30*	*0.35*	*0.37*	*0.41*	*0.39*	*0.43*
Catchment K							
Existing Peak Flow (m^3/s)	0.25	0.38	0.58	0.70	0.87	1.07	1.24
Developed Peak Flow (m^3/s)	0.93	1.21	1.56	1.78	2.06	2.20	2.46
Variance (m^3/s)	*0.68*	*0.83*	*0.98*	*1.08*	*1.19*	*1.13*	*1.22*
Catchment L							
Existing Peak Flow (m^3/s)	0.34	0.54	0.80	0.96	1.17	1.46	1.69
Developed Peak Flow (m^3/s)	1.37	1.77	2.30	2.61	3.01	3.19	3.58
Variance (m^3/s)	*1.03*	*1.23*	*1.50*	*1.65*	*1.84*	*1.73*	*1.89*

Although there are peak flow increases within these site catchments, the regional hydrological and hydraulic modelling results, presented in the *Flood Investigation Report* (Report No. B13343.W-01), determines that the development of catchments J, K and L will not cause adverse impacts at Logan River. Moreover the results still indicate no adverse impacts at Logan River as a result of the context plan development.

It is proposed to seek downstream owner consent to safely convey the post-development peak flows from catchments J, K and L into Logan River. Interim drainage swales, adequately sized for conveying Developed Scenario site peak flows, can be provided. Future development of the downstream property is to provide adequately sized drainage infrastructure (pipe and road networks) to convey the upstream flows.

In the absence of current written consent from the property owner, detention basins have been sized to mitigate peak flows at the boundary of the site (refer to **Section 4.3.2**). If or when discharge approval is granted the requirement for detention can be removed. This addresses Item D-4 of EDQ's IR (January 2017).

Preliminary detention basin volumes in **Table 4-7** have been sized based on Boyd's calculations.

Table 4-8: Preliminary Detention Basin Volumes for Catchment J, K and L

Catchment	Preliminary Detention Basin Volume (m³)
J	725
K	2,050
L	3,200

4.3.3 DOWNSTREAM DRAINAGE SWALE

The below investigation demonstrates possible options for managing peak flows from Catchment P that discharge to the road reserve. Further details will be provided during ROL application phase.

Catchment P discharges into a road reserve. The road reserves follows the natural topography and enters the drainage reserve behind MacKenzie Road. It is proposed to provide a drainage swale to convey additional flows in the Developed Scenario from Catchment P into the drainage reserve/floodplain. Refer to Drawing No. **B13343.W-SK09** in **Appendix G** for the concept.

The drainage swale has been conceptually sized using the Manning's Equation. **Table 4-9** presents the peak flows for Catchment P and the variances.

Table 4-9: Developed Scenario Catchment P Peak Flow

Catchment P	63% AEP Peak Flow (m³/s)	39% AEP Peak Flow (m³/s)	20% AEP Peak Flow (m³/s)	10% AEP Peak Flow (m³/s)	5% AEP Peak Flow (m³/s)	2% AEP Peak Flow (m³/s)	1% AEP Peak Flow (m³/s)
Existing Peak (m³/s)	0.94	1.43	2.10	2.52	3.09	3.87	4.57
Developed Peak (m³/s)	4.34	5.59	7.15	8.05	9.33	9.96	11.13
Variance (m³/s)	*3.40*	*4.16*	*5.05*	*5.53*	*6.24*	*6.09*	*6.56*

The Manning's Equation has been used for conceptual sizing of the diversion swale. **Table 4-10** presents the proposed drainage swale calculation

Table 4-10 – Diversion Swale

Parameter	Value
Base Width (m)	3
Top Width (m)	11
Side Batters (1 in X)	4
Min. Depth (m)	1
Manning's n	0.10
Longitudinal Slope (%)	1.7%
Flow Capacity (m³/s)	6.64
Flow Velocity (m/s)	0.95

The proposed swale has the flow capacity to convey the additional 1% AEP flow of 6.56m³/s from Catchment P.

The swale will follow the road reserve and will traverse Lot 901/SP222166 (reserve area with a LCC water reservoir) and enter the tributary drainage reserve behind Mackenzie Road, diagrammatic route as presented in Drawing No. **B13343.W-SK09.** Prior to ROL application for Catchment P, further design and consent from LCC will be required for the swale across this site.

In future, when the road reserve is developed the drainage swale can be connected to the road drainage which is to be sized appropriately to convey Catchment P flows.

Alternatively, onsite detention can be provided within Catchment P to ensure post-development peak flows do not exceed the existing.

5 STORMWATER QUALITY & TOTAL WATER CYCLE MANAGEMENT

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.

Roof water and stormwater harvesting is proposed for achieving an integrated total water cycle management solution.

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;
- Proposed strategies for roof water and stormwater harvesting; and
- Modelling of the proposed SQIDs to assess if they achieve the required WQOs.

While no changes have been made to this section, stormwater quality items outlined in EDQ's IR (January 2017) have been addressed through the following:

- Assessment of the sensitivity of removal of rainwater tanks to meeting overall stormwater quality objectives to address Item E-1 has been provided in Calibre Consulting's *Response to EDQ IR* (April 2017). Results indicate that pollutant reductions are lowered by 0.5% or less without Rainwater Tanks (for TSS, TP and TN). Overall objectives are still achieved in this sensitivity scenario. Therefore, no changes have been made to this analysis.
- The semi-offline nature of the proposed wetland has been highlighted on plans provided in **Appendix G** to address Item E-2. While the details and design of the proposed wetland will change during future ROL stages, this will not impact the intended concepts modelled in this preliminary analysis.

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* (2014).

Table 5-1: Water Quality Objectives

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

In addition to the above WQOs, the following SEQ Water *Development Guidelines* (June 2012) requirements for water sensitive urban design and stormwater/runoff management have also been addressed. Refer to **Appendix F** for the responses to SEQ Water code responses.

5.3 STORMWATER QUALITY & TOTAL WATER CYCLE MANAGEMENT STRATEGY

To achieve the stormwater quality and total water cycle management objectives, the following SQIDs are proposed:

- Bioretention systems at all discharge locations on the west-east drainage path, Logan River, Teviot Road and adjacent properties;
- Rainwater tanks for commercial areas, the school and medium density residential (25 dwellings/ha) areas in Catchments M and N; and
- A wetland for Catchment U.

Refer to Drawing No. **B13343.W-SK02** in **Appendix G** for the stormwater quality catchment delineation.

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 runoff to discharge from the bioretention systems.

Rainwater tanks provide simple and effective means for at source stormwater quality management. Re-use of rainwater will benefit the urban water cycle through reduced portable water demand. The provision of rainwater tanks within Catchments M and N will reduce the average annual runoff volumes to Teviot Road. Refer to **Section 8** for average annual runoff volume calculation.

The rainwater tanks for the commercial and school areas have been estimated based on 1.5kL per 50m² of roof. This is in accordance with the *Queensland Development Code MP 4.3 – Alternative Water Sources – Commercial Buildings* (2007). For the medium density residential areas 3kL of rainwater tank volume per dwelling has been adopted in accordance with the *Queensland Development Code MP 4.2 – Water Savings Targets* (2007).

The sizing of the rainwater tanks and re-use, particularly for the commercial land use areas, are preliminary only. The rainwater tanks and re-use rates have limitations at this master planning stage due to not having any allotment or development layout. It is recommended that the MUSIC and the average annual runoff volume analyses (**Section 8**) are updated during future ROL application stages.

A semi off-line wetland is proposed at the downstream end of Catchment U. It will receive runoff from local tributaries. Wetland systems generally provide optimum pollutant retention characteristics. Wetlands remove sediments and nutrients from stormwater runoff through Macrophyte zones. An inlet pond will be provided as pre-treatment facility immediately upstream of the wetland, which will provide additional sediment treatment. It is proposed to re-use the harvested stormwater from the wetland for sports field irrigation.

5.4 MUSIC MODELLING METHODOLOGY

Water quality modelling has been undertaken using MUSIC Version 6.2, developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH). 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 MUSIC model was setup in accordance with Water by Design *MUSIC Modelling Guidelines* (2010).

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 3.1* from *Music Modelling Guidelines* (2010), 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 745mm.

5.4.2 SOURCE NODES

The source nodes represent the catchment areas within the development modelled in MUSIC. The model incorporates multiple sub-catchment source nodes representing various land uses (i.e. residential, park, neighbourhood centre etc). The lumped catchment methodology outlined within the *MUSIC Modelling Guidelines* (2010) has been adopted for this master planning analyses.

Rainfall runoff and pollutant export parameters were assigned for the different land use areas in accordance with *Table 3.7* and *Table 3.8* of the *MUSIC Modelling Guidelines* (2010).

The following fraction impervious assumptions have been made, generally in accordance with *Table 3.6* of the *MUSIC Modelling Guidelines* (2010).

- Urban Residential 15 dwellings/ha: 60% impervious;
- Urban Residential 25 dwellings/ha: 70% impervious;
- Commercial / Neighbourhood Centres: 90% impervious;
- School: 70% impervious; and
- Parks and Sport Fields: 20% impervious.

The source node parameters presented in **Table 5-2** were implemented in MUSIC modelling. Refer to **Appendix D** for MUSIC model layout and a breakdown of different land use areas.

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 adjacent to the river and the floodplain have been excluded from the MUSIC analysis. Refer to Drawing No. **B13343.W-SK02** in **Appendix G** for the MUSIC catchment delineation.

No allowance has been made for any runoff from development areas to bypass stormwater quality treatment. The MUSIC modelling is to be updated during subsequent ROL application phases as necessary to reflect any updates to the site layout and stormwater drainage strategies.

Table 5-2: MUSIC Source Nodes

MUSIC Catchment	Total Area (ha)
A	16.33
B	19.22
C	13.53
D	13.77
E	98.69
F	31.04
G	4.33
H	13.70
I	4.52
J	1.44
K	3.77
L	5.56
M	17.20
N	20.14
O	7.84
P	17.67
Q	45.43
R	26.26
S	18.82
T	8.38
U	114.32
V	8.76

5.4.3 DRAINAGE LINKS

Default drainage link settings have been adopted for the model. As stated in *Section 4.17* of *MUSIC Modelling Guidelines* (2010), MUSIC's 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. Flow routing has not been incorporated in accordance with *Section 4.17* of *MUSIC Modelling Guidelines* (2010).

5.4.4 TREATMENT NODES

5.4.4.1 BIORETENTION TREATMENT

Bioretention treatment was modelled with the filter areas presented in **Table 5-3**. During detailed design, pre-treatment in accordance with *Table 13* of the *Bioretention Technical Design Guidelines* (2014) will be provided in addition to the filter areas specified.

Bioretention filter areas presented below are to be proportionally split into multiple basins within the catchments. This will be investigated further during subsequent ROL applications.

Table 5-3: Bioretention Filter Areas

MUSIC Catchment	Bioretention Filter Area (m²)	% of Catchment Area (%)
A	450	0.28%
B	850	0.44%
C	810	0.60%
D	695	0.65%
E	4,000	0.41%
F	1,750	0.56%
G	210	0.48%
H	790	0.58%
I	260	0.58%
J	110	0.76%
K	275	0.73%
L	400	0.72%
M & N	2,400	0.69%
O	550	0.52%
P	1,200	0.68%
Q	2,200	0.48%
R	975	0.37%
S	1,200	0.64%
T	400	0.48%
U	5,000	0.44%
V	560	0.64%
Total	**25,085**	**0.49%**

Bioretention filter areas to be split into multiple cells no greater than 800m²

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

- 500mm filter media depth;
- 300mm ponding extended detention depth;
- Overflow weirs were modelled as 10% of the filter area;
- 30mg/kg filter media Orthophosphate content;
- 400mg/kg filter media TN content; and
- 200mm/hr filter media saturated hydraulic conductivity.

The Orthophosphate and TN content in the filter media were adopted from Healthy Waterways *http://healthywaterways.org/initiatives/waterbydesign/stormwater* (accessed February 2016).

For catchments M & N, and O, the bioretention filter areas can be incorporated at the base of the detention basins (refer to **Section 4.3.1**). Bioretention filter areas must be split into multiple cells no greater than 800m² in accordance with the *Bioretention Technical Design Guidelines* (2014).

5.4.4.2 WETLAND

The wetland within Catchment U was modelled using the parameters presented in **Table 5-4**. The parameters adopted are preliminary and conceptual only. They are subject to further analyses during subsequent ROL application phases. The re-use modelled in this treatment node is for irrigation of the sports fields within Catchment U, which is approximately 7.5ha (excluding the wetland area) and has been calculated assuming an annual irrigation application value of 548mm. The inlet pond volume has conservatively been assumed as 2.5% of the surface area.

Table 5-4: Wetland U Parameters

Parameter	Value
Inlet Pond Volume (m^3)	280
Surface area (m^2)	11,800
Extended Detention Depth (m)	0.5
Permanent Pool Volume (m^3)	9,575
Exfiltration Rate (mm/hr)	0
Evaporative Loss as % of PET	125
Equivalent Pipe Diameter (mm)	144
Overflow Weir Width (m)	1180
Notional Detention Time (hrs)	48
Number of CSTR cells	4
K and C* values	Default
Annual Irrigation Demand (kL/yr)	23,140

A water level fluctuation analyses (using MUSIC) of the wetland is presented in **Section 6** to demonstrate the water level fluctuation and the percentage of the irrigation demand expected to be catered by the stormwater stored in the proposed wetland.

5.4.4.3 RAINWATER TANKS

Table 5-5 presents the rainwater tank parameters modelled in MUSIC. Refer to **Section 8** for the average annual runoff volume calculation.

The following assumptions were used for modelling rainwater tanks:

- Rainwater tank volumes for neighbourhood centres and school were estimated assuming 1.5kL per 50m² of roof.
- Rainwater tank volume for medium density residential (25 dwellings/ha) areas was estimated based on 3kL per dwelling.
- 50% of neighbourhood centre and school land use areas are roof.
- 33.5% of medium density residential (25 dwellings/ha) areas are roof.
- 50% of all roof areas connected to rainwater tanks.
- The commercial rainwater tanks modelled using the parameters of 5kL round tanks, the medium density residential rainwater tanks modelled using the parameters of 3kL round tanks, and the school rainwater tanks modelled using the parameters of 50kL tanks.
- Toilet flushing re-use for residential areas have been calculated based on the *MUSIC Modelling Guidelines* (2010). Refer to **Appendix D** for the re-use estimation.
- Toilet flushing re-use for commercial areas and the school have been estimated as 25% of the total water demand. Refer to *Water and Wastewater Infrastructure Master Plan* (Report No. B13343.W-03) for the total water demand estimations. Refer to **Appendix D** for the re-use estimation.

- Some roof water re-use for irrigation within the school area is required for meeting the flow frequency requirements (**Section 8**). Therefore it is proposed to irrigate a minimum of 0.21ha of the school landscaped area with harvested roof water. This has been included in MUSIC.

Table 5-5: Rainwater Tank Parameters

Parameter	Catchment M		Catchment N		Catchment O
	Neighbourhood Centres	Medium Density Res.	Neighbourhood Centres	Medium Density Res.	School
No. of Tanks	40 x 5kL	200 x 3kL	120 x 5kL	166 x 3kL	10 x 50kL
Total Rainwater Tank Volume (kL)	200	600	600	498	500
Depth above Overflow (m)	0.18	0.14	0.18	0.14	0.39
Total Surface Area (m²)	132	380	396	315.4	152
Initial Volume (kL)	200	600	600	498	500
Overflow Pipe Diameter (mm)	569	1,273	986	1,160	285
Irrigation Demand (kL/year)	-	-	-	-	791
Internal Re-Use (kL/day)	3.36	6.80	8.94	6.31	6.08

5.5 MUSIC MODELLING RESULTS

To achieve the stormwater quality and total water cycle management objectives, the following SQIDs are proposed:

- Bioretention systems at all discharge locations on the west-east drainage path, Logan River, Teviot Road and adjacent properties;
- Rainwater tanks for commercial areas, the school and medium density residential (25 dwellings/ha) areas in Catchments M and N; and
- A wetland for Catchment U.

The above strategy has been modelled in MUSIC. **Table 5-6** presents the MUSIC results achieved by the overall site.

Table 5-6: MUSIC Results

Pollutant	WQO	Load Reduction Achieved	WQO Achieved?
Total Suspended Solids (kg/yr)	80%	81%	Yes
Total Phosphorus (kg/yr)	60%	73%	Yes
Total Nitrogen (kg/yr)	45%	48%	Yes
Gross Pollutants (kg/yr)	90%	100%	Yes

The above results demonstrate that the proposed stormwater quality management strategy achieves the WQOs required under the *SPP* (2014). The master plan development can also achieve the objectives required under the SEQ Water *Development Guidelines* (June 2012). Refer to **Appendix F** for the code responses.

6 WATER LEVEL ANALYSES

Water level fluctuation analyses have been undertaken for the proposed wetland and the water play area to demonstrate their hydrological effectiveness and the water level fluctuations. The water level fluctuation analyses were undertaken using the same MUSIC model parameters as in **Section 5** with the water level fluctuation results outputted with a daily time step.

Since the previous issue (A) of this report the following updates have been made to this section to address Item E-2 and F-1 of EDQ's *Information Request* (January 2017):

- *Wetland (**Section 6.1**)* – This section has been updated to address Item E-2 and highlight that the wetland proposed is semi-offline to watercourse and has indicative shape and configuration only.
- *Water Play Area (**Section 6.2**)* – This section has been updated to address Item F-1 and highlight that the shape and configuration of the proposed water play area is preliminary only. An indicative shape and configuration has been selected for purposes of the water level fluctuation analysis to demonstrate that there can be sufficient runoff from the catchment to supply the proposed water recreational area.

6.1 WETLAND

6.1.1 PARAMETERS

The wetland parameters are presented in **Table 5-4** in **Section 5.4.4.** In summary the parameters are:

- Total contributing catchment: 114.32ha
- Top Surface Area: 11,800m²
- Volume below normal operating level: 9,575m³
- Depth (at normal operating level): 2.5m
- Extended Detention Depth (above normal operating level): 0.5m
- Annual Irrigation Demand: 23,140kL/year
- Notional Detention Time: 48 hours
- Overflow weir level (above normal operating level): 0.5m

For the purpose of this analyses, the typical wetland shape adopted is presented in **Figure 6-1**. This is a preliminary geometrical shape only, suitable for this PA application. The final layout and design is subject to further landscape and engineering designs.

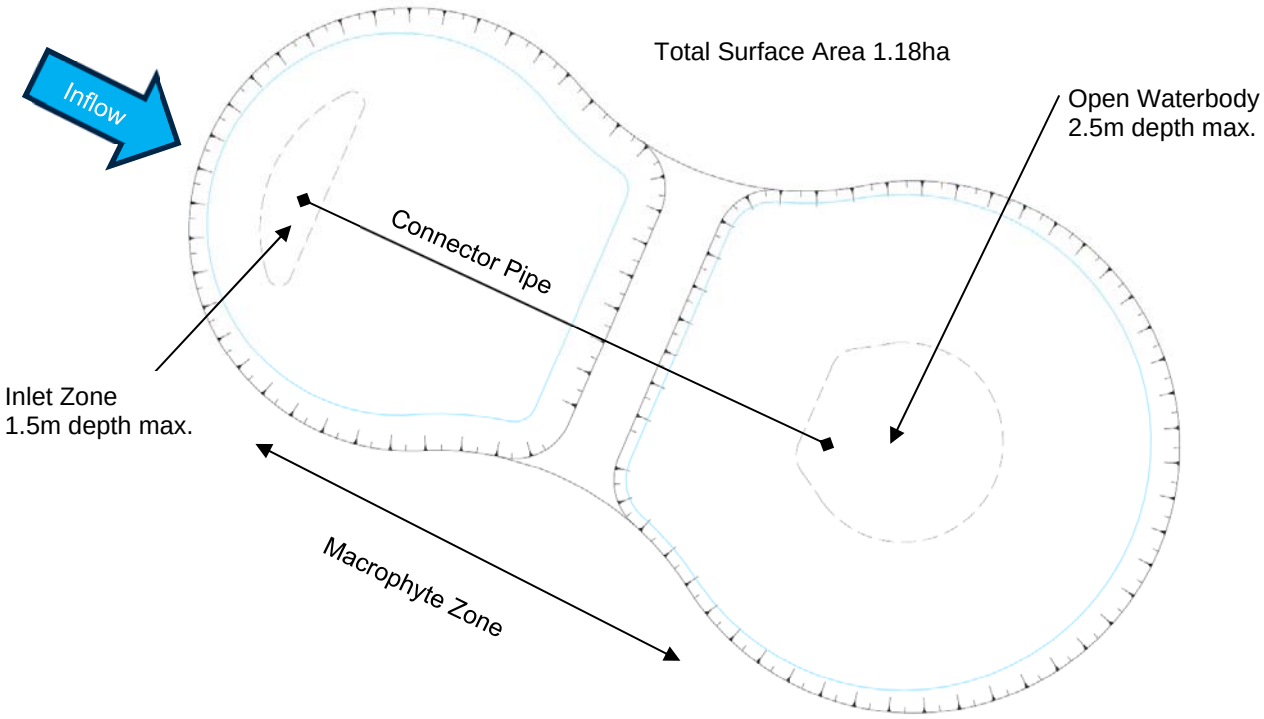

Figure 6-1: Wetland U Typical Shape (Preliminary)

The wetland is proposed as a semi-offline measure in that only low flows (63% AEP flows) will be conveyed directly to the wetland. Larger storm events above 63% AEP will be directed into the channel adjacent to the wetland. Once the channel reaches 5% AEP capacity flooding will be distributed over both wetland and channel.

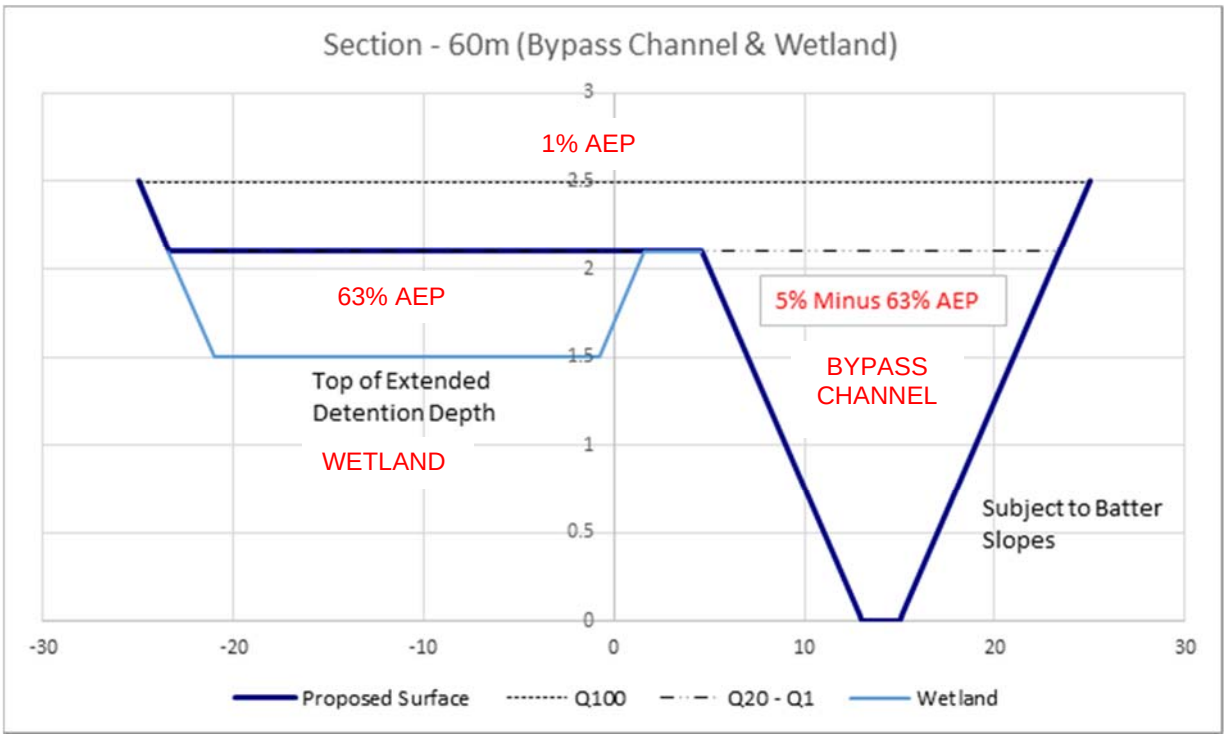

Figure 6-2: Example of Semi-Offline Wetland

6.1.2 WATER LEVEL RESULTS

Table 6-1 outlines the water level fluctuation for the 10 year period investigated. The water depths have been measured at the normal operating level.

Table 6-1: Wetland Water Level Fluctuation Results

Parameter	Depth (m)	Water Level Fluctuation from Normal Operating Level (mm)
Average	2.418	-82
20th Percentile	2.575	+75
50th Percentile	2.461	-39
80th Percentile	2.293	-207

Note: Normal Operating Level is noted as 0

The results indicate that on average the wetland will maintain a water level 82mm below the normal operating level.

The water level will exceed 2/3rd of the extended detention depth (333mm) only 7% of the time. Refer to **Figure 6-2** for a graphical illustration of the water level vs percentile.

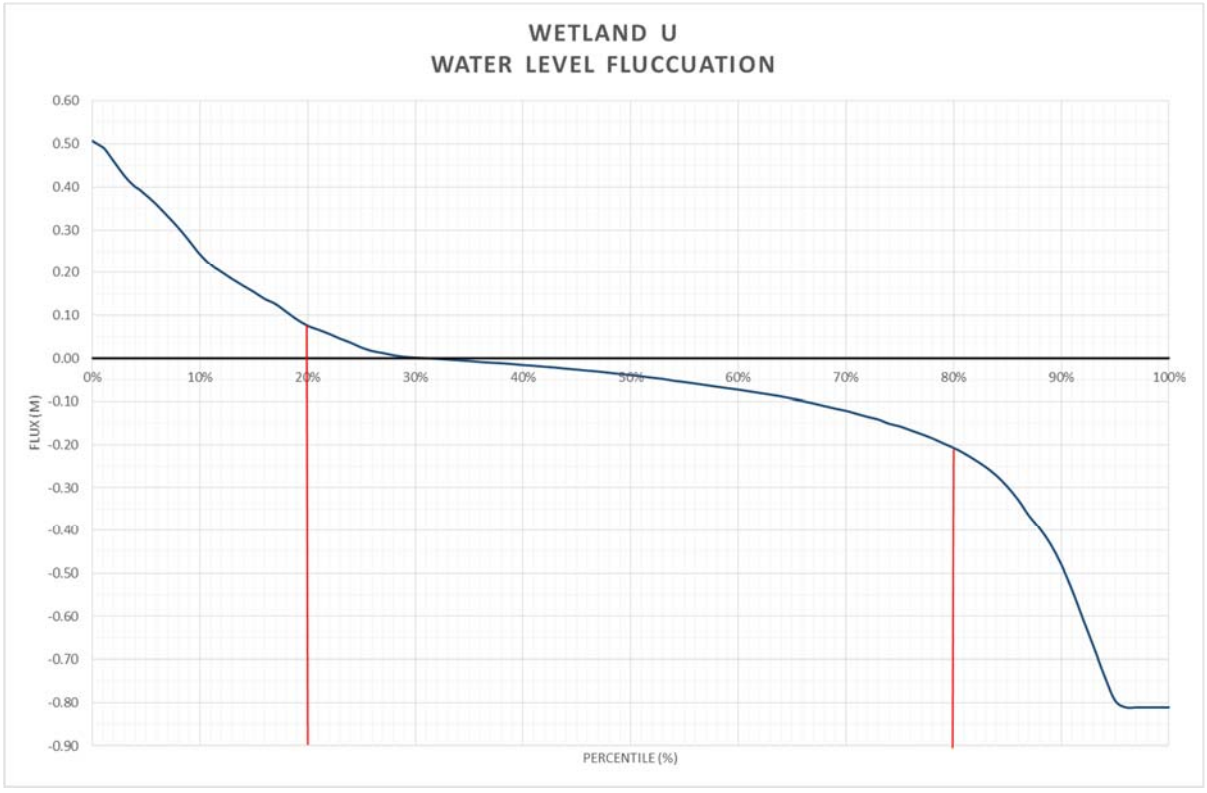

Figure 6-3: Wetland U Water Level Fluctuation

Table 6-2 presents a summary of the water balance results from the MUSIC model (same modelled as in **Section 5**) for the wetland. As can be seen the inflow and outflow is generally consistent.

Table 6-2: Wetland Inflow & Outflow Characteristics

Parameter	Value
Total Inflow (ML/year)	**469.9**
Evaporation Loss (ML/year)	19.9
Pipe & Weir Outflow (ML/year)	428.7
Irrigation Demand Supplied by Stormwater (ML/year)	21.7
Total Outflow (ML/year)	**470.3**

Table 6-3 presents a summary of the re-use supply and demand results from the MUSIC.

Table 6-3: Wetland Re-Use Results

Parameter	Value
Irrigation Demand (ML/year)	23.1
Irrigation Demand Supplied by Stormwater (ML/year)	21.7
% of Irrigation Demand Met by Re-Use	93.5%

The results demonstrate that with the proposed wetland the majority of the sport fields in stormwater quality Catchment E (Drawing No. **B13343.W-SK02**) can be irrigated using harvested stormwater. This will reduce the development's demand on potable water usage. This demonstrates that the wetland will not only assist with stormwater quality improvement but also assist with provide an integrated stormwater management solution for the site.

6.1.3 WETLAND DESIGN FEATURES

Design features should be incorporated into the final wetland configuration to reduce the risk of mosquito breeding. Possible design features are discussed in *Section 6.2.8* of the *WSUD Technical Design Guidelines* (2006), Melbourne Water's *Constructed Wetland Design Manual* (n.d) and Mackay City Council's *Engineering Design Guidelines Constructed Lakes* (2008). Such features include, but are not limited to:

- Introducing predatory fish and insects to keep the mosquito breeding low;
- Incorporating steeper batter slopes where possible (e.g. 1 in 3) without compromising safety;
- Maintaining natural water level fluctuations that disturb the breeding cycles of some mosquitoes;
- Incorporating open water bodies to enhance wave action which will disturb mosquito egg laying and larvae;
- Providing a bathymetry that regularly wets and dries;
- Providing gross pollutant control at the inlet (accumulated litter provides mosquito breeding habitat);
- Providing maintenance access to monitor and treat mosquito larvae;
- Ensuring no localised depressions or pools that will hold shallow stagnant water for long periods of time; and
- Ensuring regular vegetation maintenance so that weeds such as Water Hyacinth and Salvinia that provide a breeding medium for some mosquito species are removed.

A well-established constructed wetland will have no significant mosquito breeding associated with it, however changes in climatic and vegetation conditions could change that situation. Maintaining awareness for mosquito problems and regular monitoring should be considered as a component of the wetland management procedures.

Appropriate wetland vegetation species and the configuration of the wetland is to be undertaken as part of the future design.

6.2 WATER PLAY AREA

Details provided in this section are preliminary only to demonstrate that there will be enough runoff from the catchment to supply the proposed water recreational area. The water park area could be incorporated as various other features such as kids play fountain, shallow pool, wave pool, etc. Prior to servicing the water recreational area, runoff from the catchment will be pre-treated through bioretention basin and receive secondary treatment to achieve appropriate standards for use for the water feature.

A water play area, such as a recreational pool may be incorporated within the high-recreational area in catchment E. Refer to Drawing No. **B13343.W-SK02**. This water play area, if incorporated, will be for human recreational activities and not a SQID. Stormwater harvesting from Catchment E will be considered for supplementing the water demand as part of the integrated water management strategy. That is, stormwater from catchment E can be used for topping up the pool. The top-up stormwater is to be adequately treated to a level suitable for primary human contact. The details of the treatment plant is subject to detailed design by a suitably qualified professional during subsequent design phases.

A preliminary water level fluctuation analysis has been undertaken and presented below demonstrate the availability of stormwater for the pool top-up. The pump out for pool top-up has not been included in the stormwater quality analysis.

6.2.1 PARAMETERS

The water play area parameters presented below are very preliminary and adopted for this high-level master planning analyses. The adopted parameters are:

- Potential catchment: 98.7ha (it has been assumed all of the discharge from this catchment flow into the water play area)
- Top Surface Area: 20,725m^2
- Volume: 18,400m^3
- Extended Detention Depth Assumed: 0.1m
- Maximum Depth: 2m

For the purpose of this analyses, the water play area shape adopted is presented in **Figure 6-3**. Please note that this is a preliminary geometrical shape only, suitable for this PA stage. The final layout and design is subject to further landscape and engineering designs.

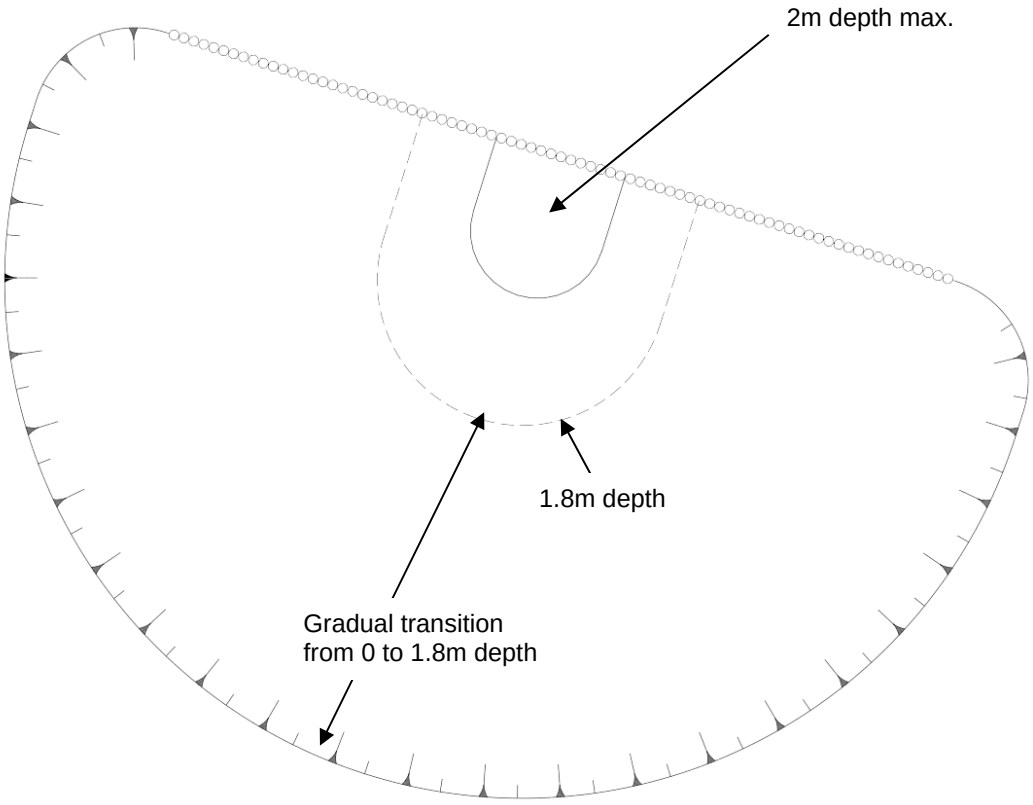

Figure 6-4: Water Play Area Typical Shape (Preliminary)

6.2.2 WATER LEVEL RESULTS

Table 6-4 outlines the water level fluctuation for the 10 year period investigated. The results are based on a 100mm extended detention depth modelled in MUSIC.

Table 6-4: Water Play Area Water Level Results

Parameter	Water Level Fluctuation (mm)
Average (m)	+11
20th Percentile (m)	+91
50th Percentile (m)	+66
80th Percentile (m)	-6

The results indicate that on average the water level fluctuates by 11mm. **Figure 6-4** presents a graphical illustration of the water level vs percentile.

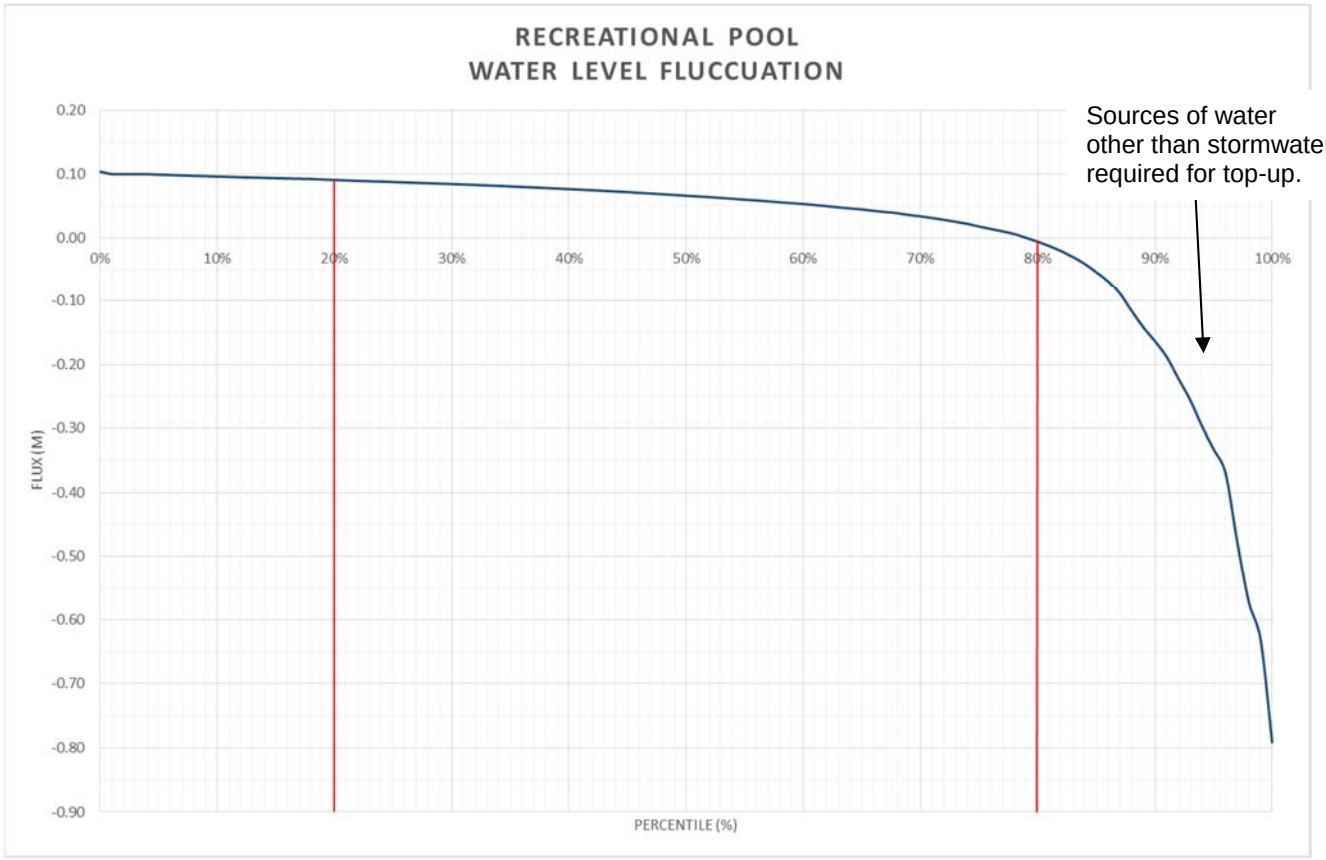

Figure 6-5: Wetland U Water Level Fluctuation

The MUSIC results also determines that there is an average annual flow of 377ML from Catchment E. This runoff, once treated and stored, could be utilised for topping up the water play area. With an average annual evaporation loss of 37.3ML, it is expected that there will be adequate stormwater runoff from Catchment E for topping up the water play area for 80% of the time.

7 WATERWAY STABILITY MANAGEMENT

This section address the waterway stability management required under the *SPP* (2014). The strategies for waterway stability management is to provide preliminary detention volumes for catchments not discharging to the Logan River. No 63% AEP peak flow mitigation is proposed for catchments discharging directly into Logan River as there will be no increase in 63% AEP peak flows in the Logan River.

Since the previous issue (A) of this report the following updates have been made to this section to address Item D-2 of EDQ's *Information Request* (January 2017):

- *Discharge to Logan River (**Section 7.1**)* – This section has been updated with **Figure 7-1** to provide further clarity to address Item D-2.

7.1 DISCHARGE TO LOGAN RIVER

The waterway stability management for catchments discharging to Logan River is not required because the 63% peak flow within the Logan River will not be affected by the site development. This is because the timing of peak flows of the local site catchment differ to the timing of regional peak flows.

From a regional catchment perspective hydrological analysis indicates that water stability management objectives are achieved (i.e. no increase in 63% AEP peak flows in Logan River). This is indicated on **Figure 7-1** and further discussed below.

