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Our Ref: 20-000606

26 May 2021

Attention: Statewide Planning Pty Ltd

Dear Charlie Demian,

741 & 755 Great Western Highway, Werrington - Stormwater Letter Report

Calibre Professional Services (NSW) Pty Ltd has been engaged to prepare documentation to support the Development Application for the residential subdivision of 741 & 755 Great Western Highway, Werrington.

Calibre Professional Services have confirmed that the previously designed detention and bio-detention basins within the previous stages cater for the Stage 4 development, in accordance to Cardno Stormwater Report (2011). This letter report documents the stormwater quantity and quality strategy for the proposed development up to the railway corridor in accordance with Penrith City Council guidelines.

1 PROJECT DESCRIPTION

1.1 Site Description

The 741 & 755 Great Western Highway, Werrington site, located in the suburb of Werrington, is formally known as Lots 125,126 and 127, DP 1215199. The existing site layout is presented in Figure 1-1. Stage 4 is located between Great Western Highway and St Charbel Boulevard. Stages 1-3 are located between St Charbel Boulevard and Great Western Railway.

The site is located within the Werrington Creek Catchment Area. A watercourse (classified as Category 2) draining in a South-North direction bisects the site. The watercourse collects the runoff from a culvert crossing under the Great Western Highway. The watercourse terminates in a culvert under the Western Railway line.

Figure 1-1 Staging plan and site layout

The development site is located between Great Western Railway and St Charbel Boulevard in the suburb of Werrington. The figure above shows the location of the site. The overall site covers an area of 5.59ha and is currently a vacant land. A watercourse draining a culvert system under the Great Western Highway bisects the site from south to north.

The watercourse starts from the southern boundary with the highway down to a culvert system under the railway line. The western boundary of the site is limited by the channel while the eastern boundary is bounded by adjoining properties.

The culverts are as follows:

- Under the Great Western Highway: two box sections 1.86m wide and 1.25m high;
- Under St Charbel Boulevard: 3 box sections 2.7m wide and 0.6, high; and
- Under the Great Western Railway: one circular conduit 1.5m diameter.

Another minor overland flowpath enters the site from the eastern boundary and connects to the watercourse in the middle of the site.

2 RELEVANT POLICIES AND GUIDELINES

The design by Cardno has been designed in accordance with the following Penrith City Council guidance documents and correspondence, along with Australian Standards:

- Cardno ITC “Werrington Subdivision Cnr of French Street & Great Western Highway Kingswood”, 2011

- Penrith City Council "Development Control Plan 2010", sections C3, C8, C10, C11 & C13
- Penrith City Council "Werrington Mixed-Use Area" DCP (effective 23 February 2007)
- Penrith City Council "Guidelines for Engineering Works and Subdivisions and Developments", part 1 design & part 2 construction dated 20 May 1997
- Penrith City Council "WELL Precinct Development Contributions Plan 2008"
- The NSW Government "Floodplain Development Manual" April 2005
- "Australian Rainfall & Runoff" (AR&R 1997) by Engineers Australia

2.1.1 College, Orth and Werrington Creeks Catchment Overland Flow Flood Study (Catchment Simulation Solutions 2017)

The site falls within the Werrington Creek catchment and in 2017 a regional flood study was prepared for Penrith City Council to identify flood risk across the 12 km^2 catchment. The study utilised 2002 ALS and 2011 Lidar topographical data to prepare a TUFLOW 2-dimensional computer model. The model utilised a 2m x 2m grid, therefore there is a simplification of the terrain that is represented in the model.

The flood mapping included the stage 1, 2 and 3 development, however the flood mapping in the Council report had been hatched out with the clause "*Preliminary flood behaviour across this area is based upon design terrain information which may not reflect final topography. Therefore, the results shown in this area are preliminary and subject to further confirmation through the finalising of the subdivision*"

The model was shown as pre developed scenario for the stage 4 development, due to the simplify of the terrain to a 2m X 2m grid and nulling of the results the flow path showed simplified conveyance of flows and discontinuity through the site to the downstream stages.

Figure 2-1 1% AEP flood levels - College, Orth and Werrington Creeks Catchment Overland Flow Flood Study (Catchment Simulation Solutions 2017)

2.1.2 TUFLOW

The 2017 flood study TUFLOW model was provided by Penrith Council. The base model was updated to include the approved stage 3 subdivision. The proposed TUFLOW model included the proposed works to the Riparian Corridor and the stage 4 development.

The models were run for the 1 in 100 AEP flood event. The flood level difference mapping for the 1% AEP is shown in figure 2.2.

Figure 2-2 100 yr ARI change in flood level

The flood assessment demonstrated no flood level increases as a result of stage 4 outside of the development site. The basins 1, 2 and 3 approved as part previous stages were included in the TUFLOW modelling and demonstrated that the stage 4 development is catered for.

3 STORMWATER DRAINAGE STRATEGY

The pipe/pit system including the inter-allotment drainage are designed to cater for 10-year ARI storm event with overland flowpath provided for storms in excess of the design storm. The road drainage has been designed using the minor/major system approach with the pipes network being the minor and the roads being the major.

The stormwater drainage will generally follow the natural gradient of the site. Ultimately, the discharge from the site will be maintained to the culverts under the railway line. An impervious fraction of 0.80 for the purpose of sizing the pipe system servicing the subdivision was adopted.

