Ripley Valley Secondary Urban Centre East - Stages 4-6

Flood Study

7901/47-027

Prepared for
AMEX Corporation Pty Ltd

24 July 2013

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Shaping the Future

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1 Introduction

This flood report has been prepared in support of the application lodged with respect to Stages 4 to 6 of the proposed Ripley Valley Secondary Urban Centre East (SUCE) development.

The location and extent of Stages 1 to 3 (which includes the construction of Barrams Road bridge and Stages 4 to 6 (the subject of this investigation) of the SUCE development are shown below on Image 1.

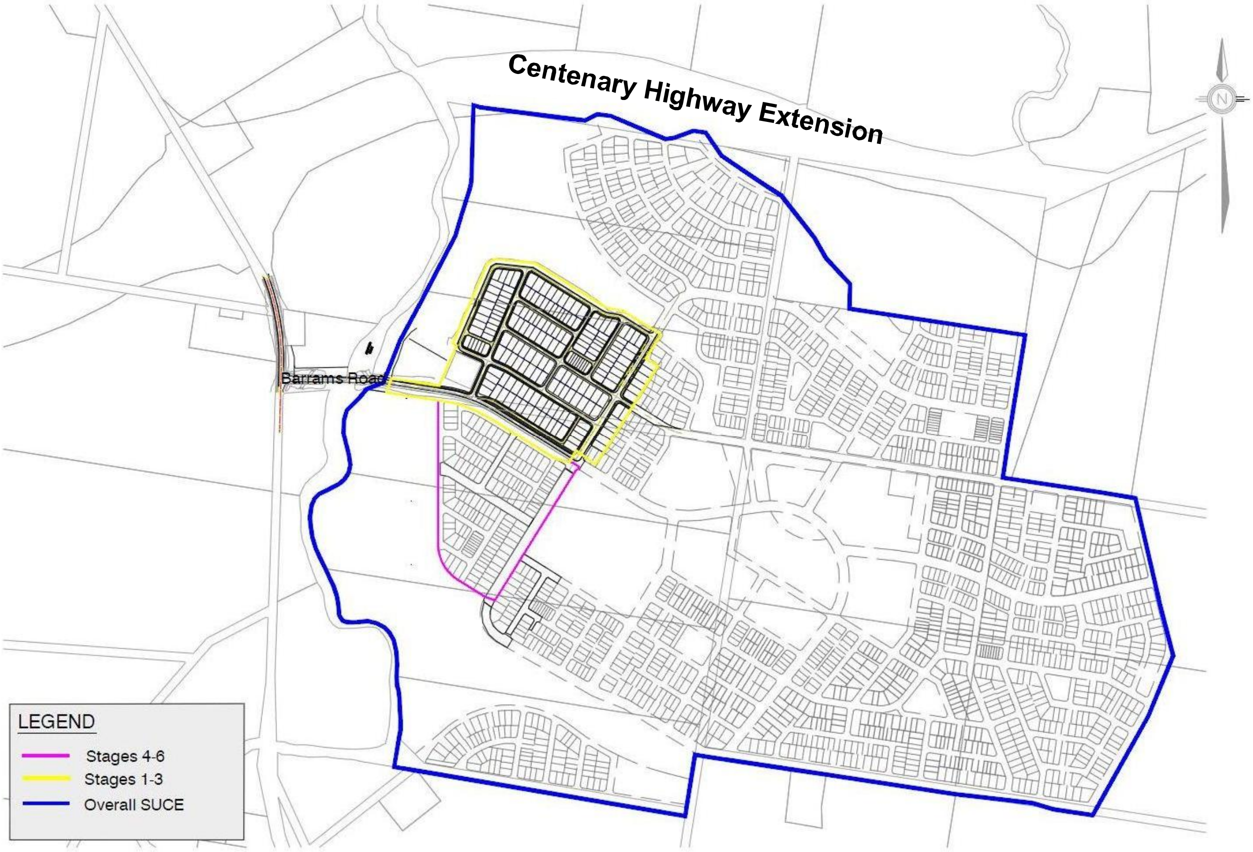


Image 1 Extent of Stages 1 to 6

With reference to Image 1, Stages 4 to 6 of the development area are located immediately to the south of Barrams Road, while Stages 1 to 3 are situated immediately to the north of Barrams Road

As part of the SUCE development, Barrams Road is to be upgraded to provide a connection from Ripley Road to the site across Bundamba Creek. The upgrading of the presently low level Barrams Road will include a bridge crossing of Bundamba Creek and culverts to provide for local catchment flows to the west and east of Bundamba Creek that currently cross Barrams Road.

Detailed flood modelling was previously completed with respect to Stages 1-3 of the development and for the development of the Secondary Urban Centre East as a whole to confirm that development can proceed without causing unacceptable flooding impacts in Bundamba Creek. The previously undertaken modelling is described in the report *Ripley Valley Secondary Urban Centre East, Flood Study* (Version 5, February 2013).

To confirm that the interim level of development associated with Stages 4 to 6 of the development and those works in place prior to the commencement of work on Stages 4 to 6 does not produce an unacceptable flood impact in Bundamba Creek, flood modelling of the interim works was completed. As per the previous modelling, the new Bundamba Creek model (referred to as the KBR model) was used for the analysis.

Apart from changes to the hydrologic model and hydraulic model to reflect the level of development in place when Stages 4 to 6 are constructed, the model is the same as that used for the previous analysis.

Therefore, the majority of Section 2 (Hydrology) and Section 3 (Hydraulics) are the same as in the previous report and have been included for completeness.

2 Hydrology

2.1 General

A detailed RAFTS model of the Bundamba Creek catchment has been developed and calibrated by consultants KBR. This model, in combination with a calibrated 1D/2D TUFLOW model also prepared by KBR, provides a basis for future floodplain risk management within the catchment.

To demonstrate that the development of the AMEX SUCE site will not produce an unacceptable impact on flooding in Bundamba Creek the calibrated RAFTS model was therefore obtained and subsequently modified to simulate the effects of the proposed development, and to provide hydrographs for use as inputs for flood modelling. The catchment delineation adopted for the RAFTS model is shown on Figure 2. As the model is calibrated, the only parameters which were changed were the catchment areas and impervious percentages for those sub catchments affected by development. In some cases, sub catchments were further subdivided to allow for the simulation of detention basins as discussed below.

In the case of the developed case, to determine the impact of increased impervious areas and earthworks on the timing and magnitude of peak flows, the fraction impervious of that part of the Secondary Urban Centre East to be developed by AMEX was increased to reflect the ultimate level of proposed development. Modelling has assumed that the owners of properties that will be ultimately developed and that drain to land controlled by AMEX will be responsible for the attenuation of runoff in accordance with common law principles relating to actionable nuisance.

The hydrologic modelling that was undertaken is detailed in the following sections.

2.2 Catchment Parameters

2.2.1 Overall Parameters

Typically, catchment parameters defined in the KBR RAFTS model were adopted. The only changes made were to the proportion of pervious and impervious sub-catchments within those catchments affected by the development. In some cases, catchments in the model were further subdivided to allow for more detailed analysis. For areas to be developed a fraction impervious of between 70 and 80 percent was adopted depending on the extent of development proposed.

2.2.2 Developed Catchments

The extent of the development as part of the current flood modelling is shown in Figure 5. The area included parts of the development including stages 1 to 6. The original and modified catchments are shown in Figure 5. The catchment areas that have been modified are listed below in Table 2-1.

Table 2-1 Catchment Areas

Catchment Name	Area(ha)			
	Existing		Developed (Stages 4 to 6)	
	Pervious	Impervious	Pervious	Impervious
BC26	73.50	11.75	66.96	18.29
BC29	73.75	2.00	64.95	10.75
BC30	73.25	3.75	68.37	8.63

2.3 Rainfall and Losses

Rainfall intensities and initial and continuing losses as used by the KBR RAFTS model were adopted.

Therefore, the losses for pervious areas were as follows:

- 100 year ARI - 5 mm initial loss and a 2.5 mm/h continuing loss;
- 50 year ARI - 10 mm initial loss and a 2.5 mm/h continuing loss;
- 20 year ARI - 15 mm initial loss and a 2.5 mm/h continuing loss;
- 10 year ARI - 15 mm initial loss and a 2.5 mm/h continuing loss;
- 5 year ARI - 15 mm initial loss and a 2.5 mm/h continuing loss;
- 2 year ARI - 15 mm initial loss and a 2.5 mm/h continuing loss; and
- 1 year ARI - 15 mm initial loss and a 2.5 mm/h continuing loss.

As for all modelling conducted to date, and in accordance with the calibrated RAFTS model, no losses were applied to impervious areas.

3 Hydraulic Analysis

3.1 General

The calibrated TUFLOW model of Bundamba Creek catchment was used to analyse the proposed development. The changes made to the model to reflect the proposed development are discussed below.

3.2 Inflows

As described in Section 2, the calibrated RAFTS model of the catchment was used to assess the impact of detention basins on the north-eastern side of the development and to derive runoff hydrographs which were subsequently applied to the hydraulic model.

3.3 Roughness Values

The Secondary Urban Centre East will include sportsgrounds, parks and other open space areas. With the exception of the sports grounds, these areas will be mainly grassed with a few trees. Therefore a roughness value of 0.08 was considered to be appropriate for use within basin areas, and 0.035 within sports fields. In areas of Bundamba Creek to be revegetated in association with the SUCE development (refer Section 4.5.1), a value of 0.10 was adopted. For comparative purposes, the calibrated Council model adopted roughness values of 0.08 and 0.05 respectively for the main channel and floodplain of Bundamba Creek.

3.4 TUFLOW Model Scenarios

The calibrated TUFLOW hydraulic model of Bundamba Creek supplied by Council was used to confirm that the development can proceed without causing an unacceptable impact on flood levels. For this relative analysis, a number of scenarios were considered. For these scenarios, only limited modification of the model occurred in order to provide additional detail in the area of interest (all cases) and to reflect the proposed development (with modifications relevant to the development scenario being considered).

Following the completion of the relative analysis, the model was modified to more conservatively represent development external to the SUCE site and the flood response of the catchment. The resultant model was used to calculate flood levels relevant for the specification of minimum development levels across the site.

For the relative analysis of impacts, the following scenarios were modelled.

- **Existing Case**

  This scenario represents the base case flood model in accordance with the KBR flood model.

- **Stages 4 to 6 Scenario**

  This scenario was based on only Stages 1 to 6 fully developed

For the analysis, the 100, 20, 2, and 1 year ARI events were modelled. In each case, to ensure that the storm duration producing peak conditions at all points in the catchment was modelled, the analysis considered the 2, 3, 4.5 and 6 hour storm durations for each recurrence interval modelled.