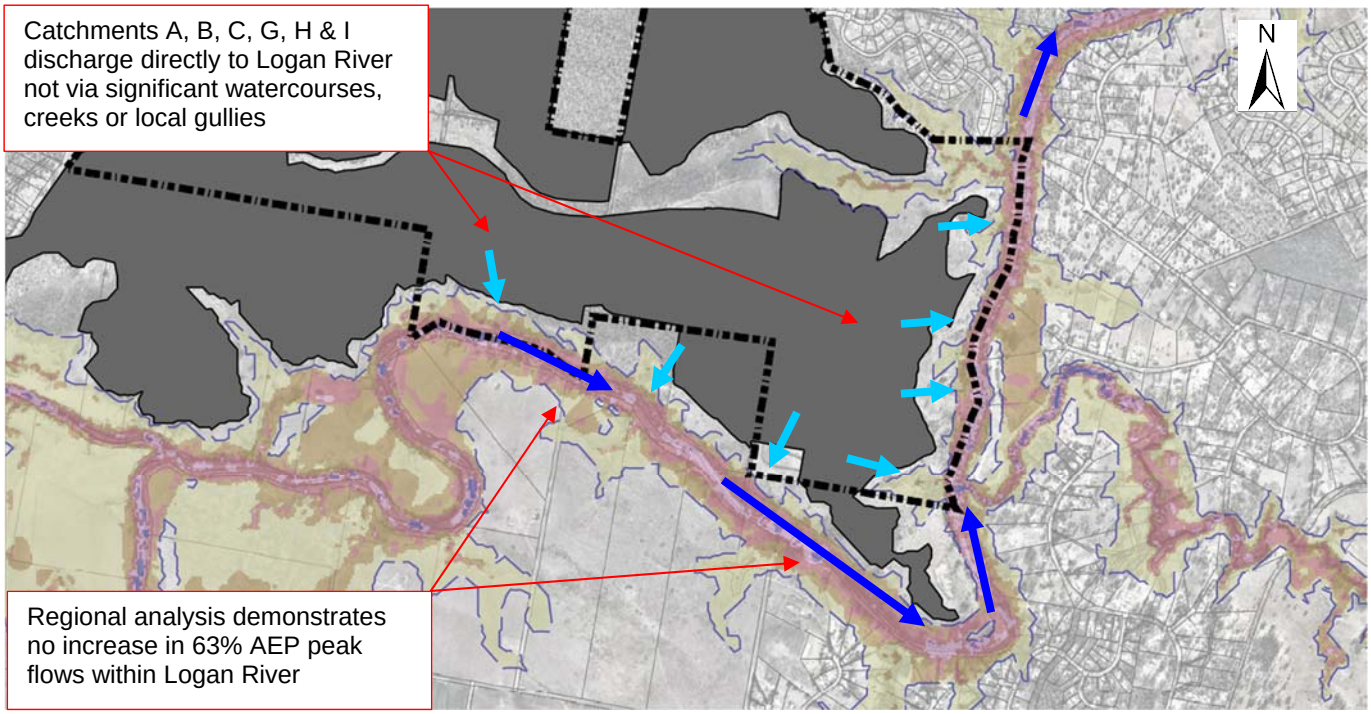

Figure 7-1: Direct Discharge to Logan River from Catchments A, B, C, G, H and I

Mitigation measures will be provided where site runoff discharges to minor gullies prior to Logan River, i.e. energy dissipaters at outlets, scour protection as required (addressed at ROL & Certification phase) to reduce the potential for scour.

LCC has provided the 10%, 5%, 2% and 1% AEP regional XP-RAFTS hydrological models for the Logan River. A comparison between the regional vs local peak times have been undertaken and is presented in **Table 7-1.**

Table 7-1: Regional vs Local Peak Flow Timing

Catchment	10% AEP Local Peak Time (hr)	10% AEP Regional Peak Time (hr)	5% AEP Local Peak Time (hr)	5% AEP Regional Peak Time (hr)	2% AEP Local Peak Time (hr)	2% AEP Regional Peak Time (hr)	1% AEP Local Peak Time (hr)	1% AEP Regional Peak Time (hr)
A	0.23	39	0.23	37	0.23	33.25	0.23	33
B	0.23	39	0.23	37	0.23	33.25	0.23	33
C	0.23	39	0.23	37	0.23	33.25	0.23	33
D	0.23	39	0.23	37	0.23	33.25	0.23	33
V	0.23	39	0.23	37	0.23	33.25	0.23	33
G	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5
H	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5
I	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5
J	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5
K	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5
L	0.23	38.25	0.23	36.5	0.23	32.5	0.23	32.5

The results indicate that the local catchment peaks occur at around 13 to 14 minute of the storm while the regional peak flows occur at around 32 to 39th hour. There is over 24 hour time lag between the peak times of local catchment to peaks within Logan River for 10%, 5%, 2% and 1% AEPs. This is for 10% AEP and larger storm events.

For smaller storm events such as the 63% AEP the lag between local to regional peak flow will be even greater. It can be concluded that 63% AEP peak flow within Logan River will not be adversely impacted by the site development and therefore achieves the waterway stability management requirement of the *SPP* (2014).

7.2 DISCHARGE TO DRAINAGE RESERVE BEHIND MACKENZIE AVENUE

Peak flows from the 63% AEP storm event at the drainage reserve behind Mackenzie Avenue will be increased if the Developed Scenario Catchments P, S & T are left unmitigated. Therefore, to address the waterway stability management requirement, detention is proposed for mitigating the 63% AEP peak flow from Catchments P, S & T.

Boyd's calculation has been used for determining the preliminary volume required to achieve 63% AEP peak flow mitigation. The runoff volumes were calculated from the hydrographs exported from XP-RAFTS models. **Table 7-2** presents the preliminary detention basin volume.

Table 7-2: Waterway Stability Management Volumes – Catchments P, S & T

Catchment	Preliminary Detention Basin Volume (m³)
P	4,700
S	5,000
T	2,100

These volumes can be provided within the stormwater quality bioretention basins. The conceptual design and modelling are to be undertaken during the subsequent ROL phase.

7.3 DISCHARGE TO TEVIOT ROAD

Catchments M, N and O discharge to Teviot Road. Detention basins are proposed for these catchments, as presented in **Section 4.3.1** for 1% AEP peak flow management. The detention basins and outlets are to be designed and modelled during the subsequent ROL phase, and they will be designed to achieve 63% AEP peak flow mitigation as well. This addresses the waterway stability management requirement for Catchments M, N and O.

7.4 DISCHARGE TO WEST-EAST DRAINAGE CORRIDOR

It is proposed to provide 63% AEP local peak flow mitigation within the west-east drainage corridor of the site to achieve the waterway stability management at the downstream floodplain. This 63% AEP peak flow mitigation has not been modelled in XP-RAFTS nor incorporated in the HEC-RAS analyses in **Section 3.** This can be integrated into the local flood modelling during subsequent ROL phase.

Boyd's calculation has been used for determining the preliminary volume required to achieve 63% AEP peak flow mitigation. The runoff volumes were calculated from the hydrographs exported from XP-RAFTS models. **Table 7-3** presents the preliminary detention basin volume.

Table 7-3: Waterway Stability Management Volume

Catchment	Preliminary Detention Basin Volume (m^3)
U	75,200

It is proposed to provide detention behind the road crossing connecting Precinct 4 and Precinct 5 (refer to **Appendix A**). The preliminary road level proposed at the crossing is RL 33m AHD. Based on the existing contours, the estimated volume available upstream of this road crossing is in the order of 100,000m^3. As such it is expected that 63% AEP peak flow mitigation for waterway stability management can be achieved within the west-east drainage corridor at this crossing. Refer to Drawing No. **B13343.W-SK11** for the concept location. The culverts at this road crossing are to be designed and modelled during the subsequent ROL phase.

Subject to further analyses, additional waterway stability management volumes may need to be provided within site catchments downstream of this crossing in order to achieve the required 63% AEP peak flow mitigation at the downstream floodplain. These additional volumes may be achieved by providing additional extended detention depths within stormwater quality bioretention basins.

8 FLOW FREQUENCY

Runoff volume analyses have been undertaken at several discharge locations to demonstrate that the Developed Scenario average annual runoff volumes will not increase from the Existing Scenario.

The analyses exclude discharge locations to Logan River and dedicated drainage reserves as increases in flow frequency will not adversely impact the river. It also excludes Catchments J, K & L which will be provided with adequate downstream drainage for conveying runoff to Logan River.

The critical catchments for managing the flow frequency are Catchments M & N, and O.

8.1 CATCHMENT DATA

Table 8-1 presents the Existing and Developed Scenario Catchment Data for Catchments M, N and O. Refer to Drawing No. **B13343.W-SK01** in **Appendix G** for the catchment delineation.

The volumetric runoff coefficient Cv for the Existing Scenario represents the site's undeveloped condition. The Cv for the Developed Scenario has been calculated as a weighted Cv representing neighbourhood centres (Cv 0.57), residential (low and medium density Cv 0.38 and 0.48 respectively), and the proposed school (Cv 0.38).

Table 8-1: Catchment Data

Scenario	Catchment Area (ha)	Cv
Catchments M & N		
Existing Scenario	33.96	0.15
Developed Scenario	34.59	0.48
Catchment O		
Existing Scenario	9.96	0.15
Developed Scenario	10.60	0.38

8.2 RE-USE

Under Existing Conditions the site is undeveloped and there is no stormwater infrastructure or stormwater re-use.

In the Developed Scenario, rainwater tanks are proposed for the neighbourhood centres, medium density residential and school areas. The collected roof water will be used for toilet flushing and some irrigation of the landscaped area within the school. **Table 8-2** presents the overall average annual re-use. Refer to **Table D6b** and **D6c** in **Appendix D** for detailed breakdown of the re-use calculations.

Table 8-2: Re-Use Demand

Land Use	Catchments M & N	Catchment O
Neighbourhood Centre (kL/year)	4,489	-
Medium Density Residential (25 dwellings/ha) (kL/year)	4,784	-
School (kL/year)	-	2,006

A minimum area of 0.21ha within the school needs to be irrigated via harvested roof water in order to ensure Developed Scenario average annual runoff volume does not exceed the Existing Scenario. Refer to **Section 8.3** for the results.

8.3 AVERAGE ANNUAL RUNOFF

The average annual runoff volumes were calculated assuming an average annual rainfall of 745mm. This is consistent with the rainfall data adopted in MUSIC (see **Section 5.4.1**).

Table 8-3: Average Annual Runoff

Scenario	Total Average Annual Runoff (m^3)	Less Re-Use Demand (kL)	Average Annual Runoff at Discharge Point (m^3)
Catchments M & N			
Existing Scenario	3,795	-	3,795
Developed Scenario	12,296	9,273	2,986
Catchment O			
Existing Scenario	1,113	-	1,113
Developed Scenario	2,997	2,006	994

The above analyses demonstrates that the frequent flows can be managed by providing integrated roof water harvesting strategies. Roof water harvesting also provides a sustainable and integrated water management strategy for the site.

9 EROSION AND SEDIMENT CONTROL, AND BANK STABILITY MANAGEMENT

9.1 EROSION AND SEDIMENT CONTROL

Bulk earthworks is proposed for some portions of the site, particularly some filling within the floodplain. Refer to Drawings Numbered **B13343.W-SK100** to **SK102** in **Appendix G** for preliminary concept earthworks drawings.

Erosion and sediment control measures will be provided during all construction activities. At some areas of the site, particularly adjacent to the river has steep slopes, erosion and sediment control measures are paramount to be provided during all construction activities. Measures will consist of (but not limited to) diversion drains, temporary sediment basins, silt fences, and shakedown services.

Detailed erosion and sediment control plans will be prepared during future phases of the design. These strategies will be implemented during construction activities. All erosion and sediment control measures will be designed in accordance with EDQ's relevant erosion and sediment control standards.

9.2 BANK STABILITY

Bulk earthworks is proposed for some portions of the site, particularly some filling within the floodplain. Refer to Drawings Numbered **B13343.W-SK100** to **SK102** in **Appendix G** for preliminary concept earthworks drawings.

The site development will be undertaken in stages. Care will be taken during earthworks and construction activities to ensure existing embankments are not adversely disturbed. Any disturbed areas will be restabilised and surfaces treated to landscape specifications (by others) to ensure embankment stability and avoid erosion and sedimentation issues.

Appropriate detailed design will ensure stormwater flows will not be concentrated at steep embankments. Appropriate scour protection will be provided at all stormwater outlets.

Some retaining walls may be required at the edge of the development. This will be determined during subsequent ROL applications. Retaining walls will be appropriately designed to minimise disturbance to existing river banks.

9.3 DISPERSIVE SOILS

An Erosion Assessment & Dispersive Soil Management Plan will be provided by a suitably qualified geotechnical consultant during subsequent ROL application phase. The document will define the overall erosion hazard and soil dispersion risk of the site soils and provide over-arching principles to ensure that earthworks do not cause land degradation or soil erosion during the construction phases.

In general, dispersive soils have the tendency to release and form a colloidal "cloud" upon contact with water and can also occur within a still body of water.

The geotechnical investigations will identify various soil characteristics over the site. It will also identify areas with dispersive soils and subsoils. If identified, appropriate dispersive soil and subsoil control measures can be provided. These include the use of non-dispersive topsoil material, compaction of back fill and soil treatment with agricultural gypsum.

Furthermore, the downstream embankments of stormwater basins will not be constructed of dispersive soils (or unstable soils). All earth batters, particularly adjacent to the river and drainage corridors will be at no steeper than 1 in 5 slope for the first 1m. Beyond this depth 1 in 4 grassed slopes or 1 in 3 vegetated slopes may be applied. Revegetation and landscape areas will have appropriate geofabric or jute matting.

10 CONTEXT PLAN AREA

The analyses that has been presented in this report are for the site area only (i.e. land being developed by Celestino Pty Ltd). For the areas outside of the site, but are still within the context plan area (refer to **Appendix A**) the following strategies are proposed for stormwater management.

- Stormwater quality management can be provided via end of line SQIDs such as bioretention basins. This is consistent with the strategy adopted for the site. MUSIC modelling will be required to determine appropriate bioretention filter areas. This can be undertaken at the ROL phase of the subject land development.

- Peak flow mitigation via onsite detention is not required for the context plan area. The regional hydrological and hydraulic analyses presented in the *Flood Investigation Report* (Report No. B13343.W-01) considers the development of the entire context plan area. The results of the regional analyses demonstrate no adverse impact in peak flows or maximum flood levels in Logan River during 10% through to 1% AEP storm events.

- Similar to peak flow mitigation, waterway stability management is also not required for the context plan area. This is because as presented in **Section 7.1** of this report, the regional 63% AEP peak flow is not expected to be increased by the development of the context plan area.

- Although onsite detention basins are not required, the management of upstream catchment flows will be required for some of the context plan areas. In particular, the area to the south of Catchments J, K L will require to provide appropriate drainage infrastructure to convey upstream catchment flows.

- Appropriate erosion and sediment control measures will be required during construction activities. Bank stability management and dispersive soils management will also be required during construction and post-construction phases of the context plan area.

11 CONCLUSION

Calibre Consulting (Qld) Pty Ltd has prepared this *Concept Stormwater Management Plan* for the proposed Jimboomba Celestino development within the Greater Flagstone PDA. This report addresses total water cycle management, stormwater quality, stormwater quantity, and local flood management for the site.

Following submission of Issue A of this report for master planning approval, Economic Development Queensland (EDQ) have provided an Information Request (*Summary of Flood Investigation and Stormwater Management Review* document dated January 2017). The current issue (B) of this report has been updated to address items outlined in EDQ's Information Request. This has not resulted in any significant changes to the proposed strategies or analysis provided in the original report. Only minor updates to the wording and presentation of management measures have been provided. A summary of Calibre Consulting's responses are provided in *Responses to EDQ Information Request* letter (Ref No. **B13343.W.10L.AMP.cm.docx** dated 20 April 2017) submitted in conjunction with this updated report.

The outcomes of the analyses are:

- The verified XP-RAFTS hydrological and HEC-RAS steady state (1D) hydraulic analyses determine the Existing and Developed Scenario local flood characteristics for the 20%, 10%, 5%, and 1% AEP storm events. Changes to the local flood levels, when compared to the Existing Scenario, will not cause adverse impacts as the drainage path is located wholly within the site and the new development areas will be designed accordingly.

- Flood immunity levels for habitable floor levels, sport fields and parks have been nominated based on the local and regional flood levels. The freeboard levels have been confirmed with a Sensitivity Scenario using a high Manning's n value (0.15).

- The results from the regional hydrological and hydraulic analyses (presented in Report No. B13343.W-01) demonstrate that site areas discharging directly to Logan River do not require peak flow mitigation. However, for site areas discharging into adjacent properties or road reserves, peak flow management is required.

- The local XP-RAFTS hydrological model has been used to develop peak flow management strategies for site areas discharging into adjacent properties or road reserves. These include:
    - Provide 21,400m³ and 6,050m³ detention volumes for Catchments M&N, and Catchment O respectively.
    - Catchments J, K & L discharge to Logan River via a downstream private property. This downstream private property is external to the site, however it forms part of the overall context plan. It is proposed to seek downstream owner consent for safely conveying the post-development peak flows from catchments J, K and L into Logan River. Prior to obtaining discharge consent, detention basin volumes have been provided.
    - Catchment P discharges into a road reserve and then into the drainage reserve behind MacKenzie Road. It is proposed to provide a 13m wide (top width) drainage swale to convey Developed Scenario peak flows from Catchment P into the drainage reserve.

- For stormwater quality and total water cycle management, a strategy comprising bioretention systems, a wetland, and rainwater tanks are proposed. Runoff collected in rainwater tanks and wetland are proposed to be used for toilet flushing and sports field irrigation. MUSIC modelling demonstrates the effectiveness in achieving the required water quality objectives. The re-use from rainwater tanks provide a total water cycle management solution and reduce the volume of frequent flows discharging through adjoining areas.

- A water play area is also proposed however this is not a SQID. Nonetheless, it is proposed to re-use stormwater for topping up the water play area. The top-up stormwater will be adequately treated, to a level suitable for primary human contact, prior to entering the water play area.

- Water level analyses for the wetland and the water play demonstrate the viability of stormwater harvesting and demonstrate that the water level fluctuations are not adverse.

- The results from the regional hydrological and hydraulic analyses also demonstrate that the timing of local peak flows are different to the timing of regional peak flows. This is why site areas discharging directly to Logan River do not require peak flow mitigation. Consequently, this achieves compliance with the waterway stability management requirement as 63% AEP peak flow will not be adversely impacted in Logan River.

- For site areas discharging into adjacent properties or road reserves, waterway stability management is proposed to be achieved via 63% AEP peak flow mitigation. That is:
    - Catchment P: 4,700m³ detention volume;
    - Catchment S: 5,000m³ detention volume;
    - Catchment T: 2,00m³ detention volume;
    - Catchment U: 75,200m³ detention volume; and
    - Catchments M, N and O will be provided with detention basins for 1% AEP peak flow mitigation which will also achieve 63% AEP peak flow mitigation.

- Erosion and sediment control measures will be provided during all construction activities. Measures will consist of (but not be limited to) diversion drains, temporary sediment basins, silt fences, and shakedown services.
- Care will be taken during construction activities to ensure existing creek and river embankments are not adversely disturbed. Any disturbed areas will be restabilised.

- A Dispersive Soil Management Plan will be provided by a suitably qualified geotechnical consultant, which will define the overall erosion hazard and soil dispersion risk of the site soils and provide over-arching principles to ensure that earthworks do not cause land degradation or soil erosion during the construction phases. If identified, appropriate dispersive soil and subsoil control measures such as, using non-dispersive topsoil material, compaction of back fill and soil treatment with agricultural gypsum, can be provided.

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

12 RECOMMENDATION

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

13 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 (July 2014), State Planning Policy.
- Healthy Waterways (2010), MUSIC Modelling Guidelines Version 1.0.
- Healthy Waterways (2010), Water Sensitive Urban Design Technical Design Guidelines.
- Institution of Engineers, Australia (1987), Australian Rainfall and Runoff.
- *Greater Flagstone Urban Development Area Development Scheme* dated October 2011;
- EDQ (May 2015) *Guideline 12 Park Planning*.
- EDQ (May 2015) *Guideline 13 Engineering Standards*.
- EDQ (May 2015) *Guideline 14 Environmental Values & Sustainable Resource Use*.
- EDQ (May 2015) *Guideline 15 Protection from Flood and Storm*.
- SEQ Water (June 2012) *Development Guidelines.*

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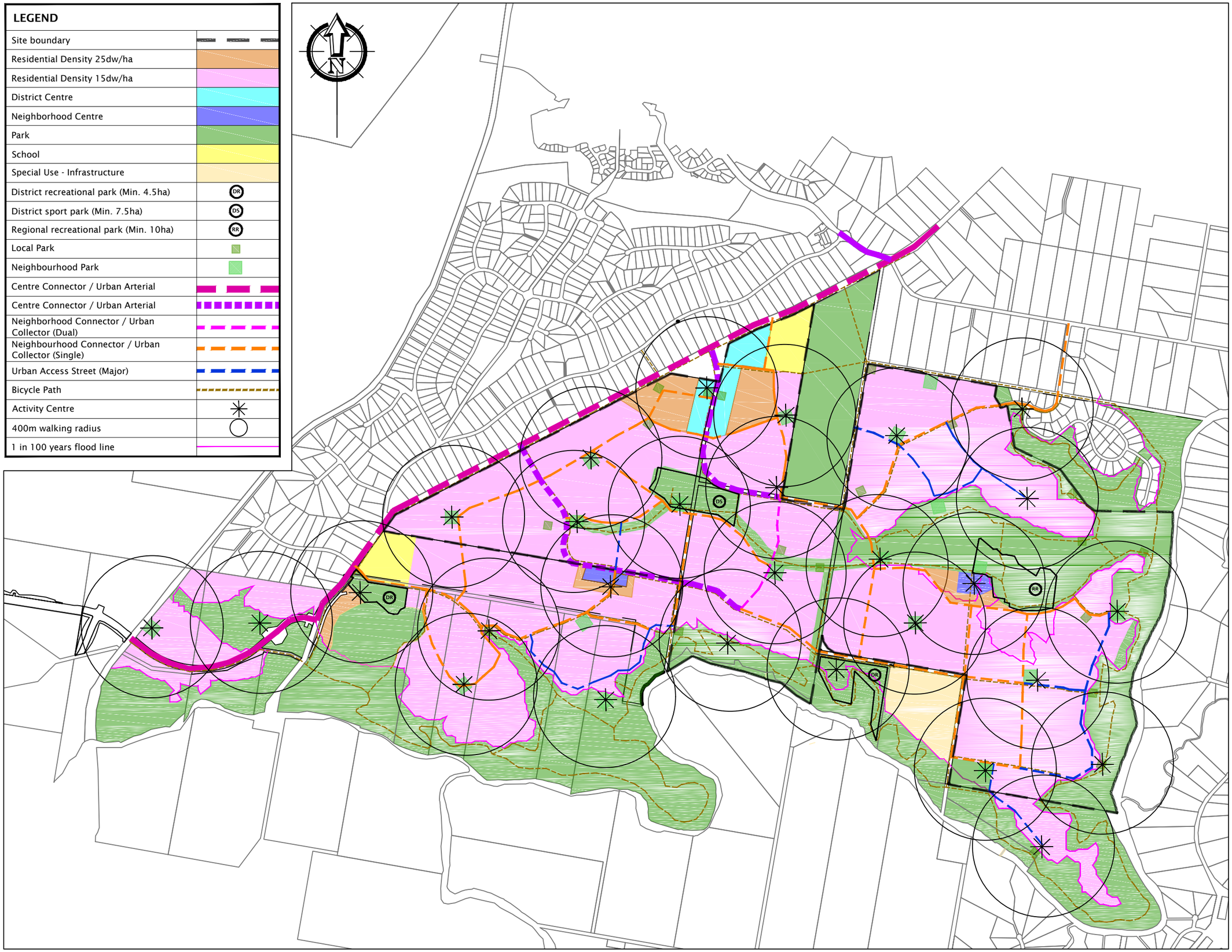
APPENDICES

APPENDIX A : CONTEXT PLAN LAYOUT
APPENDIX B : RATIONAL METHOD CALCULATION
APPENDIX C : HEC-RAS SUMMARY
APPENDIX D : MUSIC SUMMARY
APPENDIX E : PRELIMINARY DETENTION BASIN SIZING
APPENDIX F : SEQ WATER CODE RESPONSES
APPENDIX G : CONCEPT DRAWINGS

APPENDIX A : CONTEXT PLAN LAYOUT

LEGEND

Site boundary	
Residential Density 25dw/ha	
Residential Density 15dw/ha	
District Centre	
Neighborhood Centre	
Park	
School	
Special Use - Infrastructure	
District recreational park (Min. 4.5ha)	DR
District sport park (Min. 7.5ha)	DS
Regional recreational park (Min. 10ha)	RR
Local Park	
Neighbourhood Park	
Centre Connector / Urban Arterial	
Centre Connector / Urban Arterial	
Neighborhood Connector / Urban Collector (Dual)	
Neighbourhood Connector / Urban Collector (Single)	
Urban Access Street (Major)	
Bicycle Path	
Activity Centre	
400m walking radius	
1 in 100 years flood line	



0 1000m 50 mm 2000m 100 mm 3000m 150 mm SCALE BAR

Teviot Road, Jimboomba

For

Jimboomba | CELESTINO

IMPORTANT NOTES:
(These notes are an integral part of this plan)
This plan has been prepared for Celestino Pty Ltd for the purposes of preliminary site structure planning.
It is not to be used by any other person or corporation or for any other purposes and is subject to the following limitations: Detailed ecological, cultural / heritage, engineering and environmental assessments as well as federal, state and local authority approvals and site surveys.

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Data Sources

Cadastral Boundaries	Original Survey Plans/GP07-J
Contours / Topographic	LIDAR - DNR&M
Flood Level	Logan City Council shp file
Engineering Design	Calibre Consulting

No	Revisions	Date	Chkd
A	Original Issue	26.10.2016	KS/PS

Locality:	Jimboomba
Local Authority:	Logan City Council
Horizontal Meridian:	MGA
Vertical Level Datum:	AHD
Scale:	1: 20,000 @ A3
Designed:	PS / KS
Drawn:	PS
Checked:	PS
Plot Date:	27 Oct, 2016
Computer File Ref:	30697-CP01-A.dwg

Context Plan

ISO 9001 Quality Management

THG

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Drawing No 30697-CP01

Issue A

APPENDIX B : RATIONAL METHOD CALCULATION

Catchment U - Existing

File: \\bnenas01\projects\B13\300-349\B13343.W\Stormwater\Spreadsheets\[B13343.W_Rational Calc.xlsx]Existing
Date: 30/08/2016
Job: B13343.W
By: CS
Locality: Riverbend
IFD Ref: IFD_Riverbend
IFD Source: BOM IFD

Time of Concentration

Reference	Equation / Method	Area (ha)	Length (m)	Av. Slope (%)	Velocity (m/s)	Roughness (Hortons)	tc (min)
Table 4.6.2 QUDM	*QUDM Standard Inlet Times*	369.69					
4.06.6 QUDM	*Overland Sheet Flow - Friends Equation*		100	2.33		0.045	19
4.6.3 a(iv) QUDM	*Assumed Channel Velocity*		3700		1.0		62
						Adopted tc	81

C_{10} Value

Enter Fraction Impervious	f_i	$1I_{10}$ (mm/hr)	C_{10}
Brisbane City Plan 2014 - Table 7.3.3.1.A	0.005	61.9	0.59

Flow Calculations (QUDM 4.03.1) tc (min) 81

ARI	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)	Q (m^3/s) RAFTS	Variance (%)
1	0.47	29	369.688	14.25	14.12	-1%
2	0.50	38	369.688	19.45	20.91	8%
5	0.56	48	369.688	27.56	29.24	6%
10	0.59	54	369.688	32.67	34.38	5%
20	0.62	62	369.688	39.52	41.49	5%
50	0.68	73	369.688	50.87	50.02	-2%
100	0.71	81	369.688	59.23	57.08	-4%

APPENDIX C : HEC-RAS SUMMARY

HEC-RAS Plan: EXISTING River: main Reach: 121

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	4093	3.13	48.00	48.45	0.45	48.33	48.47	0.010729	0.54	5.84	33.79	0.41
121	4093	3.74	48.00	48.48	0.48	48.35	48.49	0.010732	0.57	6.61	35.17	0.42
121	4093	4.63	48.00	48.51	0.51	48.37	48.53	0.010955	0.60	7.69	37.95	0.43
121	4093	6.89	48.00	48.56	0.56	48.43	48.59	0.011455	0.70	9.83	39.88	0.45
121	4034	3.13	47.17	47.50	0.33	47.43	47.53	0.025393	0.83	3.76	21.35	0.63
121	4034	3.74	47.17	47.53	0.36	47.46	47.57	0.024939	0.85	4.42	24.19	0.63
121	4034	4.63	47.17	47.56	0.39	47.49	47.60	0.024043	0.90	5.12	24.69	0.63
121	4034	6.89	47.17	47.62	0.45	47.55	47.68	0.021573	1.01	6.81	25.57	0.63
121	3983	3.13	46.32	46.79	0.47	46.63	46.81	0.008984	0.69	4.53	15.66	0.41
121	3983	3.74	46.32	46.82	0.50	46.66	46.85	0.008904	0.73	5.12	16.12	0.41
121	3983	4.63	46.32	46.88	0.56	46.69	46.91	0.008669	0.78	5.96	16.77	0.42
121	3983	6.89	46.32	46.99	0.67	46.77	47.02	0.008378	0.87	7.89	18.14	0.42
121	3922	3.13	45.97	46.33	0.36	46.18	46.34	0.006567	0.56	5.60	21.02	0.35
121	3922	3.74	45.97	46.36	0.39	46.20	46.37	0.006836	0.60	6.21	21.50	0.36
121	3922	4.63	45.97	46.39	0.42	46.22	46.41	0.007494	0.67	6.94	22.05	0.38
121	3922	6.89	45.97	46.46	0.49	46.28	46.49	0.009043	0.81	8.50	23.19	0.43
121	3850	4.58	44.84	45.11	0.27	45.09	45.15	0.045556	0.86	5.35	45.23	0.80
121	3850	5.48	44.84	45.13	0.29	45.11	45.17	0.043482	0.90	6.08	46.08	0.79
121	3850	6.88	44.84	45.16	0.32	45.13	45.20	0.037491	0.93	7.38	47.54	0.76
121	3850	10.16	44.84	45.22	0.38	45.17	45.27	0.030037	0.96	10.63	55.77	0.70
121	3790	4.58	43.84	44.30	0.46	44.09	44.31	0.006628	0.50	9.22	41.60	0.34
121	3790	5.48	43.84	44.33	0.49	44.12	44.34	0.006629	0.53	10.43	43.26	0.34
121	3790	6.88	43.84	44.36	0.52	44.15	44.38	0.006956	0.57	11.99	45.15	0.36
121	3790	10.16	43.84	44.43	0.59	44.22	44.46	0.007628	0.67	15.14	48.33	0.38
121	3741	4.58	43.21	43.58	0.37	43.54	43.64	0.043556	1.07	4.26	24.79	0.83
121	3741	5.48	43.21	43.61	0.40	43.58	43.67	0.043364	1.04	5.27	32.09	0.82
121	3741	6.88	43.21	43.65	0.44	43.62	43.71	0.038526	1.07	6.43	34.35	0.79
121	3741	10.16	43.21	43.72	0.51	43.67	43.79	0.030847	1.13	8.99	37.48	0.74
121	3665	4.58	42.45	43.05	0.60	42.81	43.06	0.002956	0.39	11.64	40.64	0.23

HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	3665	5.48	42.45	43.09	0.64	42.84	43.10	0.002929	0.42	13.13	41.69	0.24
121	3665	6.88	42.45	43.14	0.69	42.88	43.15	0.002925	0.45	15.27	43.15	0.24
121	3665	10.16	42.45	43.24	0.79	42.93	43.25	0.002918	0.51	19.79	45.91	0.25
121	3597	6.32	42.28	42.63	0.35	42.51	42.66	0.011526	0.76	8.32	30.03	0.46
121	3597	7.58	42.28	42.67	0.39	42.53	42.70	0.011562	0.81	9.36	30.77	0.47
121	3597	9.44	42.28	42.71	0.43	42.56	42.75	0.011706	0.88	10.77	31.75	0.48
121	3597	13.76	42.28	42.80	0.52	42.63	42.85	0.011909	1.00	13.76	33.73	0.50
121	3490	6.32	41.09	41.52	0.43	41.38	41.55	0.009472	0.70	9.07	32.22	0.42
121	3490	7.58	41.09	41.56	0.47	41.40	41.59	0.009425	0.74	10.25	33.18	0.42
121	3490	9.44	41.09	41.61	0.52	41.44	41.64	0.009259	0.79	11.96	34.59	0.43
121	3490	13.76	41.09	41.71	0.62	41.50	41.75	0.009027	0.88	15.55	37.18	0.44
121	3392	6.32	40.31	40.65	0.34	40.54	40.66	0.008566	0.55	11.48	53.78	0.38
121	3392	7.58	40.31	40.67	0.36	40.55	40.69	0.008867	0.60	12.72	54.35	0.39
121	3392	9.44	40.31	40.70	0.39	40.58	40.72	0.009448	0.66	14.32	55.13	0.41
121	3392	13.76	40.31	40.76	0.45	40.62	40.79	0.010639	0.79	17.51	56.65	0.45
121	3305	6.32	39.54	39.87	0.33	39.77	39.88	0.009268	0.54	11.76	60.61	0.39
121	3305	7.58	39.54	39.90	0.36	39.79	39.91	0.008874	0.57	13.41	62.04	0.39
121	3305	9.44	39.54	39.93	0.40	39.81	39.95	0.008182	0.60	15.84	63.67	0.38
121	3305	13.76	39.54	40.02	0.48	39.85	40.04	0.007010	0.65	21.19	66.73	0.37
121	3238	9.53	38.73	39.33	0.60	39.16	39.35	0.007337	0.66	14.43	45.85	0.38
121	3238	11.38	38.73	39.37	0.64	39.19	39.39	0.007211	0.70	16.28	46.86	0.38
121	3238	13.96	38.73	39.41	0.68	39.22	39.44	0.007322	0.75	18.50	48.05	0.39
121	3238	20.14	38.73	39.52	0.79	39.28	39.55	0.007423	0.85	23.68	51.91	0.40
121	3185	9.94	38.52	39.02	0.50	38.82	39.04	0.004678	0.53	18.80	59.50	0.30
121	3185	11.86	38.52	39.06	0.54	38.84	39.08	0.004795	0.56	21.14	62.34	0.31
121	3185	14.53	38.52	39.11	0.59	38.87	39.13	0.004671	0.60	24.35	64.17	0.31
121	3185	20.92	38.52	39.20	0.68	38.93	39.23	0.004984	0.69	30.39	67.89	0.33
121	3155	9.94	37.89	38.82	0.93	38.53	38.84	0.009572	0.69	14.39	52.12	0.42
121	3155	11.86	37.89	38.85	0.96	38.57	38.88	0.009877	0.74	16.02	53.57	0.43

HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	3155	14.53	37.89	38.90	1.01	38.63	38.93	0.010602	0.77	18.84	62.49	0.45
121	3155	20.92	37.89	38.97	1.08	38.79	39.01	0.011313	0.88	23.64	66.95	0.48
121	3134	9.94	37.74	38.52	0.78	38.35	38.56	0.022537	0.86	11.54	57.13	0.61
121	3134	11.86	37.74	38.54	0.80	38.43	38.59	0.022388	0.91	13.01	58.86	0.62
121	3134	14.53	37.74	38.58	0.84	38.48	38.62	0.022270	0.97	14.93	60.93	0.63
121	3134	20.92	37.74	38.65	0.91	38.56	38.71	0.020474	1.07	19.52	64.71	0.62
121	3073	9.94	37.33	37.88	0.55	37.69	37.89	0.006267	0.55	18.09	67.31	0.34
121	3073	11.86	37.33	37.91	0.58	37.72	37.93	0.006225	0.59	20.22	68.03	0.34
121	3073	14.53	37.33	37.95	0.62	37.75	37.97	0.006145	0.63	23.02	68.97	0.35
121	3073	20.92	37.33	38.03	0.70	37.81	38.06	0.006355	0.73	28.60	70.80	0.37
121	2983	11.43	35.91	36.39	0.48	36.39	36.53	0.054249	1.67	6.86	24.28	1.00
121	2983	13.59	35.91	36.43	0.52	36.43	36.59	0.052926	1.73	7.86	25.84	1.00
121	2983	16.71	35.91	36.49	0.58	36.49	36.65	0.051088	1.80	9.27	27.90	1.00
121	2983	23.79	35.91	36.60	0.69	36.58	36.78	0.043079	1.86	12.80	32.40	0.94
121	2820	11.43	34.16	35.36	1.20	34.76	35.37	0.001986	0.57	20.01	29.57	0.22
121	2820	13.59	34.16	35.44	1.28	34.81	35.46	0.002014	0.60	22.63	31.32	0.23
121	2820	16.71	34.16	35.55	1.39	34.87	35.57	0.002056	0.64	26.27	33.88	0.23
121	2820	23.79	34.16	35.77	1.61	35.00	35.79	0.002144	0.70	34.18	39.75	0.24
121	2670	11.43	33.46	34.35	0.89	34.33	34.56	0.039186	2.01	5.68	11.77	0.92
121	2670	13.59	33.46	34.43	0.97	34.39	34.65	0.037222	2.08	6.54	12.41	0.91
121	2670	16.71	33.46	34.52	1.06	34.47	34.76	0.034465	2.15	7.79	13.30	0.90
121	2670	23.79	33.46	34.75	1.29	34.64	34.99	0.027838	2.16	11.04	15.93	0.83
121	2554	11.43	32.54	33.76	1.22	33.20	33.78	0.002424	0.65	17.49	24.42	0.25
121	2554	13.59	32.54	33.86	1.32	33.25	33.88	0.002378	0.68	19.93	25.76	0.25
121	2554	16.71	32.54	33.99	1.45	33.32	34.01	0.002331	0.72	23.33	27.58	0.25
121	2554	23.79	32.54	34.19	1.64	33.45	34.22	0.002590	0.82	29.06	30.41	0.27
121	2463	11.43	32.13	33.19	1.06	33.00	33.31	0.017275	1.53	7.46	12.55	0.63
121	2463	13.59	32.13	33.29	1.16	33.06	33.41	0.017890	1.55	8.77	14.91	0.64
121	2463	16.71	32.13	33.42	1.29	33.16	33.53	0.020873	1.50	11.16	22.49	0.68

HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	2463	23.79	32.13	33.61	1.48	33.40	33.72	0.017773	1.46	16.27	30.19	0.64
121	2376	11.43	31.20	32.88	1.68	32.02	32.89	0.001987	0.55	20.72	32.12	0.22
121	2376	13.59	31.20	33.02	1.82	32.08	33.03	0.001716	0.53	25.77	38.34	0.21
121	2376	16.71	31.20	33.11	1.91	32.16	33.13	0.001807	0.57	29.43	40.75	0.21
121	2376	23.79	31.20	33.26	2.06	32.33	33.28	0.002176	0.67	35.70	44.70	0.24
121	2283	14.93	31.13	32.57	1.44	32.13	32.60	0.004653	0.77	19.45	34.89	0.33
121	2283	17.69	31.13	32.73	1.60	32.23	32.75	0.005091	0.67	26.39	62.14	0.33
121	2283	21.64	31.13	32.80	1.67	32.30	32.83	0.005665	0.69	31.39	76.88	0.34
121	2283	30.43	31.13	32.91	1.78	32.41	32.94	0.006081	0.75	40.65	92.81	0.36
121	2171	14.93	30.73	31.45	0.72	31.36	31.56	0.026261	1.49	10.00	24.26	0.74
121	2171	17.69	30.73	31.56	0.83	31.41	31.64	0.026483	1.32	13.44	39.63	0.72
121	2171	21.64	30.73	31.64	0.91	31.47	31.72	0.021036	1.30	16.65	42.13	0.66
121	2171	30.43	30.73	31.80	1.07	31.61	31.87	0.016801	1.13	26.84	90.33	0.60
121	2142	14.93	30.20	31.19	0.99	30.84	31.23	0.006034	0.87	17.10	30.82	0.37
121	2142	17.69	30.20	31.23	1.03	30.89	31.28	0.007298	0.96	18.41	33.11	0.41
121	2142	21.64	30.20	31.28	1.08	30.95	31.34	0.009107	1.08	20.09	35.97	0.46
121	2142	30.43	30.20	31.38	1.19	31.08	31.46	0.012267	1.25	24.39	43.81	0.53
121	2013	14.93	28.84	29.63	0.79	29.57	29.73	0.029992	1.42	10.54	30.50	0.77
121	2013	17.69	28.84	29.73	0.89	29.61	29.81	0.019645	1.30	13.62	32.70	0.64
121	2013	21.64	28.84	29.85	1.01	29.65	29.93	0.013237	1.21	17.83	35.23	0.54
121	2013	30.43	28.84	30.10	1.26	29.76	30.16	0.008380	1.10	27.65	44.91	0.45
121	1866	18.54	28.08	29.32	1.24	28.60	29.33	0.001032	0.51	36.60	39.51	0.17
121	1866	21.89	28.08	29.42	1.34	28.63	29.43	0.001052	0.54	40.63	40.56	0.17
121	1866	26.69	28.08	29.55	1.47	28.69	29.57	0.001078	0.58	46.03	41.89	0.18
121	1866	37.31	28.08	29.79	1.71	28.79	29.81	0.001162	0.66	56.61	44.98	0.19
121	1748	18.54	27.50	29.01	1.51	28.47	29.07	0.007444	1.04	17.87	28.92	0.42
121	1748	21.89	27.50	29.12	1.62	28.54	29.18	0.006465	1.04	21.14	30.89	0.40
121	1748	26.69	27.50	29.26	1.76	28.64	29.32	0.005625	1.04	25.59	33.30	0.38
121	1748	37.31	27.50	29.49	1.99	28.83	29.55	0.005949	1.10	34.07	43.01	0.39

HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

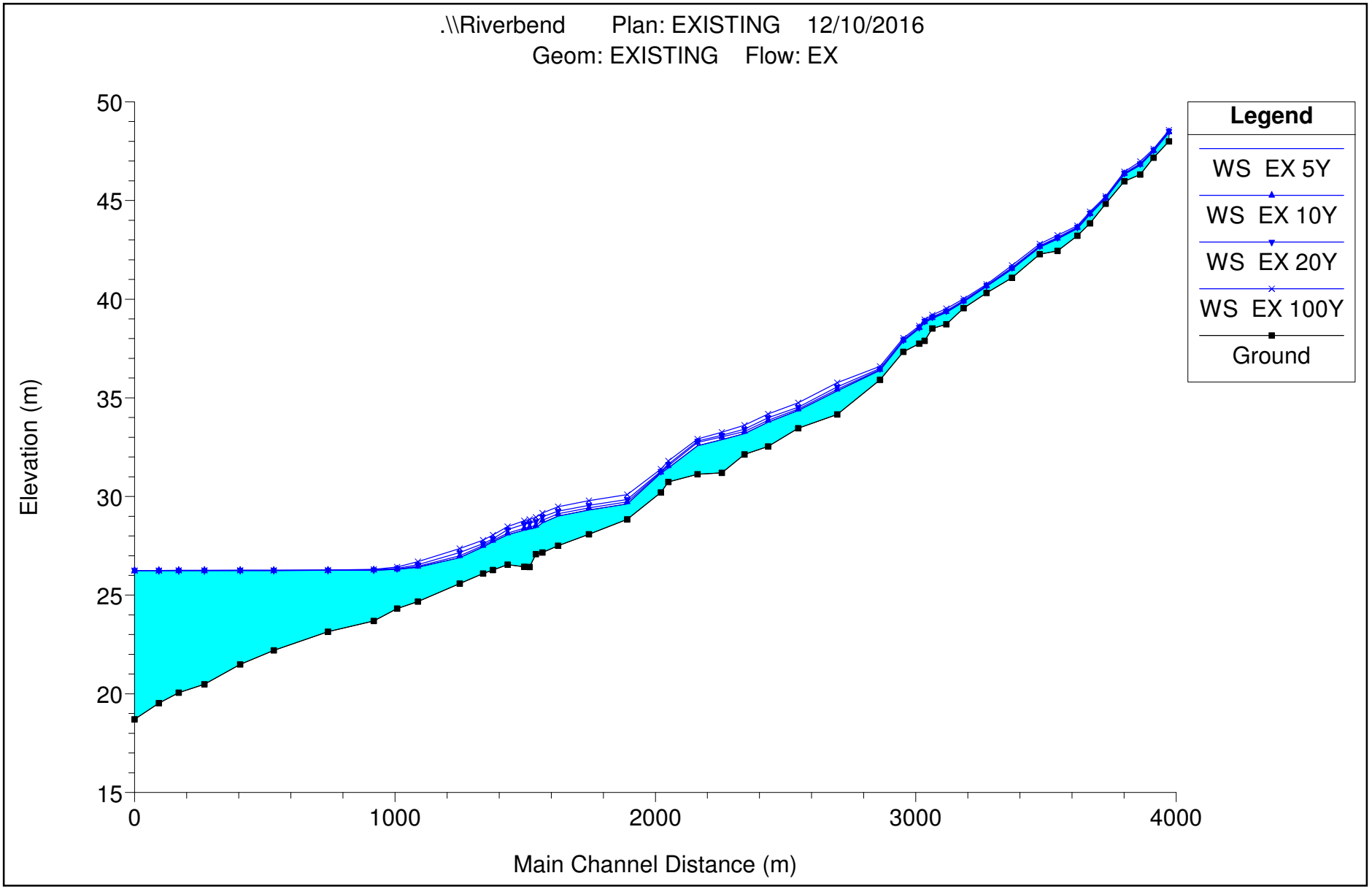
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	1687	18.54	27.16	28.67	1.51	28.09	28.71	0.004679	0.95	19.51	25.38	0.35
121	1687	21.89	27.16	28.80	1.64	28.16	28.84	0.004762	0.95	23.08	30.54	0.35
121	1687	26.69	27.16	28.97	1.81	28.25	29.01	0.004496	0.92	28.92	38.19	0.34
121	1687	37.31	27.16	29.16	2.00	28.42	29.21	0.005088	0.99	37.50	48.62	0.36
121	1662	18.54	27.08	28.42	1.34	28.08	28.53	0.012048	1.49	12.40	16.54	0.55
121	1662	21.89	27.08	28.53	1.45	28.16	28.65	0.013865	1.52	14.42	20.94	0.58
121	1662	26.69	27.08	28.74	1.66	28.27	28.83	0.012982	1.31	20.37	35.25	0.55
121	1662	37.31	27.08	28.95	1.87	28.52	29.03	0.010411	1.28	29.10	44.11	0.50
121	1638	18.54	26.43	28.35	1.92	27.50	28.39	0.002596	0.81	22.81	23.98	0.27
121	1638	21.89	26.43	28.45	2.02	27.59	28.49	0.002795	0.87	25.29	25.58	0.28
121	1638	26.69	26.43	28.66	2.23	27.69	28.69	0.002525	0.87	30.80	28.83	0.27
121	1638	37.31	26.43	28.84	2.41	27.89	28.89	0.003231	1.02	36.40	31.90	0.31
121	1618	18.54	26.44	28.29	1.85	27.64	28.33	0.003217	0.83	22.39	27.00	0.29
121	1618	21.89	26.44	28.39	1.95	27.71	28.43	0.003285	0.87	25.08	28.40	0.30
121	1618	26.69	26.44	28.60	2.16	27.81	28.63	0.003256	0.83	32.01	46.09	0.29
121	1618	37.31	26.44	28.77	2.33	27.98	28.81	0.004521	0.88	42.23	73.70	0.34
121	1554	20.37	26.54	28.06	1.52	27.42	28.10	0.004057	0.87	23.40	31.30	0.32
121	1554	24.10	26.54	28.15	1.61	27.50	28.19	0.004287	0.92	26.29	37.68	0.33
121	1554	29.42	26.54	28.32	1.78	27.60	28.36	0.005861	0.81	36.32	94.74	0.37
121	1554	40.87	26.54	28.48	1.94	27.78	28.51	0.004921	0.73	55.85	152.56	0.34
121	1497	20.37	26.27	27.70	1.43	27.30	27.76	0.009202	1.12	18.15	30.68	0.47
121	1497	24.10	26.27	27.77	1.50	27.38	27.84	0.009358	1.18	20.42	32.40	0.47
121	1497	29.42	26.27	27.86	1.59	27.53	27.94	0.009465	1.25	23.49	34.38	0.48
121	1497	40.87	26.27	28.05	1.78	27.67	28.14	0.009479	1.35	30.20	42.63	0.49
121	1460	20.37	26.09	27.44	1.35	27.11	27.48	0.005861	0.89	22.77	38.56	0.37
121	1460	24.10	26.09	27.51	1.42	27.16	27.56	0.005851	0.94	25.59	40.07	0.38
121	1460	29.42	26.09	27.61	1.52	27.22	27.66	0.005850	1.00	29.40	42.02	0.38
121	1460	40.87	26.09	27.79	1.70	27.33	27.85	0.005855	1.06	38.54	78.03	0.39

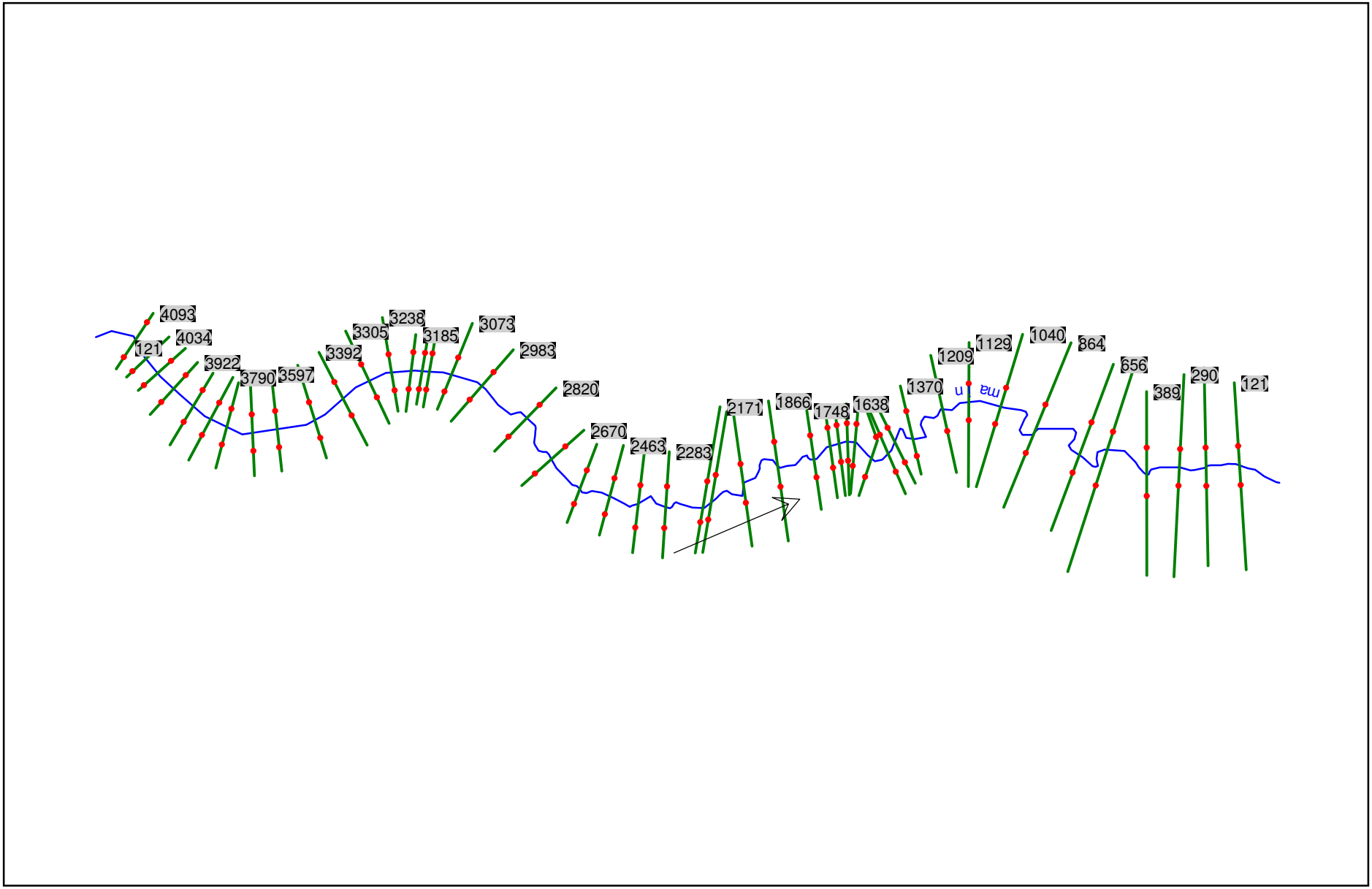
HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	1370	20.37	25.58	26.90	1.32	26.41	26.94	0.006165	0.90	22.71	39.84	0.38
121	1370	24.10	25.58	27.00	1.42	26.48	27.04	0.005690	0.90	26.77	43.95	0.37
121	1370	29.42	25.58	27.16	1.58	26.57	27.20	0.004455	0.86	34.39	50.73	0.33
121	1370	40.87	25.58	27.36	1.78	26.77	27.40	0.004312	0.90	45.60	63.20	0.33
121	1209	22.17	24.67	26.41	1.74	25.71	26.43	0.001978	0.60	36.97	50.49	0.22
121	1209	26.22	24.67	26.46	1.79	25.78	26.48	0.002360	0.66	39.49	52.85	0.25
121	1209	31.91	24.67	26.55	1.88	25.86	26.57	0.003413	0.71	44.91	71.69	0.29
121	1209	44.17	24.67	26.70	2.03	25.99	26.73	0.004001	0.77	57.40	91.70	0.31
121	1129	22.17	24.32	26.30	1.98	25.25	26.31	0.001087	0.46	47.78	61.41	0.17
121	1129	26.22	24.32	26.32	2.00	25.32	26.34	0.001425	0.54	48.99	62.25	0.19
121	1129	31.91	24.32	26.35	2.03	25.41	26.37	0.001911	0.63	50.87	63.48	0.22
121	1129	44.17	24.32	26.43	2.11	25.57	26.46	0.002879	0.79	56.06	75.14	0.28
121	1040	23.20	23.69	26.26	2.57	24.64	26.27	0.000277	0.25	91.04	126.14	0.09
121	1040	27.42	23.69	26.27	2.58	24.70	26.28	0.000379	0.30	91.80	127.15	0.10
121	1040	33.13	23.69	26.28	2.59	24.78	26.29	0.000535	0.36	93.02	128.75	0.12
121	1040	45.82	23.69	26.31	2.62	24.94	26.32	0.000934	0.47	96.51	131.07	0.16
121	864	23.20	23.15	26.26	3.11	23.71	26.26	0.000025	0.11	214.10	162.85	0.03
121	864	27.42	23.15	26.26	3.11	23.76	26.26	0.000035	0.13	214.54	162.98	0.03
121	864	33.13	23.15	26.26	3.11	23.82	26.26	0.000051	0.15	215.26	163.21	0.04
121	864	45.82	23.15	26.28	3.13	23.93	26.28	0.000095	0.21	217.30	163.83	0.06
121	656	23.74	22.20	26.25	4.05	23.31	26.25	0.000012	0.08	281.86	175.44	0.02
121	656	28.05	22.20	26.25	4.05	23.39	26.25	0.000017	0.10	282.11	175.48	0.02
121	656	33.83	22.20	26.26	4.06	23.48	26.26	0.000025	0.12	282.51	175.56	0.03
121	656	46.67	22.20	26.26	4.06	23.63	26.26	0.000046	0.16	283.67	175.76	0.04
121	526	23.74	21.49	26.25	4.76	22.32	26.25	0.000003	0.05	439.38	195.65	0.01
121	526	28.05	21.49	26.25	4.76	22.39	26.25	0.000004	0.06	439.62	195.69	0.01
121	526	33.83	21.49	26.26	4.77	22.48	26.26	0.000006	0.08	440.01	195.76	0.02
121	526	46.67	21.49	26.26	4.77	22.63	26.26	0.000011	0.11	441.12	195.95	0.02
121	389	27.71	20.48	26.25	5.77	21.50	26.25	0.000005	0.07	384.64	157.36	0.01

HEC-RAS Plan: EXISTING River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	389	32.61	20.48	26.25	5.77	21.56	26.25	0.000007	0.08	384.79	157.39	0.02
121	389	39.32	20.48	26.25	5.77	21.63	26.25	0.000010	0.10	385.04	157.44	0.02
121	389	54.39	20.48	26.26	5.78	21.78	26.26	0.000019	0.14	385.75	157.60	0.03
121	290	27.71	20.06	26.25	6.19	21.07	26.25	0.000003	0.06	442.86	185.34	0.01
121	290	32.61	20.06	26.25	6.19	21.14	26.25	0.000004	0.07	443.01	185.39	0.01
121	290	39.32	20.06	26.25	6.19	21.24	26.25	0.000006	0.09	443.26	185.49	0.02
121	290	54.39	20.06	26.26	6.20	21.42	26.26	0.000012	0.12	443.98	185.75	0.02
121	214	29.24	19.52	26.25	6.73	20.62	26.25	0.000013	0.12	252.22	132.83	0.02
121	214	34.38	19.52	26.25	6.73	20.71	26.25	0.000018	0.14	252.28	132.85	0.03
121	214	41.49	19.52	26.25	6.73	20.83	26.25	0.000026	0.16	252.38	132.88	0.03
121	214	57.08	19.52	26.25	6.73	21.05	26.26	0.000050	0.23	252.65	132.96	0.04
121	121	29.24	18.71	26.25	7.54	20.07	26.25	0.000011	0.13	231.17	62.86	0.02
121	121	34.38	18.71	26.25	7.54	20.16	26.25	0.000015	0.15	231.17	62.86	0.02
121	121	41.49	18.71	26.25	7.54	20.28	26.25	0.000021	0.18	231.17	62.86	0.03
121	121	57.08	18.71	26.25	7.54	20.51	26.25	0.000041	0.25	231.17	62.86	0.04


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
Legend
WS EX 5Y
WS EX 10Y
WS EX 20Y
WS EX 100Y
Ground
Elevation (m)
50
45
40
35
30
25
20
15
0
1000
2000
3000
4000
Main Channel Distance (m)


4093
4034
121
3922
3790
3597
3392
3305
3238
3185
3073
2983
2820
2670
2463
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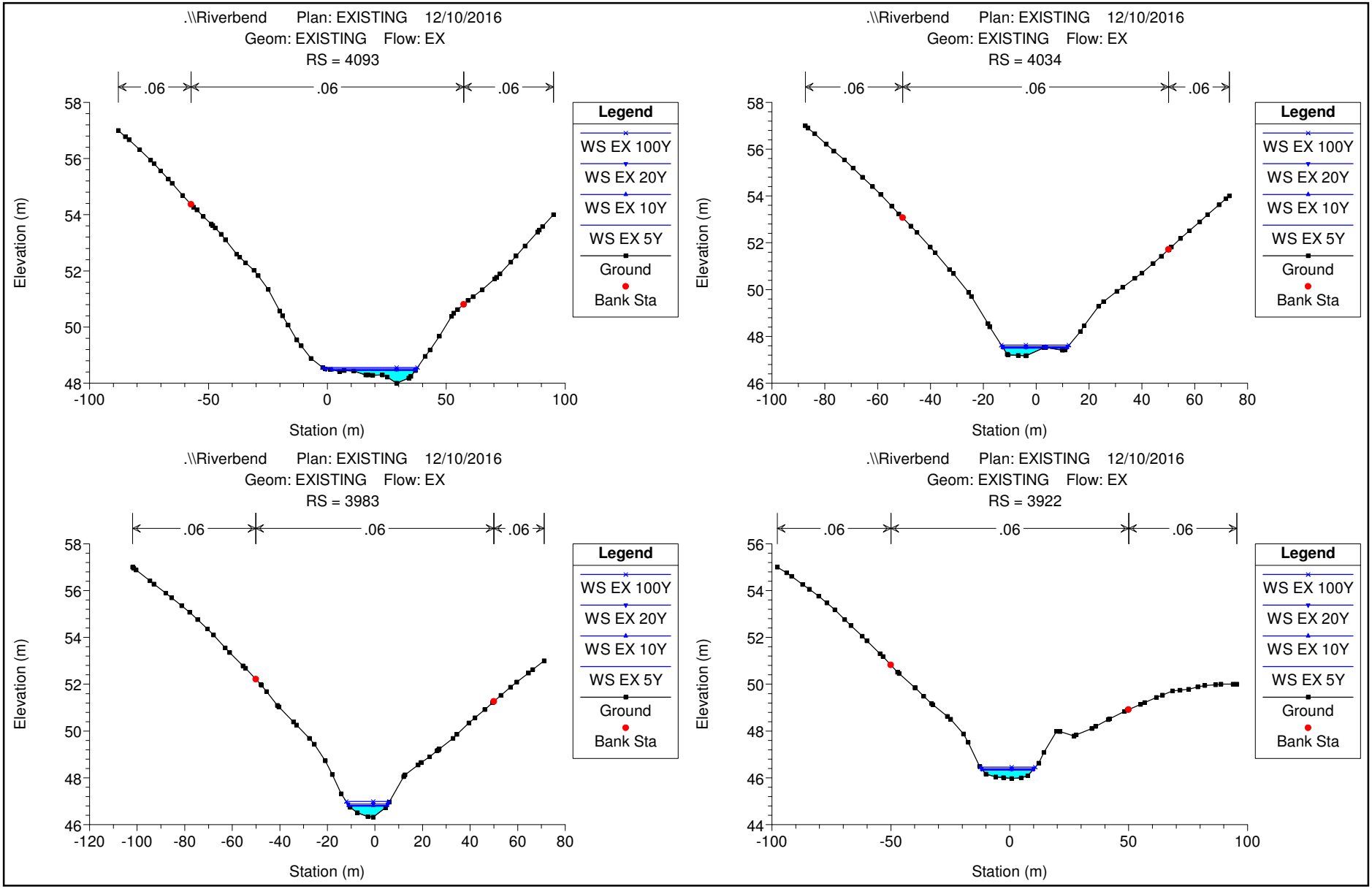
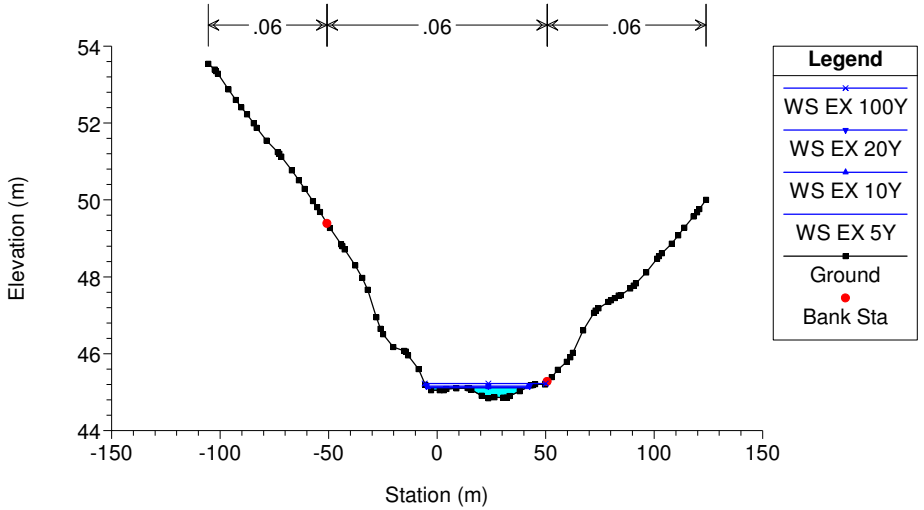
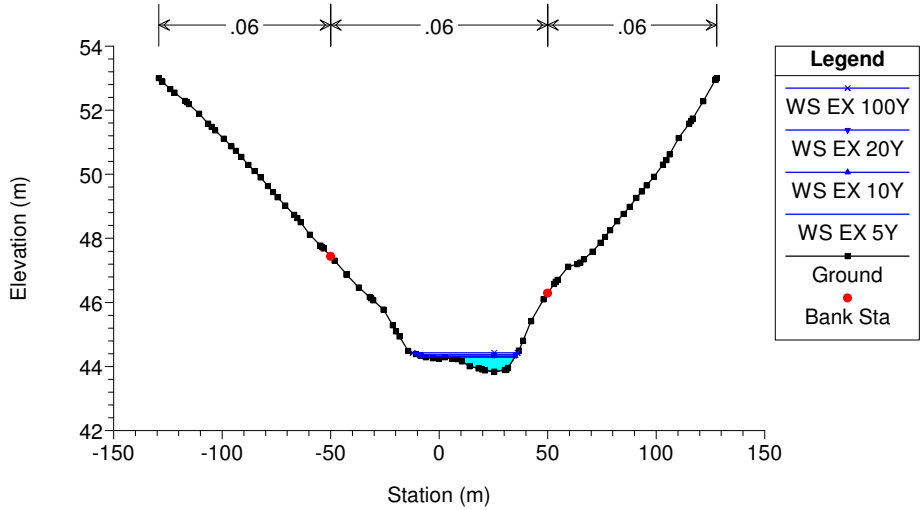
1209
1129
1040
364
656
389
290
121
ma
n


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 4093
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 4034
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3983
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3922
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta

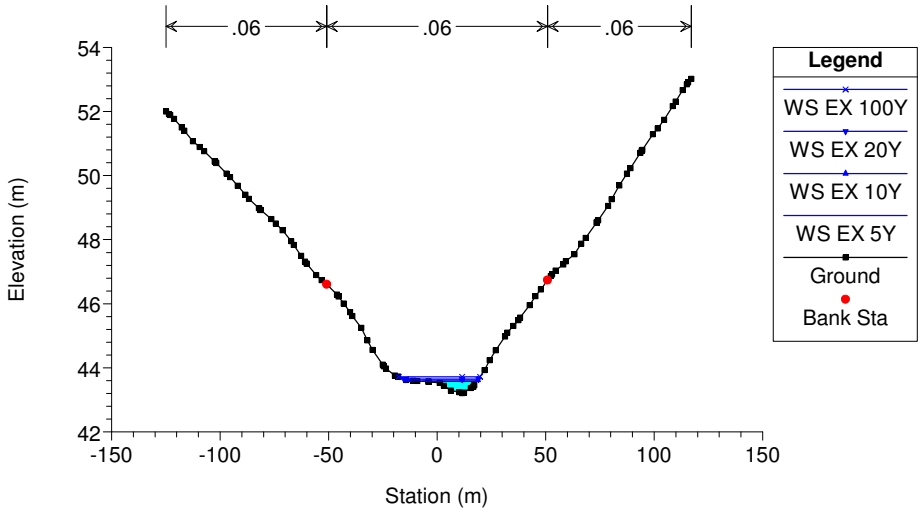
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3850



.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3790



.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3741



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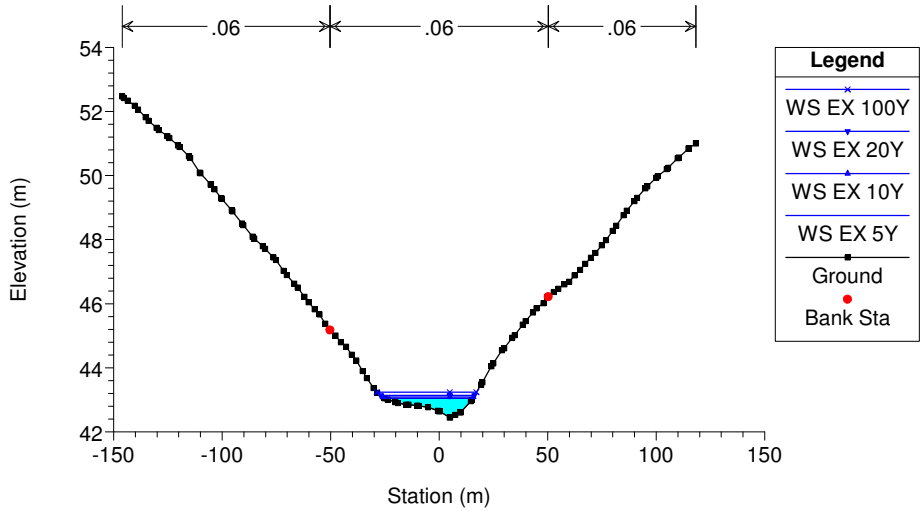
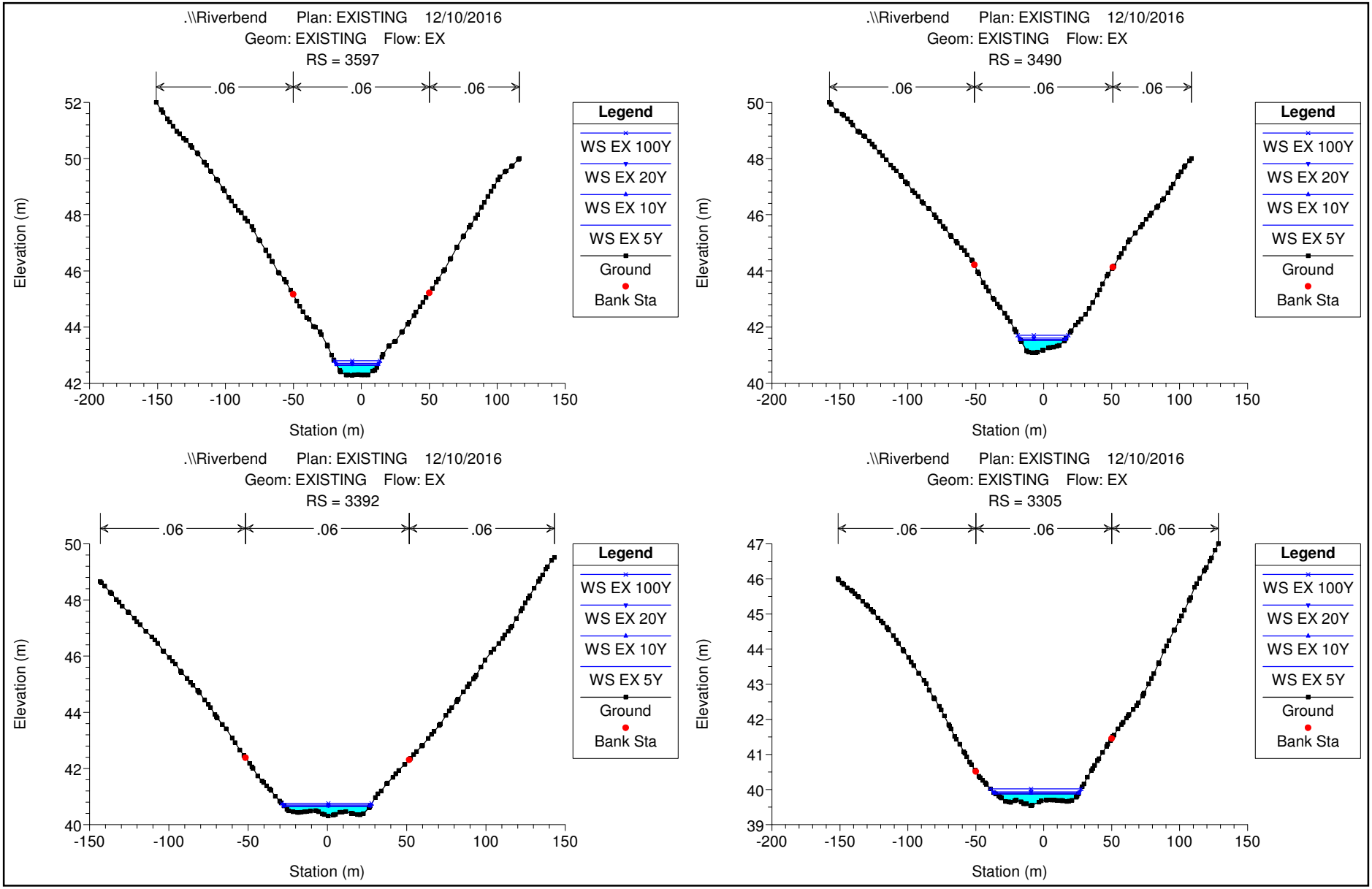
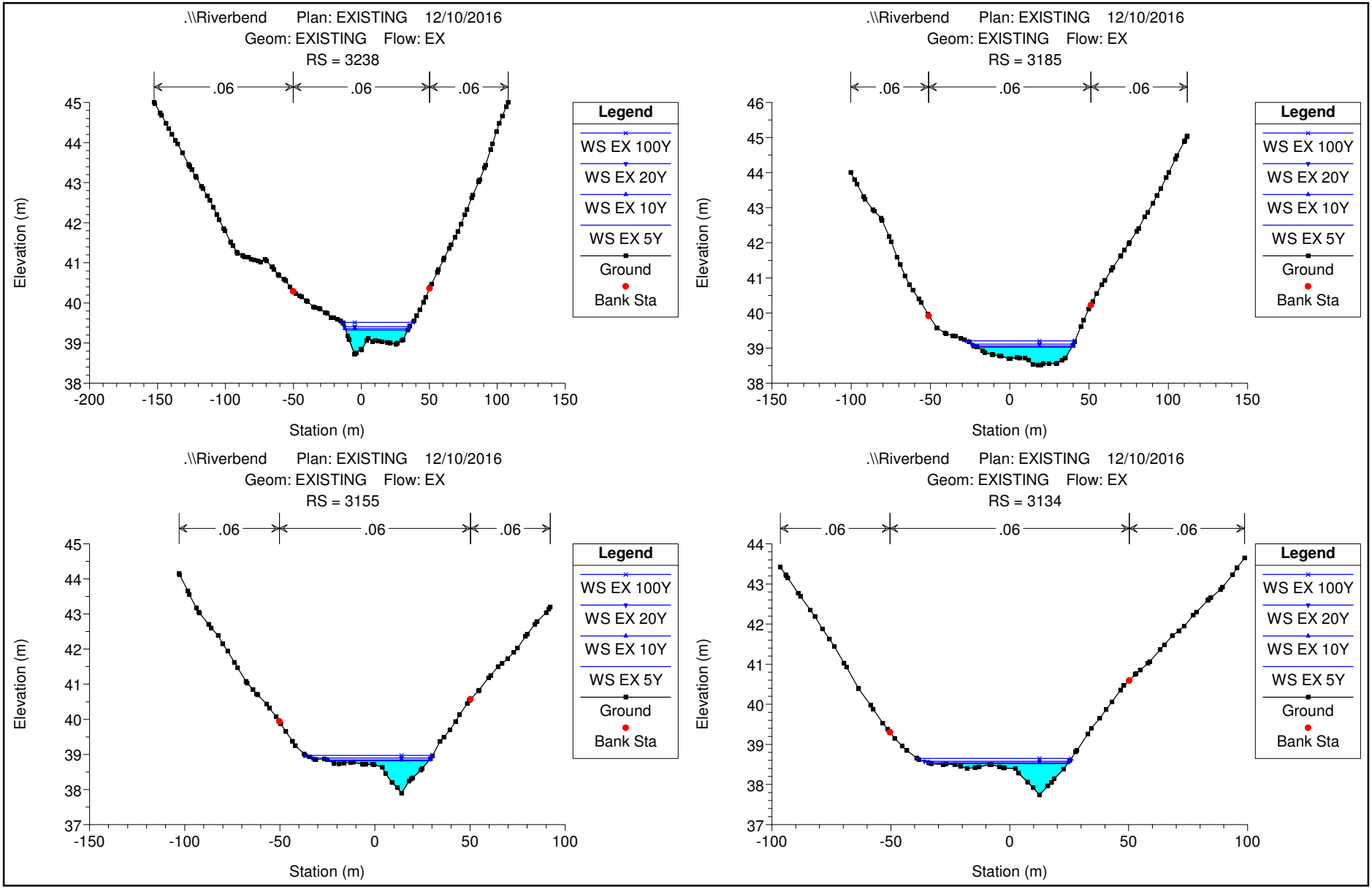
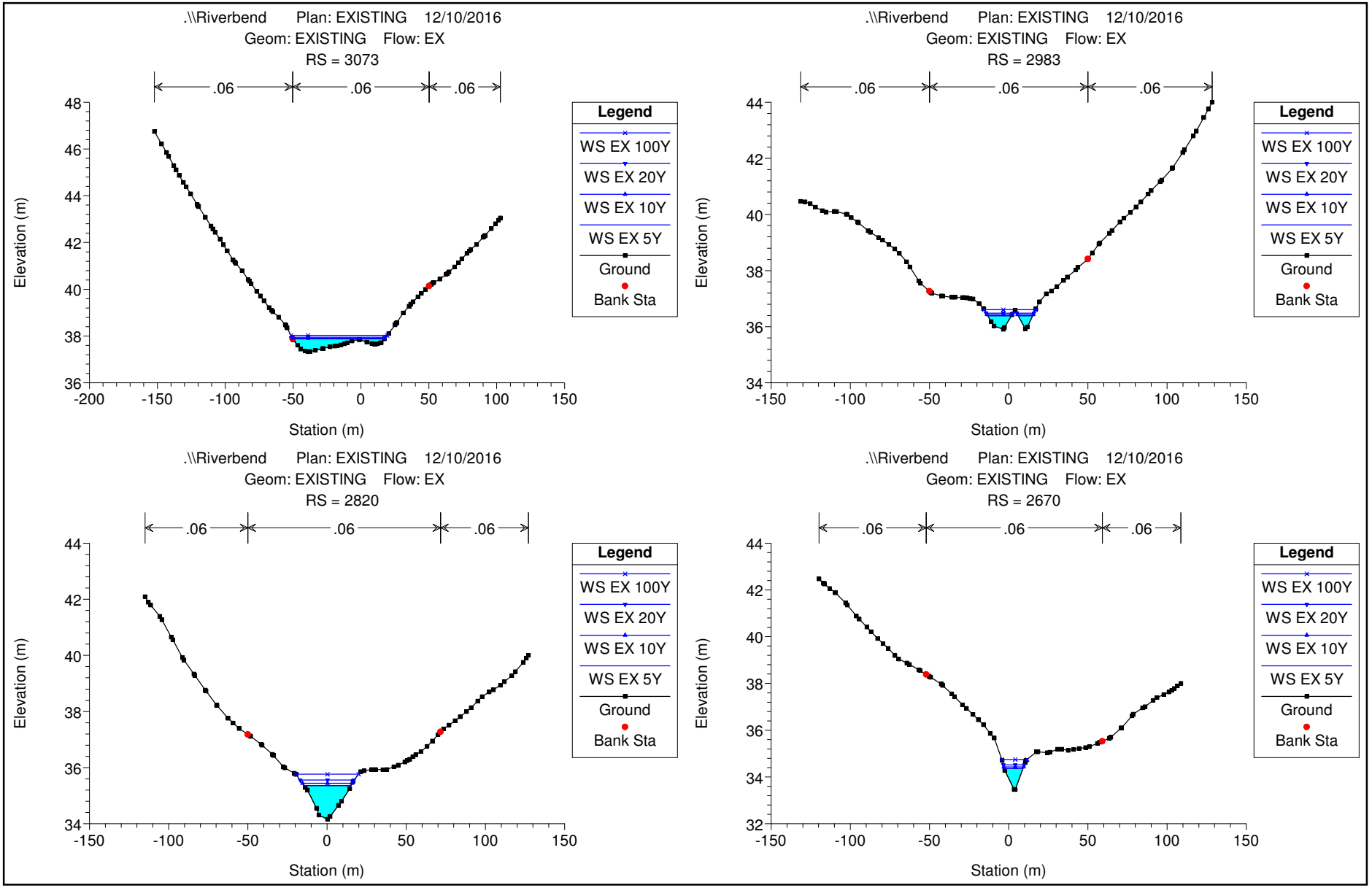
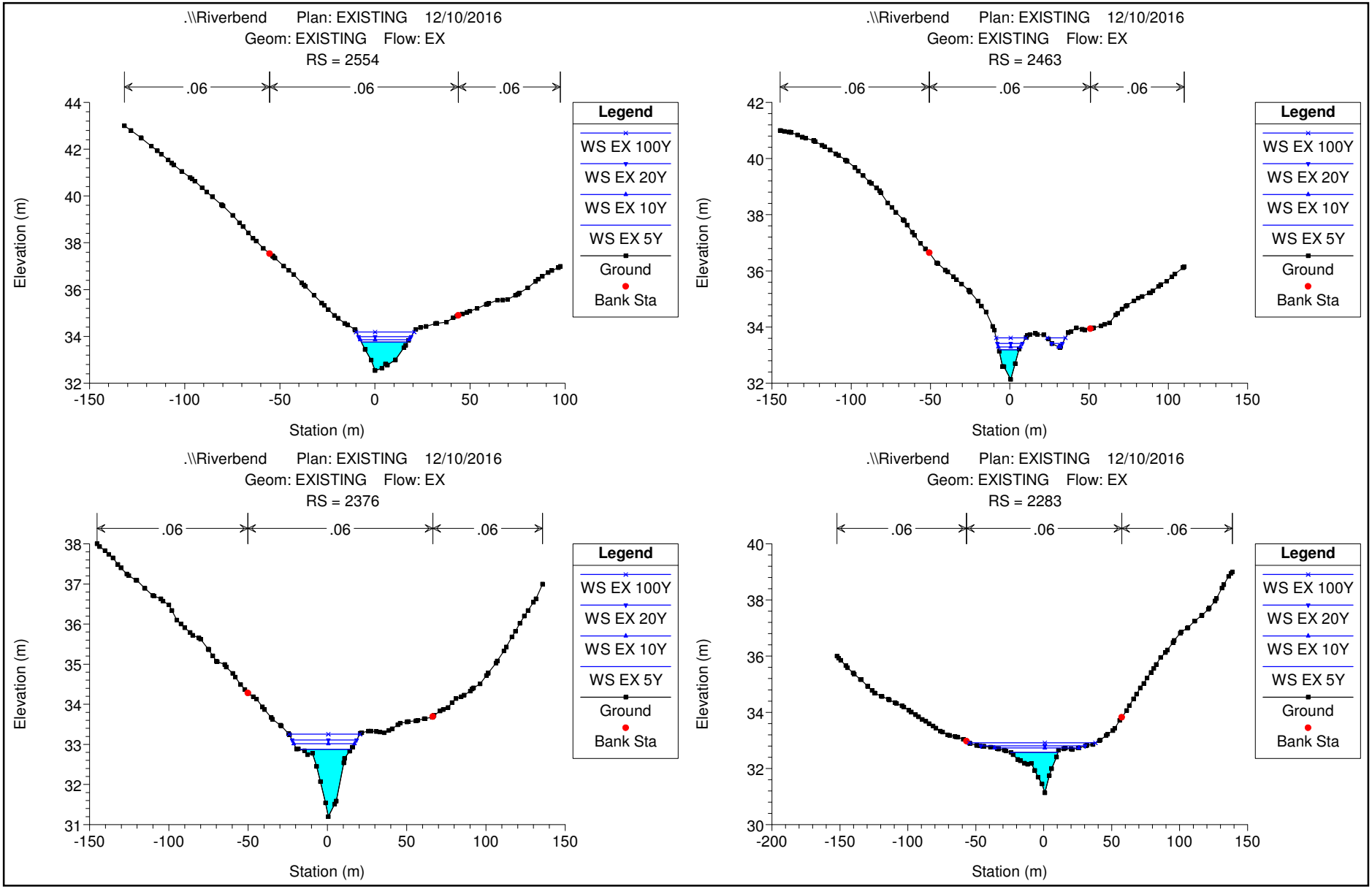
Geom: EXISTING Flow: EX
RS = 3665