3.1 On-Site Detention

The On-Site Detention (OSD) basins have been sized using “DRAINS” software by Cardno. The simulations ensured the site discharge in all storms for the post-developed conditions does not exceed the pre-developed natural state of the site.

3.1 On-Site Detention

The On-Site Detention (OSD) basins have been sized using "DRAINS" software by Cardno. The simulations ensured the site discharge in all storms for the post-developed conditions does not exceed the pre-developed natural state of the site.

Basin 3 design was undertaken by SCG Consultants to cater for majority of the Stage 4 catchment (allowing for 90% impervious) and has a capacity of 1289m^3. The two additional OSD basins were reported by Cardno and proposed as part of the previous stages of the subdivision to control the runoff from the areas north of Road 1. Basin 1 has a capacity of 1746m^3 and controls the runoff from the site area west of the conservation zone as well as the remaining catchment of Stage 4. Basin 2 has a capacity of 1014m^3 and controls the runoff from the site area east of the conservation zone. Refer to Figure 3-1 for the locations of Basins 1, 2 and 3.

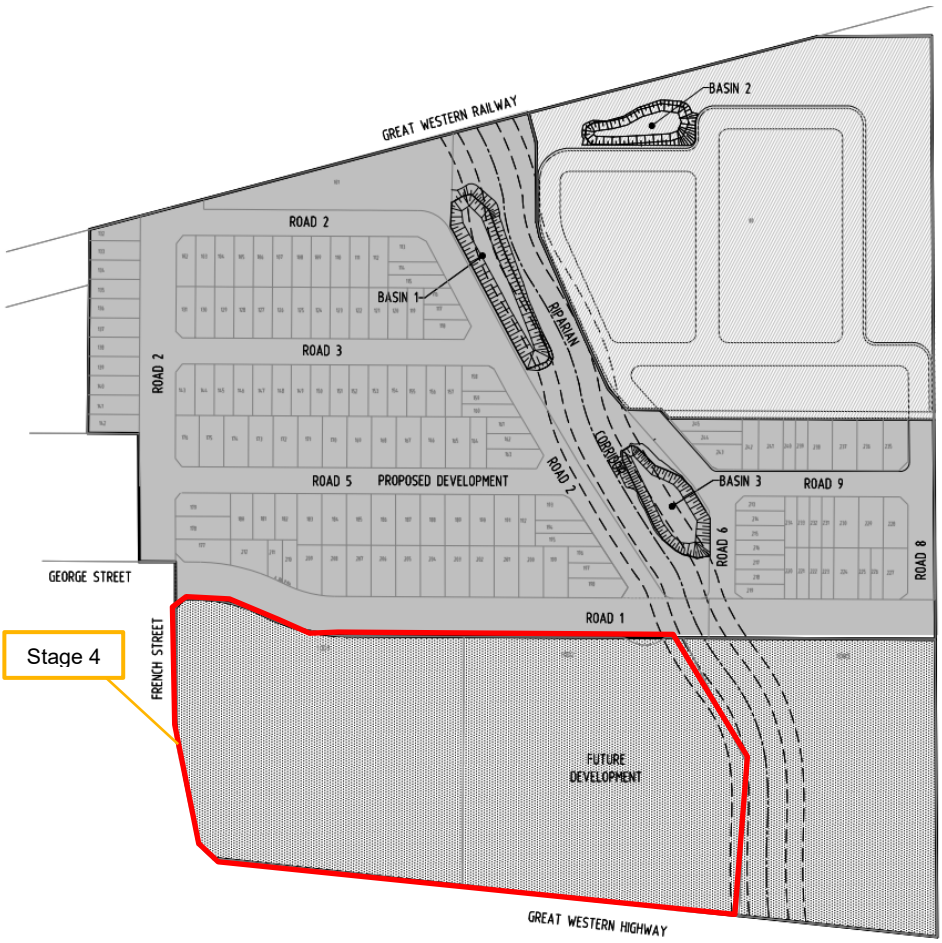


Figure 3-1 Basin Layout

The table on the following page summarises the results of the DRAINS model. The controlled peak flow from the On-Site Detention basins is equal or less than the existing peak flow in all storm events.

Table 3-1 Basin 1 Results – Cardno

ARI (yrs)	Existing Peak Flow (m^3/s)	Uncontrolled Peak Flow (m^3/s)	Controlled Peak Flow (m^3/s)	Pipes Flow (m^3/s)	Spillway Flow (m^3/s)	OSD Volume (m^3)
5	0.64	1.67	0.63	0.63	0	995
20	1.19	2.37	1.07	0.71	0.36	1478
100	1.86	3.09	1.86	0.74	1.12	1746

Table 3-2 Basin 2 Results – Cardno

ARI (yrs)	Existing Peak Flow (m^3/s)	Uncontrolled Peak Flow (m^3/s)	Controlled Peak Flow (m^3/s)	Pipes Flow (m^3/s)	Spillway Flow (m^3/s)	OSD Volume (m^3)
5	0.50	1.20	0.50	0.50	0	576
20	0.89	1.67	0.82	0.59	0.23	874
100	1.38	2.11	1.38	0.62	0.76	1014

Basin 3 was based on the previous designed and detailed plans of *Werrington Subdivision Corner French Street and Great Western Highway, Werrington NSW 2747 – Construction Certificate Stormwater Package* drawing set, prepared by SGC. The impervious value adopted for the subdivision was 90%.