3.5 Model Adjustments

As noted above, it was necessary to make a number of modifications to the supplied model in order to improve the level of detail of the model in the region of interest and to ensure that the comparison of base case and developed case models was valid. The modifications were kept to the minimum possible to ensure that the base case model remained as similar as possible to the supplied calibrated model to avoid the potential for the modifications to affect the calibration previously completed by the consultants who constructed the model.

The changes effected to the base case model (and therefore the developed case models) are listed below (refer Figure 3).

- The existing 1200 mm diameter RCP culvert to the east of the Centenary Highway main crossing was added to the model.
- Additional channels were created at BC1.251 and BC1.239 to represent the proposed Barrams Bridge and the point of discharge from the southern basin to Bundamba Creek respectively. In each case, cross sections were interpolated between the upstream and downstream sections. The channels were added to the base case model to ensure that the impact of the bridge (added as part of the developed case scenarios) was correctly quantified.
- The inflow database setup and locations were changed to allow for the application of inflows from the local catchments BC26, BC29 and B30 at multiple locations proportionally to provide a more realistic application of inflows within the SUCE development area.
- The 2d_code_ULDA_049.mif was removed from the 4m grid domain.
- A Code of 1 was applied to 2d_bc_SUCE_2d2d_049.mif.
- The “invert” command was added to 2d_bc_SUCE_2d2d_049.mif for the 20m grid domain to deactivate the nested grid within the larger grid.

The changes detailed above were applied to the models used to assess the relative impact of development. As noted above, following the completion of the relative analysis the model was further revised to allow the conservative calculation of flood levels for the purpose of defining minimum lot and habitable floor levels.

To provide this more conservative estimation of flood levels in the creek for the specification of minimum development levels, the following modifications were made to the model.

- The initial water level in Daleys Lagoon at the head of the Bundamba Creek catchment was increased from 75 mAHD to 75.3 mAHD to reflect the road crest levels downstream of the lagoon (i.e. it was assumed that the lake was full at the commencement of rainfall).
- The negative bed slope around Barrams Road was corrected based on interpolated cross sections.
- Two existing culvert crossings of the Centenary Highway Extension (refer image below) on minor tributaries of Bundamba Creek to the west of the main channel (and discharging to Bundamba Creek downstream of the Centenary Highway extension) were added to the model.
- The existing culvert crossing of Ripley Road (refer image below) to the south of the Centenary Highway was added to the model.
- The 2D inflows that were applied in the main Creek were changed to 1D inflow points to maximise flow in the creek.
- The inflows from catchment BC28 (on the western side of Bundamba Creek- refer Figure 2) were split into two branches.

The other modification to the model made to allow the specification of minimum development levels is provided in Section 4.6.3.

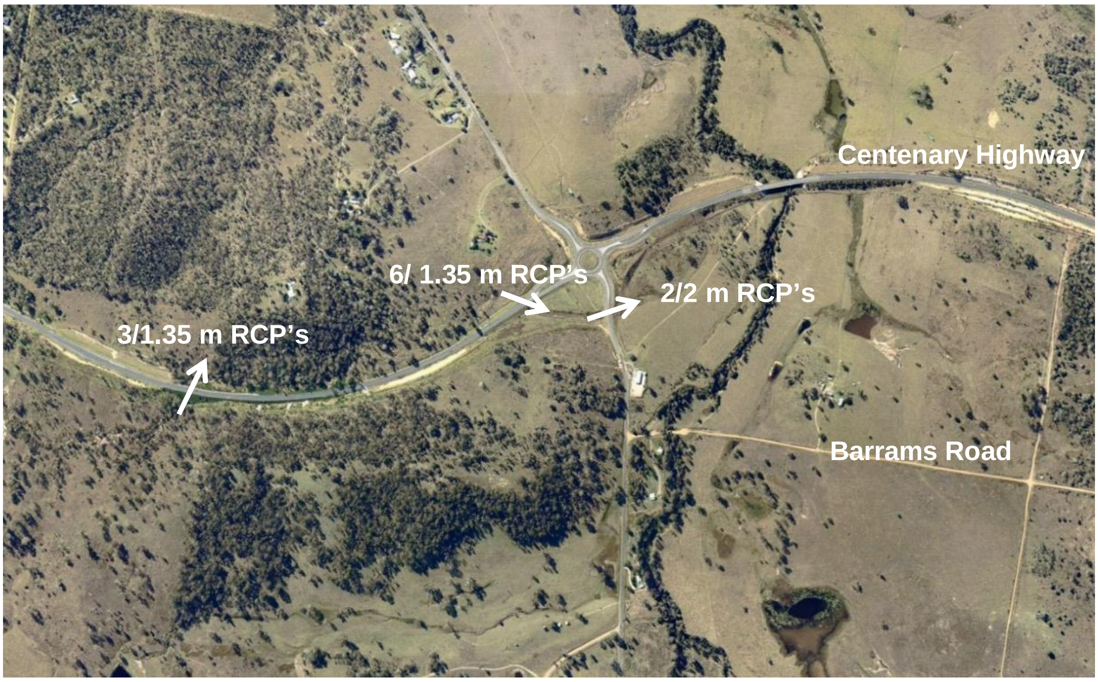


Image 2 Location of additional structures modelled for calculation of development levels

3.6 Developed Site Modelling

The specific elements added to the developed case TUFLOW model are detailed.

3.6.1 Relative Analysis- Stages 4 to 6

The works considered for Stages 4 to 6 of the development include those works that will be in place at the commencement of works. This will include Stages 1 to 3 of the development and the construction of the Barrams Road Bridge and culverts. The works considered for Stages 4 to 6 are shown in Figure 3 and are described below.

- **Barrams Road Bridge**

  The proposed Barrams Road crossing includes a three 25 metre span bridge of 75 metres total span across Bundamba Creek. The assumed ultimate width of the bridge was 30 metres. The bridge, located at model cross section BC1.251, was modelled in 1D. To minimise afflux, the bridge soffit level was set at 44.38 mAHD. Allowing a 1.5 metre structure depth, the resultant minimum road level across the bridge is 45.9 mAHD. This road level will be sufficient to provide the road with a 100 year ARI flood immunity (Section 4.7.8 provides more discussion on the flood immunity of Barrams Road).

  The main bridge crossing was modelled using a localised HEC-RAS model to quantify the loss produced by the crossing. The afflux produced by the bridge was found to be 250 mm in the main channel. To match this afflux in TUFLOW a dynamic head loss coefficient (K) of 2.5 was adopted for the 1-D channel representing the proposed bridge.

  To ensure that the three-span bridge has adequate conveyance capacity, it is proposed to excavate beneath the span that crosses the eastern floodplain of Bundamba Creek. The extent of excavation is shown on Figure 3. With reference to Figure 3, it is proposed to excavate an area approximately 20 metres wide to a depth of less than two metres, removing the fill embankment associated with the existing alignment of Barrams Road. The resultant invert level of the excavation has been set relative to levels downstream of the bridge to allow for free drainage of flow at the downstream end of the excavated area.

The excavation will not affect the bed or banks of Bundamba Creek and will be wholly located in the eastern floodplain of the creek. Consequently, the excavated area will only convey flow when events of sufficient magnitude to cause the creek to overtop occur. The works will therefore not have any impact on the conveyance of low flows in Bundamba Creek.

- **Barrams Road Culverts**

  Flow from a local catchment to the west of Bundamba Creek currently crosses Barrams Road. It will be necessary to provide for the drainage of this flow as part of the upgrading of Barrams Road.

  Based on hydraulic modelling completed in support of the preparation of this report, it is proposed to construct culverts with the following configuration:

  - 2/ 3.0 x 1.5 m box culverts;
  - 40 metre culvert length (at an angle in the ultimate configuration);
  - Upstream invert level = 42.9 mAHD; and
  - Downstream invert level = 42.5 mAHD.

  The area just upstream of these culverts will have to be excavated by around 500 mm so that the slope of the culverts can be reduced and the fill embankment of the existing unmade Barrams Road removed. The headwall will also need to be rounded to reduce the entrance losses at this point. An entrance loss of 0.2 and exit loss of 1.0 were adopted for the culverts.

  A channel of approximately 20 metres width and 1 metre depth will be provided to link to the culverts at Ripley Road. The channel will be vegetated, except for a rock-lined low flow channel. The alignment of the channel was designed to minimise disturbance to existing vegetation.

  Barrams Road is also crossed by flow produced by runoff from local catchments to the east of Bundamba Creek. Similar to the western side of Bundamba Creek, it is proposed to provide for the drainage of this flow as part of the upgrading of Barrams Road. For the eastern floodplain crossing the following culvert configuration was found to be necessary:

  - 5/ 0.9 m RCPs;
  - 44 metre culvert length;
  - Upstream invert level = 43.49 mAHD; and
  - Downstream invert level = 43.29 mAHD.

  The eastern culverts will be located approximately 30 metres to the west of the existing low point in the floodplain. This is to allow for future development of this area for sportsgrounds. To ensure that flows can be directed towards these culverts some minimal excavation upstream will be required. Downstream of these culverts a rock-lined channel is proposed to convey flows to the main channel of Bundamba Creek. The channel will be approximately 25 metres wide and half a metre deep. The purpose of this channel is to divert low flows away from future parks and sportsground areas that will be located downstream of the bridge. During major flows the channel will overtop and flow will also be conveyed across the eastern floodplain. The headwall will also need to be rounded to reduce the entrance losses at this point. An entrance loss of 0.2 and exit loss of 1.0 were used.

  It can be noted that the final number and size of culverts will be confirmed as part of detailed design of the bridge crossing.

- **Filling for Stages 1 to 6**

  The area of the Stage 1-6 works will be filled above the 100 year ARI flood level. To allow for earthworks batters, a 10 metre buffer around the boundary of these works was also assumed to be filled.

- **Revegetation**

  The modelling included an allowance for revegetation of the creek as part of the SUCE development. For the analysis, only the revegetation of the buffer along the eastern side of the Creek was included as part of the impact assessment. A manning's 'n' of 0.1 was adopted for the proposed revegetation. Figure 3 shows the extent of the proposed revegetation for Stages 4 to 6 included in the relative impact assessment.

3.7 TUFLOW Results

3.7.1 Flood Mapping Outputs

The results obtained from the TUFLOW model are presented graphically in Appendices B, C, and D.