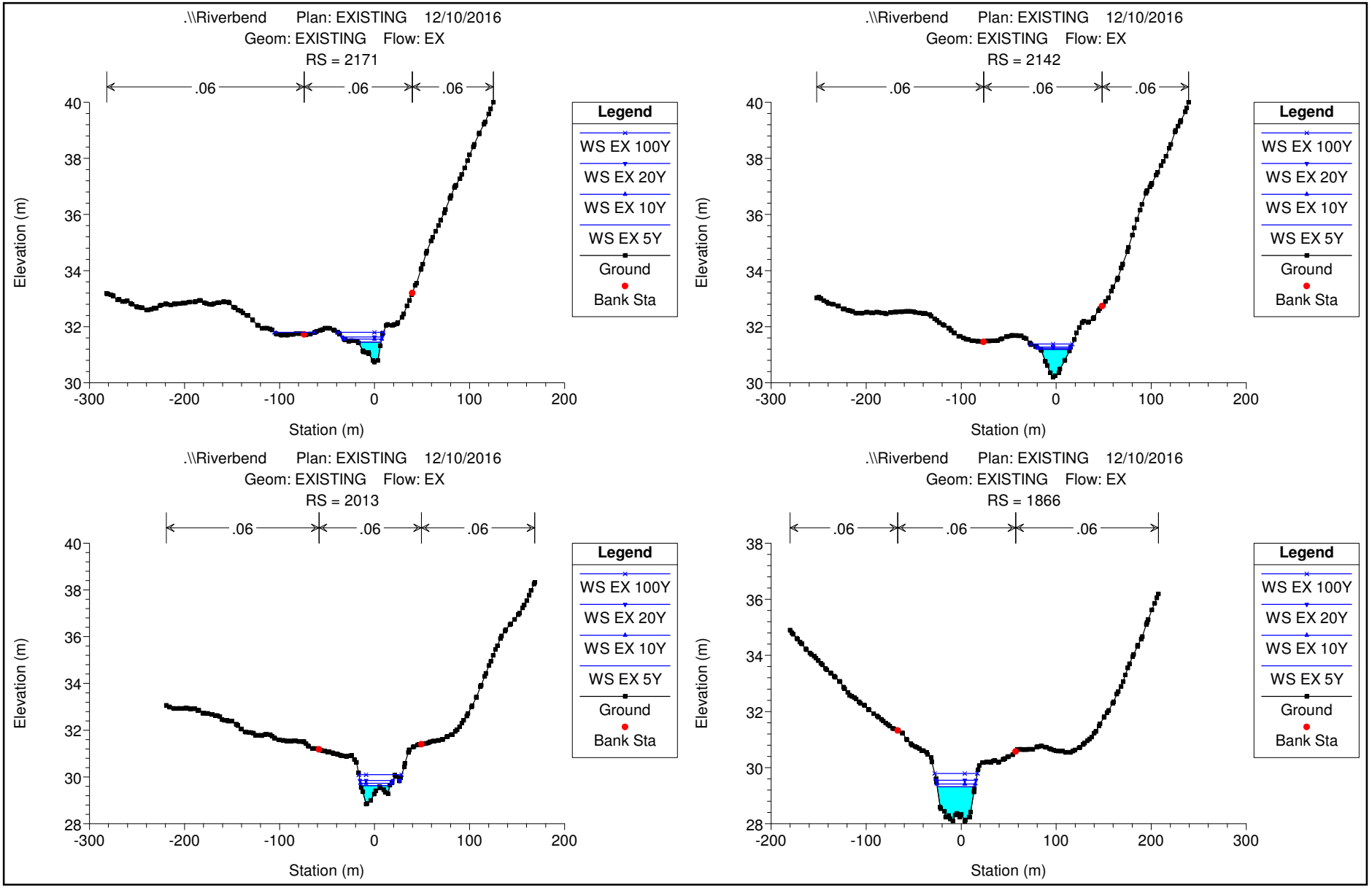


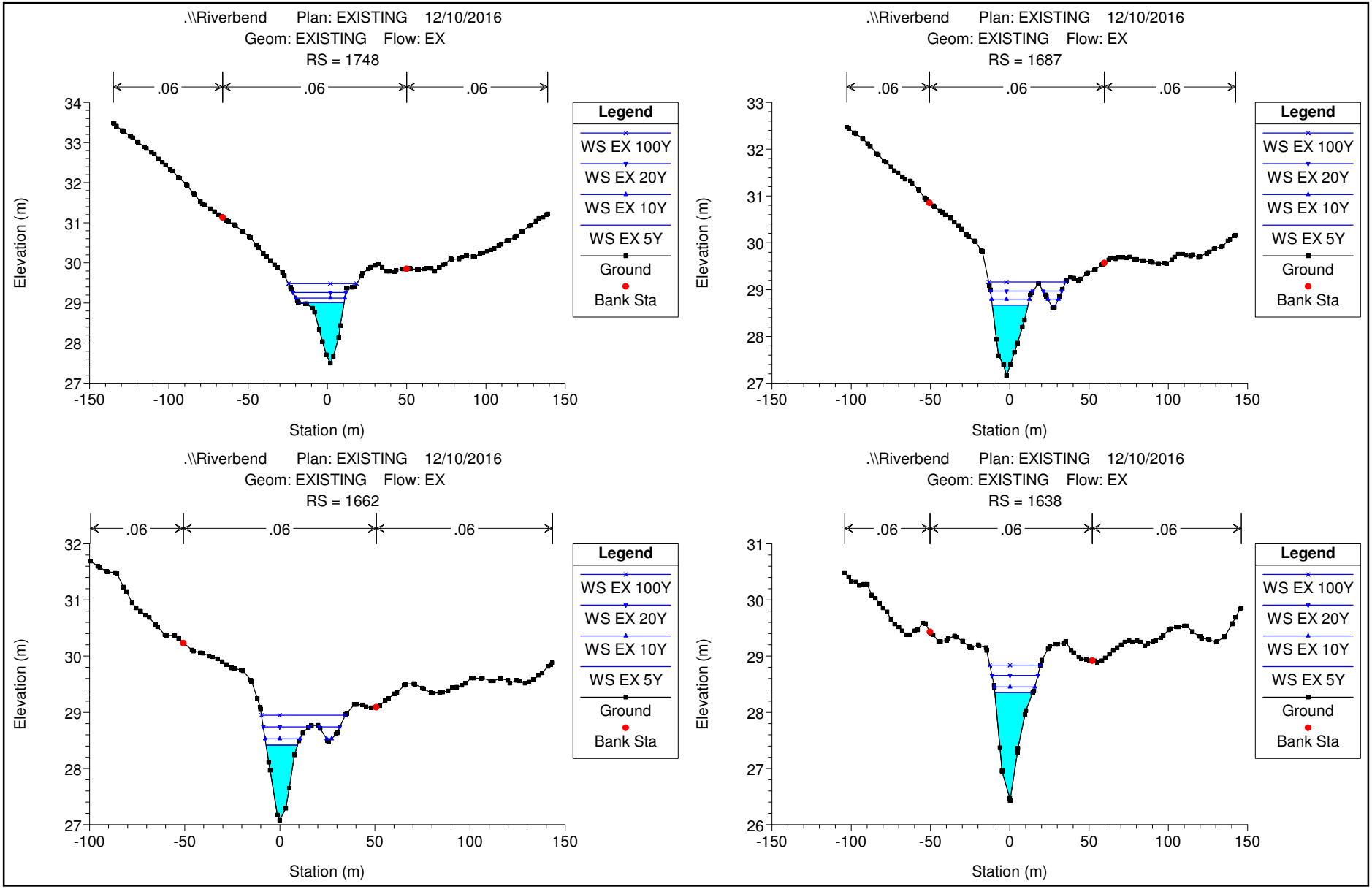

.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3597
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3490
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3392
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3305
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta

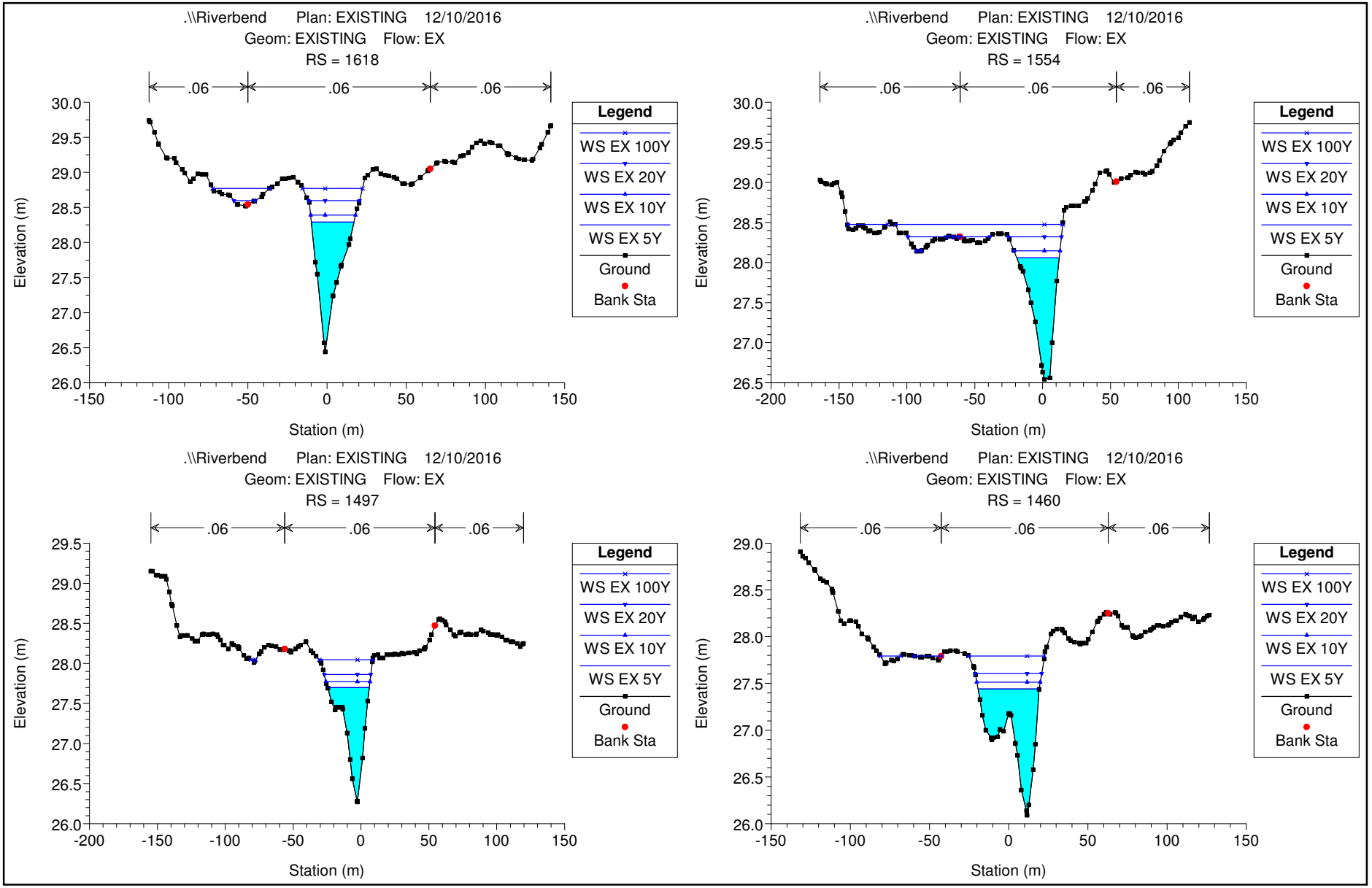

.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3238
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3185
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3155
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3134
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta

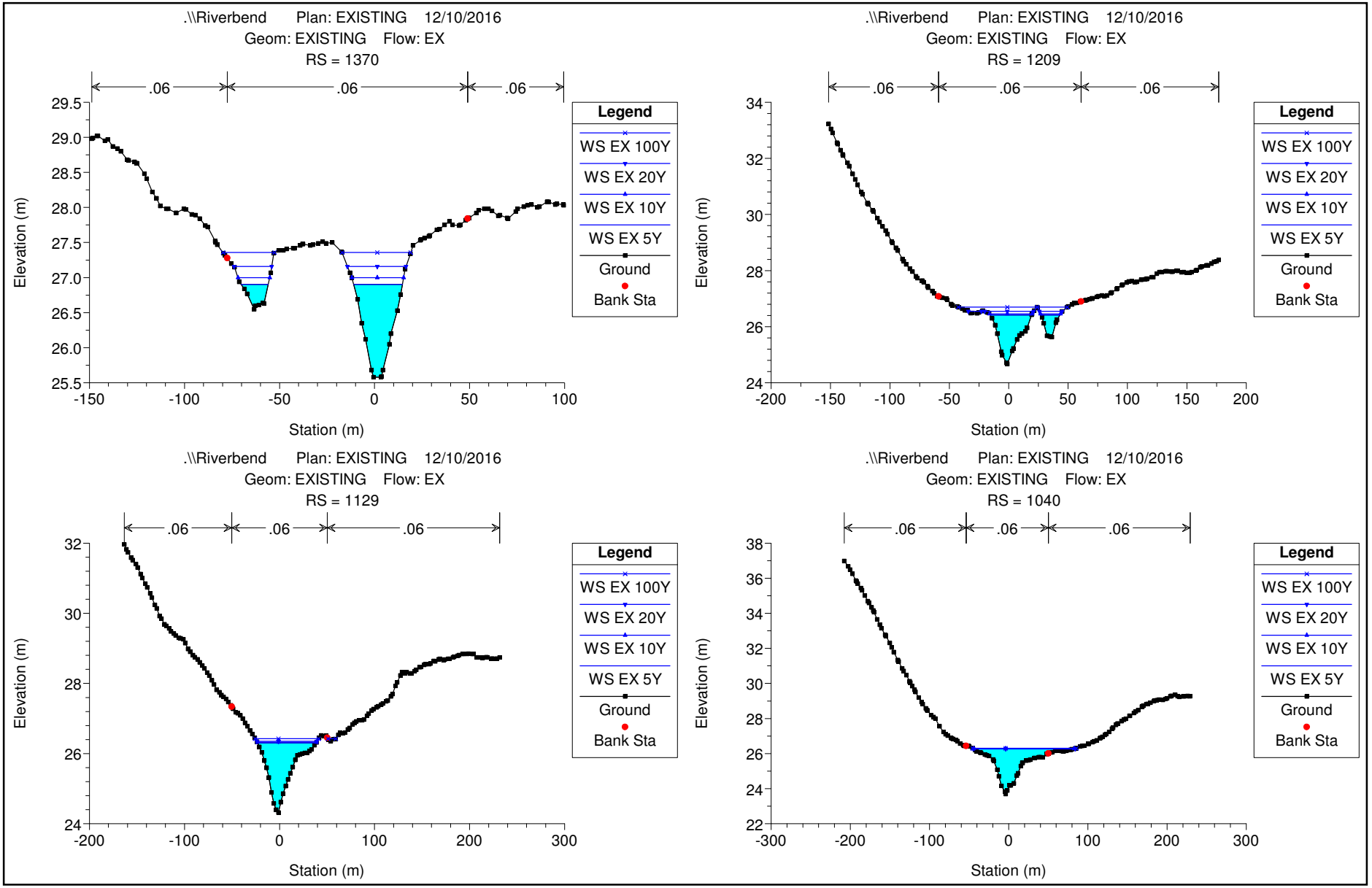

.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 3073
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2983
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2820
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2670
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta

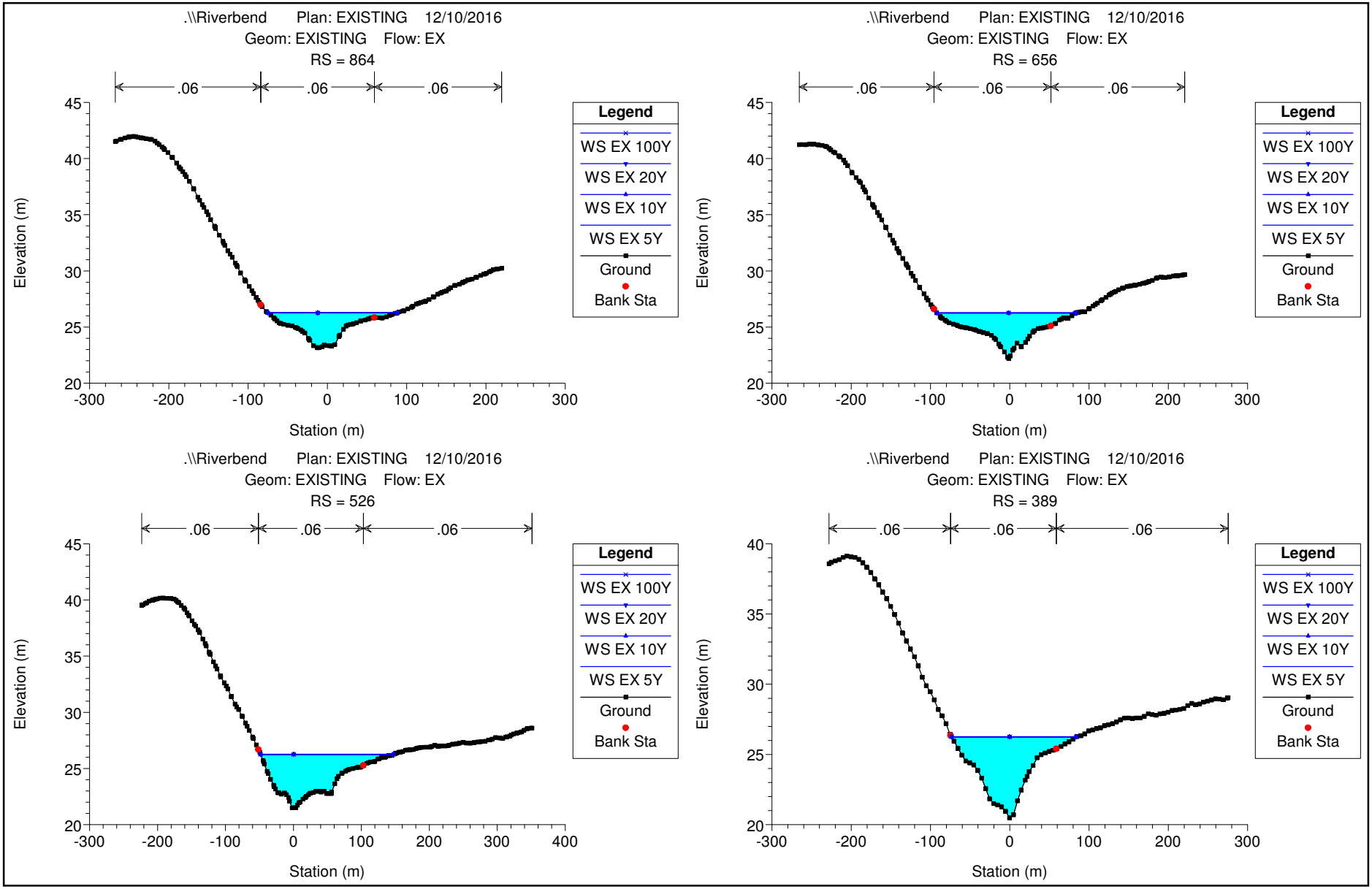

.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2554
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2463
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2376
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2283
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta

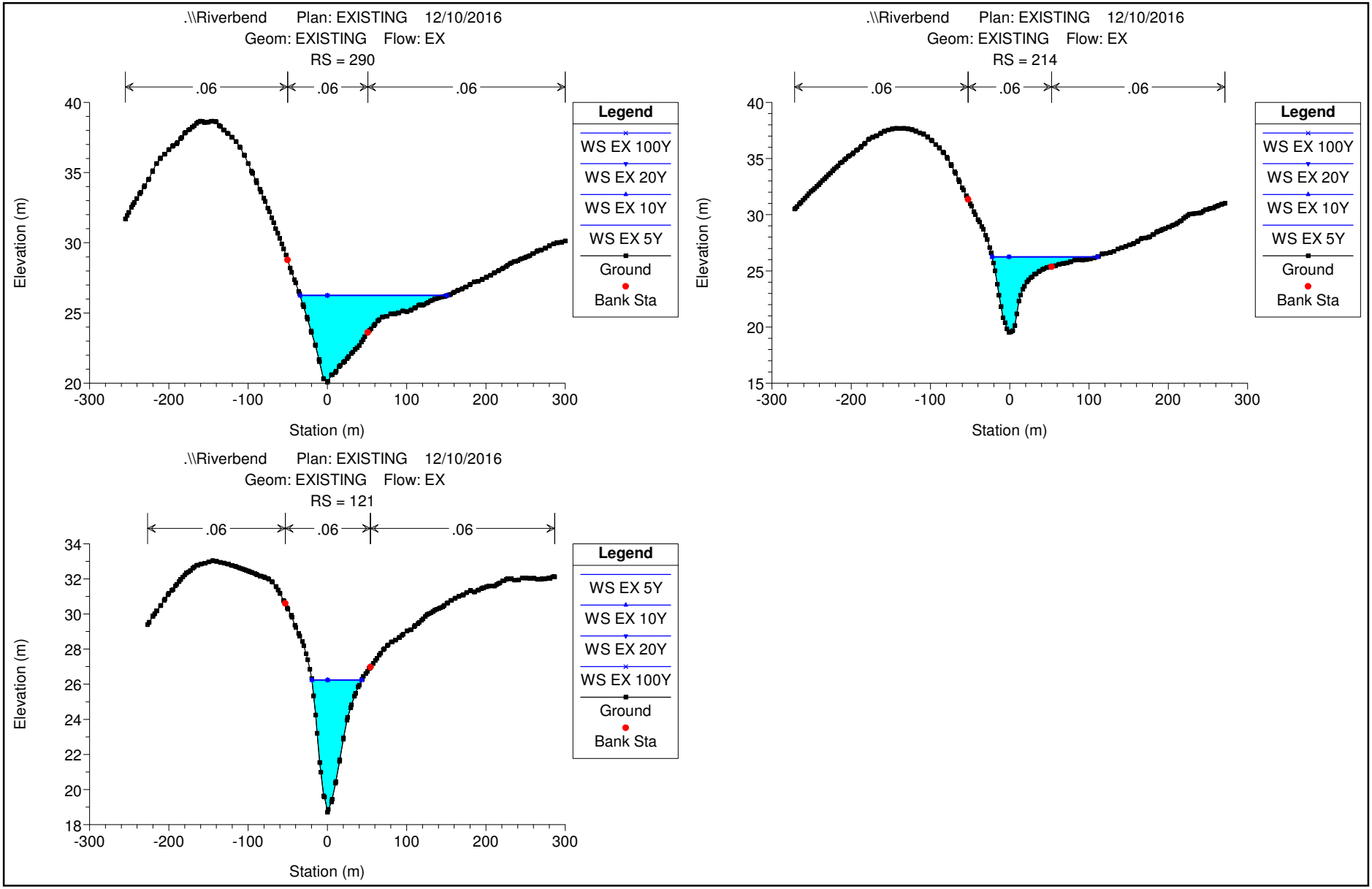

.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2171
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2142
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 2013
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1866
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1748
.06
.06
.06
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1687
.06
.06
.06
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1662
.06
.06
.06
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1638
.06
.06
.06
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
Elevation (m)
Station (m)


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1618
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1554
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1497
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1460
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1370
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1209
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1129
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 1040
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 864
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 656
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 526
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 389
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta


.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 290
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 214
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 100Y
WS EX 20Y
WS EX 10Y
WS EX 5Y
Ground
Bank Sta
.\\Riverbend Plan: EXISTING 12/10/2016
Geom: EXISTING Flow: EX
RS = 121
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS EX 5Y
WS EX 10Y
WS EX 20Y
WS EX 100Y
Ground
Bank Sta

HEC-RAS Plan: DEV River: main Reach: 121

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	4093	12.74	48.29	48.88	0.59	48.77	48.97	0.021291	1.30	9.82	24.61	0.66
121	4093	14.36	48.29	48.91	0.62	48.80	49.00	0.022326	1.37	10.45	24.84	0.68
121	4093	16.63	48.29	48.94	0.65	48.84	49.05	0.023611	1.47	11.28	25.15	0.70
121	4093	19.82	48.29	48.98	0.69	48.89	49.11	0.025298	1.60	12.36	25.54	0.74
121	4034	12.74	47.17	47.78	0.61	47.65	47.85	0.016704	1.16	10.97	27.62	0.59
121	4034	14.36	47.17	47.82	0.65	47.68	47.89	0.015778	1.19	12.08	28.14	0.58
121	4034	16.63	47.17	47.87	0.70	47.71	47.95	0.014765	1.22	13.59	28.82	0.57
121	4034	19.82	47.17	47.94	0.77	47.76	48.02	0.013661	1.27	15.55	29.20	0.56
121	3983	12.74	46.32	47.19	0.87	46.91	47.25	0.008622	1.07	11.91	20.62	0.45
121	3983	14.36	46.32	47.24	0.92	46.95	47.30	0.008837	1.12	12.83	21.15	0.46
121	3983	16.63	46.32	47.29	0.97	46.99	47.37	0.009113	1.18	14.06	21.84	0.47
121	3983	19.82	46.32	47.37	1.05	47.05	47.45	0.009530	1.27	15.63	22.60	0.49
121	3922	12.74	45.97	46.60	0.63	46.40	46.66	0.010946	1.06	12.00	25.21	0.49
121	3922	14.36	45.97	46.64	0.67	46.43	46.71	0.010801	1.10	13.05	25.70	0.49
121	3922	16.63	45.97	46.70	0.73	46.46	46.76	0.010635	1.15	14.43	26.19	0.50
121	3922	19.82	45.97	46.78	0.81	46.51	46.85	0.009984	1.20	16.52	26.92	0.49
121	3850	16.33	45.05	45.67	0.62	45.48	45.75	0.014095	1.26	12.92	24.67	0.56
121	3850	18.51	45.05	45.72	0.67	45.52	45.80	0.013997	1.31	14.10	25.30	0.56
121	3850	21.46	45.05	45.78	0.73	45.56	45.87	0.013924	1.37	15.63	26.08	0.57
121	3850	26.58	45.05	45.87	0.82	45.63	45.98	0.013940	1.47	18.11	27.31	0.58
121	3790	16.33	44.04	44.74	0.70	44.60	44.81	0.017453	1.25	13.08	29.92	0.60
121	3790	18.51	44.04	44.76	0.73	44.63	44.85	0.018197	1.33	13.94	29.93	0.62
121	3790	21.46	44.04	44.80	0.77	44.67	44.90	0.018997	1.43	15.05	29.93	0.64
121	3790	26.58	44.04	44.86	0.83	44.73	44.99	0.019902	1.57	16.90	29.93	0.67
121	3741	16.33	43.21	43.90	0.69	43.77	43.98	0.016680	1.22	13.38	30.51	0.59
121	3741	18.51	43.21	43.95	0.74	43.80	44.03	0.015603	1.26	14.73	30.51	0.58
121	3741	21.46	43.21	44.01	0.80	43.83	44.09	0.014504	1.30	16.48	30.51	0.57
121	3741	26.58	43.21	44.10	0.89	43.89	44.19	0.013254	1.38	19.29	30.51	0.55
121	3665	16.33	42.45	43.39	0.94	43.02	43.42	0.003987	0.79	20.65	30.49	0.31

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	3665	18.51	42.45	43.44	0.99	43.05	43.47	0.004077	0.84	22.14	30.49	0.31
121	3665	21.46	42.45	43.50	1.05	43.08	43.54	0.004180	0.89	24.05	30.49	0.32
121	3665	26.58	42.45	43.61	1.16	43.14	43.66	0.004218	0.97	27.34	30.49	0.33
121	3597	17.68	42.28	42.85	0.57	42.69	42.93	0.014732	1.24	14.28	29.34	0.57
121	3597	19.96	42.28	42.90	0.62	42.72	42.98	0.014633	1.29	15.48	29.74	0.57
121	3597	23.17	42.28	42.95	0.67	42.76	43.04	0.014300	1.35	17.12	29.99	0.57
121	3597	29.53	42.28	43.05	0.77	42.84	43.16	0.013574	1.46	20.17	29.99	0.57
121	3490	17.68	41.09	41.82	0.73	41.55	41.87	0.007050	0.98	18.11	30.30	0.40
121	3490	19.96	41.09	41.87	0.78	41.58	41.92	0.007033	1.02	19.51	30.30	0.41
121	3490	23.17	41.09	41.93	0.84	41.62	41.99	0.007113	1.09	21.30	30.30	0.41
121	3490	29.53	41.09	42.03	0.94	41.69	42.11	0.007379	1.21	24.43	30.30	0.43
121	3392	17.68	40.31	40.93	0.62	40.74	40.99	0.011796	1.13	15.71	31.03	0.50
121	3392	19.96	40.31	40.96	0.65	40.77	41.03	0.012108	1.19	16.78	31.03	0.52
121	3392	23.17	40.31	41.01	0.70	40.81	41.09	0.012094	1.26	18.38	31.03	0.52
121	3392	29.53	40.31	41.12	0.81	40.87	41.21	0.011500	1.36	21.64	31.03	0.52
121	3305	17.68	39.58	40.34	0.75	40.00	40.37	0.004637	0.82	21.48	33.65	0.33
121	3305	19.96	39.58	40.41	0.83	40.03	40.44	0.004192	0.84	23.85	33.65	0.32
121	3305	23.17	39.58	40.50	0.92	40.06	40.54	0.003813	0.86	26.89	33.65	0.31
121	3305	29.53	39.58	40.67	1.09	40.12	40.71	0.003260	0.90	32.73	33.65	0.29
121	3238	21.76	38.97	40.08	1.11	39.54	40.11	0.003427	0.82	26.52	33.31	0.29
121	3238	24.68	38.97	40.17	1.20	39.58	40.20	0.003215	0.83	29.58	34.50	0.29
121	3238	28.69	38.97	40.28	1.31	39.63	40.32	0.002955	0.86	33.44	34.95	0.28
121	3238	37.04	38.97	40.48	1.51	39.73	40.52	0.002676	0.92	40.33	34.95	0.27
121	3185	22.38	38.52	39.97	1.45	39.10	39.99	0.001470	0.65	34.23	31.57	0.20
121	3185	25.49	38.52	40.06	1.54	39.15	40.09	0.001515	0.69	37.13	32.49	0.21
121	3185	29.68	38.52	40.17	1.65	39.20	40.20	0.001575	0.73	40.82	33.69	0.21
121	3185	38.36	38.52	40.37	1.85	39.31	40.41	0.001613	0.80	47.78	35.96	0.22
121	3155	22.38	38.16	39.87	1.71	39.22	39.92	0.004579	1.01	22.18	24.45	0.34
121	3155	25.49	38.16	39.95	1.79	39.28	40.01	0.004609	1.05	24.36	25.52	0.34

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	3155	29.68	38.16	40.06	1.90	39.36	40.12	0.004620	1.09	27.15	26.68	0.35
121	3155	38.36	38.16	40.25	2.09	39.51	40.32	0.004726	1.18	32.54	29.01	0.36
121	3134	22.38	38.00	39.76	1.77	39.13	39.82	0.005139	1.07	20.86	22.68	0.36
121	3134	25.49	38.00	39.85	1.85	39.20	39.91	0.005236	1.12	22.82	23.68	0.36
121	3134	29.68	38.00	39.95	1.95	39.28	40.02	0.005366	1.17	25.37	25.01	0.37
121	3134	38.36	38.00	40.14	2.14	39.42	40.22	0.005593	1.27	30.31	27.40	0.38
121	3073	22.38	37.69	38.79	1.10	38.79	39.09	0.045858	2.43	9.22	15.31	1.00
121	3073	25.49	37.69	38.85	1.16	38.85	39.17	0.045307	2.50	10.20	16.05	1.00
121	3073	29.68	37.69	38.93	1.24	38.93	39.27	0.044394	2.58	11.50	16.98	1.00
121	3073	38.36	37.69	39.08	1.39	39.08	39.45	0.042759	2.70	14.19	18.97	1.00
121	2983	24.71	35.91	36.85	0.94	36.60	36.92	0.010170	1.14	21.65	38.54	0.49
121	2983	28.16	35.91	36.91	1.00	36.63	36.98	0.010230	1.18	23.82	40.42	0.49
121	2983	32.82	35.91	36.98	1.07	36.68	37.05	0.010372	1.23	26.67	43.05	0.50
121	2983	42.79	35.91	37.12	1.21	36.78	37.20	0.009184	1.29	33.08	45.01	0.48
121	2820	24.71	34.16	36.04	1.88	35.09	36.07	0.003076	0.73	33.64	45.62	0.27
121	2820	28.16	34.16	36.11	1.95	35.15	36.14	0.003015	0.77	36.64	45.62	0.27
121	2820	32.82	34.16	36.20	2.04	35.22	36.23	0.002881	0.80	40.78	45.62	0.27
121	2820	42.79	34.16	36.32	2.16	35.37	36.37	0.003175	0.92	46.54	45.62	0.29
121	2670	24.71	33.46	34.78	1.32	34.66	35.01	0.027543	2.15	11.52	16.62	0.82
121	2670	28.16	33.46	34.87	1.41	34.73	35.11	0.026623	2.13	13.23	18.87	0.81
121	2670	32.82	33.46	35.12	1.66	34.84	35.27	0.023733	1.72	19.08	34.51	0.74
121	2670	42.79	33.46	35.33	1.86	35.01	35.45	0.015834	1.57	27.18	41.34	0.62
121	2554	24.71	32.54	34.21	1.67	33.46	34.24	0.002622	0.83	29.74	30.73	0.27
121	2554	28.16	32.54	34.30	1.76	33.52	34.34	0.002639	0.86	32.71	32.19	0.27
121	2554	32.82	32.54	34.41	1.87	33.59	34.46	0.003131	0.90	36.65	38.72	0.29
121	2554	42.79	32.54	34.59	2.05	33.72	34.63	0.003804	0.97	44.20	48.06	0.32
121	2463	24.71	32.13	33.64	1.51	33.42	33.74	0.017302	1.45	17.02	31.29	0.63
121	2463	28.16	32.13	33.75	1.62	33.48	33.84	0.016925	1.33	21.15	43.64	0.61
121	2463	32.82	32.13	33.86	1.73	33.55	33.94	0.012897	1.25	26.32	48.86	0.54

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	2463	42.79	32.13	33.99	1.86	33.68	34.08	0.011443	1.32	32.51	50.81	0.53
121	2376	24.71	31.20	33.24	2.04	32.34	33.27	0.002474	0.71	34.97	44.14	0.25
121	2376	28.16	31.20	33.31	2.11	32.41	33.33	0.002774	0.74	38.05	48.85	0.27
121	2376	32.82	31.20	33.40	2.20	32.50	33.43	0.003244	0.76	43.20	59.98	0.29
121	2376	42.79	31.20	33.52	2.32	32.66	33.55	0.003515	0.85	50.54	63.21	0.30
121	2283	29.80	31.13	32.87	1.74	32.41	32.91	0.005945	0.82	36.16	70.00	0.37
121	2283	33.97	31.13	32.92	1.79	32.45	32.95	0.005935	0.87	39.15	70.00	0.37
121	2283	39.49	31.13	32.97	1.84	32.51	33.01	0.005910	0.92	42.93	70.00	0.37
121	2283	50.66	31.13	33.07	1.94	32.63	33.12	0.006005	1.02	49.67	70.00	0.39
121	2171	29.80	30.73	31.77	1.04	31.61	31.86	0.016742	1.33	22.47	46.47	0.61
121	2171	33.97	30.73	31.82	1.09	31.65	31.92	0.016252	1.35	25.14	49.43	0.60
121	2171	39.49	30.73	31.89	1.16	31.69	31.99	0.015759	1.37	28.80	54.14	0.60
121	2171	50.66	30.73	32.01	1.28	31.78	32.11	0.014686	1.43	35.54	59.75	0.59
121	2142	29.80	30.20	31.40	1.20	31.07	31.48	0.010709	1.18	25.24	44.47	0.50
121	2142	33.97	30.20	31.44	1.24	31.12	31.52	0.011815	1.27	26.82	45.80	0.53
121	2142	39.49	30.20	31.47	1.27	31.18	31.57	0.013699	1.39	28.43	47.22	0.57
121	2142	50.66	30.20	31.56	1.36	31.32	31.69	0.015333	1.54	32.86	50.78	0.61
121	2013	29.80	28.84	30.04	1.20	29.75	30.11	0.010396	1.19	25.03	42.46	0.50
121	2013	33.97	28.84	30.13	1.29	29.79	30.20	0.008865	1.17	29.15	45.34	0.46
121	2013	39.49	28.84	30.24	1.40	29.85	30.31	0.007177	1.15	34.46	46.89	0.43
121	2013	50.66	28.84	30.42	1.58	29.95	30.49	0.005988	1.17	43.14	49.39	0.40
121	1866	33.72	28.08	29.72	1.64	28.76	29.74	0.001111	0.63	53.56	44.07	0.18
121	1866	38.30	28.08	29.81	1.73	28.80	29.83	0.001177	0.67	57.41	45.21	0.19
121	1866	44.49	28.08	29.93	1.85	28.85	29.96	0.001226	0.71	62.91	46.81	0.19
121	1866	55.81	28.08	30.10	2.02	28.95	30.13	0.001353	0.79	70.97	48.37	0.21
121	1748	33.72	27.50	29.43	1.93	28.77	29.48	0.005918	1.07	31.60	41.32	0.39
121	1748	38.30	27.50	29.50	2.00	28.85	29.56	0.005970	1.10	34.70	43.44	0.39
121	1748	44.49	27.50	29.62	2.12	29.02	29.68	0.005458	1.11	40.24	46.98	0.38
121	1748	55.81	27.50	29.77	2.27	29.13	29.84	0.005667	1.18	47.30	51.55	0.39