Table 3-3 Basin 3 Results – Cardno

ARI (yrs)	Existing Catchment Flows (m^3/s)	Proposed Catchment Flows (m^3/s)	Basin Outflow Piped (m^3/s)	Basin Outflow Weir (m^3/s)	Total Basin Outflow (m^3/s)	Basin Volume (m^3)	TWL (mAHD)
5	0.795	1.82	0.795	0	0.778	583	38.72
20	1.44	2.5	0.875	0.022	0.897	1017.5	39.01
100	2.23	3.13	0.924	0.88	1.804	1289	39.17

The basins were included in the TUFLOW model and demonstrated that the provision of stage 4 draining to the basins ensured no aggravating of flood levels outside the site.

4 WATER QUALITY MANAGEMENT

To address the water quality requirements, the site's runoff will be treated prior to discharging into the railway culverts. It is proposed to use a treatment train approach to meet the water quality objectives.

The site is classified Medium (10-50ha) under Council DCP 2010 Section C3 and hence a Level 2 (Actual Event Load) is required to assess the pollutants load from a storm event on a daily basis.

The following table summarises the requirements for pollution retention criteria as required by Council.

Table 4-1 Pollution Retention Criteria – Cardno

Pollutant	Description	Retention Criteria
Litter	All anthropogenic material (cans, bottles, wrapping, etc)	70% of material ≥ 5mm
Coarse Sediment	Coarse sand (≥0.5mm)	80% of the load for particles ≤ 0.5mm diameter
Nutrients	Total Phosphorus & total Nitrogen	45% retention of the load for each
Fine Particles	Fine sand (0≥0.05mm)	50% of the load for particles ≤0.1mm diameter
Free Oil & Grease	Free floating viscous liquids ≥ 150 µm that do not emulsify in aqueous solutions	90% of the load with no visible discharges

The treatment train approach adopted for the subdivision is described below.

- It is assumed that each lot will be fitted with an individual rainwater reuse tank in the future when the lots will be developed with residential single dwellings to respond to BASIX requirements
- It is proposed to install gross pollutant traps in front of the OSD basins. The devices will be designed to capture litter, gross and fine sediments and hydrocarbons generated from the site to manufacturer's requirements. The gully pits in the streets will be fitted with trash baskets only if required by Council

- Water quality bio-retention ponds are proposed in conjunction with the OSD basins. The basins will be underlaid with a layer of fine material and a network of subsoil pipes. The purpose of the fine material is to treat the runoff from the 3-month storm through percolation. The runoff will be drained through the subsoil network and discharged into the stormwater system. The ponds could possibly have an extended depth as well to allow for more treatment volume and time.

The performance of the above treatment train measures will be verified against the criteria in Table 4-1 by calculations and real rainfall event simulations using “MUSIC” software in the advanced stages of the design development.

5 FLOOD MODELLING

The site is bisected by a watercourse traversing the site from the culverts under the Great Western Highway down to the culverts under the Railway Corridor. The area of the watercourse is considered a conservation zone and is potentially subject to flooding in major storm events.

The culverts are as follows:

- Under the Great Western Highway: two box sections 1.86m wide and 1.25m high;
- Under St Charbel Boulevard: 3 box sections 2.7m wide and 0.6, high; and
- Under the Great Western Railway: one circular conduit 1.5m diameter.

The 2017 TUFLOW model was updated to include the approved stages and stage 4. However the simplifying of the terrain associated with the TUFLOW model meant that additional 1 -dimensional modelling was undertaken.

5.1 Hydrological Modelling

The rainfall intensities obtained from ARR 1987 have been used in the hydrological DRAINS model prepared to simulate the runoff from the catchments.

The catchment area was subdivided into several sub-catchments based on the topography and the outlet controls, such as location of culverts, road blocking flows, directions of flows, etc), as shown in Figure 5-1. The catchment area extends into the Western Sydney University to the South and into adjoining properties to the east. The catchment to the east has been included as a separate sub-catchment, which drains through a depression within the site and discharges into the watercourse.