Appendix B contains existing and developed case flood extent maps:

- Figure B1 Existing Case Q100 Flood Extent
- Figure B2 Existing Case Q20 Flood Extent
- Figure B3 Existing Case Q2 Flood Extent
- Figure B4 Existing Case Q1 Flood Extent
- Figure B5 Stages 4-6 Q100 Flood Extent
- Figure B6 Stages 4-6 Q20 Flood Extent
- Figure B7 Stages 4-6 Q2 Flood Extent
- Figure B8 Stages 4-6 Q1 Flood Extent

Appendix C presents the afflux (change in flood level) plots for the developed case:

- Figure C1 Stages 4-6 Q100 Afflux
- Figure C2 Stages 4-6 Q20 Afflux
- Figure C3 Stages 4-6 Q2 Afflux
- Figure C4 Stages 4-6 Q1 Afflux

Appendix D presents flood depth mapping for the existing and developed cases:

- Figure D1 Existing Case Q100 Flood Depth
- Figure D2 Existing Case Q20 Flood Depth
- Figure D3 Existing Case Q2 Flood Depth
- Figure D4 Existing Case Q1 Flood Depth
- Figure D5 Stages 4-6 Q100 Flood Depth
- Figure D6 Stages 4-6 Q20 Flood Depth
- Figure D7 Stages 4-6 Q2 Flood Depth
- Figure D8 Stages 4-6 Q1 Flood Depth

3.7.2 Afflux

Figures C1 to C4 in Appendix C show the calculated flood level changes associated with the construction of Stages 4 to 6. The 100 year and 20 year ARI afflux plots show that the development will not cause any significant adverse impacts downstream and upstream of the subject site. While for the minor events, a slight increase in flood level was obtained, any increase is contained within the creek. Given the minimal impacts obtained overall, it is considered that the results are acceptable.

Further, a comparison with the afflux plots presented in Appendix C of the *Ripley Valley Secondary Urban Centre East, Flood Study* (Version 4, February 2013) indicate that the afflux associated with development is either less than or similar to the afflux calculated for the ultimate level of development.

Following the reporting convention of KBR, flood levels were compared at 11 downstream catchment control points. The approximate locations of these points were provided by KBR and are shown in Figure 1. The results are summarised in Table 3-1 to Table 3-4.

As discussed above, it is considered that the results obtained from the analysis indicate that the development will have a minimal impact on flood levels external to the site. It can be noted that a slight increase in level (up to 57 mm) is reported for the 1 year event. It can be noted that the change in depth at the point (point 1) where the increase was determined represents less than 4 percent of the overall depth of flow. This, combined with the negligible change in velocity obtained for the 1 year event (refer Table 3-8) indicates that the change in level for the 1 year event is not of consequence.

Table 3-1 100 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)		Impact (m)
		Existing	Developed	
1	BC1.262.2	42.532	42.520	-0.012
2	BC1.305.2	37.373	37.359	-0.014
3	BC1.336.2	30.874	30.864	-0.010
4	BC1.367.2	26.848	26.839	-0.009
5	BC1.418.2	23.568	23.558	-0.010
6	BC1.443.2	21.007	20.996	-0.011
7	BC1.481.2	17.186	17.175	-0.011
8	BC1.519.2	10.986	10.971	-0.015
9	BC1.561.2	6.163	6.152	-0.011
10	N/A	47.395	47.395	0.000
11	N/A	38.868	38.852	-0.016

Note: Refer to Figure 1 for location of reporting points

Table 3-2 20 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)		Impact (m)
		Existing	Developed	
1	BC1.262.2	42.144	42.144	0.000
2	BC1.305.2	36.881	36.878	-0.003
3	BC1.336.2	30.474	30.472	-0.002
4	BC1.367.2	26.332	26.330	-0.002
5	BC1.418.2	23.057	23.055	-0.002
6	BC1.443.2	20.401	20.401	0.000
7	BC1.481.2	16.554	16.554	0.000
8	BC1.519.2	9.972	9.973	0.001
9	BC1.561.2	5.198	5.200	0.002
10	N/A	47.117	47.117	0.000
11	N/A	38.294	38.289	-0.005

Note: Refer to Figure 1 for location of reporting points

Table 3-3 2 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)		Impact (m)
		Existing	Developed	
1	BC1.262.2	40.262	40.325	0.063
2	BC1.305.2	35.682	35.702	0.020
3	BC1.336.2	29.791	29.797	0.006
4	BC1.367.2	25.295	25.304	0.009
5	BC1.418.2	21.953	21.978	0.025
6	BC1.443.2	19.049	19.078	0.029
7	BC1.481.2	14.870	14.901	0.031
8	BC1.519.2	7.965	7.995	0.030
9	BC1.561.2	2.385	2.399	0.014
10	N/A	46.502	46.502	0.000
11	N/A	37.659	37.640	-0.019

Note: Refer to Figure 1 for location of reporting points

Table 3-4 1 Year Event Peak Flood Level Comparison

Catchment Control point	Corresponding 1D Node Name	Flood Level (mAHD)		Impact (m)
		Existing	Developed	
1	BC1.262.2	39.439	39.496	0.057
2	BC1.305.2	34.845	34.876	0.031
3	BC1.336.2	29.449	29.462	0.013
4	BC1.367.2	24.776	24.791	0.015
5	BC1.418.2	20.961	20.988	0.027
6	BC1.443.2	18.083	18.110	0.027
7	BC1.481.2	13.851	13.874	0.023
8	BC1.519.2	6.985	7.006	0.021
9	BC1.561.2	1.927	1.928	0.001
10	N/A	46.294	46.294	0.000
11	N/A	37.259	37.260	0.001

Note: Refer to Figure 1 for location of reporting points

With reference to the results presented in the above tables, it is considered that the impact of the development is acceptable.

3.7.3 Peak Velocities

The velocity impacts at the 11 downstream catchment control points are summarised in Table 3-5 to Table 3-8. The results show that change in velocity due to the proposed development is not considered to be significant. Although relatively small, the largest increase is noted at point 1 which is located at the Centenary Highway Extension bridge.

The increase noted in the table was derived based on a review of flow velocities and flow rates. It is noted that the review indicated that the results at point 1 were not representative of conditions in the creek given the relatively small change in level and peak flow caused by development.

Table 3-5 100 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)		Change (positive for increase) (m/s)
		Existing	Developed	
1	BC1.567	3.63	3.83	0.20
2	BC1.306	1.62	1.61	-0.01
3	BC1.337	0.89	0.88	-0.01
4	BC1.570	2.84	2.81	-0.03
5	BC1.418	1.30	1.30	0.00
6	BC1.571	1.67	1.67	0.00
7	BC1.482	1.96	1.95	-0.01
8	BC1.519	1.12	1.11	-0.01
9	BC1.563	3.87	3.87	0.00
10	N/A	3.05	3.05	0.00
11	N/A	1.08	1.06	-0.02

Note: Refer to Figure 1 for location of reporting points

Table 3-6 20 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)		Change (positive for increase) (m/s)
		Existing	Developed	
1	BC1.567	3.26	3.43	0.17
2	BC1.306	1.29	1.29	0.00
3	BC1.337	0.75	0.75	0.00
4	BC1.570	2.32	2.32	0.00
5	BC1.418	1.25	1.25	0.00
6	BC1.571	1.58	1.58	0.00
7	BC1.482	1.39	1.39	0.00
8	BC1.519	0.98	0.98	0.00
9	BC1.563	3.34	3.35	0.01
10	N/A	2.90	2.90	0
11	N/A	0.98	0.97	-0.01

Note: Refer to Figure 1 for location of reporting points

Table 3-7 2 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)		Change (positive for increase) (m/s)
		Existing	Developed	
1	BC1.567	3.06	3.24	0.18
2	BC1.306	0.81	0.82	0.01
3	BC1.337	0.64	0.64	0.00
4	BC1.570	2.31	2.31	0.00
5	BC1.418	0.97	0.97	0.00
6	BC1.571	1.41	1.41	0.00
7	BC1.482	0.70	0.70	0.00
8	BC1.519	0.73	0.73	0.00
9	BC1.563	1.44	1.51	0.07
10	N/A	1.42	1.42	0.00
11	N/A	0.65	0.65	0.00

Note: Refer to Figure 1 for location of reporting points

Table 3-8 1 Year Event Peak Flood Velocity Comparison

Catchment Control point	Corresponding 1D Node Name	Peak Velocity (m/s)		Change (positive for increase (m/s)
		Existing	Developed	
1	BC1.567	3.10	3.15	0.05
2	BC1.306	0.66	0.67	0.01
3	BC1.337	0.56	0.56	0.00
4	BC1.570	2.29	2.29	0.00
5	BC1.418	0.87	0.88	0.01
6	BC1.571	1.14	1.14	0.00
7	BC1.482	0.73	0.73	0.00
8	BC1.519	0.68	0.68	0.00
9	BC1.563	0.84	0.85	0.01
10	N/A	0.53	0.53	0.00
11	N/A	0.21	0.22	0.01

Note: Refer to Figure 1 for location of reporting points

3.7.4 Impact on Timing of Peak Flows

Flow hydrographs were derived at each of the 9 reporting points located in the 1-D area identified by KBR (refer Figure 1).

In each case, hydrographs were derived for the existing case and Stage 4-6 developed case. The hydrographs are provided in Appendix A.

The graphs show that the proposed development does not have a significant impact on the timing of the peak flows at all locations of interest and therefore no significant impact on current warning times with respect to flooding of downstream areas.

3.7.5 Flood Levels at Nearby Residences

For consistency with previous reports, flood levels have also been calculated at each of the nearby residences to the SUCE area. The location of these residences/buildings is shown on Figure 1.

Table 3-9 lists the floor/ground level applicable to each location, together with the peak flood levels calculated for the 100 and 20 year recurrence interval events.

With reference to Table 3-9, the location of buildings in most cases is such that the building is not affected by flooding (hence the N/A value). In those cases where a building is potentially affected by flooding, the development does not increase flood levels.

Further, agreement has been reached with the owner of BLD1 and BLD2 (immediately upstream of Barrams Road on the western side of Bundamba Creek) in relation to the acceptance of the increase in level noted for BLD1 due to the fact that the developed case flood level is approximately a metre below the floor level of BLD1 and the flood immunity of the building is adequate given the freeboard typically adopted to the 100 year flood level.

It is therefore considered that the development is acceptable with respect to existing residences.

Table 3-9 Flood Level Comparison at Nearby Building Locations

Building	Floor /Ground Level (mAHD)	100 Year Peak Flood Level (mAHD)		20 Year Peak Flood Level (mAHD)	
		Existing	Developed	Existing	Developed
BLD1	46.22 (floor)	45.13	45.26	45.02	N/A
BLD2	45.95 (floor)	N/A	N/A	N/A	N/A
BLD3	47.46 (floor)	46.73	46.73	N/A	N/A
BLD4	48.74 (floor)	N/A	N/A	N/A	N/A
BLD5	48.53 (floor)	48.14	48.14	N/A	N/A
BLD6	51.08 (floor)	N/A	N/A	N/A	N/A
BLD7	55.16	N/A	N/A	N/A	N/A

Note: Refer to Figure 1 for location of reporting points.
N/A indicates no flooding at site for event being considered.