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

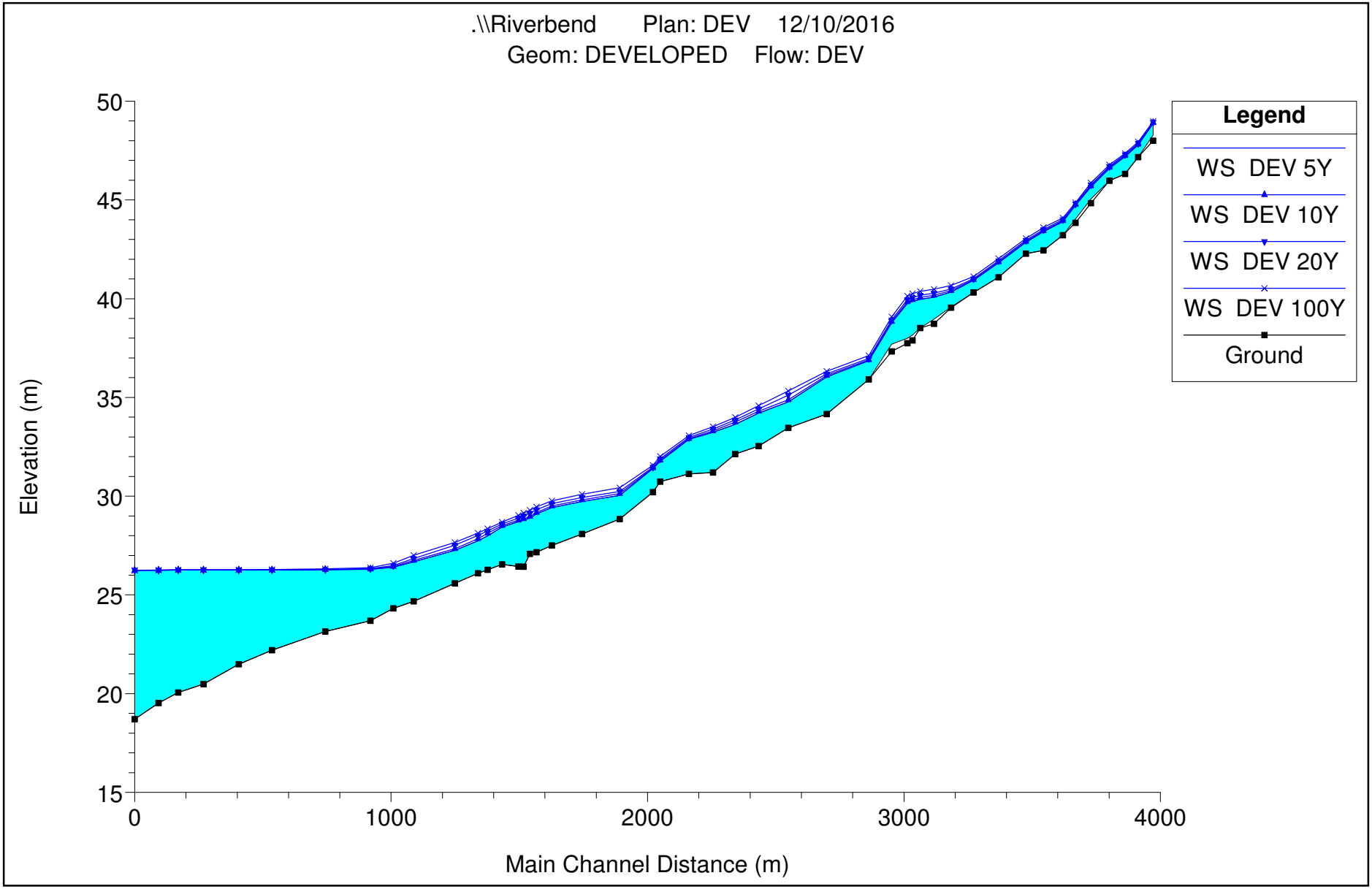
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	1687	33.72	27.16	29.11	1.95	28.37	29.15	0.005013	0.97	34.85	46.58	0.36
121	1687	38.30	27.16	29.18	2.02	28.43	29.23	0.005062	1.00	38.25	48.92	0.36
121	1687	44.49	27.16	29.32	2.16	28.52	29.37	0.004996	0.96	46.15	61.95	0.36
121	1687	55.81	27.16	29.46	2.30	28.70	29.51	0.005101	1.01	55.21	70.15	0.36
121	1662	33.72	27.08	28.89	1.81	28.42	28.97	0.011424	1.28	26.35	42.95	0.52
121	1662	38.30	27.08	28.97	1.89	28.56	29.05	0.010126	1.28	29.94	44.60	0.50
121	1662	44.49	27.08	29.13	2.05	28.68	29.20	0.008704	1.17	37.97	59.77	0.46
121	1662	55.81	27.08	29.29	2.21	28.82	29.36	0.007214	1.16	48.32	70.82	0.43
121	1638	33.72	26.43	28.78	2.35	27.82	28.83	0.003007	0.98	34.58	30.93	0.29
121	1638	38.30	26.43	28.86	2.43	27.91	28.91	0.003271	1.04	36.98	32.21	0.31
121	1638	44.49	26.43	29.00	2.57	28.00	29.05	0.004316	1.04	42.73	53.20	0.34
121	1638	55.81	26.43	29.15	2.72	28.17	29.21	0.005010	1.07	51.94	69.14	0.37
121	1618	33.72	26.44	28.72	2.28	27.93	28.76	0.003585	0.95	35.44	37.67	0.31
121	1618	38.30	26.44	28.78	2.34	28.00	28.84	0.004372	1.00	38.14	43.39	0.34
121	1618	44.49	26.44	28.89	2.45	28.07	28.94	0.006506	1.01	44.00	66.88	0.40
121	1618	55.81	26.44	29.03	2.59	28.21	29.08	0.008044	1.00	55.67	100.65	0.43
121	1554	37.33	26.54	28.44	1.90	27.72	28.47	0.005542	0.78	47.74	109.13	0.36
121	1554	42.36	26.54	28.51	1.97	27.79	28.54	0.004548	0.76	55.49	109.13	0.33
121	1554	49.30	26.54	28.59	2.05	27.88	28.63	0.003868	0.76	64.56	109.13	0.31
121	1554	63.34	26.54	28.69	2.15	28.05	28.73	0.003966	0.84	75.14	109.13	0.32
121	1497	37.33	26.27	27.99	1.72	27.63	28.08	0.009398	1.33	28.03	37.22	0.49
121	1497	42.36	26.27	28.12	1.85	27.68	28.20	0.008972	1.24	34.10	58.73	0.48
121	1497	49.30	26.27	28.24	1.97	27.76	28.31	0.009982	1.15	42.81	97.40	0.49
121	1497	63.34	26.27	28.36	2.09	27.89	28.43	0.008948	1.15	54.94	101.85	0.47
121	1460	37.33	26.09	27.73	1.65	27.30	27.79	0.005925	1.07	35.00	45.92	0.39
121	1460	42.36	26.09	27.85	1.76	27.34	27.90	0.006778	1.01	42.04	82.17	0.41
121	1460	49.30	26.09	28.01	1.92	27.40	28.05	0.004831	0.88	56.01	92.54	0.35
121	1460	63.34	26.09	28.13	2.04	27.51	28.18	0.005128	0.93	68.07	103.01	0.36

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	1370	37.33	25.58	27.25	1.67	26.73	27.30	0.004989	0.99	37.67	48.09	0.36
121	1370	42.36	25.58	27.34	1.76	26.78	27.39	0.004891	1.01	41.79	50.76	0.36
121	1370	49.30	25.58	27.51	1.93	26.85	27.56	0.006298	0.92	53.60	91.47	0.38
121	1370	63.34	25.58	27.66	2.08	26.97	27.70	0.005523	0.94	67.15	99.95	0.37
121	1209	40.30	24.67	26.68	2.01	25.95	26.71	0.002843	0.78	51.73	62.34	0.27
121	1209	45.80	24.67	26.75	2.08	26.00	26.78	0.003005	0.82	56.14	65.78	0.28
121	1209	53.33	24.67	26.84	2.17	26.07	26.88	0.003114	0.86	62.23	69.52	0.29
121	1209	68.98	24.67	27.00	2.33	26.20	27.05	0.003198	0.92	74.87	84.60	0.30
121	1129	40.30	24.32	26.40	2.08	25.57	26.44	0.003939	0.94	42.83	52.50	0.32
121	1129	45.80	24.32	26.43	2.11	25.64	26.49	0.004540	1.02	44.84	57.73	0.34
121	1129	53.33	24.32	26.49	2.17	25.73	26.55	0.005373	1.11	48.03	61.92	0.38
121	1129	68.98	24.32	26.60	2.28	25.91	26.69	0.006664	1.23	56.17	76.71	0.42
121	1040	41.90	23.69	26.30	2.61	24.90	26.31	0.000725	0.47	88.48	104.72	0.15
121	1040	47.64	23.69	26.31	2.62	24.96	26.33	0.000899	0.53	89.87	104.72	0.16
121	1040	55.49	23.69	26.33	2.64	25.04	26.35	0.001145	0.60	92.01	104.72	0.18
121	1040	72.00	23.69	26.38	2.69	25.21	26.41	0.001655	0.74	97.32	104.72	0.22
121	864	41.90	23.15	26.27	3.12	23.90	26.27	0.000077	0.22	189.35	100.01	0.05
121	864	47.64	23.15	26.28	3.13	23.95	26.28	0.000099	0.25	190.03	100.01	0.06
121	864	55.49	23.15	26.29	3.14	24.01	26.29	0.000131	0.29	191.07	100.01	0.07
121	864	72.00	23.15	26.32	3.17	24.14	26.32	0.000211	0.37	193.78	100.01	0.09
121	656	42.78	22.20	26.26	4.06	23.59	26.26	0.000049	0.19	220.69	100.29	0.04
121	656	48.63	22.20	26.26	4.06	23.65	26.27	0.000063	0.22	221.02	100.29	0.05
121	656	56.63	22.20	26.27	4.07	23.71	26.27	0.000085	0.26	221.54	100.29	0.05
121	656	73.57	22.20	26.28	4.08	23.85	26.29	0.000141	0.33	222.91	100.29	0.07
121	526	42.78	21.49	26.26	4.77	22.59	26.26	0.000011	0.12	350.60	100.01	0.02
121	526	48.63	21.49	26.26	4.77	22.65	26.26	0.000014	0.14	350.88	100.01	0.02
121	526	56.63	21.49	26.27	4.78	22.81	26.27	0.000019	0.16	351.31	100.01	0.03
121	526	73.57	21.49	26.28	4.79	22.94	26.28	0.000031	0.21	352.47	100.01	0.04
121	389	46.73	20.48	26.26	5.78	21.70	26.26	0.000017	0.15	313.70	93.49	0.03

HEC-RAS Plan: DEV River: main Reach: 121 (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	389	53.20	20.48	26.26	5.78	21.76	26.26	0.000022	0.17	313.90	93.51	0.03
121	389	62.01	20.48	26.26	5.78	21.84	26.26	0.000029	0.20	314.21	93.54	0.03
121	389	81.46	20.48	26.27	5.79	21.98	26.27	0.000050	0.26	315.04	93.63	0.04
121	290	46.73	20.06	26.25	6.19	21.33	26.26	0.000013	0.15	321.18	79.45	0.02
121	290	53.20	20.06	26.26	6.20	21.40	26.26	0.000016	0.17	321.31	79.46	0.03
121	290	62.01	20.06	26.26	6.20	21.50	26.26	0.000022	0.19	321.52	79.48	0.03
121	290	81.46	20.06	26.27	6.21	21.67	26.27	0.000038	0.25	322.08	79.51	0.04
121	214	47.54	19.52	26.25	6.73	20.92	26.25	0.000036	0.21	226.61	72.53	0.04
121	214	54.20	19.52	26.25	6.73	21.01	26.26	0.000047	0.24	226.68	72.54	0.04
121	214	63.15	19.52	26.25	6.73	21.13	26.26	0.000064	0.28	226.77	72.54	0.05
121	214	82.46	19.52	26.26	6.74	21.36	26.26	0.000109	0.36	227.04	72.55	0.07
121	121	47.54	18.71	26.25	7.54	20.37	26.25	0.000028	0.21	231.17	62.86	0.03
121	121	54.20	18.71	26.25	7.54	20.47	26.25	0.000037	0.23	231.17	62.86	0.04
121	121	63.15	18.71	26.25	7.54	20.59	26.25	0.000050	0.27	231.17	62.86	0.05
121	121	82.46	18.71	26.25	7.54	20.82	26.26	0.000085	0.36	231.17	62.86	0.06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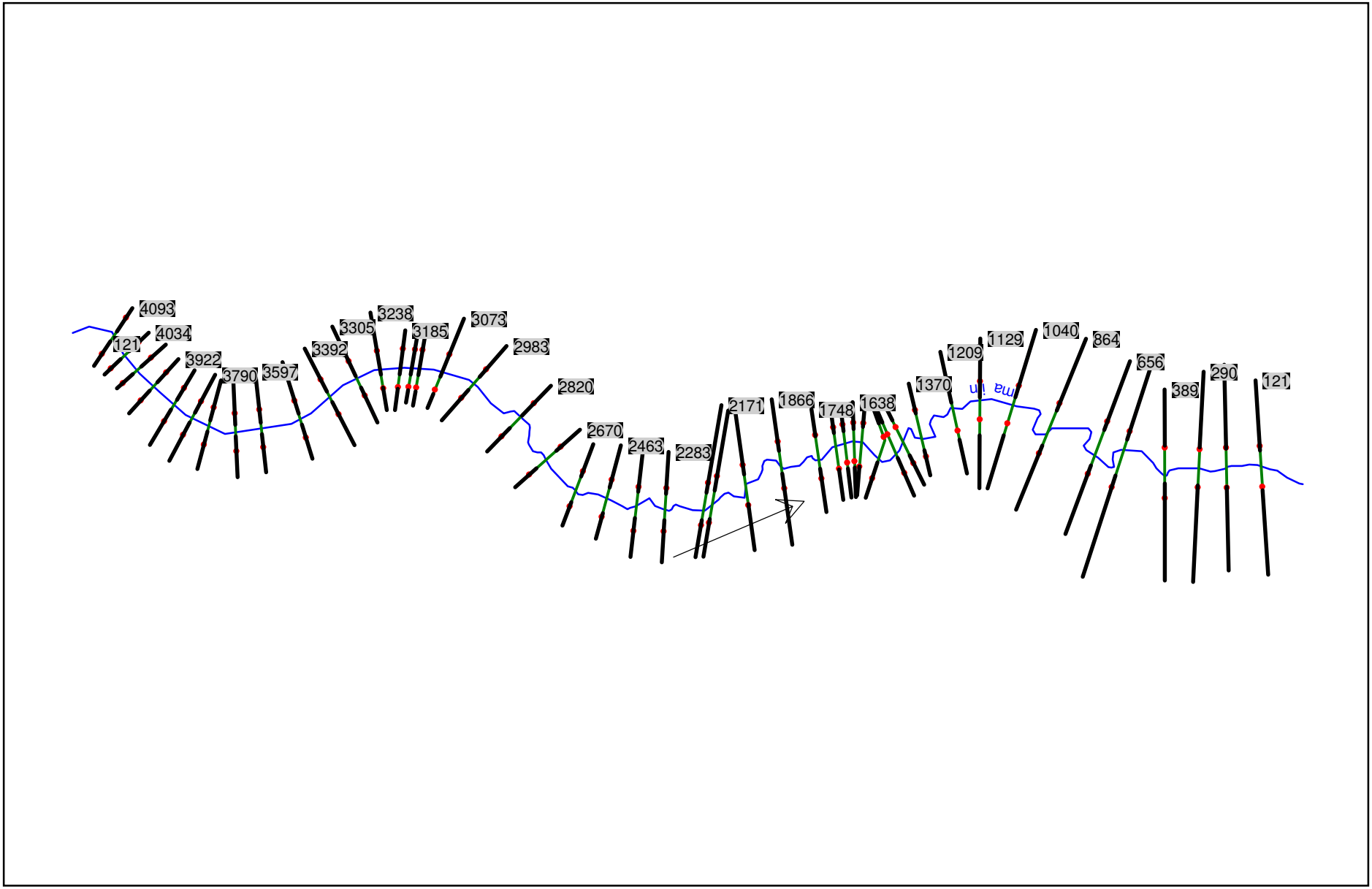
Geom: DEVELOPED Flow: DEV
Elevation (m)
50
45
40
35
30
25
20
15
0
1000
2000
3000
4000
Main Channel Distance (m)
Legend
WS DEV 5Y
WS DEV 10Y
WS DEV 20Y
WS DEV 100Y
Ground


4093
4034
121
3922
3790
3597
3392
3305
3238
3185
3073
2983
2820
2670
2463
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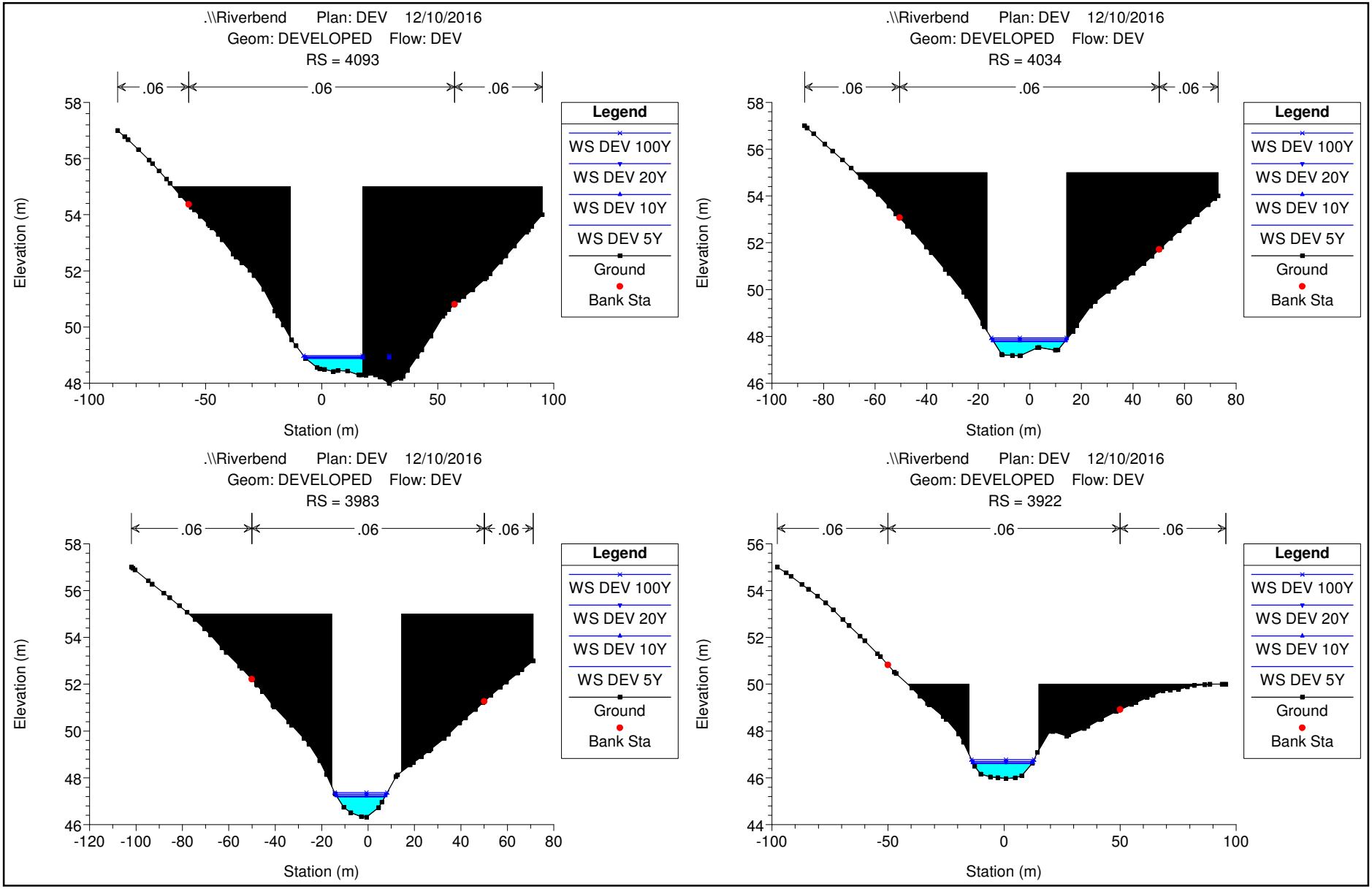
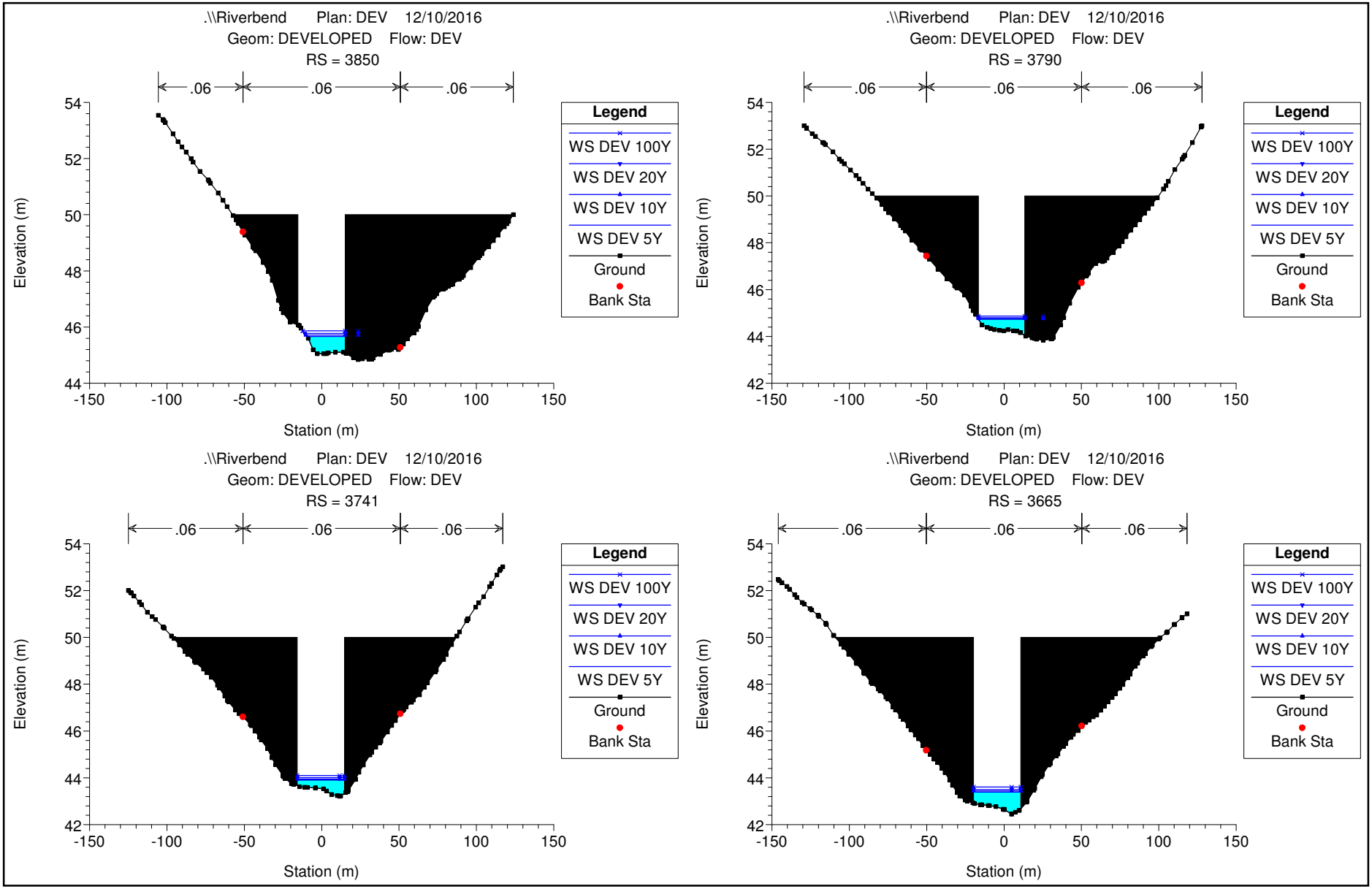
656
389
290
121


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 4093
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 4034
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3983
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3922
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta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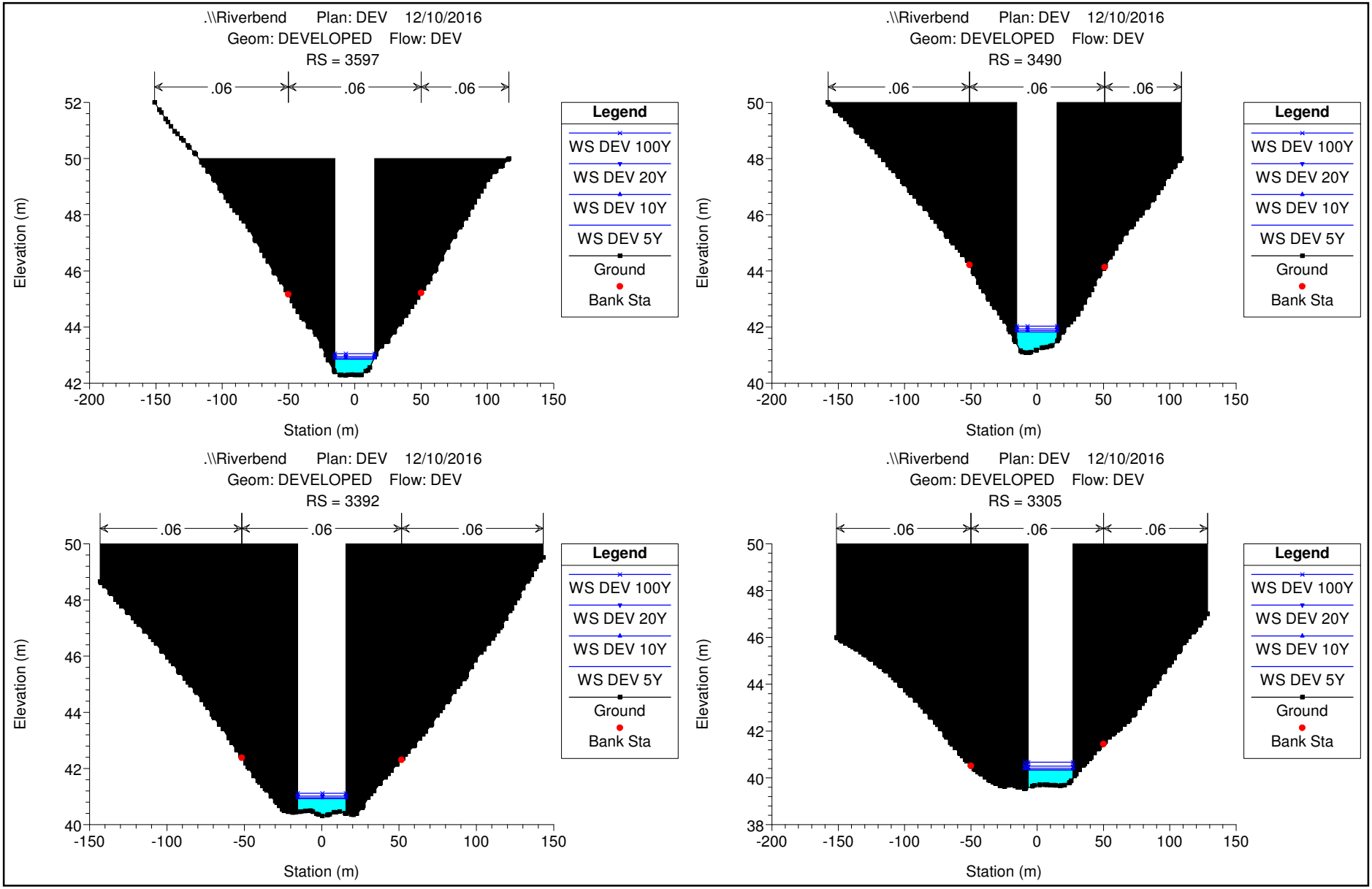
Geom: DEVELOPED Flow: DEV
RS = 3850
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3790
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3741
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3665
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)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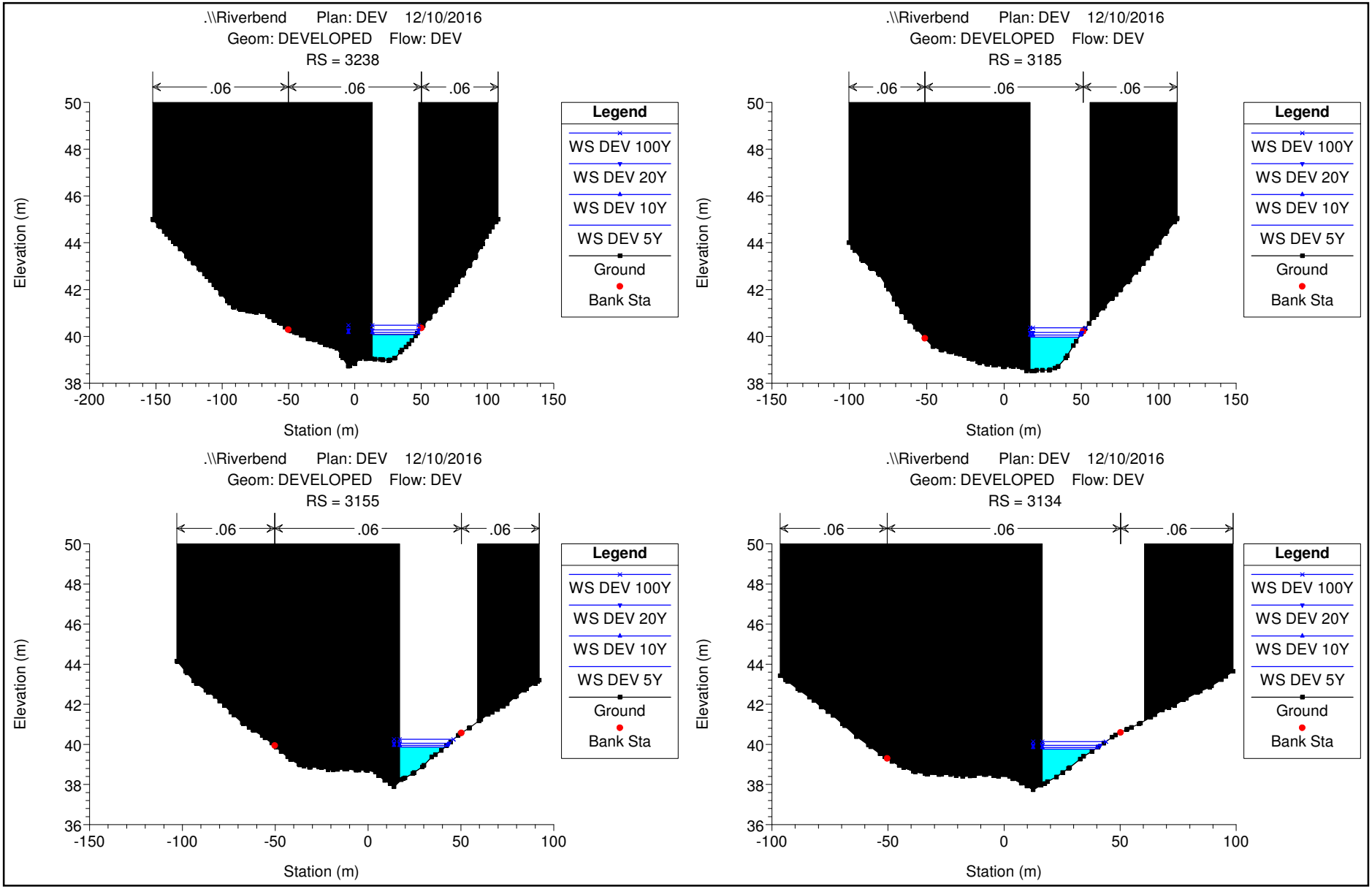
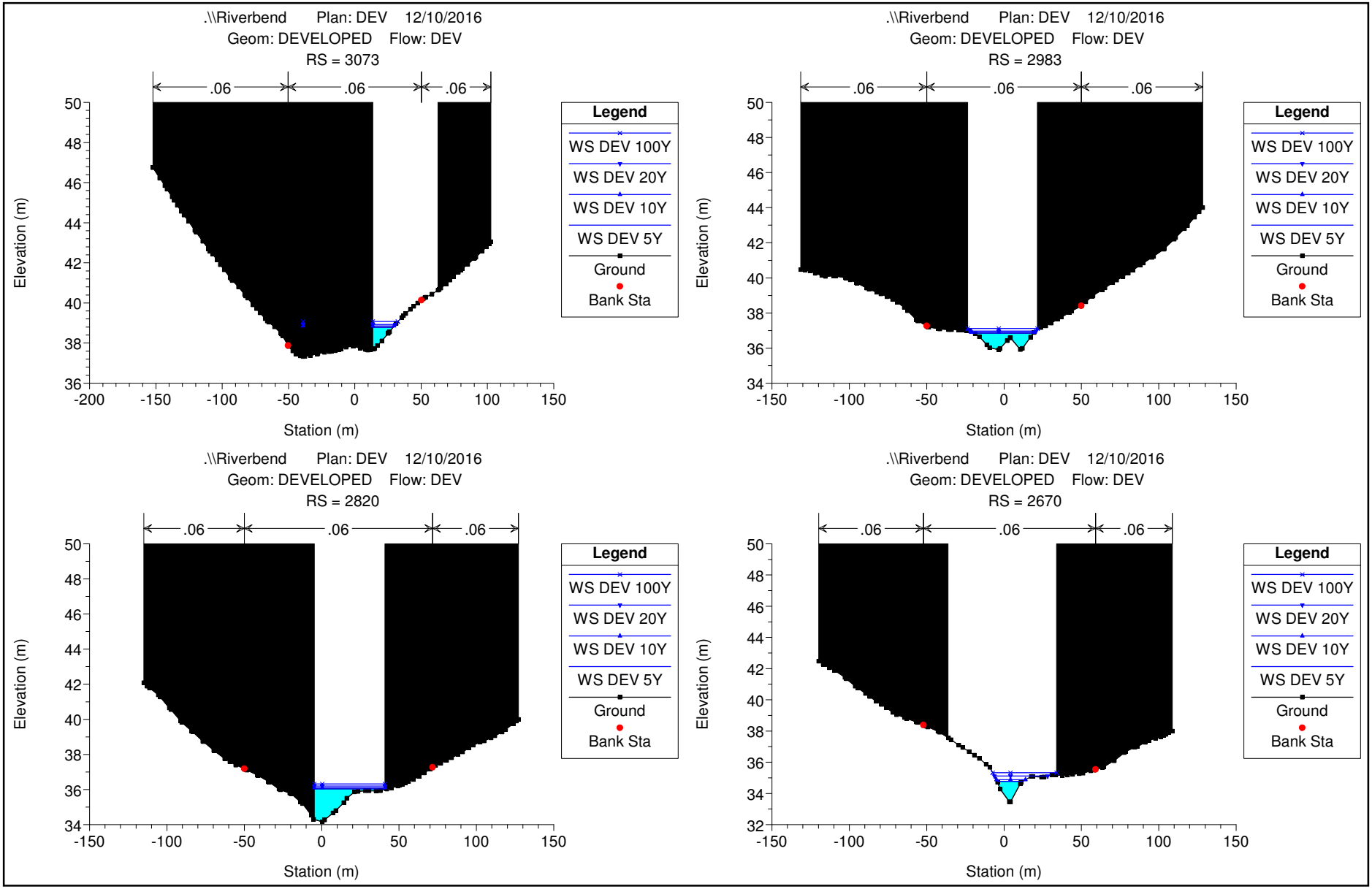
Geom: DEVELOPED Flow: DEV
RS = 3597
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3490
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3392
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3305
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3238
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3185
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3155
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 3134
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)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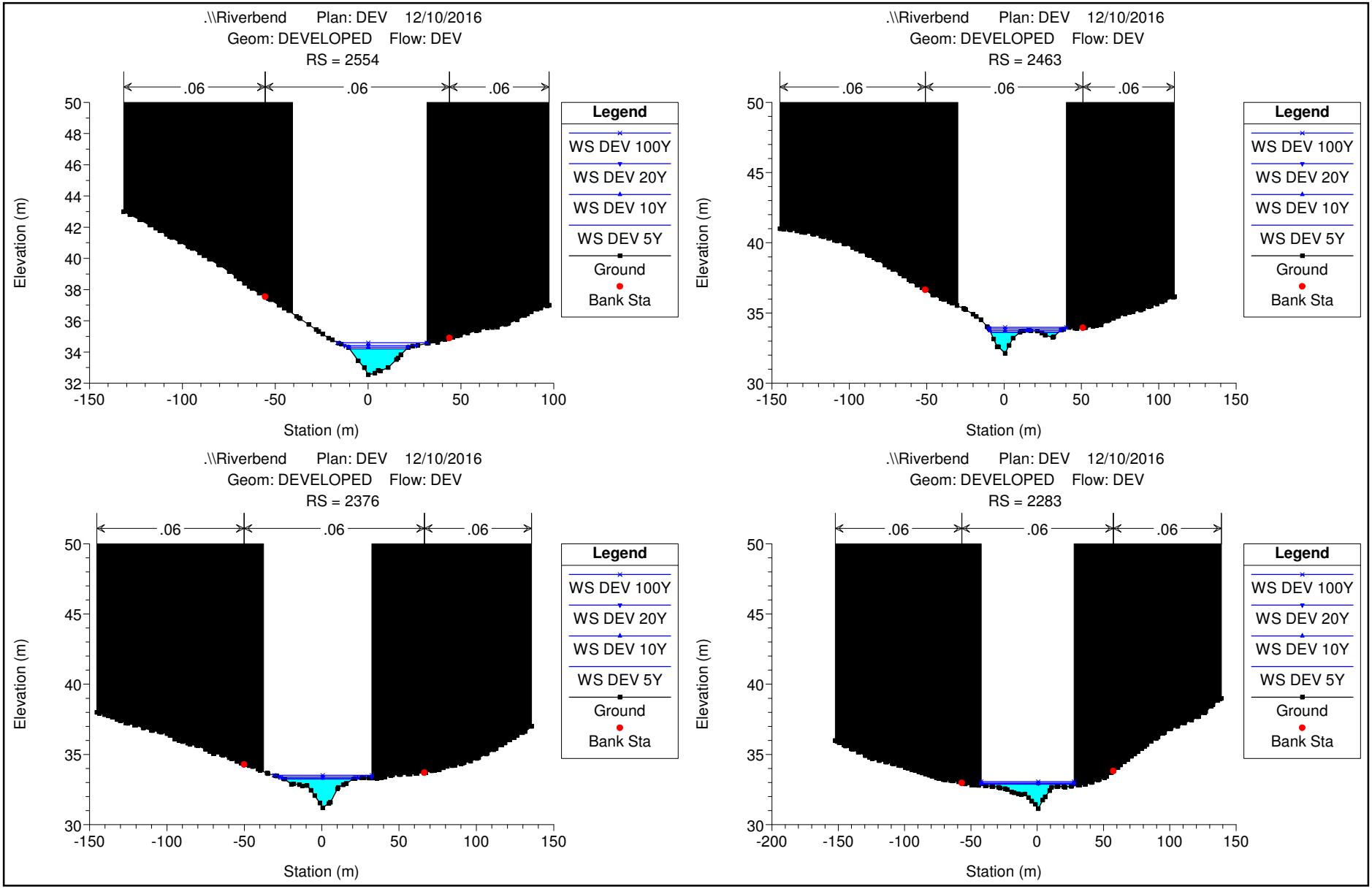
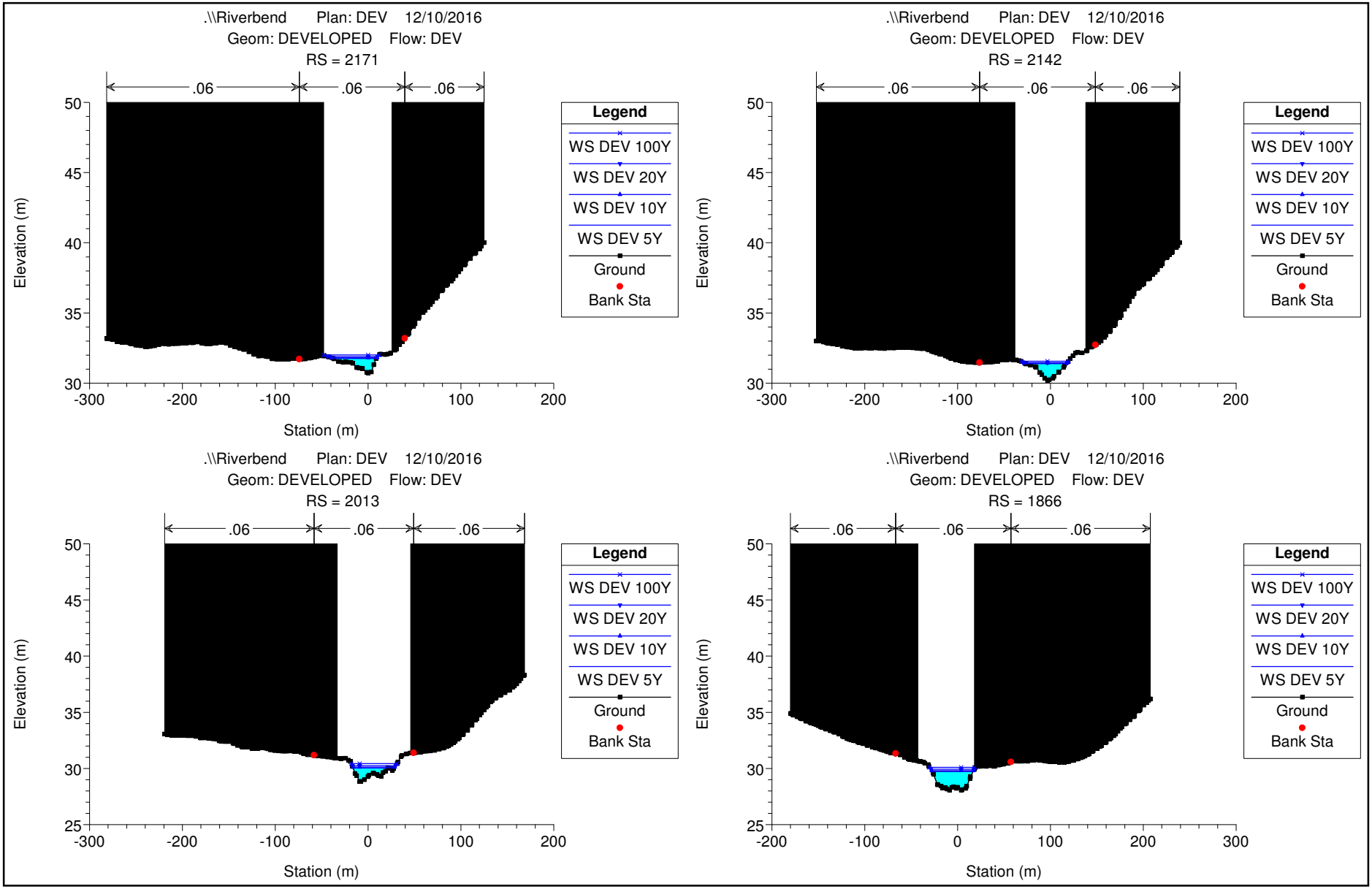
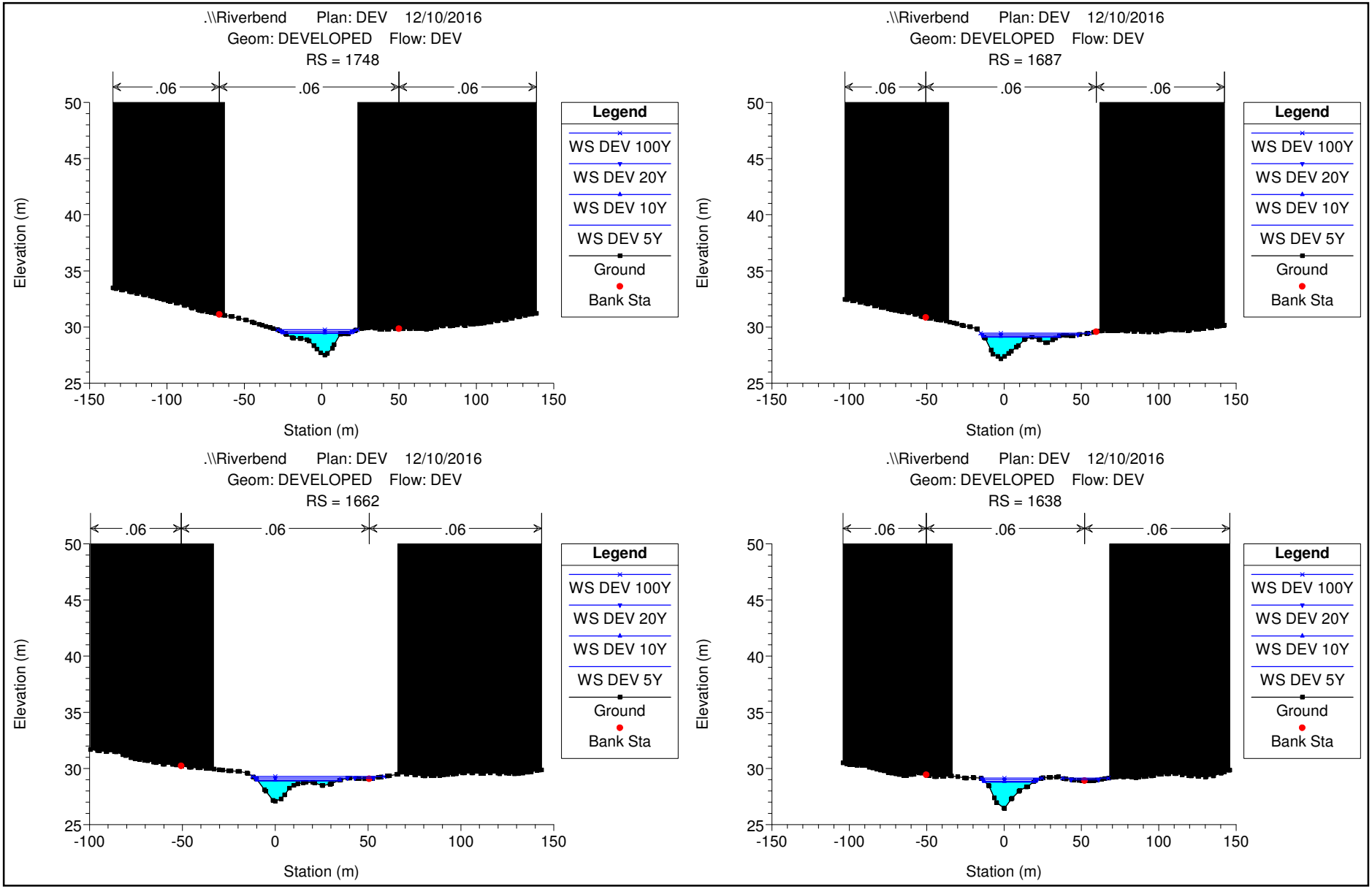
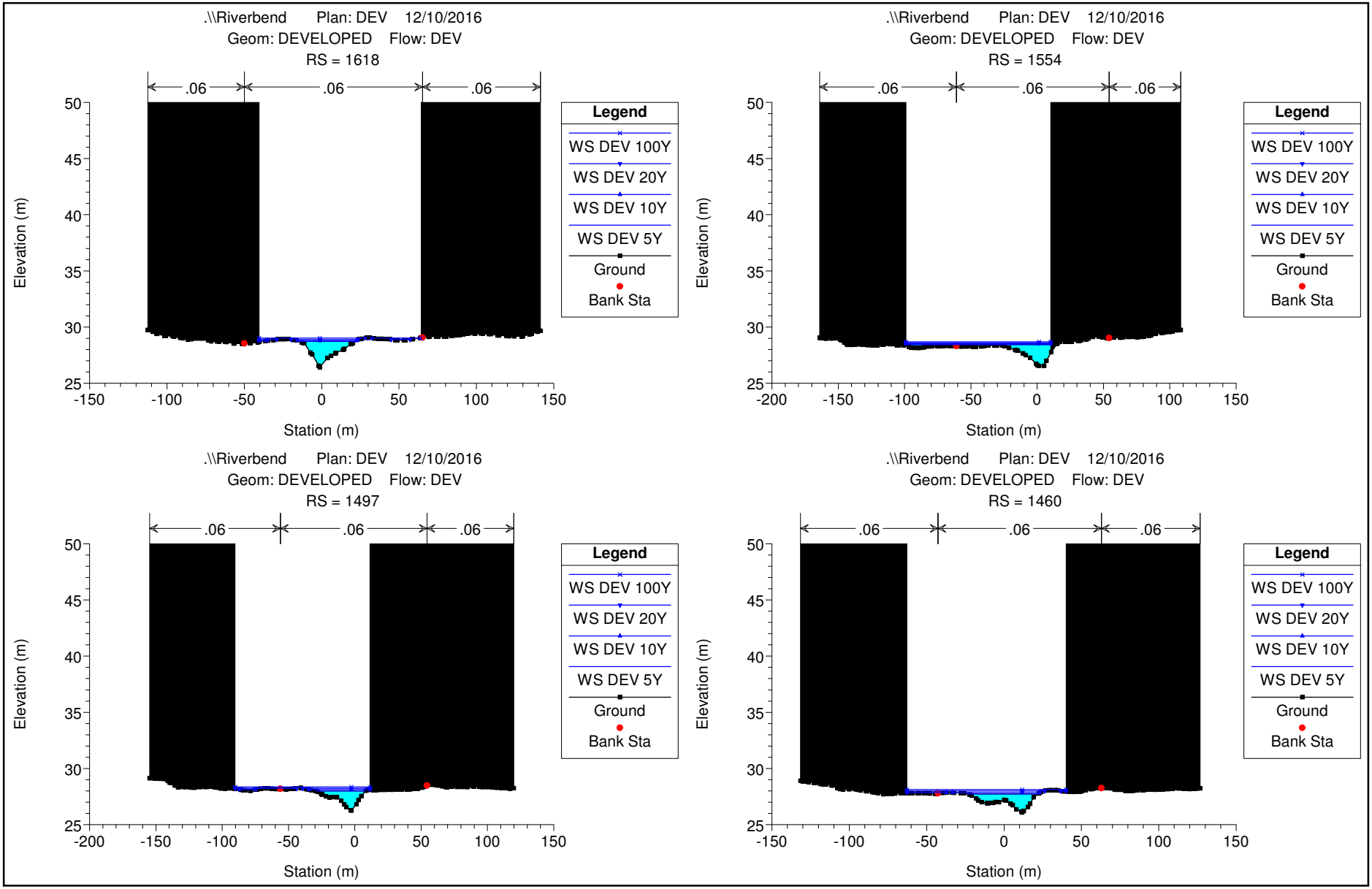
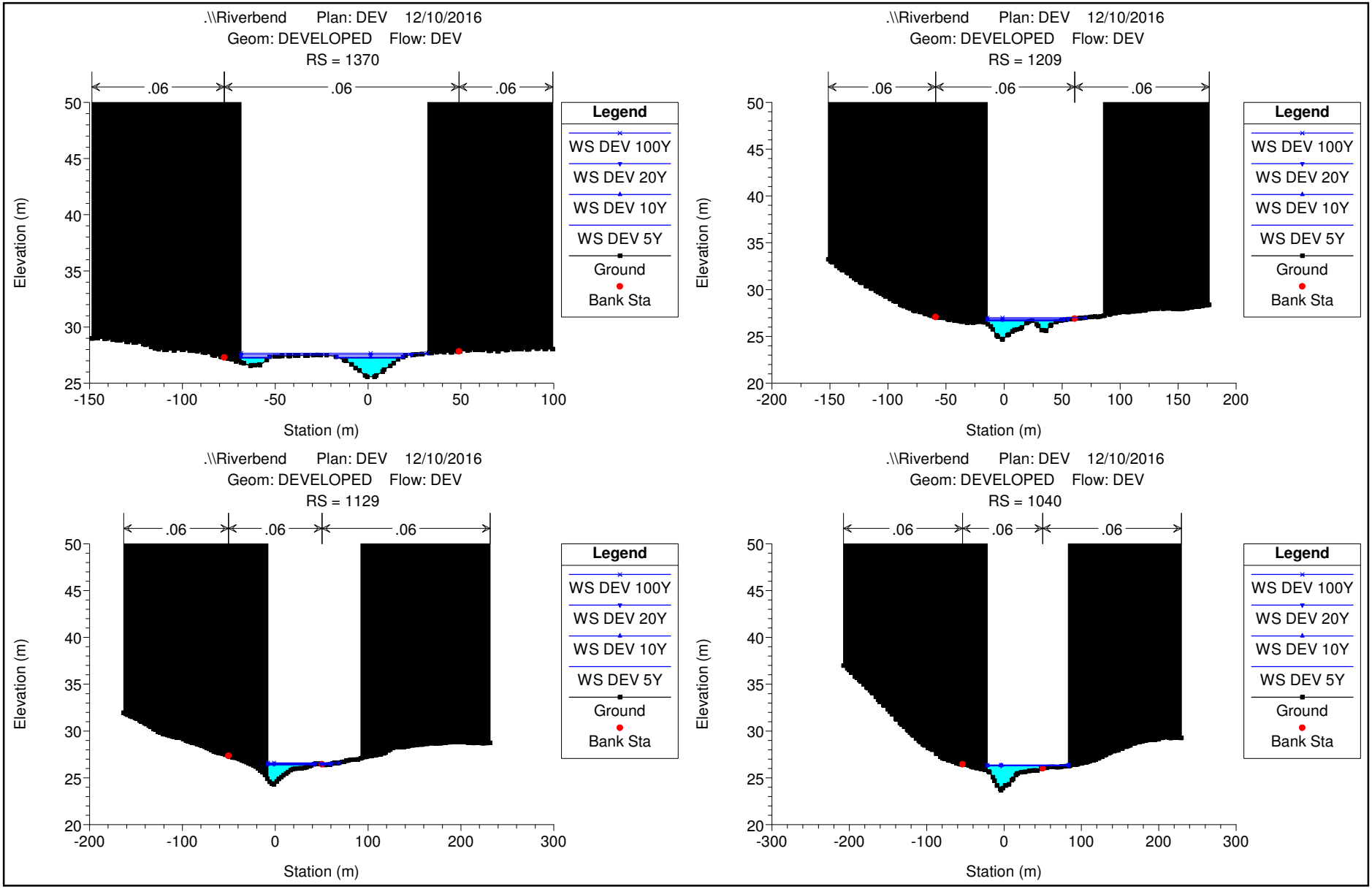
Geom: DEVELOPED Flow: DEV
RS = 3073
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2983
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2820
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2670
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta