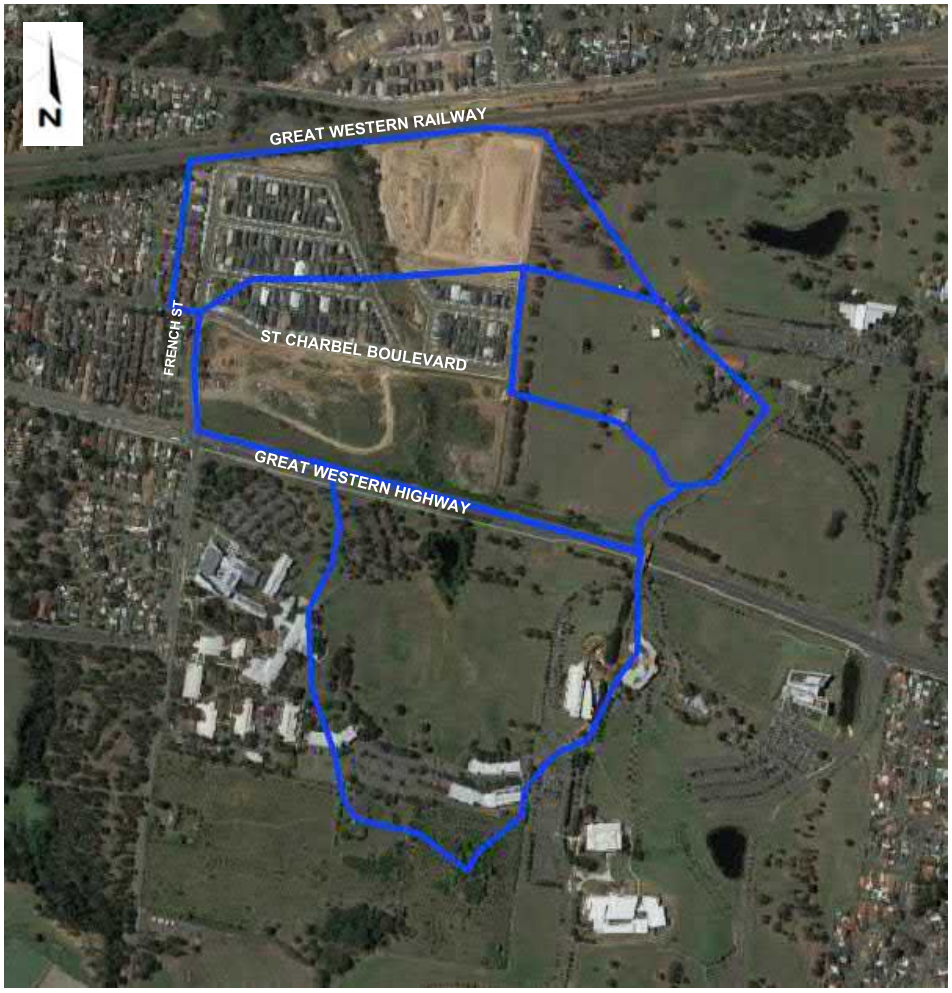


Figure 5-1 Catchment map

The northern and western boundaries of the catchment are bounded by the railway corridor and French Street respectively. There are no external catchments in these directions. The catchments are classified as residential with 80% imperviousness.

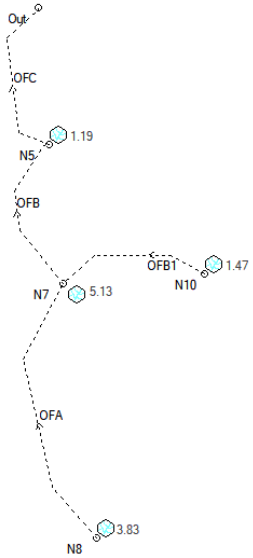


Figure 5-2 DRAINS model

The simulations were carried out for the 1, 5, 10, 20 and 100 year ARI storm events. The table below shows the peak flood overland flow through the sub-catchments, for catchments A, B and C.

Table 5-1 DRAINS results

	1yr (m^3/s)	5yr (m^3/s)	10yr (m^3/s)	20yr (m^3/s)	100yr (m^3/s)
OF A	0.638	1.68	2.07	2.56	3.83
OF B	1.67	4.12	5.05	6.28	9.17

5.2 Hydraulic Modelling

A Hec-Ras model was used to simulate the channel through the site and to determine the flood levels. The cross sections are shown below in Figure 5-3.

The data included in the Hec-Ras model was extrapolated from the Digital Terrain Model (DTM) created from the detailed survey of the site. Cross sections at 20m intervals were created from the DTM and exported into the Hec-Ras model. Cross section outputs are included in Appendix.

Figure 5-3 Hec-Ras Channel Cross Sections

The extent of the model is limited to the site boundaries. A perspective plot is shown in Figure 5-4. The flood peak discharges were derived from a DRAINS model, based on the parameters from the Cardno report. The culverts along St Charbel Boulevard were modelled. Manning's roughness coefficient of 0.035 was adopted for the main watercourse, with the banks having a higher roughness of 0.1. The catchments were modelled with an impervious rate of 80%.