3.7.6 Emergency Access to Site Via Barrams Road

In the early stages of development, access to the Secondary Urban Centre East will be achieved from the Centenary Highway via Ripley Road and Barrams Road. Emergency access will also need to be achieved by this route.

Based on the detailed modelling described in this report, both the Centenary Highway and Ripley Road are immune to flooding for the 100 year event. The immunity achieved by Barrams Road is discussed below.

- **Ripley Road and Barrams Road Intersection**

  The existing ground level at the intersection of Ripley Road and Barrams Road is of the order of 46.3 mAHD. This level is well above the 100 year flood level and the intersection will have immunity to the 100 year event.

- **Western Culvert Crossing**

  As noted in Section 4.6.1 of the report, a set of culverts will be provided to allow for the drainage of the local catchment to the west of Bundamba Creek that drains across Barrams Road. The level of the soffit of the culvert (allowing for a link slab in the final design) will be approximately 44.8 mAHD. In comparison, the peak flood level for the 100 year event at this point is 45.4 mAHD. The need to allow for services in the Barrams Road crossing will result in a depth of fill over the culverts of more than 600 mm. Consequently, the minimum road level at the western culvert crossing will be higher than the 100 year flood level.

- **Main Creek Crossing**

  With reference to Section 4.6.1, allowing for the structure depth associated with a 25 metre span, the road level at the main crossing of Bundamba Creek will be approximately 45.9 mAHD. In comparison, the calculated 100 year flood level upstream of the bridge is 44.8 mAHD. Consequently, the road crossing of the bridge will be immune to flooding for the 100 year event.

- **Eastern Culvert Crossing**

  As noted in Section 4.6.1 of the report, a set of culverts will be provided to allow for the drainage of the local catchment to the east of Bundamba Creek that drains across Barrams Road. The level of the soffit of the culvert (allowing for link slabs) will be approximately 45.3 mAHD. In comparison, the peak flood level for the 100 year event at this point is 45 mAHD. The top of the culvert will therefore be higher than the 100 year flood level. In addition, similar to the western culvert crossing, there will be a need for fill above the culvert to allow for services in the road corridor. Therefore, the minimum road level at the western culvert crossing will be higher than the 100 year flood level.

- **Point of Entry to Secondary Urban Centre East (Edge of floodplain)**

  The Secondary Urban Centre East will be set above the 100 year flood level. Consequently, Barrams Road at the point of entry to the Secondary Urban Centre East will have immunity to flooding for the 100 year event.

In summary, based on the flood modelling detailed in this report, the Barrams Road connection to the Secondary Urban Centre East from Ripley Road will be immune to flooding for the 100 year flood event. Consequently, it can be concluded that appropriate emergency access to the Secondary Urban Centre East can be achieved.

4 Conclusion

Detailed modelling has been completed in support of the development of Stages 4 to 6 of the AMEX Secondary Urban Centre East site.

This modelling, which has been completed using the calibrated model of Bundamba Creek provided by Ipswich City Council, has indicated that development can proceed without producing a significant change in flood level external to the site and certainly no change in level sufficient to cause an actionable nuisance.

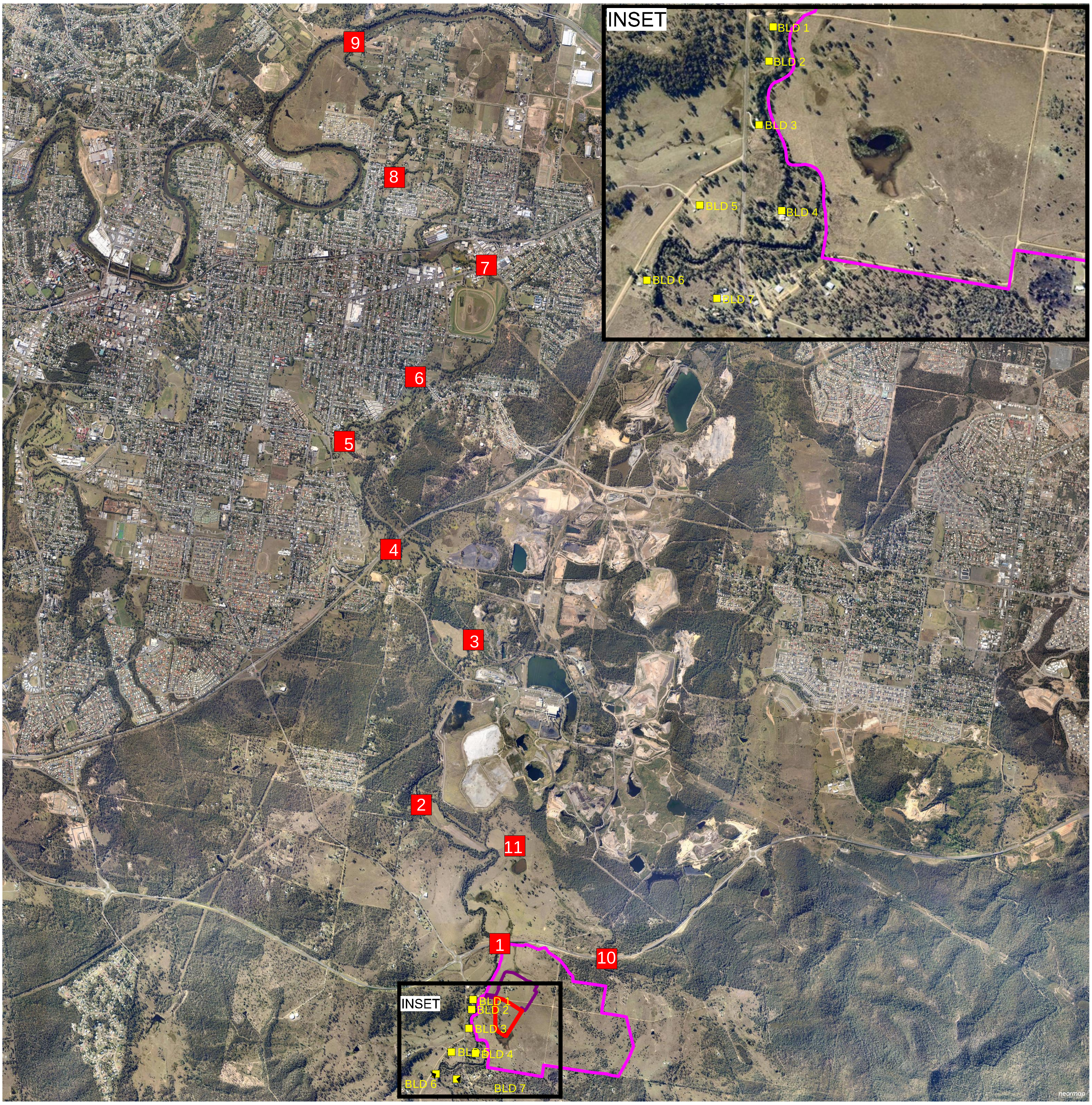
Further, the development will not produce any significant change in the rate of rise or peak flood level in downstream areas, thereby protecting existing flood immunity and flood warning times.

Given this, it is considered that the interim stage of development can proceed as proposed and will not produce unacceptable impacts with respect to flooding.

Ripley Valley Secondary Urban Centre
East - Stages 4-6

FIGURES

Shaping the Future



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SHEET	A3
Project No:	7901-47-027
Date:	24 July 2013
Revision Number:	1
Designed by:	NE
Client Name:	Amex Corporation Pty Ltd

LEGEND

- Existing Building
- Catchment Control Point
- Overall SUCE
- Stage 4 to 6 (site of investigation)
- Stages 1 to 3

N
W E
S

Figure 1

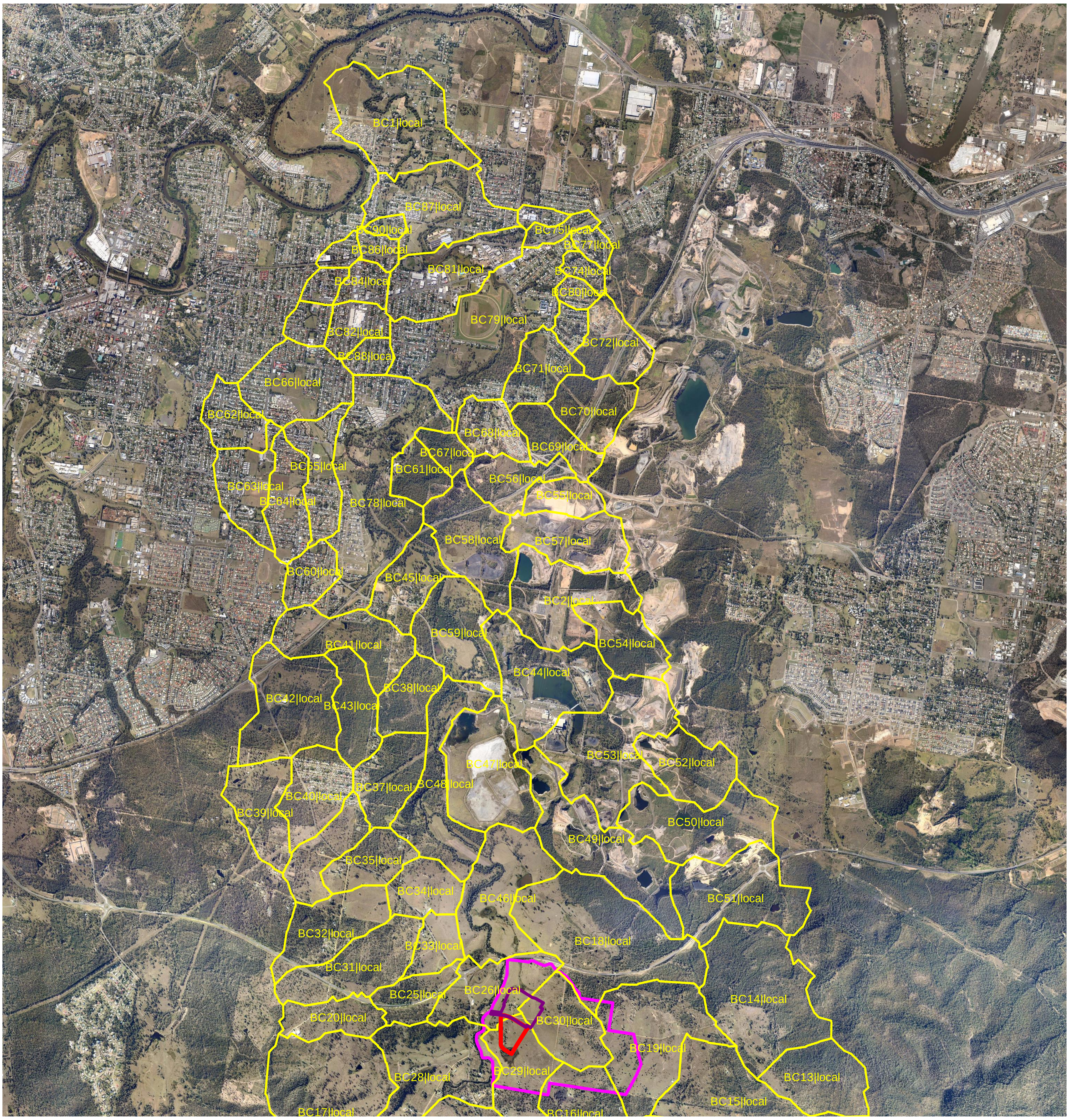
Location of Site and Catchment Control Points