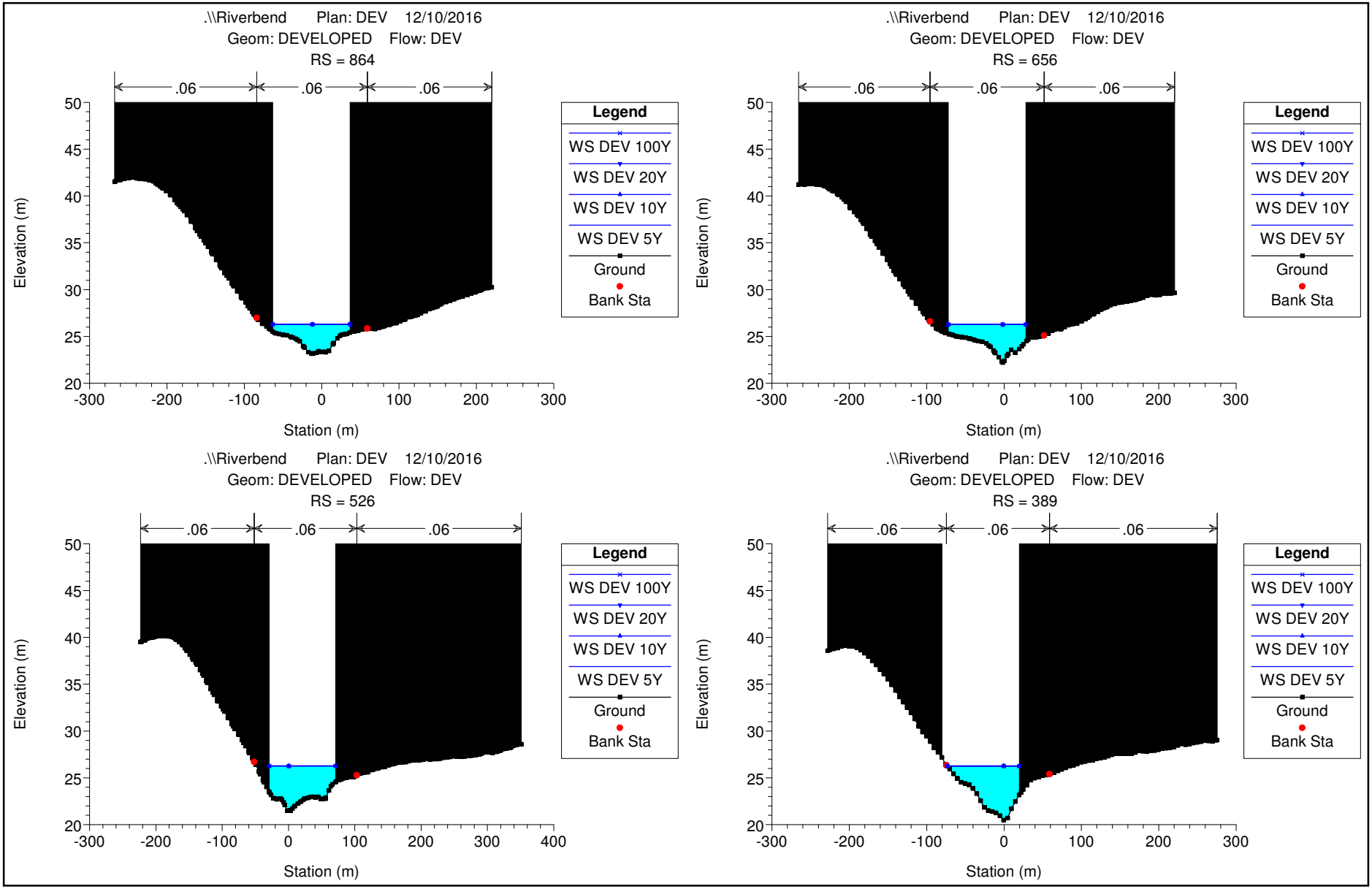

.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2554
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2463
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2376
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2283
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta

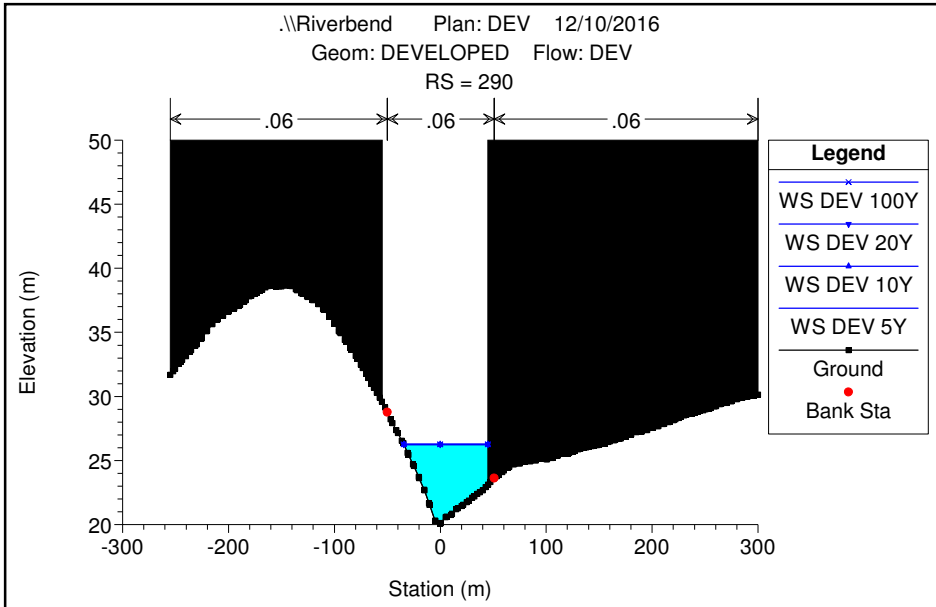

.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2171
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2142
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 2013
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1866
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta

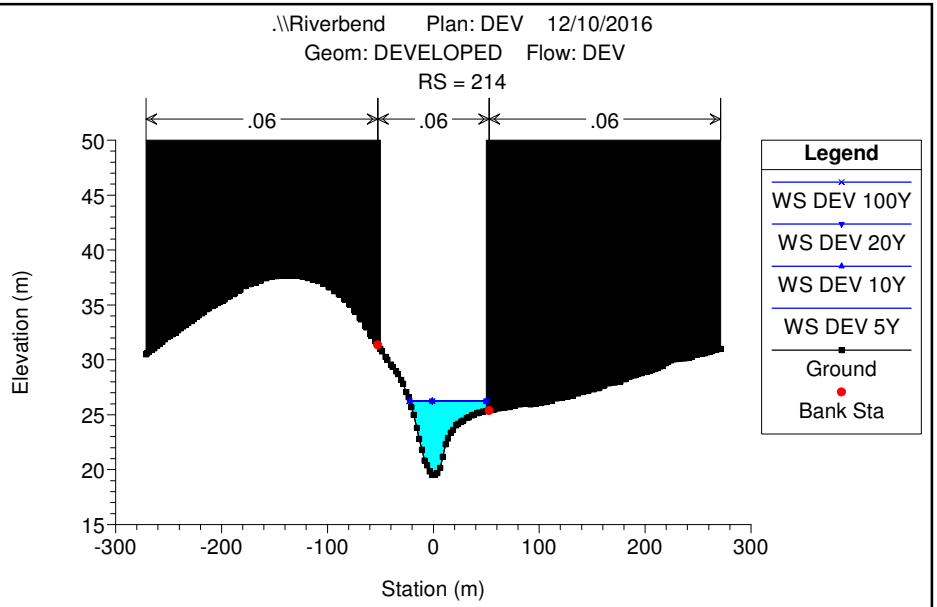

.\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1748
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1687
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1662
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1638
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta

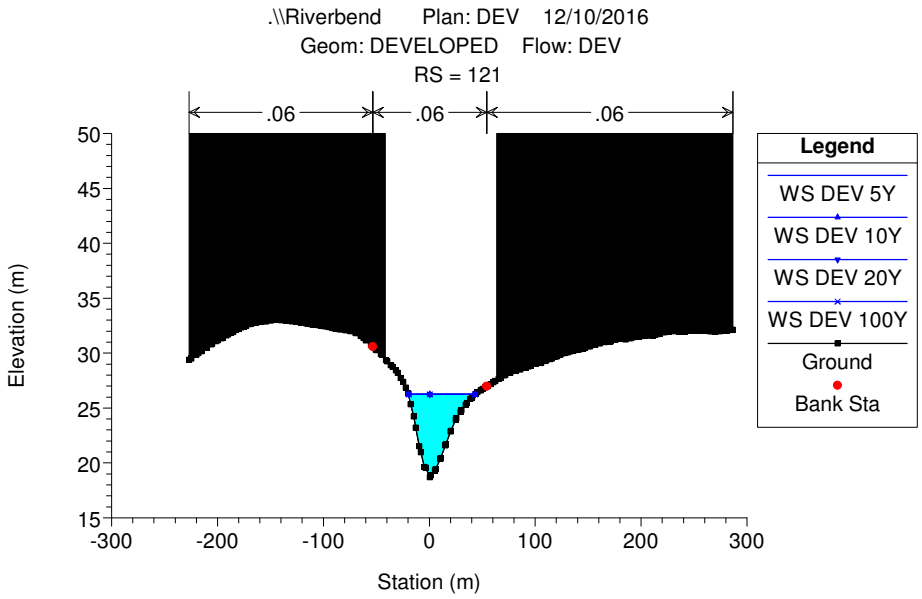

.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1618
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1554
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1497
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1460
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1370
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1209
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1129
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 1040
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 864
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 656
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 526
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 389
.06
.06
.06
Elevation (m)
Station (m)
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 290
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 214
.06
.06
.06
Legend
WS DEV 100Y
WS DEV 20Y
WS DEV 10Y
WS DEV 5Y
Ground
Bank Sta
Elevation (m)
Station (m)


.\\Riverbend Plan: DEV 12/10/2016
Geom: DEVELOPED Flow: DEV
RS = 121
.06
.06
.06
Legend
WS DEV 5Y
WS DEV 10Y
WS DEV 20Y
WS DEV 100Y
Ground
Bank Sta
Elevation (m)
Station (m)

HEC-RAS Plan: HIGH MANNINGS River: main Reach: 121 Profile: DEV 100Y

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	4093	19.82	48.29	49.35	1.06	48.89	49.39	0.026409	0.89	22.30	28.90	0.32
121	4034	19.82	47.17	48.41	1.24	47.76	48.44	0.010705	0.66	29.86	30.77	0.22
121	3983	19.82	46.32	47.87	1.55	47.05	47.89	0.010554	0.70	28.18	26.62	0.22
121	3922	19.82	45.97	47.26	1.29	46.51	47.28	0.009630	0.65	30.37	29.99	0.21
121	3850	26.58	45.05	46.33	1.28	45.63	46.37	0.015779	0.83	31.84	30.43	0.26
121	3790	26.58	44.04	45.31	1.28	44.73	45.35	0.018330	0.88	30.37	29.93	0.28
121	3741	26.58	43.21	44.70	1.49	43.89	44.72	0.009397	0.71	37.62	30.51	0.20
121	3665	26.58	42.45	44.17	1.72	43.14	44.19	0.005451	0.60	44.48	30.49	0.16
121	3597	29.53	42.28	43.62	1.34	42.84	43.66	0.011444	0.79	37.33	29.99	0.23
121	3490	29.53	41.09	42.59	1.50	41.69	42.62	0.008342	0.71	41.38	30.30	0.19
121	3392	29.53	40.31	41.83	1.52	40.87	41.85	0.007271	0.67	43.77	31.03	0.18
121	3305	29.53	39.58	41.45	1.86	40.12	41.46	0.003061	0.50	58.79	33.65	0.12
121	3238	37.04	38.97	41.23	2.26	39.73	41.25	0.003298	0.56	66.72	34.95	0.13
121	3185	38.36	38.52	41.08	2.56	39.31	41.09	0.002550	0.51	74.69	38.70	0.12
121	3155	38.36	38.16	40.95	2.79	39.51	40.98	0.006160	0.68	56.27	39.37	0.17
121	3134	38.36	38.00	40.81	2.81	39.42	40.83	0.008024	0.74	51.67	37.53	0.19
121	3073	38.36	37.69	39.20	1.51	39.08	39.47	0.178215	2.31	16.59	20.71	0.82
121	2983	42.79	35.91	37.80	1.89	36.78	37.82	0.006719	0.67	63.71	45.01	0.18
121	2820	42.79	34.16	36.95	2.79	35.37	36.97	0.004174	0.57	75.06	45.62	0.14
121	2670	42.79	33.46	35.99	2.53	35.01	36.02	0.010608	0.76	56.24	47.07	0.22
121	2554	42.79	32.54	35.17	2.63	33.72	35.19	0.005138	0.57	74.92	56.45	0.16
121	2463	42.79	32.13	34.56	2.43	33.68	34.58	0.009087	0.68	62.81	55.53	0.20
121	2376	42.79	31.20	34.05	2.85	32.66	34.06	0.004157	0.49	87.11	70.00	0.14
121	2283	50.66	31.13	33.53	2.40	32.63	33.55	0.007134	0.62	82.17	70.00	0.18
121	2171	50.66	30.73	32.52	1.79	31.78	32.55	0.011555	0.70	72.24	73.59	0.23
121	2142	50.66	30.20	32.19	1.99	31.32	32.21	0.011844	0.72	70.78	71.61	0.23
121	2013	50.66	28.84	31.33	2.49	29.95	31.35	0.004268	0.51	98.73	76.43	0.14
121	1866	55.81	28.08	30.87	2.79	28.95	30.88	0.002488	0.49	113.12	61.07	0.12
121	1748	55.81	27.50	30.39	2.89	29.13	30.41	0.007346	0.66	84.46	66.96	0.19
121	1687	55.81	27.16	30.00	2.84	28.70	30.01	0.005942	0.57	97.39	83.15	0.17
121	1662	55.81	27.08	29.82	2.74	28.82	29.84	0.008220	0.61	91.41	92.67	0.19
121	1638	55.81	26.43	29.64	3.21	28.17	29.65	0.007129	0.56	99.83	101.73	0.18
121	1618	55.81	26.44	29.50	3.06	28.21	29.51	0.006410	0.53	105.34	104.86	0.17
121	1554	63.34	26.54	29.15	2.61	28.05	29.16	0.004835	0.51	124.93	109.13	0.15
121	1497	63.34	26.27	28.86	2.59	27.89	28.88	0.007284	0.60	106.30	101.85	0.19
121	1460	63.34	26.09	28.65	2.56	27.51	28.66	0.004911	0.52	121.49	103.01	0.15

HEC-RAS Plan: HIGH MANNINGS River: main Reach: 121 Profile: DEV 100Y (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
121	1370	63.34	25.58	28.24	2.66	26.97	28.25	0.004353	0.50	125.78	100.41	0.14
121	1209	68.98	24.67	27.60	2.93	26.20	27.62	0.003715	0.52	133.47	100.00	0.14
121	1129	68.98	24.32	27.22	2.90	25.91	27.24	0.006322	0.62	111.35	100.01	0.18
121	1040	72.00	23.69	26.84	3.15	25.21	26.86	0.003175	0.49	145.83	104.72	0.13
121	864	72.00	23.15	26.59	3.44	24.14	26.60	0.000853	0.33	221.31	100.01	0.07
121	656	73.57	22.20	26.43	4.23	23.85	26.44	0.000712	0.31	237.79	100.29	0.06
121	526	73.57	21.49	26.39	4.90	22.94	26.39	0.000175	0.20	363.96	100.01	0.03
121	389	81.46	20.48	26.36	5.88	21.98	26.36	0.000291	0.25	323.46	94.55	0.04
121	290	81.46	20.06	26.33	6.27	21.67	26.34	0.000226	0.25	327.54	79.87	0.04
121	214	82.46	19.52	26.30	6.78	21.36	26.31	0.000651	0.36	230.37	72.70	0.06
121	121	82.46	18.71	26.25	7.54	20.82	26.26	0.000529	0.36	231.17	62.86	0.06

APPENDIX D : MUSIC SUMMARY

Table D1 - Mateorological and rainfall runoff data reporting table

INPUT	DATA USED IN MODELLING	Reference
Rainfall Station	Greenbank Thompson Rd	*Guideline by Water by Design*
Time Step	6 min	
Modelling Period	1/1/1980 - 31/12/1989	
Mean annual rainfall (mm)	745 mm	
Evapotranspiration (mm)	1448 mm	
Rainfall runoff parameters	*Table 3.7*	
Pollutant export parameters	*Table 3.9*	

Table D2a - Catchments

Name	Catchment Area (ha)	Modelled Area (Total)	Excluded Area *	Area (ha) 15dw	Area (ha) 25dw	Area Neighborhood (ha)	Regional Park (ha)	School (ha)	Spec Use (ha)	Overall Fi
A	16.33	16.327	0	7.048			9.279			37%
B	19.22	19.218	0	12.38			6.838			46%
C	13.53	13.528	0	11.754			1.774			55%
D	13.77	10.764	3.005	10.264			0.5			45%
E	98.69	98.685	0	64.925	3.924	1.318	27.5		1.018	50%
F	31.04	31.039	0	29.71			1.329			58%
G	4.33	4.331	0	2.813			1.518			46%
H	13.70	13.695	0	13.695						60%
I	4.52	4.521	0	4.521						60%
J	1.44	1.439	0	1.439						60%
K	3.77	3.774	0	3.774						60%
L	5.56	5.563	0	5.563						60%
M	17.20	17.195	**0**	5.766	8.092	3.337				71%
N	17.38	17.381	0	1.504	7.51	8.367				79%
O	10.60	10.597	**0**	3.727				6.87		66%
P	17.67	17.671	0	17.671						60%
Q	45.43	45.427	0	36.049			9.378			52%
R	26.26	26.259	0	15.14			11.119			43%
S	18.82	18.818	0	17.85			0.968			58%
T	8.38	8.378	0	6.28			2.098			50%
U	114.32	114.316	0	99.369	1.198	2.06	11.689			57%
V	8.76	8.763	0	8.763						60%
	510.69	**507.689**	**3.005**	**380.005**	**20.724**	**15.082**	**83.99**	**6.87**	**1.018**	

Table D2b - Land use and impervious %

Land use and impervious % *Table 3.6 Guideline by Water by Design*

No.	Category	Type	Imperv.
1	15 dwelling/ha	Residential	60%
2	25 dwelling/ha	Residential	70%
3	Park/Open Space/ Sports	Residential	20%
4	Neighborhood Centre	Commercial	90%
5	School	Commercial	70%
6	Special Use	Commercial	90%

Table D3a - Rainfall Runoff Parameter

PARAMETER	Residential	Commercial	Reference
Rainfall threshold (mm)	1	1	*Table 3.7 Guideline by Water by Design*
Soil Storage capacity (mm)	500	18	
Initial Storge (% capacity)	10	10	
Field Capacity (mm)	200	80	
Infiltration Capacity exponent a	211	243	
Infiltration Capacity exponent b	5	0.6	
Initial Depth (mm)	50	50	
Daily recharge rate (%)	28	0	
Daily baseflow rate (%)	27	31	
Daily deep seepage rate (%)	0	0	

Table D3b - Pollutant export parmeter reporting table

Ref : *Table 3.9 Guideline by Water by Design*

LUMPED CATCHMENT LAND USE							
LAND USE	FLOW TYPE	TSS Log^{10} values		TP Log^{10} values		TN Log^{10} values	
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Residential	Base Flow	1	0.34	`-0.97	0.31	0.2	0.2
	Stormflow	2.18	0.39	`-0.47	0.32	0.26	0.23
Commercial	Base Flow	0.78	0.39	`-0.60	0.5	0.32	0.3
	Stormflow	2.16	0.38	`-0.39	0.34	0.37	0.34

Table 4 -Wetland Node

Reference : Table 3.9 Guideline by Water by Design

INPUT	DATA USED IN MODELLING	Comment
Inlet Pond Volume (m^3)	295	*assume 2.5% of surface area*
Surface area (m^2)	11800	*Estimated*
Extended Detention Depth(m)	0.5	
Permanent Pool Volume (m^3)	9575	*From prelim 12D model*
Exfiltration Rate (mm/hr)	0	
Evaporative Loss as % of PET	125	
Equivalent Pipe Diameter (mm)	144	
Overflow Weir Width (m)	1180	*10% of Surface Area*
Notional Detention Time (hrs)	48	*close to 48 hours*
Number of CSTR cells	4	*Default value*
K and C* values	Default	*Default value*

Table 5a - Bioretention systems

Reference : Guideline by Water by Design

INPUT	DATA USED IN MODELLING	Comment
Surface area (m^2)	Refer table 7b	
Extended Detention Depth(m)	0.3	
Filter area (m^2)	*Assumed same as surface area*	
Unlined Filter Media Perimeters (m)	0.01	
Saturated Hydraulic Conductivity (mm/hr)	200	
Filter Depth (m)	0.5	
TN content of filter media (mg/kg)	400	
Orthophosphate Content of Filter Media (mg/kg)	30	
Number of CSTR cells	2	*Default value*
Is base lined ?	no	
Effectiveness of plant TN removal	effective	
Overflow Weir Width (m)	10% of surface area	
Exfiltration Rate (mm/hr)	0	
Underdrain present ?	yes	
Submerged zonde with carbon present ?	no	
K and C* values	Default	*Default value*

Table D6a - Rainwater Tank Estimation

INPUT	Catchment M Commercial	Catchment M Residential (25dw/ha)	Catchment N Commercial	Catchment N Residential (25dw/ha)	Catchment O School
Total Area (ha)	3.337	8.092	8.367	7.51	6.87
Roof Percentage (%)	50%	33.5%	50%	33.5%	50%
Roof Area (ha)	1.67	2.71	4.18	2.52	3.44
Roof Area connected to Rainwater Tank (ha)	0.83	1.36	2.09	1.26	1.72
Total Rainwater Tank Rate	1.5kL per 50m²	3kL per dwelling	1.5kL per 50m²	3kL per dwelling	1.5kL per 50m²
Total Rainwater Tank Volume (kL)	250	607	628	563	515
Adopted Rainwater Tank Volume (kL)	200	600	600	500	500

Parameters of 3kL tank adopted from *http://www.tanksrus.com.au/store/index.php?route=product/product&product_id=53*
Parameters of 5kL tank adopted from *http://www.tanksrus.com.au/store/index.php?route=product/product&product_id=59*
Parameters of 50kL tank adopted from *http://www.rainwatertanksdirect.com.au/water-tanks/large-tanks.php*

Table D6b - Re-Use Estimation Commercial & School

INPUT	Catchment M Commercial	Catchment N Commercial	Catchment O School
Average Total Water Demand (kL/day)	13.44	35.76	6.87
Percentage of Toilet Flushing Demand	25%	25%	25%
Toilet Flushing Demand (kL/day)	3.36	8.94	1.72
Irrigaton Area (ha)			0.21
Annual Irrigation Value (mm)			548
Annual Irrigation Demand (kL/year)			791

NOTE: A minimum 0.2061ha of school landscape (pervious) area needs to be irrigated in order to meet the flow frequency requirement so that the Developed Scenario average annual runoff volume does not exceed the Existing. Refer to Section 8 for the average annual flow volume calculation.

Table D6c - Re-Use Estimation Residential

INPUT	Catchment M Commercial	Catchment N Commercial
EP per Dwelling	1.6	1.6
Area (ha)	8.092	7.51
No. of Dwellings (25 dwellings/ha)	202	188
Total EP	324	300
Re-Use Rate (kL/EP/day)	0.021	0.021
Toilet Flushing Demand (kL/day)	6.80	6.31

Table D6d - Rainwater Tanks

INPUT	DATA USED IN MODELLING				
	Catchment M Commercial	Catchment M Residential (25dw/ha)	Catchment N Commercial	Catchment N Residential (25dw/ha)	Catchment O School
Number of Tanks	40 x 5kL	200 x 3kL	120 x 5kL	166 x 3kL	10 x 50kL
Total Volume below Overflow Pipe (kL)	200	600	600	498	500
Depth above Overflow (m)	0.18	0.14	0.18	0.14	0.39
Total Surface Area (m^2)	132	380	396	315.4	152
Initial Volume (kL)	200	600	600	498	500
Total Overflow Pipe (mm)	569	1,273	986	1,160	285
Annual Irrigation Demand (kL/year)	0	0	0	0	791
Daily Demand (kL/day)	3.51	6.8	8.79	6.31	6.075

Table D7 - Stormwater quality modelling results

Overall Site with 1.18ha wetland & 5000m^2 Bioretention at Catchment U

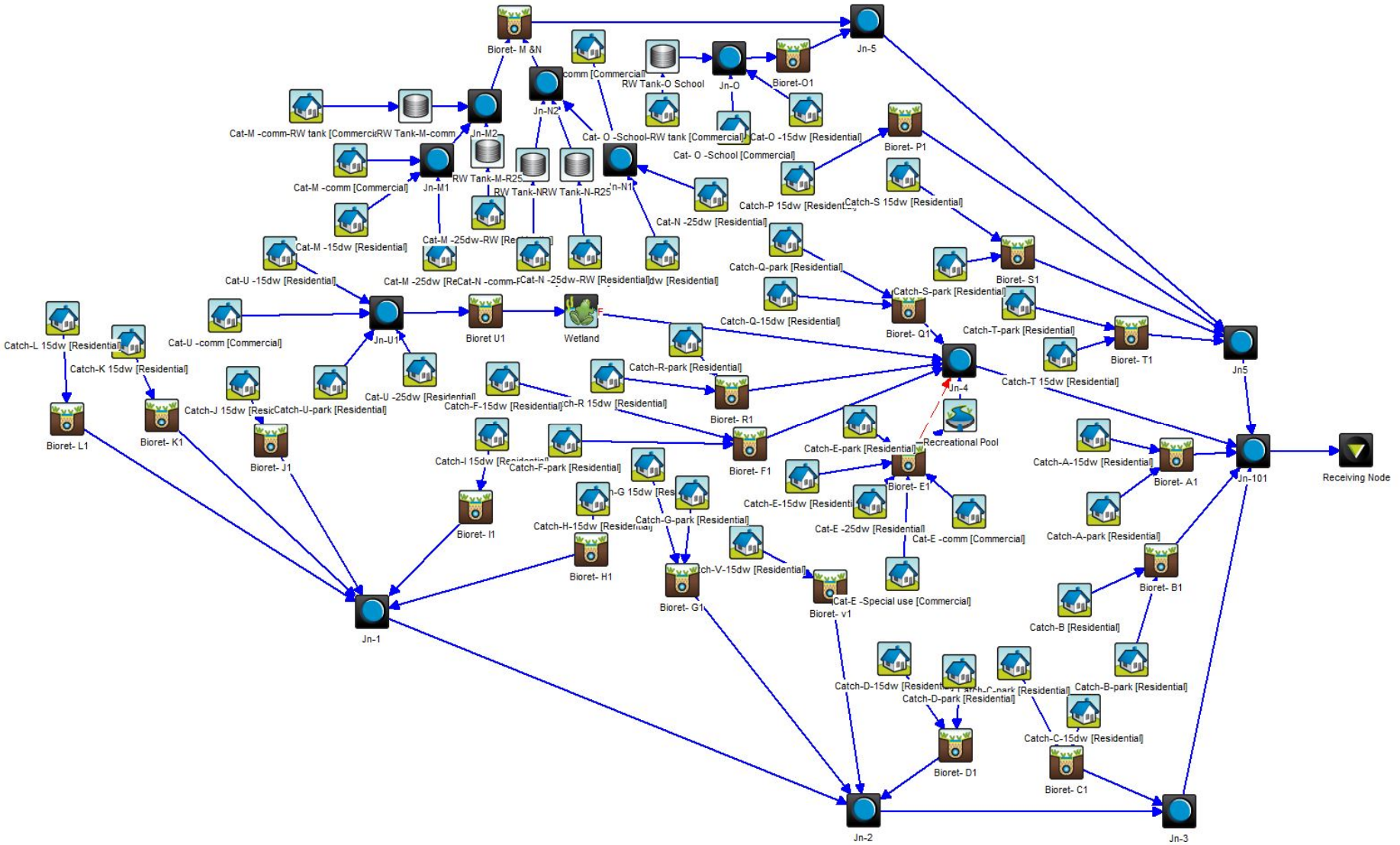
POLLUTANT	INFLOWS (KG/YR)	OUTFLOWS (KG/YR)	REDUCTION ACHIEVED (%)	OBJECTIVE (%)	TARGET MET
Total Suspended Solids (kg/yr)	446,000	86,400	81	80	Yes
Total Phosphorus (kg/yr)	903	248	73	60	Yes
Total Nitrogen (kg/yr)	4,530	2,360	48	45	Yes
Gross Pollutants (kg/yr)	62,300	-	100	90	Yes

APPENDIX E : PRELIMINARY DETENTION BASIN SIZING

Catchment M & N					
1% AEP Ex Peak Flow (m^3/s)	1% AEP Dev Peak Flow (m^3/s)	100 year Duration	Existing Volume (m^3)	Developed Volume (m^3)	Prelim Boyd's (m^3)
2.633	20.592	10min	8534	12317	7443
4.128	21.965	15min	12423	15893	10088
5.317	21.765	20min	15455	18778	11680
6.351	21.98	25min	17909	21120	12734
7.175	20.661	30min	19988	23221	13047
8.451	18.965	45min	24905	28419	13807
9.234	21.264	60min	28896	32439	16348
8.598	16.885	90min	33003	36886	16198
7.891	15.558	120min	36097	40206	17789
6.868	10.598	180min	40672	45220	14314
5.878	7.115	360min	49061	54903	8530
Detention Volume Required (m^3)					21346
Area (m^2) *assuming 1.5m average depth*					14231
Catchment Area (ha)					34.58
Detention Volume Rate (m^3/ha)					617

Catchment O					
1% AEP Ex Peak Flow (m^3/s)	1% AEP Dev Peak Flow (m^3/s)	100 year Duration	Existing Volume (m^3)	Developed Volume (m^3)	Prelim Boyd's (m^3)
0.945	6.469	10min	2609	3769	2228
1.419	6.791	15min	3702	4867	2928
1.906	6.79	20min	4575	5745	3291
2.242	6.856	25min	5253	6486	3536
2.431	6.42	30min	5835	7121	3626
2.734	5.894	45min	7343	8696	3937
2.976	6.625	60min	8435	9935	4646
2.754	5.301	90min	9680	11300	4651
2.528	4.822	120min	10586	12328	5036
2.242	3.271	180min	11939	13863	3756
1.853	2.187	360min	14392	16831	2198
Detention Volume Required (m^3)					6043
Area (m^2) *assuming 1.5m average depth*					4029
Catchment Area (ha)					10.60
Detention Volume Rate (m^3/ha)					570

Waterway Stability Management Requirement					
Catchment U					
63% AEP Ex Peak Flow (m^3/s)	63% AEP Dev Peak Flow (m^3/s)	1 year Duration	Existing Volume (m^3)	Developed Volume (m^3)	Prelim Boyd's (m^3)
1.26	17.19	10min	4131	42784	3829
2.93	18.80	15min	16883	56453	14256
4.45	20.46	20min	30889	67647	24163
5.68	22.53	25min	42166	76719	31531
6.70	23.06	30min	50888	84417	36107
9.47	26.01	45min	70451	102996	44787
11.56	27.72	60min	84760	117357	49415
13.50	27.73	90min	99073	133131	50828
14.12	27.69	120min	108905	144607	53373
13.63	23.51	180min	121887	161349	51190
10.78	19.35	360min	141366	191793	62630
Detention Volume Required (m^3)					75156
Catchment Area (ha)					369.06
Detention Volume Rate (m^3/ha)					204


Bioret- M &N
Jn-5
comm [Commercial]
RW Tank-O School
Jn-O
Bioret-O1
Jn-N2
Cat-M -comm-RW tank [Commercial]
RW Tank-M-comm
Jn-M2
Cat- O -School-RW tank [Commercial]
Cat-O -15dw [Residential]
Cat- O -School [Commercial]
Bioret- P1
Cat-M -comm [Commercial]
Jn-M1
RW Tank-M-R25
RW Tank-NRW Tank-N-R25
Jn-N1
Catch-P 15dw [Residential]
Catch-S 15dw [Residential]
Cat-N -25dw [Residential]
Cat-M -15dw [Residential]
Cat-M -25dw-RW [Re
Cat-U -15dw [Residential]
Cat-M -25dw [ReCat-N -comm-R
Cat-N -25dw-RW [Residential]
dw [Residential]
Catch-Q-park [Residential]
Bioret- S1
Catch-S-park [Residential]
Catch-Q-15dw [Residential]
Bioret- Q1
Catch-T-park [Residential]
Bioret- T1
Jn5
Catch-L 15dw [Residential]
Cat-U -comm [Commercial]
Jn-U1
Bioret U1
Wetland
Catch-K 15dw [Residential]
Catch-R-park [Residential]
Jn-4
Catch-T 15dw [Residential]
Cat-U -25dw [Residential]
Catch-F-15dw [Residential]
Catch-R 15dw [Residential]
Bioret- R1
Catch-J 15dw [Resic
Catch-U-park [Residential]
Recreational Pool
Catch-E-park [Residential]
Catch-A-15dw [Residential]
Bioret- A1
Bioret- L1
Bioret- K1
Bioret- J1
Catch-I 15dw [Residential]
Catch-F-park [Residential]
Bioret- F1
Bioret- E1
Jn-101
Receiving Node
Catch-E-15dw [Residential]
Catch-A-park [Residential]
Bioret- I1
Catch-H-15dw [Residential]
Catch-G-park [Residential]
Cat-E -25dw [Residential]
Cat-E -comm [Commercial]
Bioret- H1
Bioret- G1
Cat-E -Special use [Commercial]
Bioret- v1
Bioret- B1
Jn-1
Catch-B [Residential]
Catch-D-15dw [Residential]
Catch-B-park [Residential]
Catch-D-park [Residential]
Catch-C-15dw [Residential]
Bioret- D1
Bioret- C1
Jn-2
Jn-3

APPENDIX F : SEQ WATER CODE RESPONSES

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
S21	**Site Based Stormwater Quality (and Runoff) Management Plan** A Site Based Stormwater Quality Management Plan including water quality objectives, design, maintenance, monitoring and operation of all measures, is prepared for all High Risk Developments.	M21.1 A Site Based Stormwater Management Plan (SBSMP) is prepared that addresses all Specific Outcomes of this Element and is relevant to the particular land use, development and/or activity.	A Site Based Stormwater Management Plan has been prepared. Refer to the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02).
		M21.2 The SBSMP is prepared and signed-off by a suitably qualified and experienced engineer.	The report is signed off by a suitably qualified and experienced engineer. Refer to the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02).
		M21.3 The SBSMP establishes that erosion, sediment and stormwater quality are controlled at each stage of construction to prevent off-site movement of pollutants in compliance with the results from assessments describe under Specific Outcome S23 and the requirements outlined in any published Council/Government guideline, manual and the like.	The "Concept Stormwater Management Plan" (Report No. B13343.W-02) provides preliminary erosion and sediment control strategies. Detailed erosion and sediment control plans will be prepared for each stage of construction with the detailed design phase.
		M21.4 The SBSMP ensures that stormwater management measures will be installed and maintained by suitably qualified professionals.	The "Concept Stormwater Management Plan" (Report No. B13343.W-02) provides stormwater management measures proposed. Details of maintenance will be provided during subsequent design development phase.
		M21.5 The SBSMP demonstrates that any revegetation, measures, devices and systems will be self-regulatory and low maintenance such that provision for a regime approved by a local government is not necessary.	The design intent as indicated is for control measures with low maintenance requirements. Refer to the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02).
S22	**Site Characteristics** Site characteristics are understood in order to determine the appropriate stormwater management approach relevant to the land use, development and/or activity.	M22.1 An assessment of site characteristics is undertaken that demonstrates an appropriate approach to preventing disturbance as determined through assessment of the following: a) Soil types/properties including unconsolidated soils, hard setting and surface sealing soils and soils known to, or which have the potential to be susceptible to acidity, dispersive subsoils, salinity, sodicity, toxicity, accelerated	Site characteristics have been addressed in the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02).