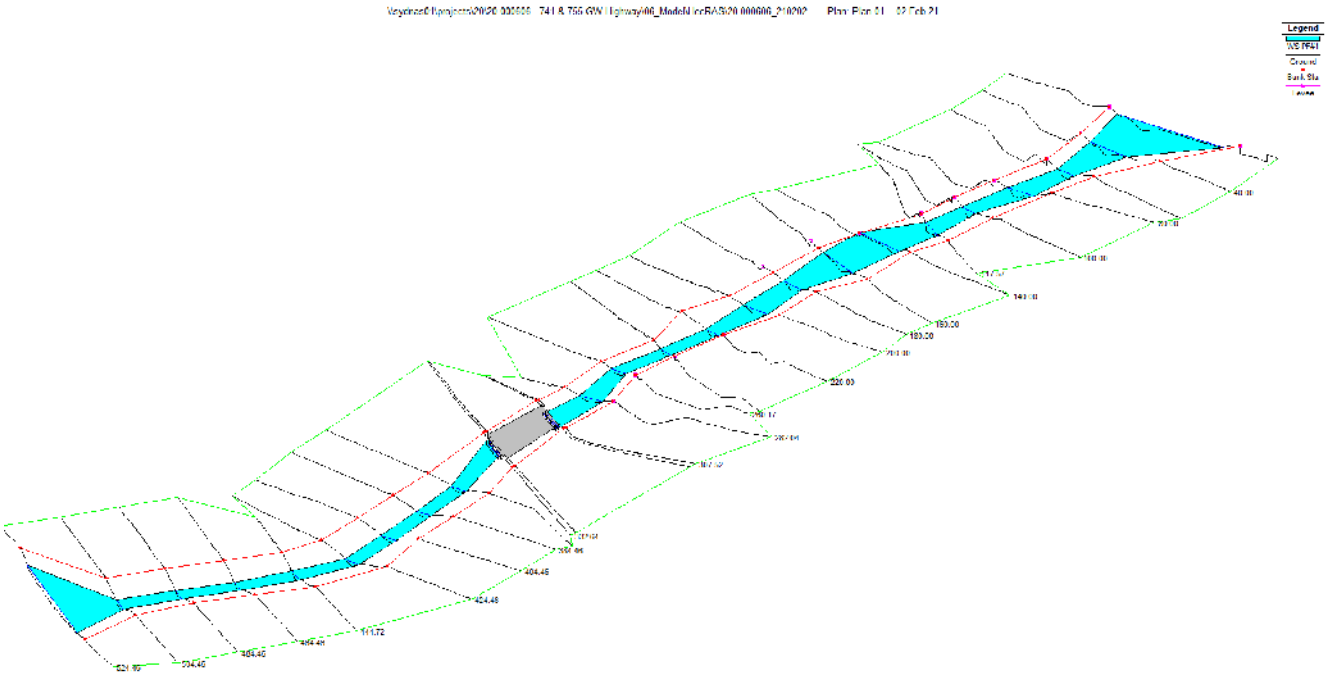


Figure 5-4 Hec-Ras Channel for Proposed Condition

The proposed Hec-Ras model simulates the proposed site with the subdivision of Stage 4, Works as Executed for Stage 1-3 and the upstream culvert under St Charbel Blvd and downstream culvert under the railway. The model was run in Mixed mode and the results are displayed below in Table 5-2.

Table 5-2 Hec-Ras results for Proposed Subdivision

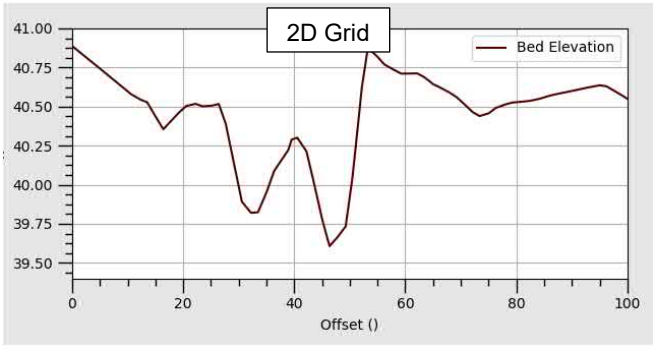
River Station	Q Total (m^3/s)	Min channel Elevation	Water Surface Elevation (m)	Depth (m)	Velocity (m/s)
524.46	3.83	43.32	44.29	0.97	0.13
504.46	3.83	43.45	44.12	0.67	1.73
484.46	3.83	43.13	43.77	0.64	1.88
464.46	3.83	42.59	43.15	0.56	2.42
444.72	3.83	42.29	42.98	0.69	1.66
424.46	3.83	41.99	42.63	0.64	1.89
404.46	3.83	41.62	42.26	0.64	1.91
384.46	3.83	41.22	41.83	0.61	2.03
364.46	3.83	40.82	41.46	0.64	1.89
332.64	3.83	39.70	40.17	0.47	0.80
331.64	Culvert				
307.52	3.83	39.55	39.93	0.38	0.97
282.04	3.83	39.2	39.74	0.54	1.30
260.17	3.83	38.85	39.45	0.60	1.67
240.40	3.83	38.5	39.12	0.62	1.92
220.00	3.83	38.00	38.77	0.77	1.89
200.00	3.83	37.53	38.64	1.11	0.68
180.00	9.17	37.32	38.29	0.97	2.21
160.00	9.17	37.17	38.20	1.03	1.35

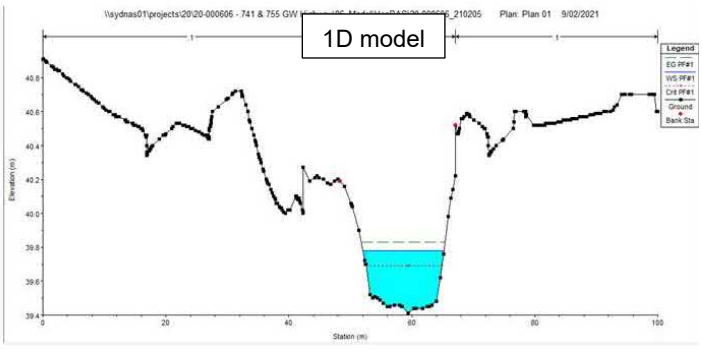
140.00	9.17	37.18	37.91	0.73	1.74
117.57	9.17	35.87	37.25	1.38	1.31
100.00	9.17	35.69	36.90	1.21	2.47
80.00	9.17	35.60	36.72	1.12	1.73
60.00	9.17	35.36	36.34	0.98	2.34
40.00	9.17	35.14	36.20	1.06	1.31
20.00	9.17	34.82	36.21	1.39	0.52

5.2.1 Comparison with College, Orth and Werrington Creeks Catchment Overland Flow Flood Study

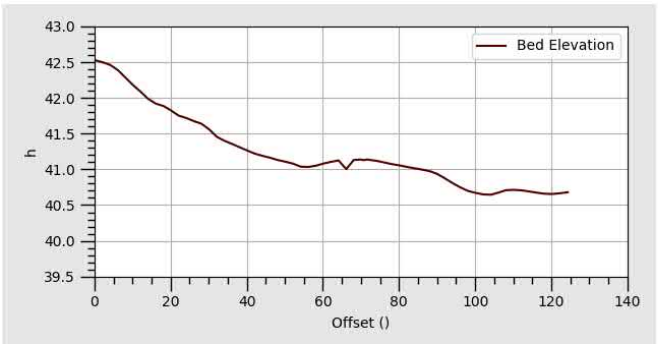
The College, Orth and Werrington Creeks Catchment Overland Flow Flood Study is considered a regional flood study and the model was prepared for the 12km^2 catchment area. As a result of the size of the model, the 2m X 2m grid was selected to manage run times and stability of the model, however there is simplifying of the terrain that is expected as a compromise.