Stages 4 to 6 Ripley Valley Secondary Urban Centre East

Scale: 1:50,000

500 0 500 1000 1500
Metres

File Path: O:\7901-47-027\MapInfo\Flood Study\SUCE\Stages 4-6\Figures\Figure 1



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Designed by:	NE
Client Name:	Amex Corporation Pty Ltd

LEGEND

- Stages 4 to 6 (site of investigation)
- Stages 1 to 3
- Catchment Boundary
- Overall SUCE

N W E S

Figure 2

Catchments Plan for Dowstream of Site

Stages 4 to 6 Ripley Valley Secondary Urban Centre East

Scale: 1:50,000

500 0 500 1000 1500
Metres

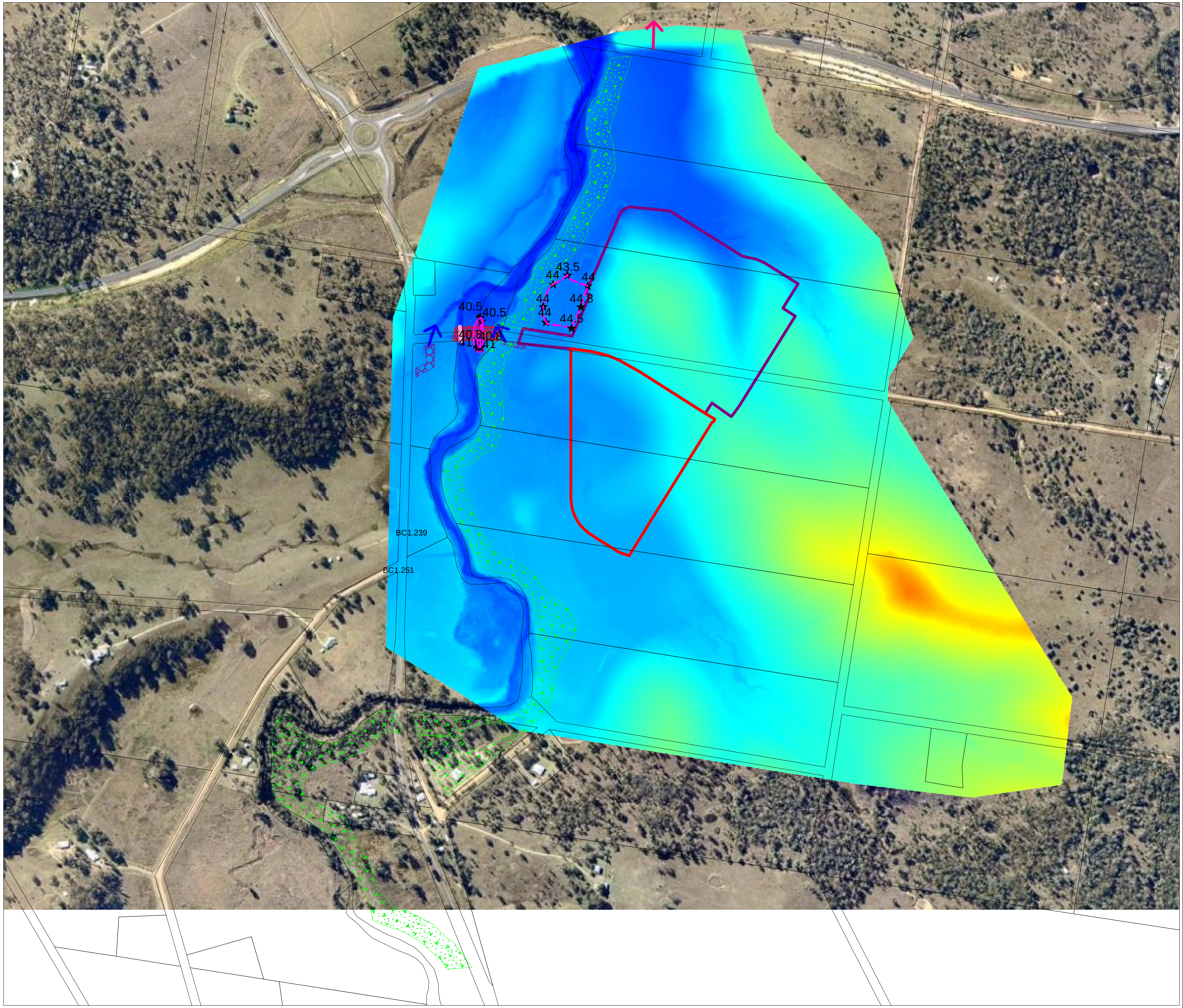

Figure 3 Developed Site

Stage 4 to 6 Ripley Valley Secondary Urban Centre East

LEGEND

N
W E
S

Proposed Bridge

Stages 4 to 6 Fill

Stages 1 to 3 Fill

Drainage Channel

Proposed Culvert

Exavation

Level

Excavation Line

Boundary

Existing 1.2m Culvert

Barrams Bridge Channel

BC1.251 BC1.239

Revegetation

Topography (mAHD)

- 38.0 to 43.0
- 43.0 to 48.0
- 48.0 to 53.0
- 53.0 to 58.0
- 58.0 to 63.0
- 63.0 to 68.0
- 68.0 to 73.0
- 73.0 to 78.0
- 78.0 to 83.0

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Ripley Valley Secondary Urban Centre
East - Stages 4-6