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
		erosion or other hazards; b) Local geology as having potential for land slip, seeps and the like; c) Watercourses, overland flow paths, wetlands, waterway vegetation, natural detention basins and water bodies within or upstream/downstream of the site; d) Ridge crests, drainage lines, waterlogged areas, discharge points, flood plains and known flood problem areas within or upstream/downstream of the site; e) Areas where removal of vegetation and ground cover will likely create erosion problems or reduce infiltration capacity; f) Areas susceptible to wind and water erosion; g) Areas which due to the length and steepness of slopes may be prone to subsidence, mass movement or erosion; and h) Areas where the depth to water table or nature of bedrock will affect infiltration capacity, land stability, and the like.	
S23	**Stormwater/Runoff Management Capacity** Development capacity is limited to a type, amount and location for which likely stormwater pollutants from construction and operation can be captured and treated on-site through best practice stormwater quality control measures, including retention and detention as appropriate to the site and the land use.	M23.1 Scale, location and intensity of land uses, development and activities are such that the sizing of stormwater management measures can be accommodated wholly within the site. *(Note the 'measures' includes a range of features and devices including basins, swales, traps, buffer strips, wetlands etc.)*	For stormwater quality and total water cycle management, a strategy comprising bioretention systems, a wetland, and rainwater tanks is proposed. Refer to the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02)
		M23.2 Scale, location and intensity of land uses, development and activities are such that all adverse water quality impacts can be mitigated onsite.	
		M23.3 Land area is set aside for the appropriately sized stormwater mitigation measures.	
S24	**Stormwater Management Measures** Stormwater management measures for	M24.1 Stormwater management measures are selected, and the overall	

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
	construction and operation are appropriate to water quality, drainage, flooding and waterway corridor issues in the catchments, catchment areas identified in any Council plans/strategies, or any endorsed catchment management plan.	stormwater management system designed and certified by a suitably qualified and experienced professional as being appropriate to the site in terms of soil type, landform and ecological characteristics, using results of the assessment for Specific Outcome S22, and recognized, locally accepted hydrological, hydraulic, hydrogeological, soil, water quality and biological data and design methodologies.	For stormwater quality and total water cycle management, a strategy comprising bioretention systems, a wetland, and rainwater tanks is proposed. Refer to the latest version of Calibre Consulting Report "Concept Stormwater Management Plan" (Report No. B13343.W-02)
		M24.2 Designs should stipulate pollutant removal performance, maintenance requirements and responsibility for the overall stormwater management system, as well as stipulate the type, location, installation, pollutant removal performance and maintenance requirements for each stormwater management measure.	
		M24.3 Stormwater management measures and the overall stormwater management system is designed and engineered for a range of storm events in compliance with published local or State objectives.	
		M24.4 Stormwater management measures and the overall stormwater management system demonstrate diversion of clean runoff around the problem areas listed in Specific Outcome S22 to stable areas and the rehabilitation/maintenance of such areas with deep-rooted vegetation or other appropriate ground cover.	
		M24.5 Stormwater management measure principally rely on non-mechanical management measures.	
		M24.6 Stormwater management measures principally rely on non-structural management measures (such as grass swales, infiltration areas, revegetated areas and the like) in situations where they offer better solutions than structural measures.	

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
		M24.7 Stormwater management measures should be integrated into the overall design and landscaping of the site.	
		M24.8 Stormwater management measures for construction are used in locations where they remain in place for the duration of development works and/or where permanent stormwater controls will eventually be incorporated.	
		M24.9 Where permanent stormwater quality management measures are required (structural and non-structural), such are selected, constructed and maintained in accordance with local government requirements, manuals, guidelines and the like with location and installation undertaken to prevent erosion or contamination of runoff and as appropriate to the existing and proposed features of the site.	
		M24.10 Selection, design and installation of stormwater management measures should reflect the following principles: a) Minimise areas subject to disturbance; b) Maintain maximum protective vegetation using selective clearing where appropriate, with retention of native vegetation to maximise infiltration; c) Minimise the area of impervious surfaces and compacted soils; d) Ensure that contaminated areas, exposed sites, unstable areas and areas with contaminated wash water are isolated with clean runoff diverted around such area without causing scouring or concentrated flows; e) For clean runoff (including roof water), use of surface design to slow overland flow velocity and to encourage maximum soakage and infiltration (except in unstable areas); f) Protect natural stormwater flow paths; g) Prevent any effluent from overflow at any stage in its	

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
		treatment and disposal process (including effluent from sewage treatment and other effluent producing land uses); h) Intercept and treat runoff and sediment from road ways and other impervious surfaces at the point of source to prevent oil, grease, chemicals, silt, trace metals, nutrients such as phosphorus and nitrogen and other contaminants from entering the environment; i) Use filter strips at the point of erosion source and at stormwater discharge points; j) Prevent any clearing or earthworks in riparian lands or within sensitive areas; k) Establish where erosion, sediment and flow control devices should be used and the most effective devices in the circumstances (including storm events) which should be installed at the source to improve water quality; l) Re-establish vegetation and stabilise as soon as practical on areas that have been disturbed using stripped soils and vegetation consistent with native species in the area or appropriate to the soil types and climatic conditions; and m) Provide for maximised on-site stormwater reuse, rainwater storage and the like.	
S25	**Erosion and Sediment Control Plan** Where land uses, development or activities involve any earthworks, roadworks and building works, appropriate practices, procedures and devices are identified in an Erosion and Sediment Control Plan.	M25.1 The Erosion and Sediment Control Plan (ESCP) is prepared and signed-off by a suitably qualified and experienced professional.	The "Concept Stormwater Management Plan" (Report No. B13343.W-02) provides preliminary erosion and sediment control strategies. Detailed erosion and sediment control plans will be prepared for each stage of construction with the detailed design phase.
		M25.2 ESCPs establish that erosion, sediment and stormwater quality are controlled at each stage of construction to prevent off-site movement of pollutants in compliance with the results from assessments described under Specific Outcome S23 and the requirements outlined in any published Council/Government guideline, manual and the like.	
		M25.3 ESCPs establish that stormwater management measures are used in locations where they remain in place for the duration of development works and/or where	

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
		permanent stormwater management measures will eventually be incorporated.	
		M25.4 ESCPs establish that stormwater management measures are installed and maintained by suitably qualified professionals.	
S26	**Outcomes of Stormwater/Runoff Management** Stormwater management does not cause an adverse impact on flooding, drainage or water quality.	M26.1 Land uses, development, activities and stormwater management ensure: a) No increased peak discharges outside the boundaries of the site; b) No increased flood levels or volumes outside the boundaries of the site; c) No adverse impacts of flooding on developed or developable areas; d) No increased erosion potential on or outside the boundaries of the site; e) No adverse impacts on water quality outside the boundaries of the site; and f) No damage or erosion of waterways.	Refer to the latest version of Calibre Consulting "Flood Investigation Report" (Report No. B13343.W-01) for regional hydrological and hydraulic analyses. The results demonstrate no adverse impact on regional flooding. Refer to the latest version of Calibre Consulting "Concept Stormwater Management Plan" (Report No. B13343.W-02) for local stormwater management strategies. The analyses for local flooding, peak flow management, stormwater quality & total water cycle management demonstrate the development does not cause adverse impact on local flooding, drainage or water quality.
S27	**Water Quality Monitoring** Monitoring of water quality is undertaken to ensure that construction, operation and decommissioning of land uses, development and activities do not cause an adverse impact on water quality.	M27.1 Site specific discharge is monitored annually through approved testing under the DERM Monitoring & Sampling Manual 2009, or the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC, 2000) for land uses, development and activities: a) In or within 100 metres of riparian land; b) That significantly increase impervious surface areas; or c) On areas with potential to contaminate or increase runoff.	No water quality monitoring is proposed for the Jimboomba Celestino development. Stormwater management proposed is the current Best Practice Management standards. The development generally maintains a 100m wide buffer between the residential lots and the banks of Logan River.
		M27.2 Reporting is sent to the local government establishing that agreed water quality parameters are being fulfilled. Where problems are reported, appropriate	

Table 8 – Element 5: Water Sensitive Design and Stormwater/ Runoff Management Specific Outcomes & Measures

	Specific Outcome	Measures	Response
		techniques are implemented immediately at the expense of the owner to ensure that standards can be met.	
		M27.3 Site Based Stormwater Management Plans for High Risk development provides for annual monitoring of revegetation areas and other approved devices, measures and systems by proponents, or, at the owners expense, the local government, to ensure their effectiveness in capturing and treating stormwater quality to an agreed discharge level. Maintenance is outlined in the Plan with provision to use local resources, and clear procedures to address poor operations. *(Refer to Section 6 of these Guidelines regarding Environmental Management and monitoring)*	

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Our Ref: B13343.W.09L.AMP.cm.docx
Contact: Andrew McPhail

16 March 2017

Seqwater
C/- PSA Consulting
PO Box 10824
Brisbane, QLD 4000

Attention: Carly Enever

Dear Carly,

Jimboomba Celestino Master Plan Development within the Greater Flagstone Priority Development Area (PDA)

Responses to Seqwater Advice Letter (Ref No. F16/4958 dated 16 January 2016).

Calibre Consulting (QLD) previously prepared the following documentation for Jimboomba Celestino master plan development within the Greater Flagstone Priority Development Area (PDA):

- *Concept Stormwater Management Plan* Report (*Concept SWMP,* No. **B13343.W-02A** dated November 2016)
- *Flood Investigation Report* (No. **B13343.W-01B** dated November 2016)
- *Water and Wastewater Infrastructure Master Plan* (No. **B13343.W-03A** dated October 2016)

Since the submission of the abovementioned reports to Economic Development Queensland (EDQ), Seqwater has provided an information request letter (*Seqwater Advice Letter,* Ref No. F16/4958 dated 16 January 2016).

Our response to Item 1 & 2 and Further Advice Notes 1 & 2 outlined in the *Seqwater Advice Letter* are as follows. Note that response to Items 3 & 4 are not addressed in this letter.

1. Issue: Temporary Sewage Treatment Plant

The proposed temporary sewage treatment plant {STP} has the potential to pose a risk to the drinking water storage above Cedar Grove Weir as a result of contamination from the irrigation area or effluent contaminating stormwater supplies.

Information Required:

Please confirm that the proposed effluent irrigation areas is located entirely outside of the catchment for the Cedar Grove Weir and confirm what measures are in place to prevent effluent contaminating stormwater supplies as a result of backflow events or re-direction of contaminated stormwater.

The proposed effluent irrigation areas will be located entirely outside of the catchment for the Cedar Grove Weir. The proposed irrigation areas are shown schematically on drawings **B13343.W-WW001** and **WW002** provided in **Attachment 1**. Potential runoff will not flow to the Cedar Grove Weir.

2. Issue: Stormwater Management

The proposal involves the use of stormwater quality treatment devices (bioretention basins and wetlands) to manage stormwater flows from the development. It would appear that catchments L, K, J, I, H, G, V and D will discharge to the Logan River upstream of the Cedar Grove Weir, whilst all other areas will be discharged to the east, downstream of the weir. Stormwater which enters the weir pool may present a risk to drinking water quality.

According to the proposal plans, some areas of the development contains setbacks of approximately 100-150m to the Logan River. In accordance with the Seqwater Development Guidelines, development is to maintain a setback of 400m from a water storage. It is noted that Seqwater maintains easements on the banks of the Logan River for the purpose of water storage and any setback should be based on the outmost edge of the easement (refer to further advice note below regarding easement details)

Information Required

Please confirm a setback of 400m to the outermost edge of the Seqwater easements. Where this may not be achieved, the applicant should demonstrate that stormwater released from the site upstream of the Cedar Grove Weir will achieve the Drinking Water EV's as specified in the *Environmental Protection (Water) Policy 2009* – Logan River environmental values and water quality objectives, Basin No 145 (part) including all tributaries of the Logan River. Seqwater's preference is for the applicant to consider options for diverting all stormwater to a discharge point downstream of the weir.

Calibre Consulting acknowledges that proposed Catchments D, V, G, H, I, J, K and L discharge to Logan River upstream of the Cedar Grove Weir as per Drawing No. **B13343.W-SK02** provided in the *Concept SWMP* (November 2016). Refer to **Attachment 2** for a copy of the drawing. **Table A** below indicates current setback from outermost edge of Seqwater easements (located on banks of Logan River) for each catchment.

Table A – Setback from Outermost Edge of Seqwater Easement

Catchment discharging to Logan River U/S of Weir	Approximate Setback from Seqwater Easement
Catchment D	125m
Catchment V	275m
Catchment G	150m
Catchment H	100m
Catchment I	125m
Catchment J	>1km
Catchment K	>1km
Catchment L	>1km

For Catchments D, V, G, H, and I the setbacks from discharge point to the Seqwater easement are less than 400m. As indicated in Seqwater's request the 400m setback is a requirement for water quality purposes (i.e. where a setback of less than 400m is provided applicant is required to demonstrate water quality objectives or diverting runoff downstream of weir).

Diverting Runoff Downstream of Cedar Grove Weir

Calibre has considered the option of discharging runoff from the development downstream of Cedar Grove Weir. Through our review and analysis it has been found that this is not feasible for the following reasons:

- A 2km pipe or channel would be required adjacent to Logan River. The works to provide this infrastructure is neither practical or an economical solution.
- Earthworks to divert runoff from Catchment D, V, G, H, and I to the north cannot be achieved due to current topography of the site (earthworks would require 15-20m of cut).

Therefore it is still proposed to discharge runoff from the site to Logan River upstream of the Cedar Grove Weir.

Preliminary Analysis to Demonstrate Non-Worsening Objective is Achievable

The following investigation demonstrates that, while slightly lower setbacks to the banks of the Logan River have been provided, the same or better stormwater quality outcome will be achieved by the proposed stormwater management strategy, which incorporates Water Sensitive Urban Devices (WSUD).

Specific Outcome S26 of Table 8 of *Seqwater Development Guidelines* (2012) indicates specific outcomes and appropriate measures for Stormwater/Runoff Management. The specific outcomes are to ensure that "*Stormwater Management does not cause an adverse impact on flooding, drainage or water quality.*" The identified measure to achieve the stormwater quality outcome would be to demonstrate that "*Land Uses, development, activities and stormwater management ensure: (e) No adverse impacts on water quality outside the boundaries of site*".

Preliminary MUSIC analysis of Catchment I was undertaken to demonstrate that reducing pollutant loads from the development back to existing levels at the boundary of the site is achievable (and may require slight upsizing bioretention basin filter sizes only). It is proposed to defer detailed analysis and sizing of all basins until ROL stages of the development. However, this preliminary analysis demonstrates that meeting non-worsening objectives for stormwater quality is achievable. **Table B** provides a summary of the preliminary analysis.

Table B – Catchment I Preliminary MUSIC analysis

Parameter	TSS (kg/year)	TP (kg/year)	TN (kg/year)	GP (kg/year)
Developed Source Loads	4,320	8.7	41.2	598
Existing Source Loads using Rural MUSIC Node (Fi – 0%)	2,430	2.4	19.5	0
Mitigated Residual Loads with Bioretention Filter Size - 0.7% of Catchment to meet **SPP, 2014 (Current Proposal)**	826 (-1,604 difference from existing loads)	2.3 (-0.1 difference from existing loads)	21.6 (2.1 difference from existing loads)	0 (0 difference from existing loads)
Mitigated Residual Loads with Bioretention Filter Size - 0.9% of Catchment to meet **non-worsening objective**	604 (-1,826 difference from existing loads)	1.8 (-0.6 difference from existing loads)	19.2 (-0.3 difference from existing loads)	0 (0 difference from existing loads)

Results above indicate that an increase in filter area of 0.2% is required for Catchment I to reduce pollutant loads back to existing levels (assuming rural land use). Parameters for a Lumped Rural Residential Node was adopted based on *Table 3.7* and *Table 3.9* of the Water By Design's *MUSIC Modelling Guidelines* (2010). Considering that cleared areas on the site (including the catchments in question) are currently being used for grazing (agricultural purposes) this assumption (i.e. a rural node) is very conservative. Land used for grazing or agricultural purposes is expected to produce much higher pollutant loads than the adopted rural residential land type, and if existing source loads were higher, bioretention filter area required would be smaller.

The results of this preliminary analysis demonstrate that meeting a non-worsening stormwater quality outcome is achievable even when adopting conservative assumptions for existing land use. Since objectives are achievable with only a small change to current strategy (i.e. slight increase in bioretention filter area), it is proposed to defer further modelling and liaison with Seqwater (to confirm existing modelling assumptions) to future ROL stage for these catchments.

Further Details

Seqwater indicate that stormwater discharge needs to achieve Drinking Water Environmental Values (EV's) as specified in the *Environmental Protection (Water) Policy 2009* if setback requirements are not met. Calibre Consulting believe that this is not a reasonable requirement based on the following:

- Achieving Drinking Water EV's is presented as an alternative for providing a 400m setback or buffer to the watercourse. A 400m grassed buffer or swale would not achieve Drinking Water EV's. The proposed Bioretention Basin devices (which includes filter media and vegetation to capture & remove pollutants) provides much better treatment than grassed buffers or swales.

- The existing conditions of the Logan River upstream of Cedar Grove Weir is not a pristine waterway and does not currently achieve Drinking Water EV's. The overall catchment to the Logan River is large and involves many agricultural areas that are contributing to overall pollution of the Logan River. Changing the land use of the site (from agricultural to residential land use) and providing WSUD to treat runoff is expected to provide an improvement to stormwater quality discharging to the Logan River.

- The overall catchment discharging to the Logan River is extremely large. Changing pollutant runoff (whether worsening or improving) from site areas which forms such a small percentage of overall catchment will make a negligible difference to the overall quality of Logan River. Based on catchment conditions achieving *SPP*, 2014 would be sufficient.

Further Advice Notes:

1. Cedar Grove Wastewater Treatment Plant

While subject to works proposed by Logan Water Infrastructure Alliance, the location of two proposed sewer mains crossing the Logan River from the proposed Cedar Grove Wastewater Treatment Plant through the Celestino masterplanned development presents an unacceptable risk to drinking water supply. Please note that Seqwater is currently in discussions with Logan Water Infrastructure Alliance regarding the proposed sewerage network infrastructure.

It is noted that the proposed Logan River crossings are currently under review by the Logan Water Infrastructure Alliance. The Applicant will liaise with Seqwater and Logan Water Infrastructure Alliance to confirm appropriate infrastructure configurations prior to commencing detailed design analyses.

2. Seqwater Easements for Water Management

Seqwater maintains easements along the Logan River (including AD on SP29573, AD on SP209571 , AF on SP209572 and AG on SP209573) for the purpose of " ... water storage including overland flow and inundation of the easement land which results from the operation of the water infrastructure". The applicant's obligations regarding consent for works, infrastructure and any interference on easement land are outlined in the easement documentation (example attached for AD on SP209571).

It appears that proposed infrastructure including environmental park may enter the easements. Obligations of the landowner require that the applicant liaise with Seqwater as the easement holder regarding all activities, works or access within easement areas to ensure that works do not compromise the purpose of the easement or the rights of Seqwater as the easement holder. In particular, uses and activities must not be carried out which are determined to be inconsistent with the safe and efficient operation of the water infrastructure and / or the quality of water stored or to be stored on the easement land or in the water infrastructure.

The Applicant and the Logan Water Infrastructure Alliance will liaise with Seqwater prior to finalising development layout plans to confirm all activities, works or access within easement areas and to ensure that works do not compromise the safe and efficient operation of water infrastructure or present adverse water quality impacts.

We trust the information provided in this letter is acceptable and satisfactorily addresses Item 1 & 2 and Further Advice Notes 1 & 2 of Seqwater's Advice Letter (dated 16 January 2016). We respectfully request that our responses to these items be accepted in support of the master plan approval.

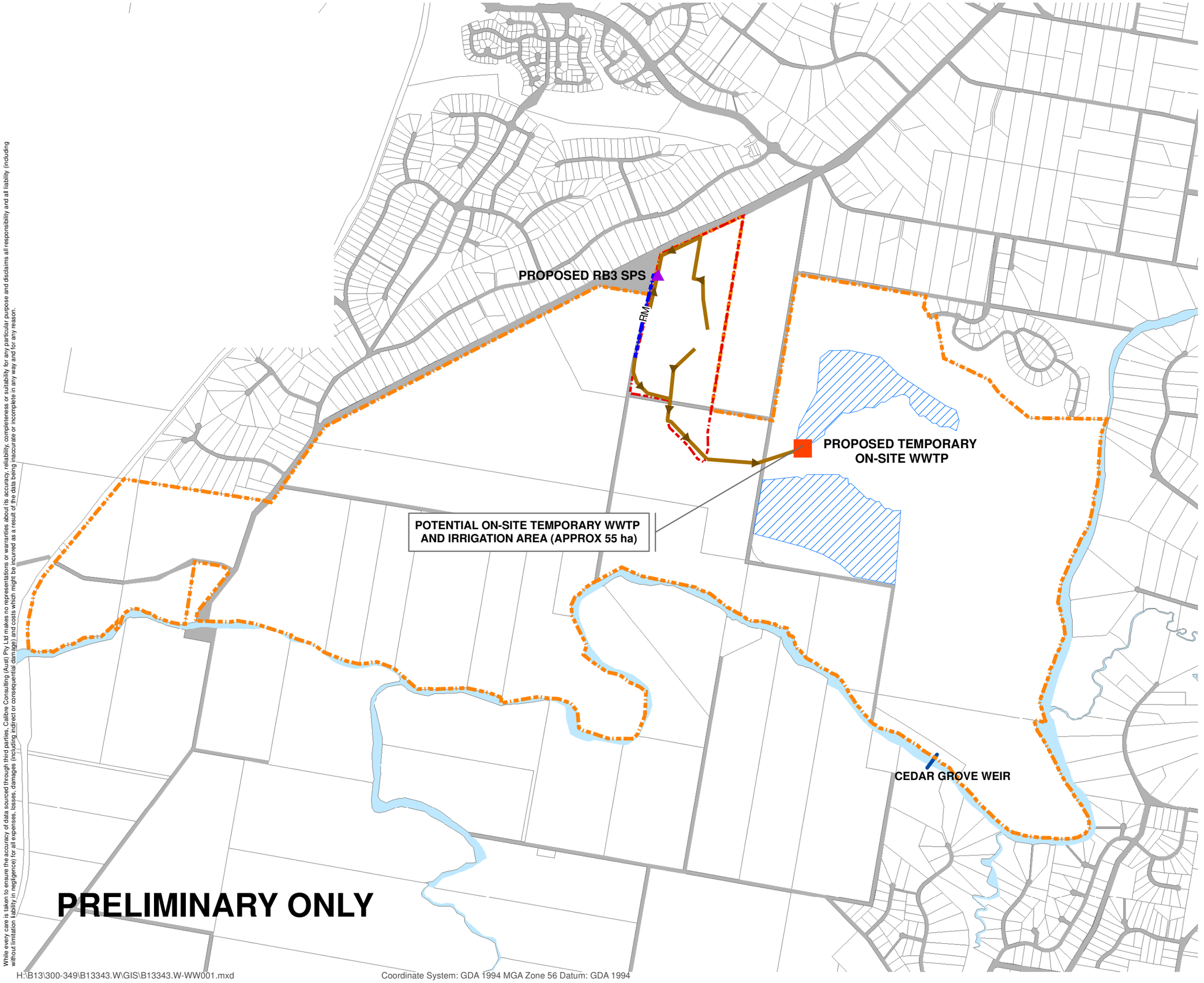
Should you require any further information please do not hesitate to contact the undersigned on (07) 3895 3444.

Yours sincerely,
Calibre Consulting

Andrew McPhail
Principal Engineer

Attachments

1. Concept Sewer Plans (Drawing No. **B13343.W-WW001** and **WW002**).
2. Stormwater Catchment Plan (Drawing No. **B13343.W-SK02**, as provided in **B13343.W-02A** dated November 2016).



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre CONSULTING

LEGEND

WASTEWATER INFRASTRUCTURE

- PROPOSED TEMPORARY ON-SITE WWTP
- PROPOSED PUMP STATION
- RM PROPOSED RISING MAIN
- PROPOSED GRAVITY MAIN
- PROPOSED IRRIGATION AREA
- PRECINCTS 1 & 3 BOUNDARY
- CONTEXT PLAN AREA

LAND USES

- LAND PARCEL
- ROAD
- LOGAN RIVER

NOTES:

1. THIS DRAWING IS CONCEPTUAL AND HAS BEEN PRODUCED FOR DISCUSSION PURPOSES ONLY.
2. WASTEWATER NETWORK ANALYSIS REQUIRED TO CONFIRM PIPE SIZES AND PUMP STATION/RISING MAIN REQUIREMENTS.
3. WASTEWATER INFRASTRUCTURE LOCATIONS AND ALIGNMENTS ARE INDICATIVE ONLY AND SUBJECT TO DESIGN.
4. REFER TO THG PRELIMINARY CONTEXT PLAN DRAWING NO. 30697-GP07(I).

0 125 250 500 m

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N

PROJECT:

Jimboomba | CELESTINO

CLIENT:

CELESTINO PTY LTD

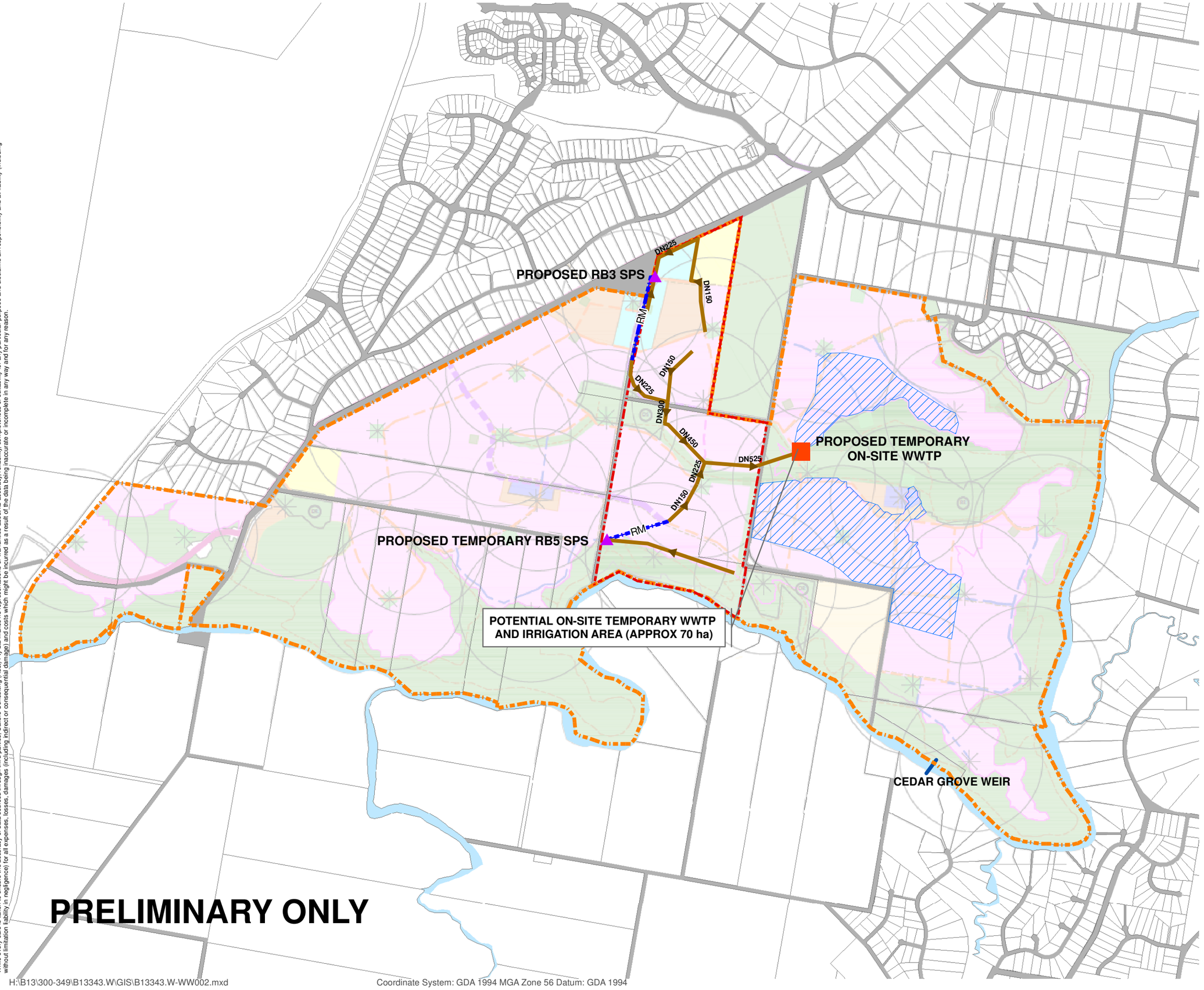
DRAWING TITLE:

CONCEPTUAL PRECINCTS 1 AND 3 WASTEWATER SERVICE STRATEGY

DRAWING NO: **B13343.W-WW001**

ISSUE: **D**

ISS	BY	CHK	DATE	DETAILS
A	MAH	ABM	13.09.16	DRAFT
B	MAH	ABM	16.09.16	WWTP LOCATION AMENDED
C	MAH	ABM	23.09.16	MINOR AMENDMENTS
D	JG	ABM	28.02.17	MINOR AMENDMENTS



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre CONSULTING

LEGEND

WASTEWATER INFRASTRUCTURE

- PROPOSED TEMPORARY ON-SITE WWTP
- PROPOSED SPS
- PROPOSED IRRIGATION AREA
- RM PROPOSED RISING MAIN
- PROPOSED GRAVITY MAIN

LAND USES

- LAND PARCEL
- ROAD
- LOGAN RIVER
- PRECINCTS 1, 3 & 8 BOUNDARY
- CONTEXT PLAN AREA

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE CONSULTING REPORT NO. B13343.W-03.
2. THIS DRAWING IS CONCEPTUAL AND HAS BEEN PRODUCED FOR DISCUSSION PURPOSES ONLY.
3. WASTEWATER NETWORK ANALYSIS REQUIRED TO CONFIRM PIPE SIZES AND PUMP STATION/RISING MAIN REQUIREMENTS.
4. WASTEWATER INFRASTRUCTURE LOCATIONS AND ALIGNMENTS ARE INDICATIVE ONLY AND SUBJECT TO DESIGN.
5. REFER TO THG CONTEXT PLAN DRAWING NO. 30697-CP01(A).

0 125 250 500 m

1:20,000 (A3)

N

PROJECT:

Jimboomba | CELESTINO

CLIENT:

CELESTINO PTY LTD

DRAWING TITLE:

CONCEPTUAL PRECINCTS 1, 3 AND 8 WASTEWATER SERVICE STRATEGY

DRAWING NO: **B13343.W-WW002**

ISSUE: **F**

ISS	BY	CHK	DATE	DETAILS
B	MAH	ABM	16.09.16	WWTP LOCATION AMENDED
C	MAH	ABM	23.09.16	MINOR AMENDMENTS
D	MAH	ABM	19.10.16	MINOR AMENDMENTS
E	MAH	ABM	31.10.16	CONTEXT PLAN UPDATED
F	JG	ABM	28.02.17	CONTEXT PLAN UPDATED

STORMWATER QUALITY TREATMENT

CATCHMENT	TREATMENT AREA (m^2)
A	450m^2 BIORETENTION FILTER
B	850m^2 BIORETENTION FILTER
C	810m^2 BIORETENTION FILTER
D	695m^2 BIORETENTION FILTER
E	4000m^2 BIORETENTION FILTER
F	1750m^2 BIORETENTION FILTER
G	210m^2 BIORETENTION FILTER
H	790m^2 BIORETENTION FILTER
I	260m^2 BIORETENTION FILTER
J	110m^2 BIORETENTION FILTER
K	275m^2 BIORETENTION FILTER
L	400m^2 BIORETENTION FILTER
M	1100m^2 BIORETENTION FILTER
N	1300m^2 BIORETENTION FILTER
O	550m^2 BIORETENTION FILTER
P	1200m^2 BIORETENTION FILTER
Q	2200m^2 BIORETENTION FILTER
R	975m^2 BIORETENTION FILTER
S	1200m^2 BIORETENTION FILTER
T	400m^2 BIORETENTION FILTER
U	5000m^2 BIORETENTION FILTER AND 11800m^2 WETLAND
V	560m^2 BIORETENTION FILTER
TOTAL	25085m^2 BIORETENTION FILTER AND 11800m^2 WETLAND

NOTE:
OBTAIN DOWNSTREAM DISCHARGE CONSENT AND FORCATCHMENTS J, K & L

PROVIDE RAINWATER TANKS AND ROOFWATER RE-USE FOR CATCHMENTS M, N AND O. REFER TO REPORT No. B13343.W-02.

11,800m^2 WETLAND. PROVIDE STORMWATER HARVESTING FOR IRRIGATION OF SPORTS FIELDS

TEVIOT ROAD

TEVIOT ROAD

IRRIGATION AREA FOR SPORTS FIELD

PROVIDE DRAINAGE SWALE WITHIN ROAD RESERVE TO CONVEY CATCHMENT P FLOWS TO LOGAN RIVER FLOOD PLAIN.

SEEK LCC CONSENT FOR CONSTRUCTION OF SWALE THROUGH LOT 901/SP222166

POSSIBLE 2ha WATER PLAY AREA (NOT A SQID) SUBJECT TO DETAILED DESIGN

STORMWATER QUALITY TREATMENT DEVICES ARE TO BE PROVIDED FOR THE OVERALL CONTEXT PLAN AREAS. APPROPRIATE ANALYSIS TO BE UNDERTAKEN DURING FUTURE ROL APPLICATION PHASES.

SEQ WEIR

LOGAN RIVER

N

LEGEND:

- SITE BOUNDARY
- STORMWATER QUALITY CATCHMENT BOUNDARY
- OVERALL CONTEXT PLAN AREA
- EXISTING CONTOURS
- A — CATCHMENT LABEL
- POSSIBLE SQID LOCATIONS REFER TO NOTE 7.
- POSSIBLE SQID LOCATIONS REFER TO NOTE 8.

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. B13343.W-02
2. ALL INFORMATION PRESENTED ON THIS DRAWING ARE CONCEPTUAL AND PRELIMINARY ONLY. THEY ARE TO BE CONFIRMED DURING FUTURE DESIGN DEVELOPMENT PHASES.
3. LOCATIONS OF STORMWATER QUALITY IMPROVEMENT DEVICES (SQIDs) ARE PRELIMINARY AND CONCEPT ONLY, SUITABLE FOR MASTER PLANNING. FURTHER DETAILS TO BE DETERMINED DURING FUTURE MCU/ROL APPLICATIONS AND SUBSEQUENT DETAILED DESIGN PHASES.
4. REFER TO CONTEXT PLAN PLAN BY THG FOR DETAILS OF LAND USE TYPES.
5. 63% AEP DETENTION TO BE PROVIDED WITHIN THE END OF LINE BIORETENTION BASINS WHERE REQUIRED.
6. SEEK DOWNSTREAM DISCHARGE CONSENT FOR CATCHMENTS J, K & L AS AN OVERALL CONTEXT PLAN MANAGEMENT STRATEGY.
7. BIORETENTION FILTER AREAS CAN BE DISTRIBUTED PROPORTIONALLY OVER MULTIPLE DISCHARGE POINTS WITHIN THE CATCHMENTS.
8. BIORETENTION LOCATED WITHIN DETENTION BASINS.