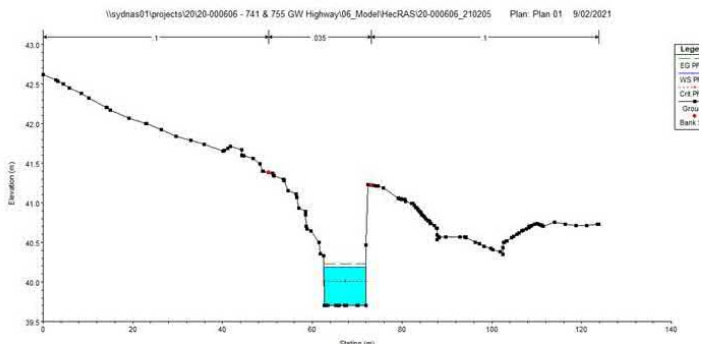
A site specific flood study needed to be prepared for the development to ensure the study could accurately identify the details of the works. Reviewing of the modelling requirements and as the proposed works include the formalised channel to convey the flows, it was concluded that a 1-d model would be more accurate in representing the stage 4 development. A comparison of the cross sections between the 2D grid (Tuflow) and 1D section (HECRAS) is shown below, the conveyance area is the 2D grid is only represented by 2-3 levels and cannot accurately identify the cross section or the proposed capacity of the channel.





Great western Highway





The flows determined in the site specific hydrology modelling (DRAINS) matched the flows modelled in the Council Tuflow model arriving at the site. However the modelling undertaken for this study allowed for additional potential development and modelled larger flows at the downstream end of the study area. This is considered a conservative approached.

The site specific hydraulic modelling prepared for this study was undertaken in accordance with the Council 2017 flood study, but developed a model on a smaller scaler to provide greater detail to identify the flood conveyance of the site and more accurately determine the proposed flood levels. The proposed works convey the 1% AEP within the waterway.

5.2.2 Worse Case Scenario

As part of the riparian corridor works for 55 French Street (downstream of stage 4) a flood assessment was undertaken for a worse case scenario associated with works to protect the trees. As part of this assessment the stage 4 development was included to ensure the Riparian Corridor could convey the ultimate development flows with the worse case scenario. The assessment demonstrated that with a narrowing of the creek corridor associated with tree protection works, the channel could still convey the developed flows.

6 CONCLUSION

The basins designed as part of the previous stages supports Stage 4 and meets Council standards. Based on the results provided in Table 3-1 and Table 3-2, the basins provide enough detention for the previous stages to ensure that the flows leaving the post-development site will not exceed the existing flows for the 1% AEP event. This is consistent with Cardno's flows and Council's guidelines. Therefore, the development should not pose an adverse impact to the properties at 741 & 755 Great Western Highway, Werrington. TUFLOW modelling was also undertaken to include stage 4 and demonstrated that the basins could function to ensure no aggravating of flood levels outside of the site.