APPENDIX
A

Hydrographs at Reference Points

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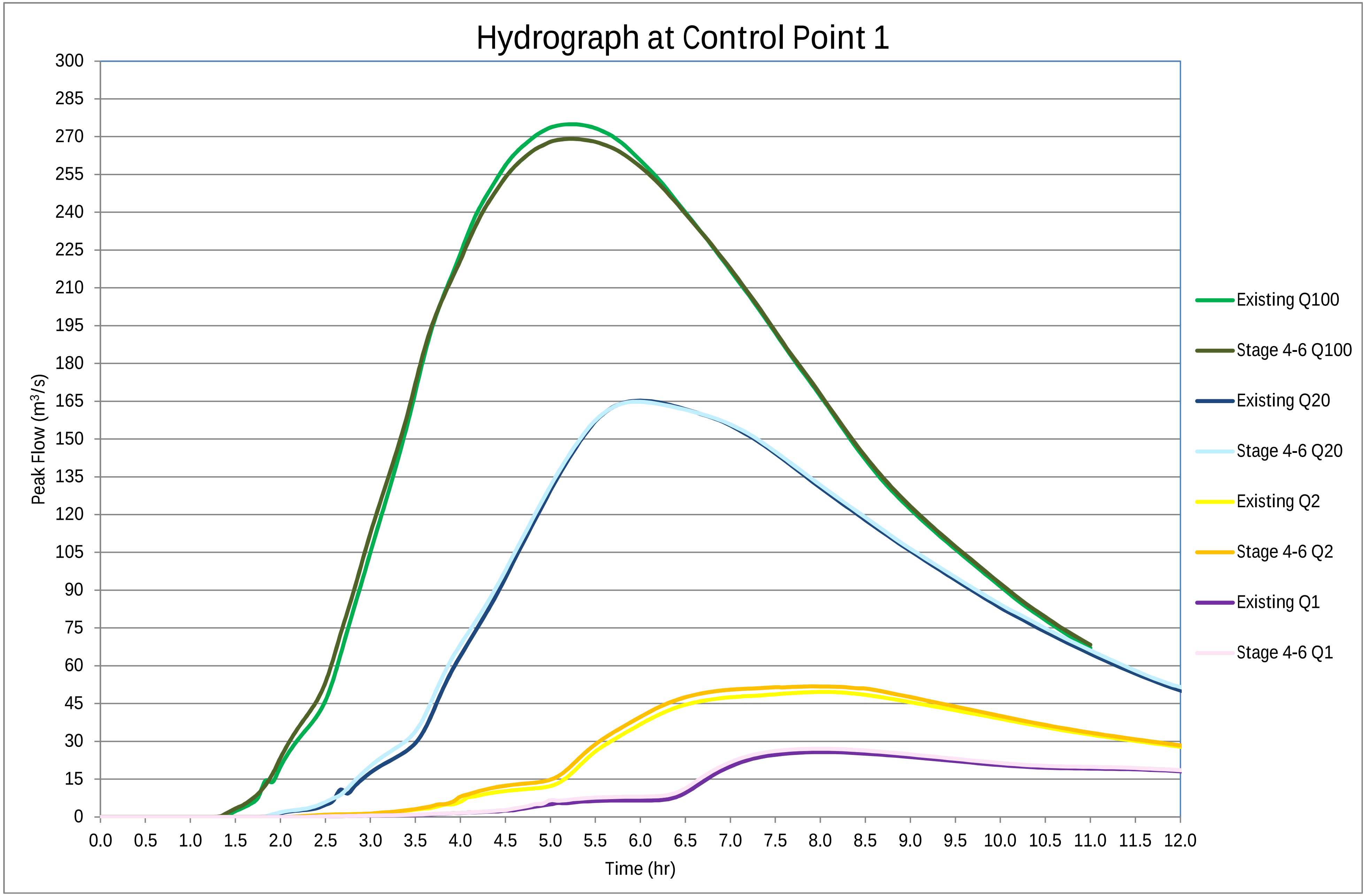
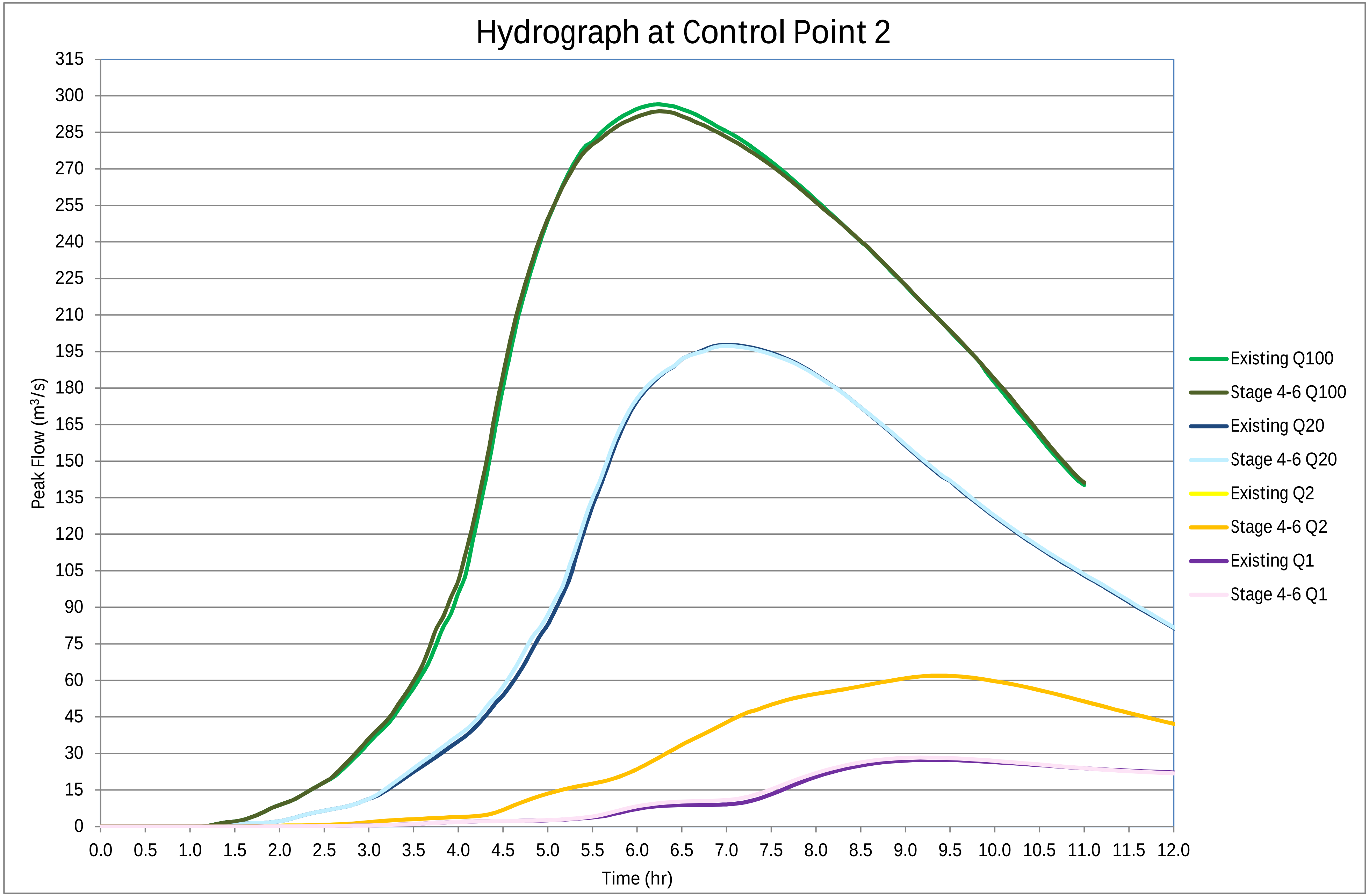
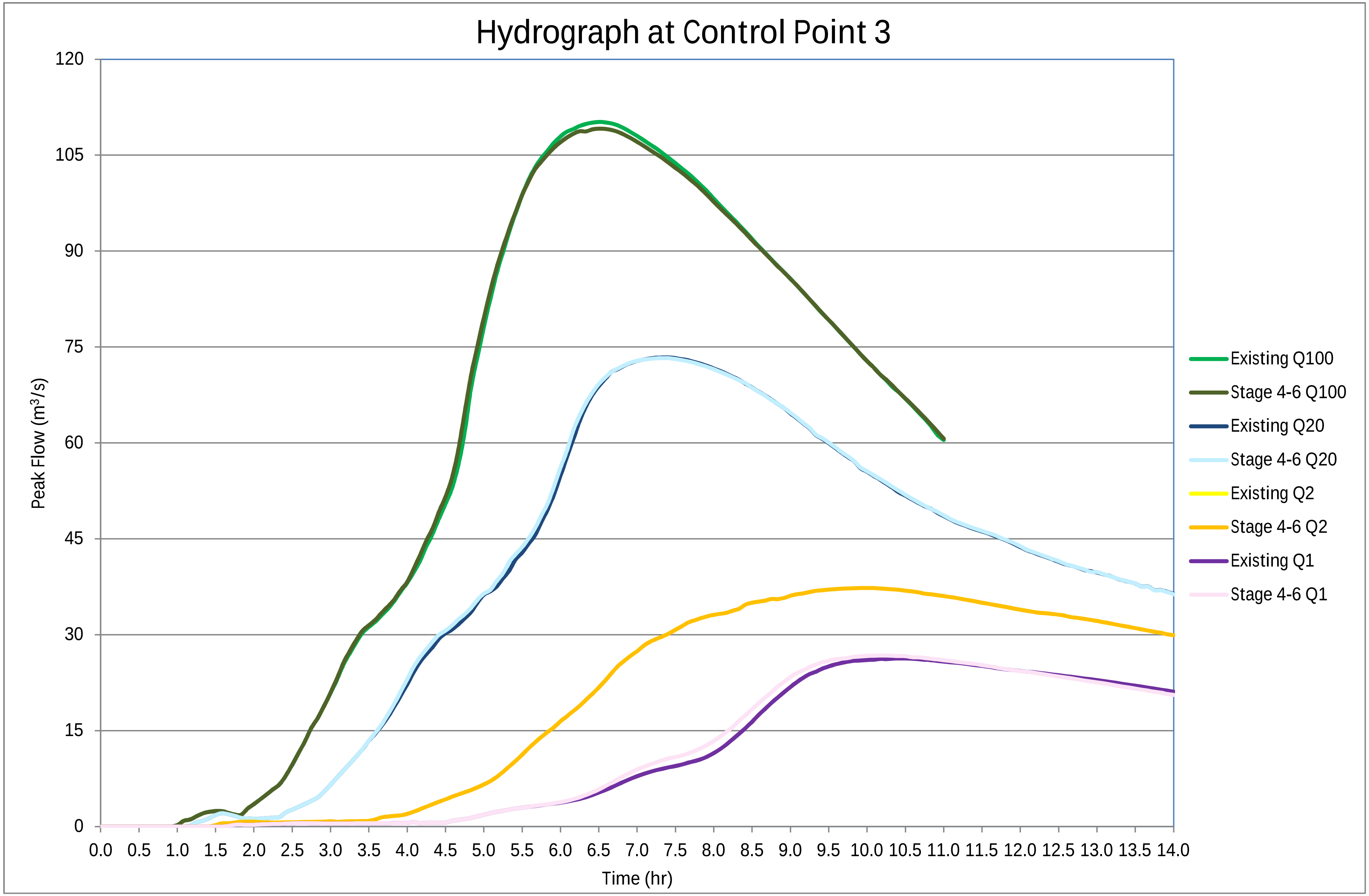
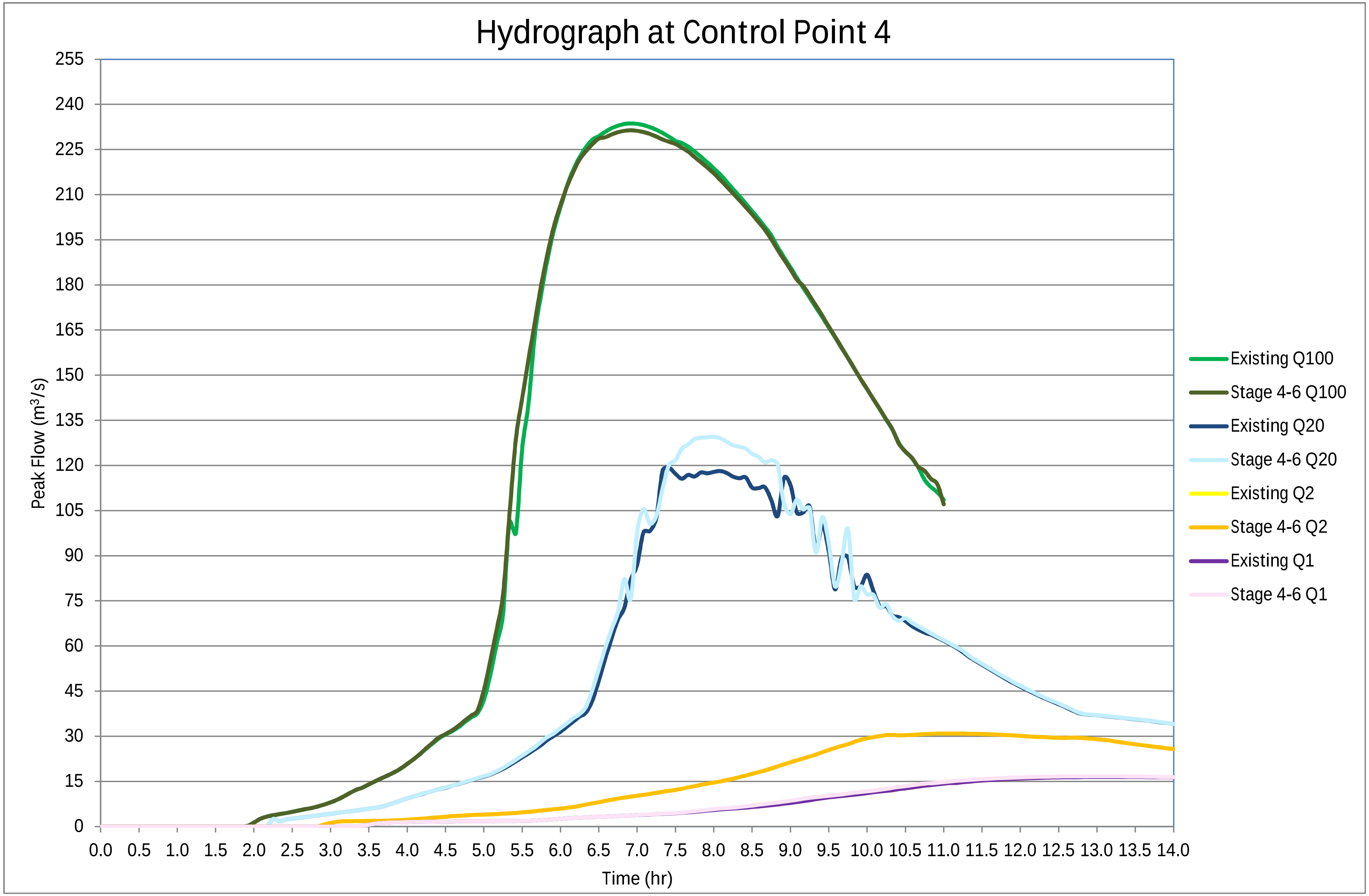
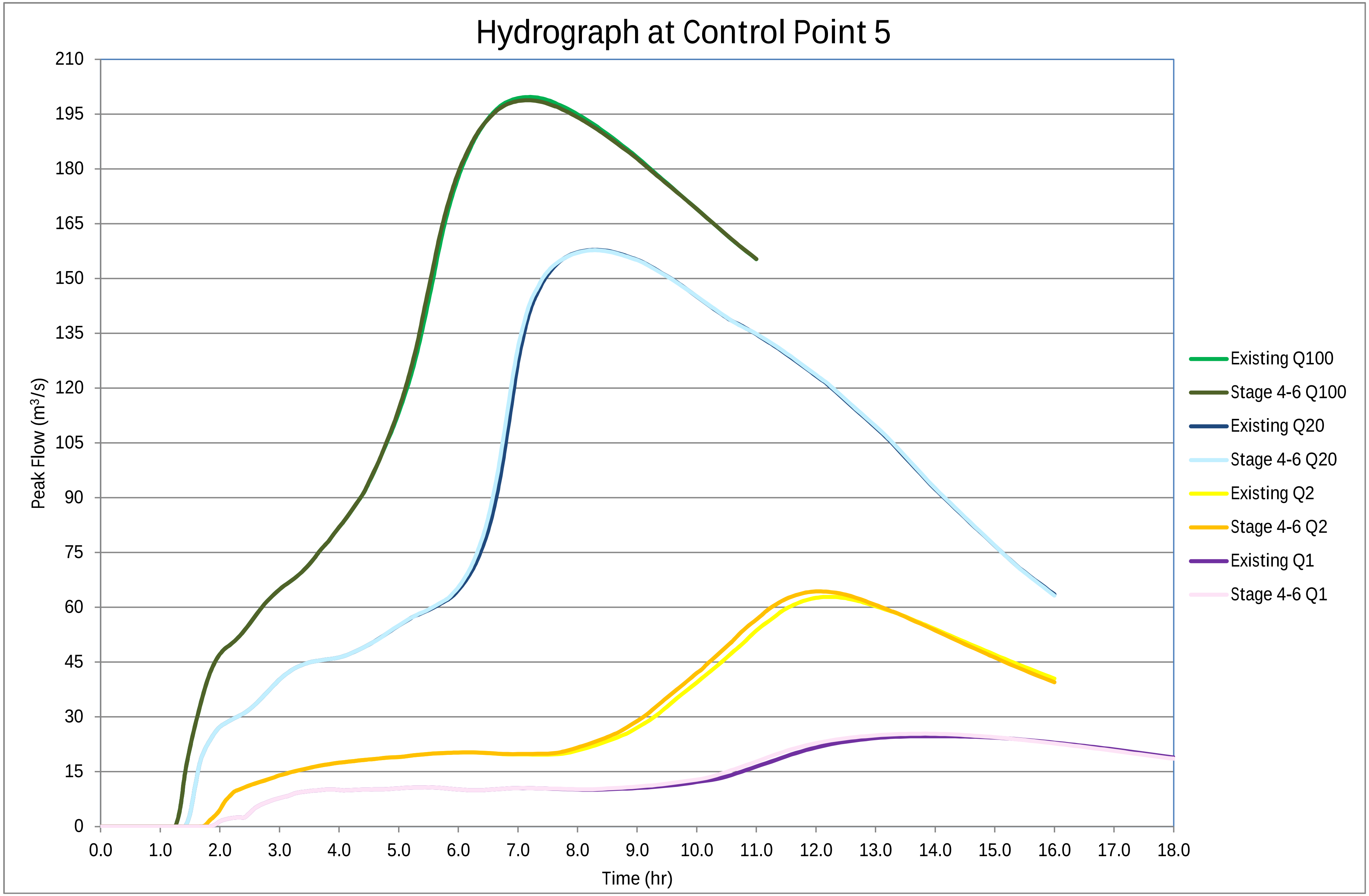