PRELIMINARY ONLY
NOT FOR LODGMENT TO COUNCIL

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
		CS	JW	06.05.16	
	A	CS	CS	10.05.16	UPDATED NOTES
	B	CS	CS	13.05.16	100m RIVER BUFFER
	C	CS	JW	25.10.16	UPDATED TITLE AND STORMWATER QUALITY CATCHMENTS
	D	CS	JW	31.10.16	CHANGES TO CONTEXT LAYOUT
	E				
	F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1:10000 100 0 100 200 300 400 500 A1
1:20000 A3

MICROFILM No.

PROJECT No. B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT CELESTINO Jimboomba CELESTINO

PROJECT JIMBOOMBA CELESTINO

calibre CONSULTING

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Brisbane Gladstone Melbourne Sydney Singapore Stockholm
Cert. Environmental Company ISO14001 Lic-4595

DRAWING TITLE
CONCEPT STORMWATER QUALITY MANAGEMENT PLAN

DRAWING NUMBER B13343.W-SK02

ISSUE D

APPENDIX G : CONCEPT DRAWINGS

STORMWATER QUALITY TREATMENT

CATCHMENT	TREATMENT AREA (m^2)
A	450m^2 BIORETENTION FILTER
B	850m^2 BIORETENTION FILTER
C	810m^2 BIORETENTION FILTER
D	695m^2 BIORETENTION FILTER
E	4000m^2 BIORETENTION FILTER
F	1750m^2 BIORETENTION FILTER
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R	975m^2 BIORETENTION FILTER
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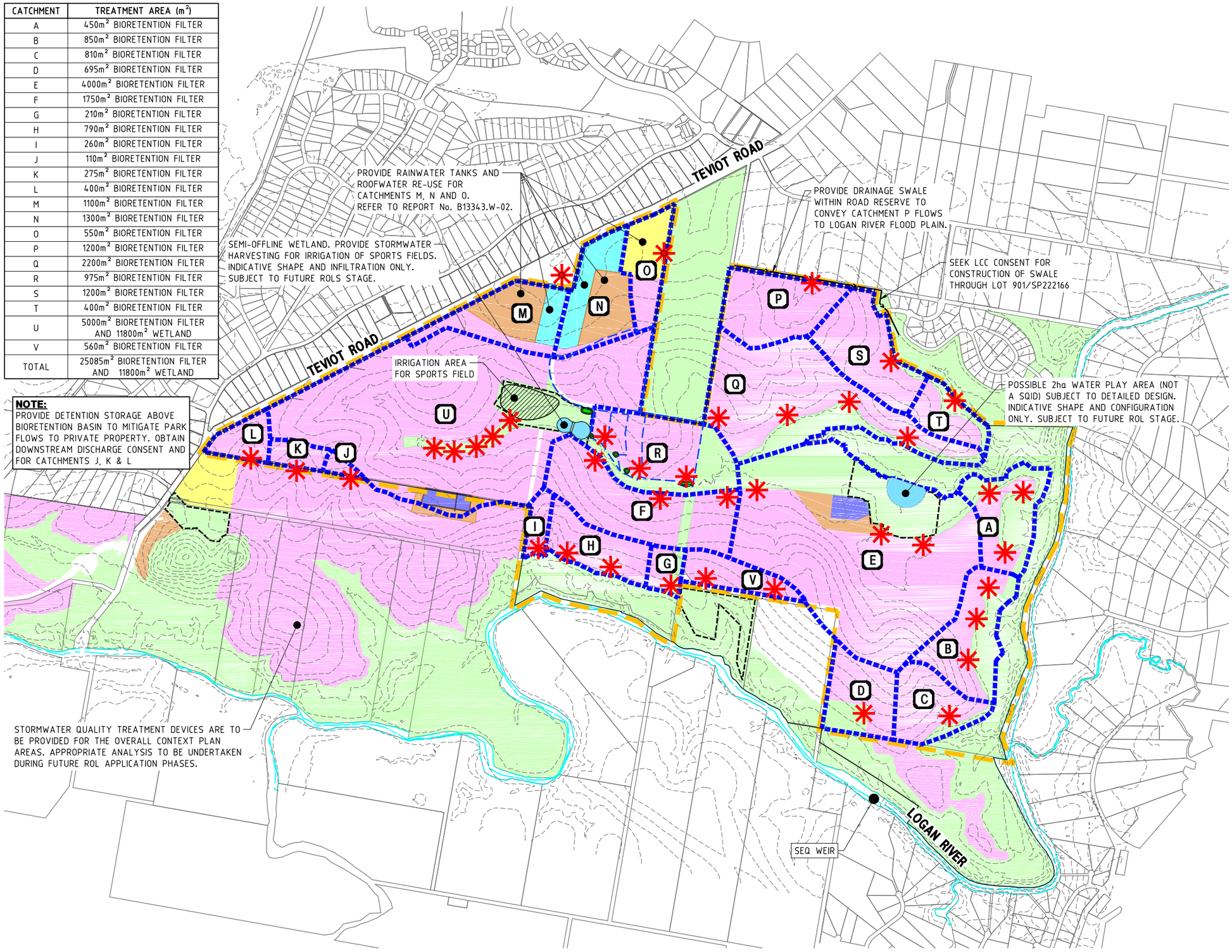
U	5000m^2 BIORETENTION FILTER AND 11800m^2 WETLAND
V	560m^2 BIORETENTION FILTER
TOTAL	25085m^2 BIORETENTION FILTER AND 11800m^2 WETLAND

NOTE:
PROVIDE DETENTION STORAGE ABOVE BIORETENTION BASIN TO MITIGATE PARK FLOWS TO PRIVATE PROPERTY. OBTAIN DOWNSTREAM DISCHARGE CONSENT AND FOR CATCHMENTS J, K & L



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LEGEND:

- SITE BOUNDARY
- STORMWATER QUALITY CATCHMENT BOUNDARY
- OVERALL CONTEXT PLAN AREA
- EXISTING CONTOURS
- (A) CATCHMENT LABEL
- POSSIBLE SQID LOCATIONS REFER TO NOTE 7.
- POSSIBLE SQID LOCATIONS REFER TO NOTE 8.

NOTES:

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4. REFER TO CONTEXT PLAN PLAN BY THG FOR DETAILS OF LAND USE TYPES.
5. 63% AEP DETENTION TO BE PROVIDED WITHIN THE END OF LINE BIORETENTION BASINS WHERE REQUIRED.
6. SEEK DOWNSTREAM DISCHARGE CONSENT FOR CATCHMENTS J, K & L AS AN OVERALL CONTEXT PLAN MANAGEMENT STRATEGY.
7. BIORETENTION FILTER AREAS CAN BE DISTRIBUTED PROPORTIONALLY OVER MULTIPLE DISCHARGE POINTS WITHIN THE CATCHMENTS.
8. BIORETENTION LOCATED WITHIN DETENTION BASINS.

PRELIMINARY ONLY
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NOT TO BE USED FOR CONSTRUCTION PURPOSES

FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	A	CS	CS	10.05.16	UPDATED NOTES
	B	CS	CS	13.05.16	100m RIVER BUFFER
	C	CS	JW	25.10.16	UPDATED TITLE AND STORMWATER QUALITY CATCHMENTS
	D	CS	JW	31.10.16	CHANGES TO CONTEXT LAYOUT
	E	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:10000 100 0 100 200 300 400 500 A1
1:20000 A3

MICROFILM No.

PROJECT No.
B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT
CELESTINO
Jimboomba CELESTINO

PROJECT
JIMBOOMBA CELESTINO

calibre CONSULTING

CONSULT AUSTRALIA
Calibre Consulting (Qld) Pty Ltd
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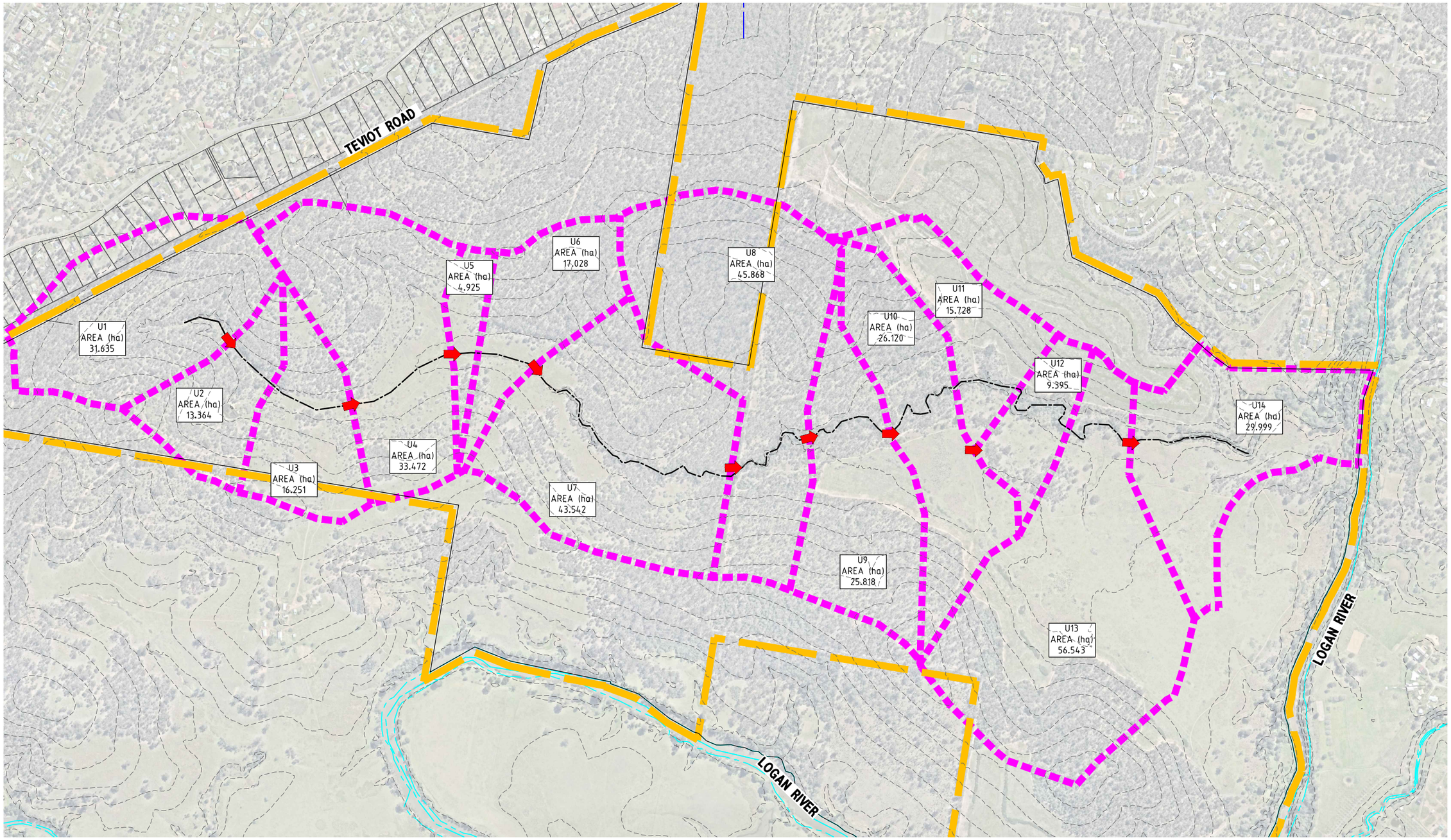
Telephone 07 3895 3444 Facsimile 07 3895 3488
Brisbane Gladstone Melbourne Sydney Singapore Sunshine Coast

DRAWING TITLE
CONCEPT STORMWATER QUALITY MANAGEMENT PLAN

DRAWING NUMBER
B13343.W-SK02

ISSUE
E



LEGEND:

- SITE BOUNDARY
- LOCAL CATCHMENT BOUNDARY
- EXISTING CONTOURS
- FLOW ARROW

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF THE CALIBRE CONSULTING REPORT No. B13343.W-02.
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FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
		CS	JW	16.05.16	
	A	CS	JW	25.10.16	MINOR AMENDMENTS
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK

DRAWN CHECK

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1:12000 A3

MICROFILM No.

PROJECT No.
B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT
CELESTINO
Jimboomba CELESTINO

PROJECT
JIMBOOMBA CELESTINO

calibre CONSULTING

CONSULT AUSTRALIA
Calibre Consulting (Qld) Pty Ltd
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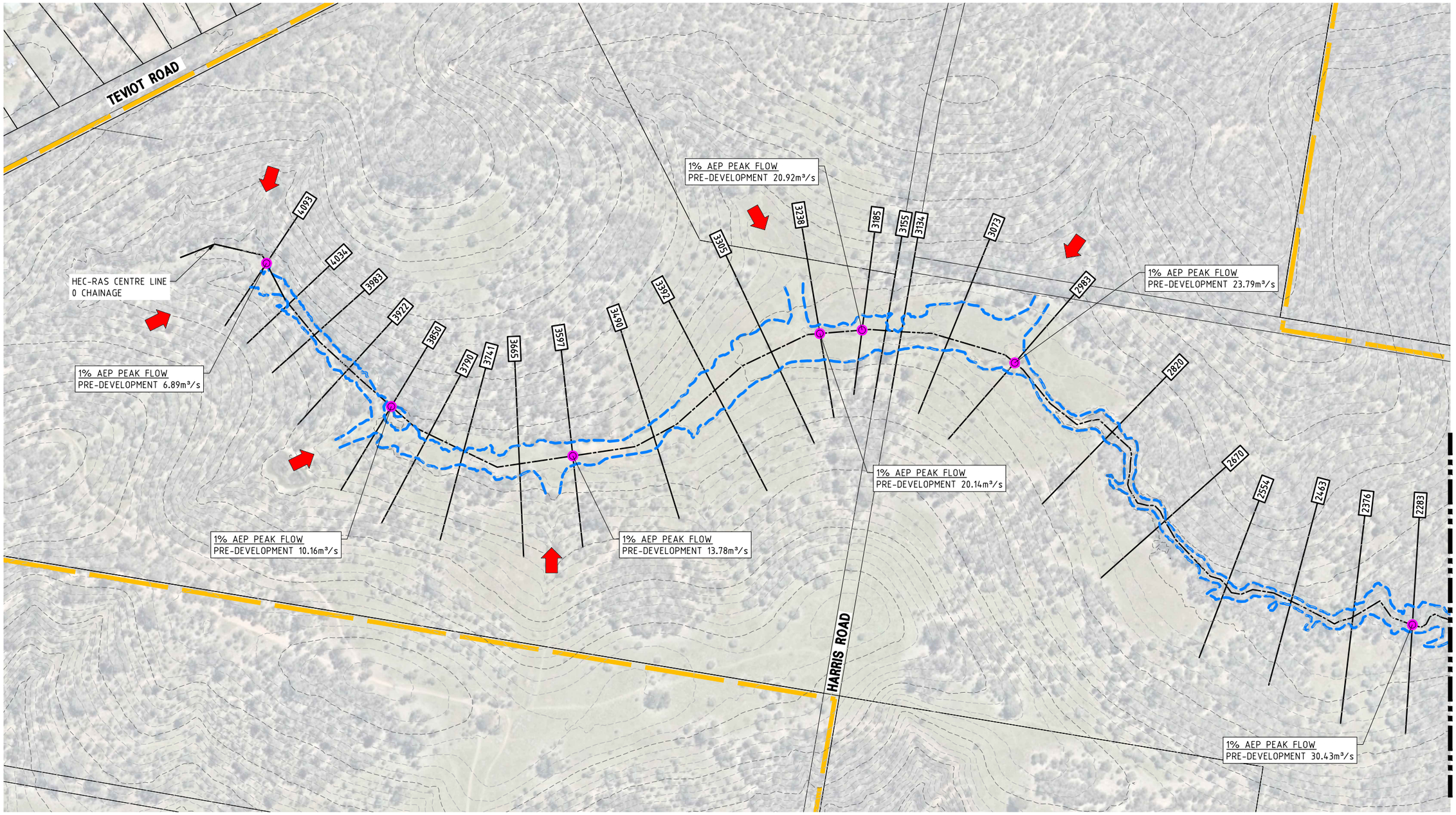
Brisbane Canberra Melbourne Sydney Singapore Christchurch

Quality Environment Company ISO9001 Lic-0591

DRAWING TITLE
EXISTING SCENARIO CATCHMENT PLAN LOCAL FLOODING

DRAWING NUMBER
B13343.W-SK03

ISSUE
B



LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- EXISTING SCENARIO 1% AEP LOCAL FLOOD EXTENT
- FLOW ARROW (CONCEPTUAL ONLY)
- 3597 HEC-RAS CROSS SECTIONS
- HEC-RAS INFLOW LOCATION

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. B13343.W-02.
2. ALL INFORMATION PRESENTED ON THIS DRAWING ARE CONCEPTUAL AND PRELIMINARY ONLY. THEY ARE TO BE CONFIRMED DURING FUTURE DESIGN DEVELOPMENT PHASES.
3. THE LOCAL FLOOD EXTENTS SHOWN ARE CONCEPTUAL ONLY.

PRELIMINARY ONLY
NOT FOR LODGMENT TO COUNCIL

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS		CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE		CS	JW	16.05.16	
	A	CS	JW	04.07.16	MINOR AMENDMENTS
	B	CS	JW	25.10.16	MINOR AMENDMENTS
	C	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	D				
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:2500 50 0 50 100 A1
1:5000 A3

MICROFILM No.

PROJECT No. B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT CELESTINO (Jimboomba CELESTINO)
PROJECT JIMBOOMBA CELESTINO

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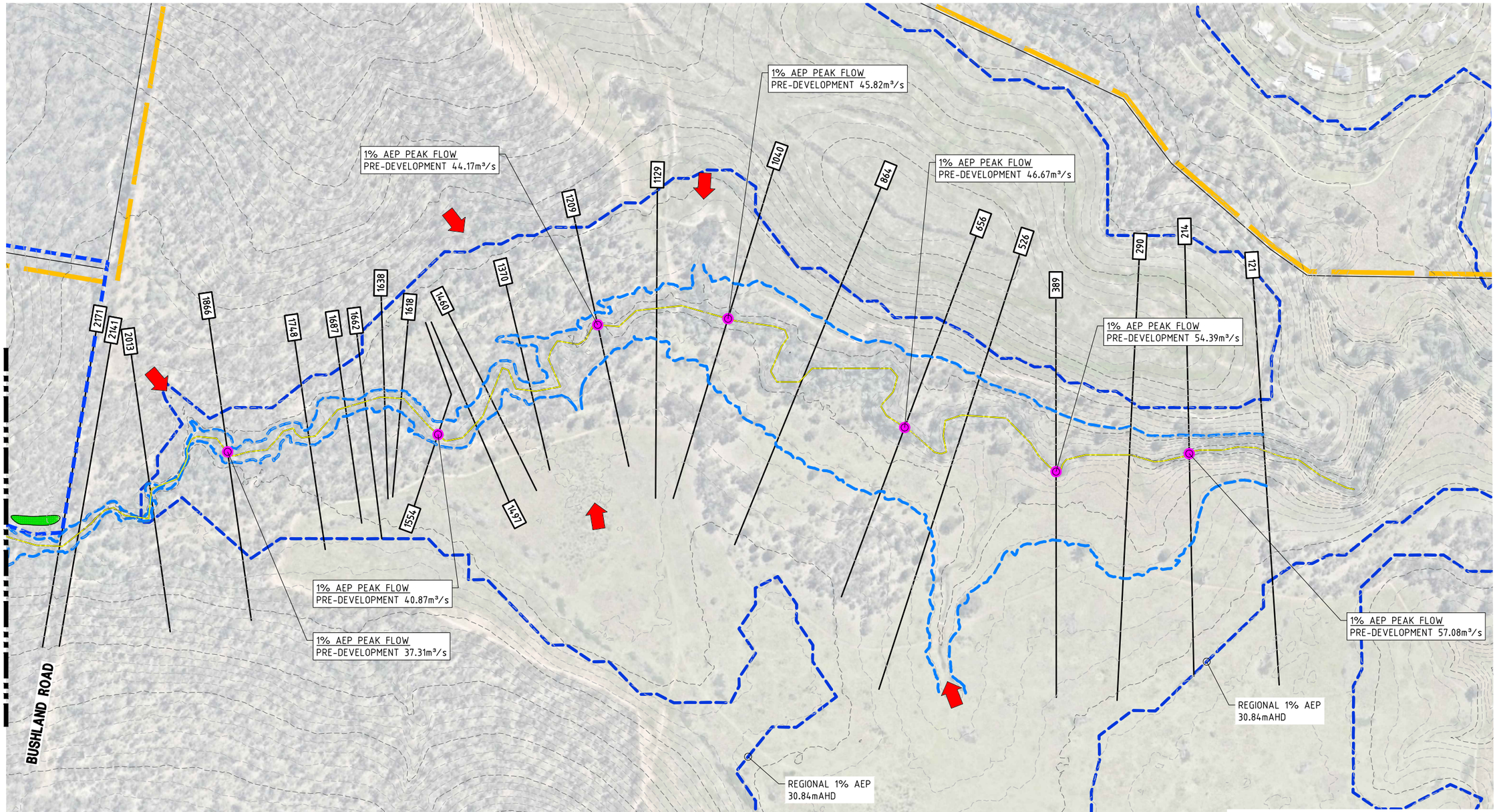
Quality Endorsed Company ISO 9001 Lic-6954

DRAWING TITLE
EXISTING SCENARIO
HEC-RAS LOCAL FLOODING
SHEET 1 OF 2

DRAWING NUMBER B13343.W-SK04
ISSUE C



LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- EXISTING SCENARIO 1% AEP REGIONAL FLOOD EXTENT
- EXISTING SCENARIO 1% AEP LOCAL FLOOD EXTENT
- FLOW ARROW
- 3597 HEC-RAS CROSS SECTIONS
- HEC-RAS INFLOW LOCATION

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. B13343.W-02.
2. ALL INFORMATION PRESENTED ON THIS DRAWING ARE CONCEPTUAL AND PRELIMINARY ONLY. THEY ARE TO BE CONFIRMED DURING FUTURE DESIGN DEVELOPMENT PHASES.
3. REGIONAL 10% AEP TAIL WATER LEVEL OF 26.25m AHD HAS BEEN ADOPTED FOR THE LOCAL FLOOD ANALYSIS.
4. THE LOCAL FLOOD EXTENTS SHOWN ARE CONCEPTUAL ONLY.

PRELIMINARY ONLY
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CONCEPT PLAN ONLY
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FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALC'S	DRAWN	DATE	AMENDMENT DETAILS
		CS	JW	16.05.16	
	A	CS	JW	04.07.16	MINOR AMENDMENTS
	B	CS	JW	25.10.16	MINOR AMENDMENTS
	C	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	D				
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:2500 50 0 50 100 A1
1:5000 A3

MICROFILM No.
PROJECT No. B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT: CELESTINO (Jimboomba CELESTINO)
PROJECT: JIMBOOMBA CELESTINO

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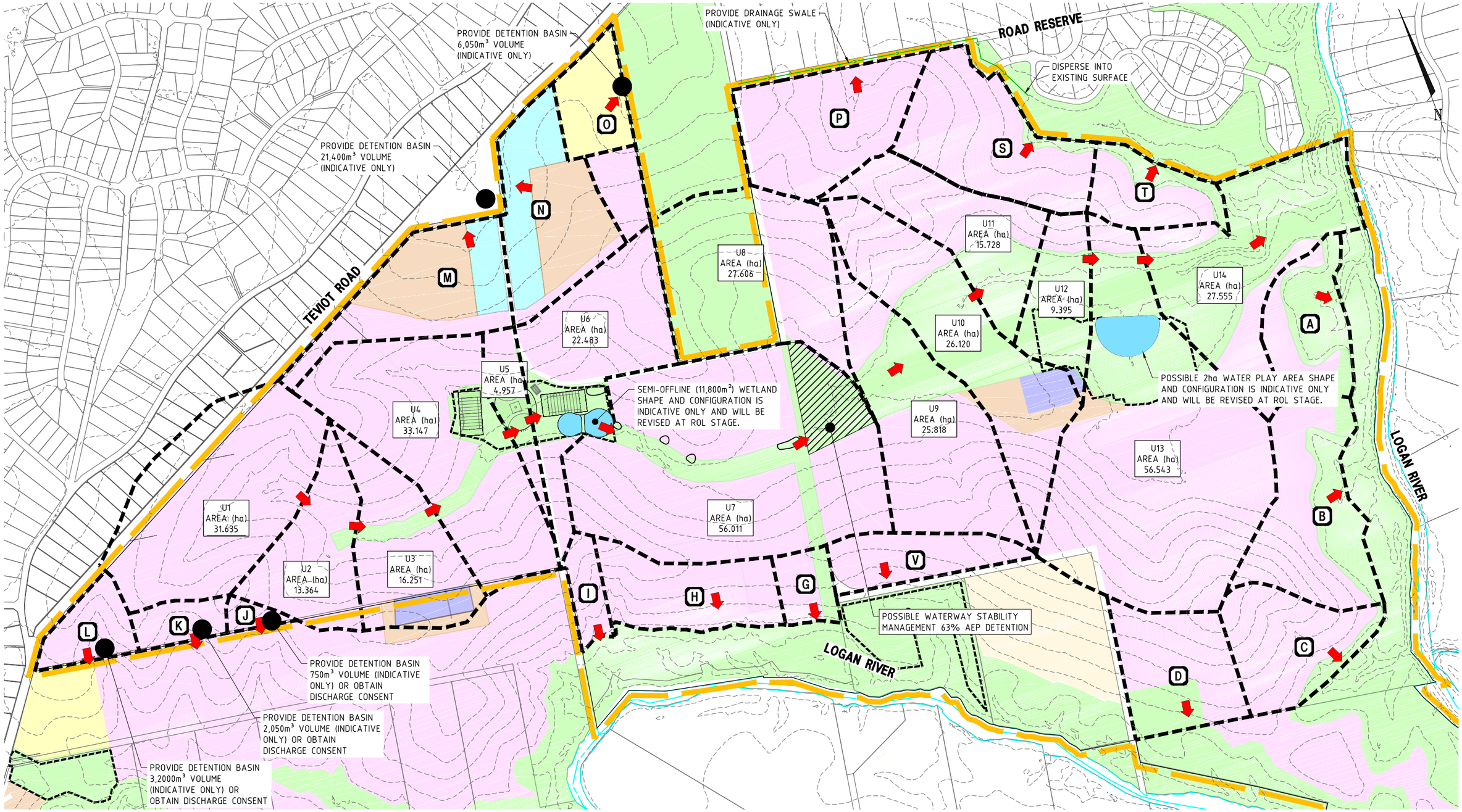
DRAWING TITLE
EXISTING SCENARIO LOCAL FLOODING SHEET 2 OF 2

DRAWING NUMBER B13343.W-SK05

ISSUE C



LEGEND:

- SITE BOUNDARY
- DEVELOPED CATCHMENT BOUNDARY
- EXISTING CONTOURS
- FLOW ARROW

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. B13343.W-02.
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FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	A	CS	JW	31.10.16	CHANGES TO CONTEXT LAYOUT
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:6000 120 0 120 240 A1
1:12000 A3

MICROFILM No.

PROJECT No.
B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT
CELESTINO
Jimboomba CELESTINO

PROJECT
JIMBOOMBA CELESTINO

calibre CONSULTING

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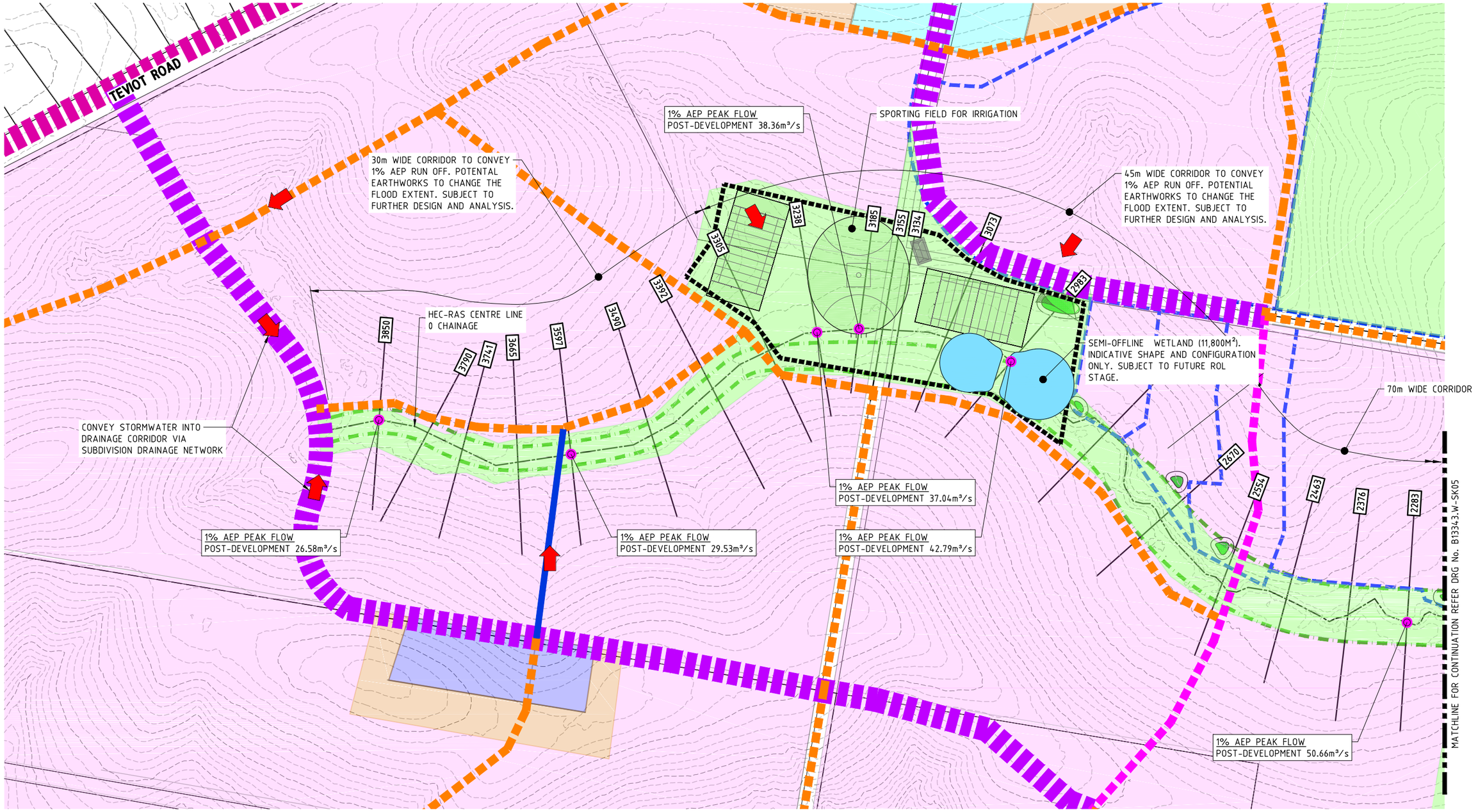
DRAWING TITLE
DEVELOPED SCENARIO
CATCHMENT PLAN
LOCAL FLOODING

DRAWING NUMBER
B13343.W-SK09

ISSUE
B



LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- FLOW ARROW (CONCEPTUAL ONLY)
- 3741 HEC-RAS CROSS SECTIONS
- HEC-RAS INFLOW LOCATION
- POSSIBLE WATERWAY CORRIDOR EXTENT

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. B13434.W-02.
2. ALL INFORMATION PRESENTED ON THIS DRAWING ARE CONCEPTUAL AND PRELIMINARY ONLY. THEY ARE TO BE CONFIRMED DURING FUTURE DESIGN DEVELOPMENT PHASES.

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FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	A	CS	JW	31.10.16	CHANGES TO CONTEXT PLAN
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:2500 50 0 50 100 A1
1:5000 A3

MICROFILM No.
PROJECT No. B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT CELESTINO (Jimboomba CELESTINO)
PROJECT JIMBOOMBA CELESTINO

calibre CONSULTING
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Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast
Quality Environment Occupational Health & Safety Lic-10661

DRAWING TITLE
DEVELOPED SCENARIO
HEC-RAS LOCAL FLOODING
SHEET 1 OF 2

DRAWING NUMBER B13343.W-SK10
ISSUE B

1% AEP PEAK FLOW
POST-DEVELOPMENT 68.98m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 72.00m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 81.46m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 82.46m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 63.34m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 55.81m³/s

1% AEP PEAK FLOW
POST-DEVELOPMENT 73.57m³/s

POSSIBLE WATERWAY STABILITY
MANAGEMENT 63% AEP DETENTION

POSSIBLE WATER PLAY AREA
(SUBJECT TO DETAILED DESIGN.
INDICATIVE SHAPE AND
CONFIGURATION ONLY.)

MATCHLINE FOR CONTINUATION REFER DRG No. B1334.3.W-SK10

BUSHLAND ROAD

N

LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- FLOW ARROW
- 1638 HEC-RAS CROSS SECTIONS
- HEC-RAS INFLOW LOCATION
- DEVELOPED 1% AEP REGIONAL FLOOD EXTENT
- DEVELOPED 5% AEP REGIONAL FLOOD EXTENT
- POSSIBLE WATERWAY CORRIDOR EXTENT

NOTES:

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2. ALL INFORMATION PRESENTED ON THIS DRAWING ARE CONCEPTUAL AND PRELIMINARY ONLY. THEY ARE TO BE CONFIRMED DURING FUTURE DESIGN DEVELOPMENT PHASES.
3. REGIONAL 10% AEP TAIL WATER LEVEL OF 26.25m AHD HAS BEEN ADOPTED FOR THE LOCAL FLOOD ANALYSIS.
4. THE LOCAL FLOOD EXTENTS SHOWN ARE CONCEPTUAL ONLY.

PRELIMINARY ONLY
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FILE: B15042-SK01.dwg DATE: 22-12-2015 TIME: 11:01
Xref's: X_B15042_TITLE X_B15042_BASE USR: Sam Linde

AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
		CS	JW	25.10.16	
	A	CS	JW	31.10.16	CHANGES TO CONTEXT PLAN
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:2500 50 0 50 100 A1
1:5000 A3

MICROFILM No.

PROJECT No.
B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT
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Jimboomba CELESTINO

PROJECT
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Quality Endorsed Company ISO 9001:2008 Lic-10014

DRAWING TITLE
DEVELOPED SCENARIO
HEC-RAS LOCAL FLOODING
SHEET 2 OF 2

DRAWING NUMBER
B13343.W-SK11

ISSUE
B

EARTHWORKS CUT AND FILL CALCULATIONS (APPROXIMATE)

	CUT (m^3)	FILL (m^3)	BALANCE (m^3)
EARTHWORKS 1 (RECREATIONAL/SPORTS FIELD)	1,250	178,000	176.750 (FILL)
EARTHWORKS 2 (RESIDENTIAL AREA)	32,000	47,000	15,000 (FILL)
EARTHWORKS 3 (SPORTS FIELD)	130,000	18,500	-111,500 (CUT)
EARTHWORKS 4 (WATERWAY CORRIDOR)	0	18,500	18,500 (FILL)
POTENTIAL EARTHWORKS 5 (PARK AREA REFER NOTE 6)	200,000	0	-200,000 (CUT)
POTENTIAL EARTHWORKS 6 (PARK AREA REFER NOTE 6)	70,000	0	-70,000 (CUT)

N

TEVIOT ROAD

REFER DRG 101

REFER DRG 102

EARTHWORKS 3

EARTHWORKS 2

EARTHWORKS 4

EARTHWORKS 2

EARTHWORKS 1

POTENTIAL EARTHWORKS 6

POTENTIAL EARTHWORKS 5

LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- EXTENT OF CUT
- EXTENT OF FILL
- POTENTIAL SOURCE OF CUT FOR FILL ZONES

PRELIMINARY ONLY
NOT FOR LODGMENT TO COUNCIL

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

NOTES:

1. THIS DRAWING REPRESENT RAW CUT AND FILL VOLUMES. NO BULKING FACTORS OR STRIPPING OF TOP SOIL HAS BEEN INCLUDED.
2. NO EARTHWORKS BELOW 10% AEP REGIONAL FLOOD LEVEL.
3. FILLING FOR ROAD EMBANKMENTS NOT QUANTIFIED AT THIS STAGE OF PLANNING
4. ADDITIONAL FILL MATERIAL CAN BE GAINED FROM ROAD AND LOT LAYOUT BENCHING.
5. NO ANTICIPATED IMPORTED OF FILL TO SITE.
6. POSSIBLE EARTHWORK AREAS AVAILABLE (5&6) TO OFFSET FILLING WITHIN REGIONAL FLOODPLAIN AREAS (1&2). AVAILABLE AREAS OF CUT - APPROXIMATELY 270,000m^3 (EARTHWORKS 5&6) CAN OFFSET AREAS OF FILLING - APPROXIMATELY 192,000m^3 (EARTHWORKS 1&2) WITHIN 1% AEP REGIONAL FLOODPLAIN. FURTHER DETAIL TO BE PROVIDED DURING ROL STAGE.

AMENDMENTS		CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE		PC	PC	05.10.16	
	A	PC	HT	01.11.16	CONTEXT PLAN UPDATED
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1:5000 100 50 0 100 200 A1
1:10000 A3

MICROFILM No.

PROJECT No. B13343.W

APPROVED
MATTHEW HILL RPEQ 11578
ANDREW McPHAIL RPEQ 6921
MATTHEW STARR RPEQ 9485
FOR & ON BEHALF OF CALIBRE CONSULTING (QLD) PTY LTD

CLIENT CELESTINO

PROJECT JIMBOOMBA CELESTINO

calibre CONSULTING
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DRAWING TITLE
HIGH LEVEL EARTHWORKS OVERALL LAYOUT PLAN

DRAWING NUMBER B13343.W-SK100

ISSUE B

N

1 IN 4 BATTERS TO EXISTING SURFACE

1 IN 4 BATTERS TO EXISTING SURFACE

EARTHWORKS 3

RL 40.00 (Q_{100} FLOOD LEVEL)

RL 38.00

RL 40.00

RL 40.00

RL 40.25 (Q_{20} FLOOD LEVEL)

1 IN 4 BATTERS TO EXISTING SURFACE

1 IN 4 BATTERS TO EXISTING SURFACE RL 30.85

EX RL 33.00

RL 33.50

EX RL 32.00

RL 33.63

EARTHWORKS 2
RL 28.25
(Q_{20} FLOOD LEVEL)

RL 34.63

LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- POSSIBLE WATERWAY CORRIDOR
- EXISTING 10% AEP REGIONAL
- DEVELOPED 1% AEP REGIONAL
- POTENTIAL SOURCE OF CUT FOR FILL ZONES
- EXTENT OF CUT
- EXTENT OF FILL
- PROPOSED OPEN SPACE
- RL 34.63 — PROPOSED ROAD LEVELS (CONCEPT)

PRELIMINARY ONLY
NOT FOR LODGMENT TO COUNCIL

CONCEPT PLAN ONLY
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AMENDMENTS	FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
		PC	PC	05.10.16	
	A	PC	HT	01.11.16	CONTEXT PLAN UPDATED
	B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
	C				
	D				
	E				
	F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)

1:2500 50 0 50 100 A1

1:5000 A3

MICROFILM No.

PROJECT No. B13343.W

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CLIENT CELESTINO

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DRAWING TITLE
HIGH LEVEL EARTHWORKS SKETCH PLAN - SHEET 1 OF 2

DRAWING NUMBER B13343.W-SK101

ISSUE B

N

EARTHWORKS 1
RL 30.90
(Q_{100} FLOOD LEVEL)

EARTHWORKS 2
RL 28.25
(Q_{20} FLOOD LEVEL)

EARTHWORKS 1
RL 30.85
(Q_{100} FLOOD LEVEL)

RL 34.63

RL 31.00

RL 33.85

RL 31.50

RL 33.15

POTENTIAL
EARTHWORKS 5

POTENTIAL
EARTHWORKS 6

LEGEND:

- SITE BOUNDARY
- EXISTING CONTOURS
- POSSIBLE WATERWAY CORRIDOR
- EXISTING 10% AEP REGIONAL
- DEVELOPED 1% AEP REGIONAL
- POTENTIAL SOURCE OF CUT FOR FILL ZONES
- EXTENT OF CUT
- EXTENT OF FILL
- PROPOSED OPEN SPACE
- RL 34.63 PROPOSED ROAD LEVELS (CONCEPT)

PRELIMINARY ONLY
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FIRST ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	PC	PC	05.10.16	
A	PC	HT	01.11.16	CONTEXT PLAN UPDATED
B	CS	RH	19.04.17	UPDATED IN RESPONSE TO EDQ INFORMATION REQUEST JAN 2017
C				
D				
E				
F				

AMENDMENTS

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1:2500 50 0 50 100 A1
1:5000 A3

MICROFILM No.

PROJECT No.
B13343.W

APPROVED
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Jimboomba CELESTINO

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Brisbane Gladstone Melbourne Sydney Singapore Queensland

DRAWING TITLE
HIGH LEVEL EARTHWORKS
SKETCH PLAN - SHEET 2 OF 2

DRAWING NUMBER
B13343.W-SK102

ISSUE
B