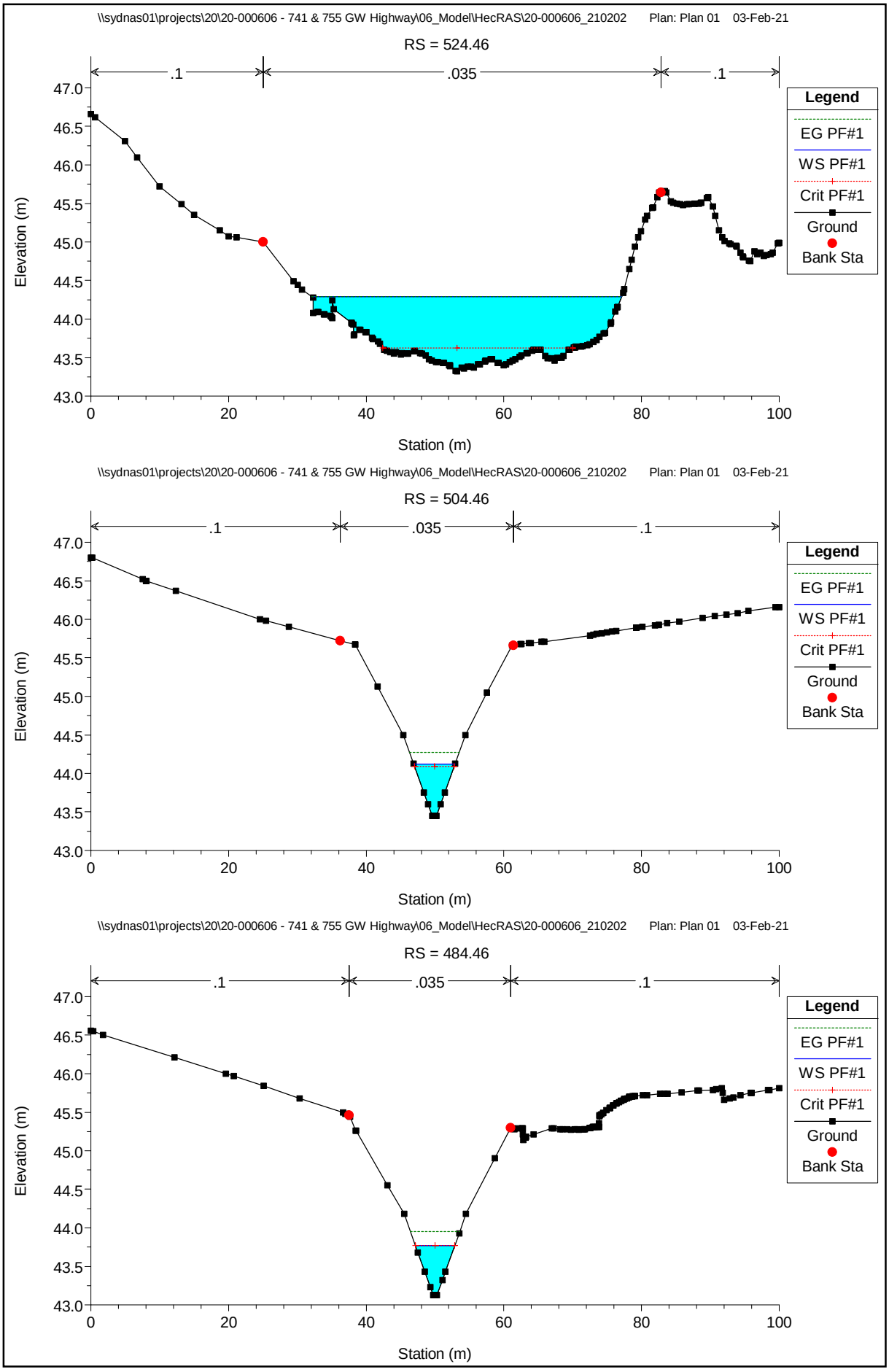
A site specific flood model was prepared for the site inaccordance with the details in the 2017 regional flood model. The 100 year ARI are contained within the channel and depths within the through Stage 4 ranges between 0.97m and 0.47m. The channel has capacity to convey the proposed flows. The velocities within the channel vary from 0.8m/s to 2.42 m/s, with the higher value along chainage 464.46 m. Allowing for a 0.5m freeboard, the minimum planning level for Stage 4 ranges from RL 46.36m to RL 41.18m along the channel.

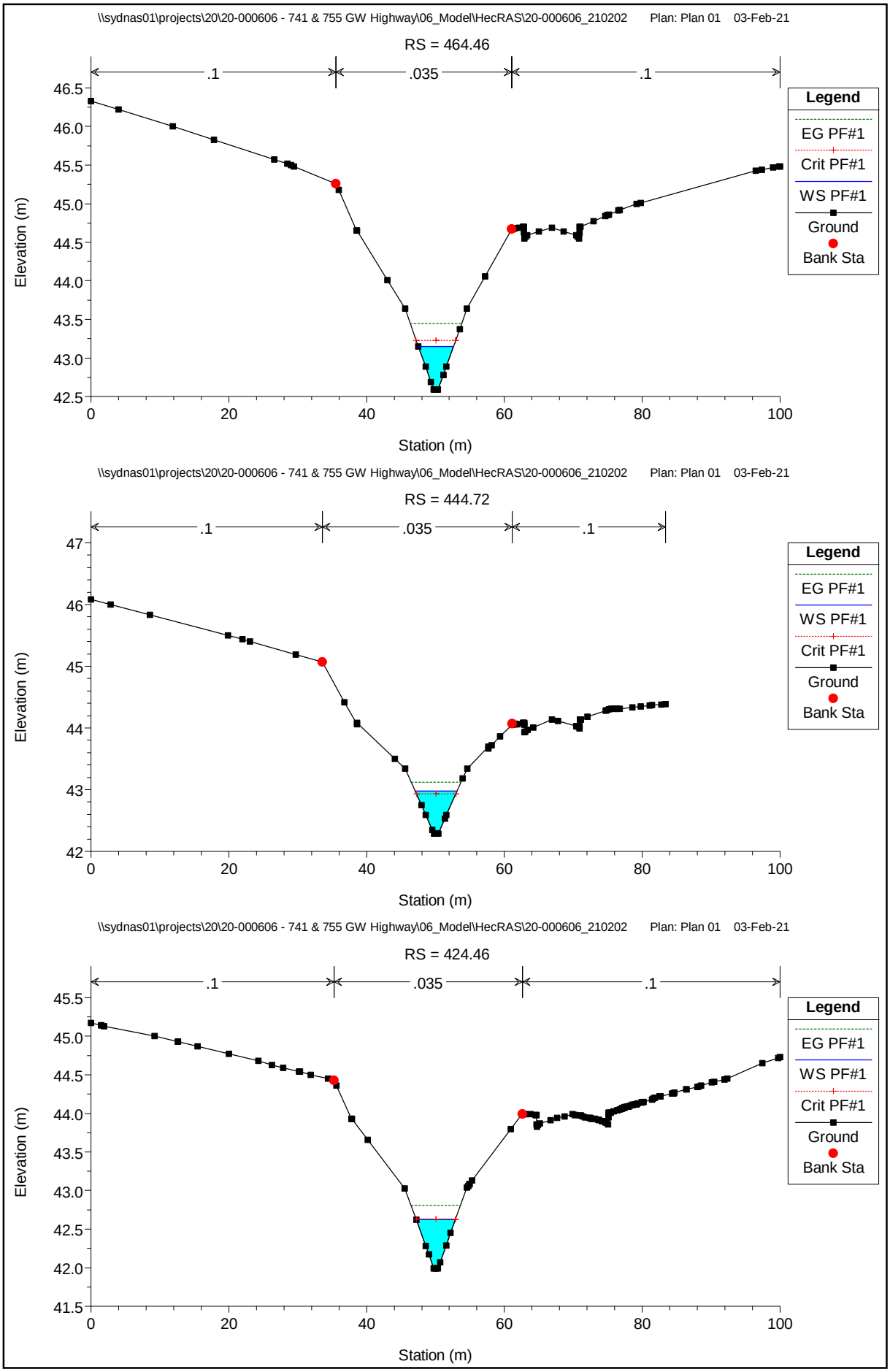
The results indicate that the water levels are contained within the channel and that the subdivision at Stage 4 will not result in an increase in flows which is consistent with Cardno's flows and Council's guidelines.