Hydrograph at Control Point 1
Peak Flow (m3/s)
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
Time (hr)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1


Hydrograph at Control Point 2
Peak Flow (m³/s)
Time (hr)
315
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1

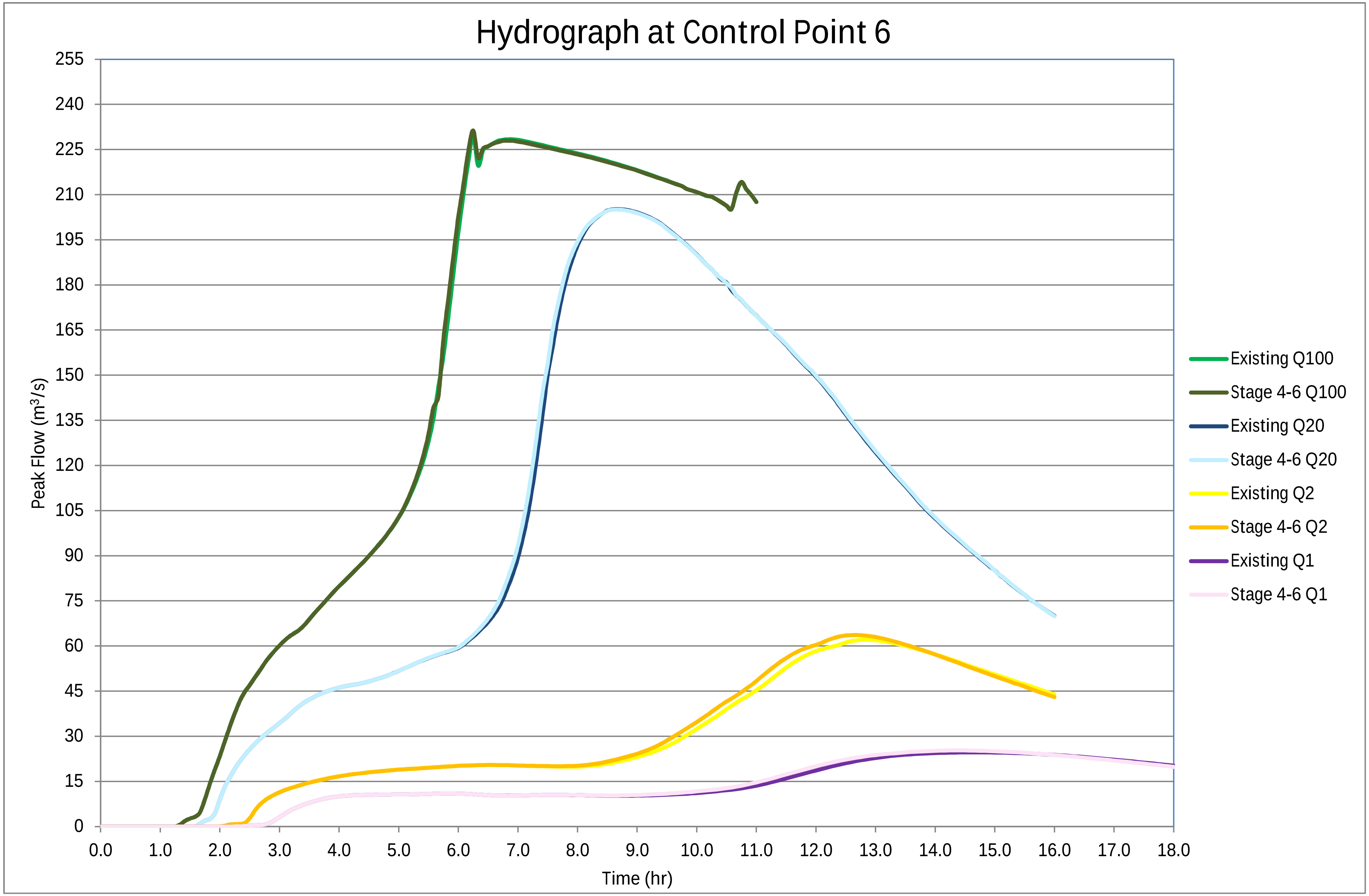


Hydrograph at Control Point 3
120
105
90
75
60
45
30
15
0
Peak Flow (m³/s)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0
Time (hr)
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1


Hydrograph at Control Point 4
Peak Flow (m³/s)
Time (hr)
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1

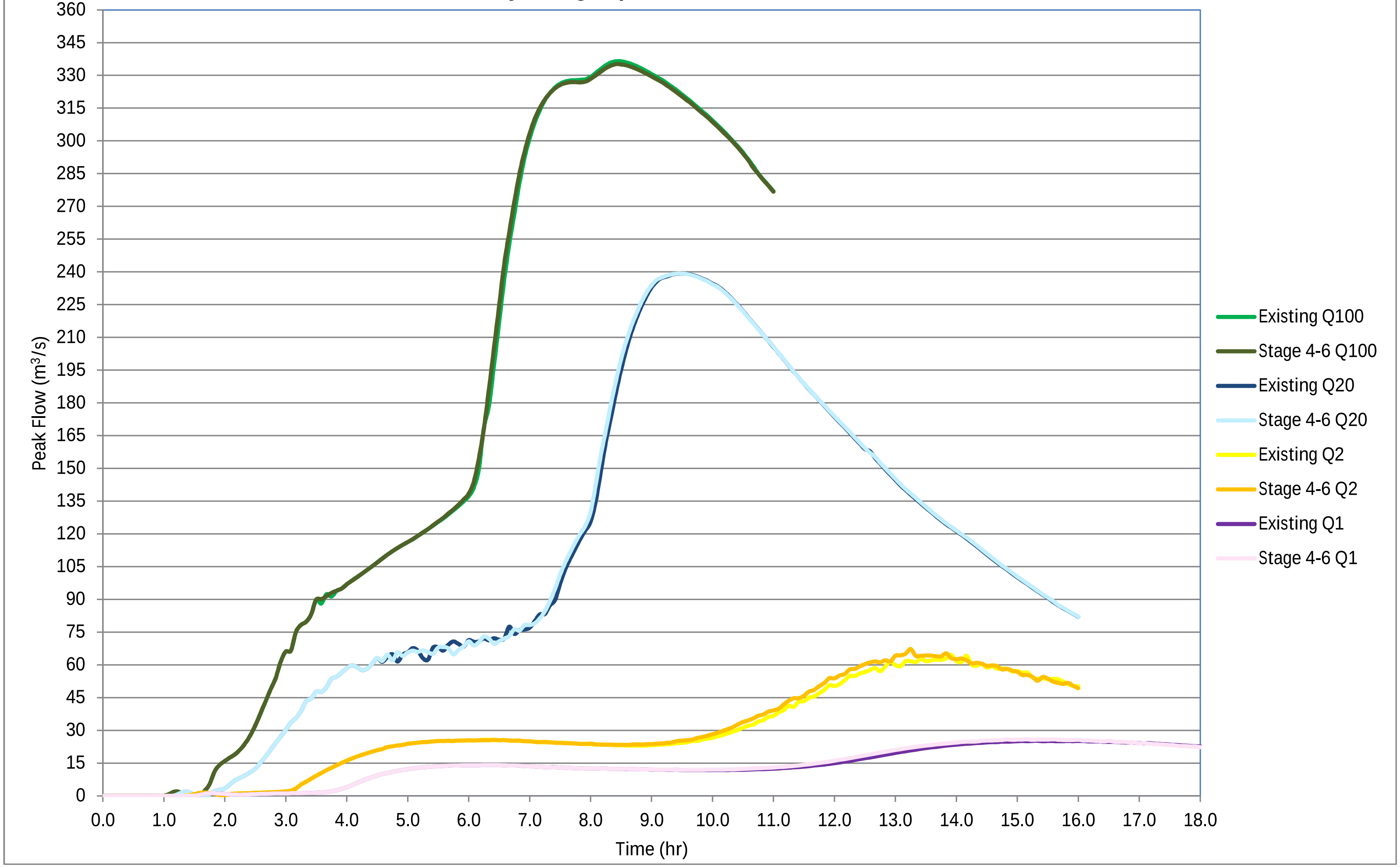


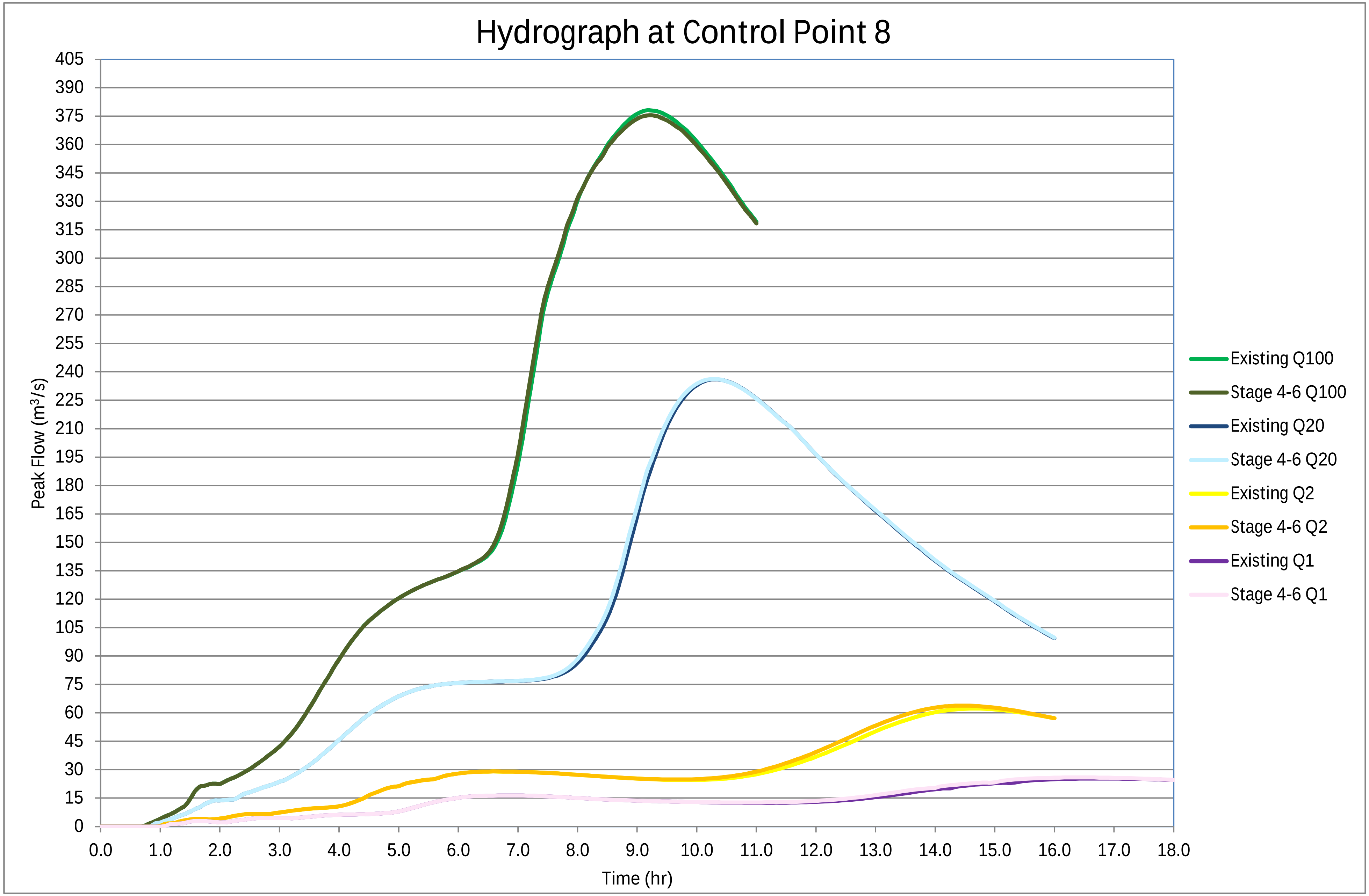
Hydrograph at Control Point 5
Peak Flow (m³/s)
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
Time (hr)
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1

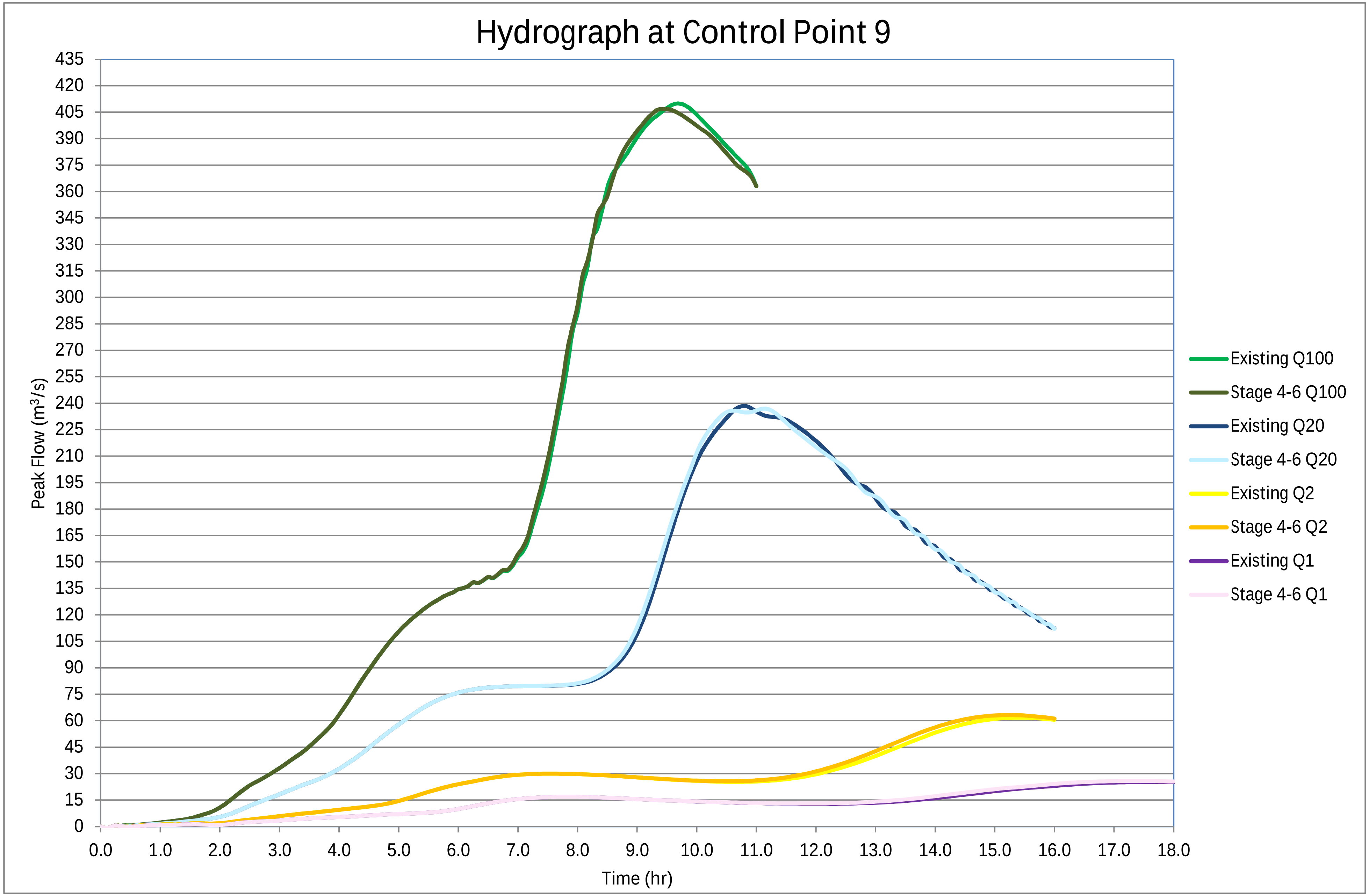


Hydrograph at Control Point 6
Peak Flow (m³/s)
Time (hr)
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1

Hydrograph at Control Point 7




Hydrograph at Control Point 8
Peak Flow (m³/s)
Time (hr)
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
360
375
390
405
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1



Hydrograph at Control Point 9
Peak Flow (m3/s)
435
420
405
390
375
360
345
330
315
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
Time (hr)
Existing Q100
Stage 4-6 Q100
Existing Q20
Stage 4-6 Q20
Existing Q2
Stage 4-6 Q2
Existing Q1
Stage 4-6 Q1

Ripley Valley Secondary Urban Centre
East - Stages 4-6

APPENDIX

B

Flood Modelling Results - Levels

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