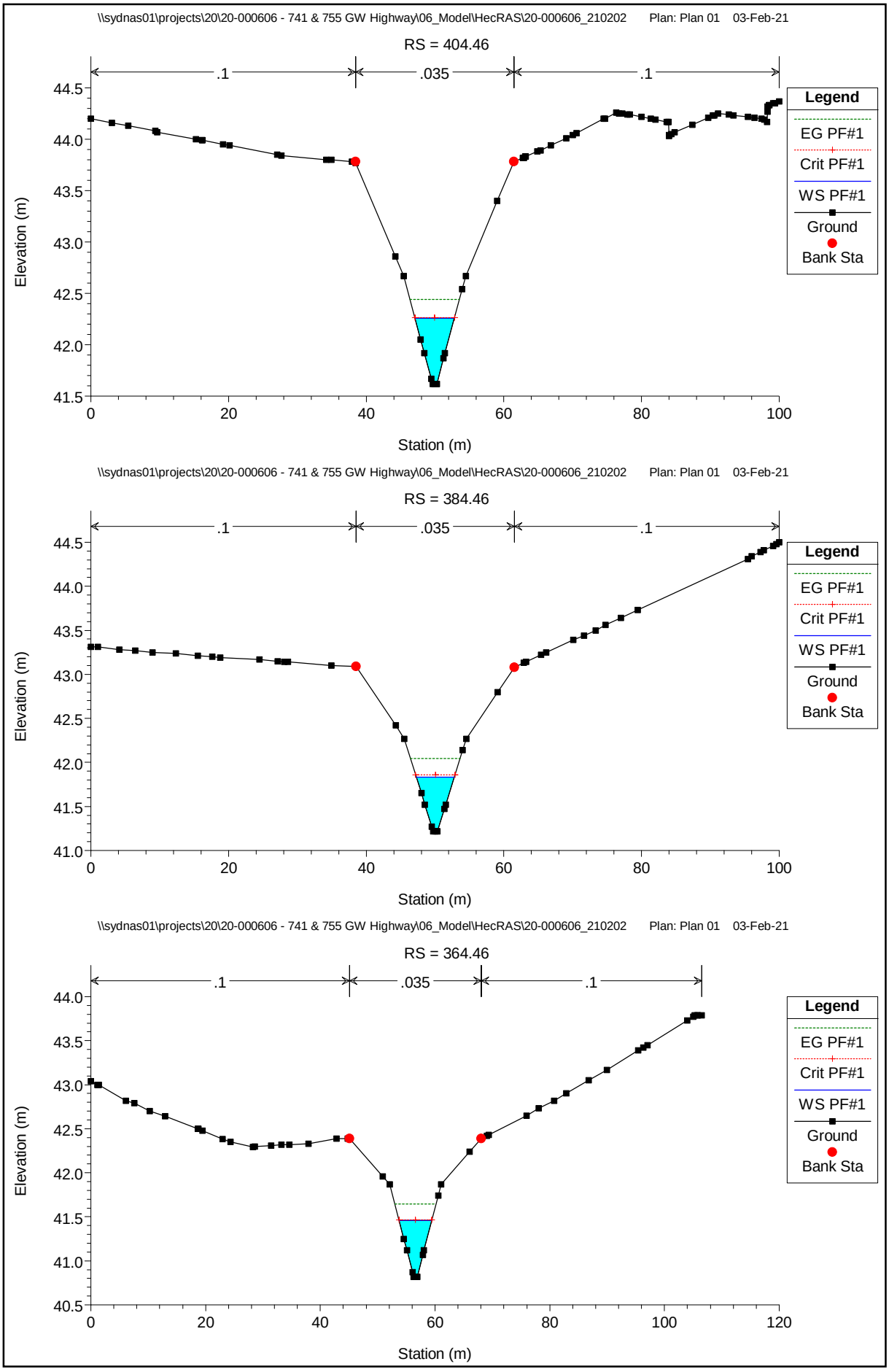
Yours sincerely
Calibre Professional Services Pty Ltd

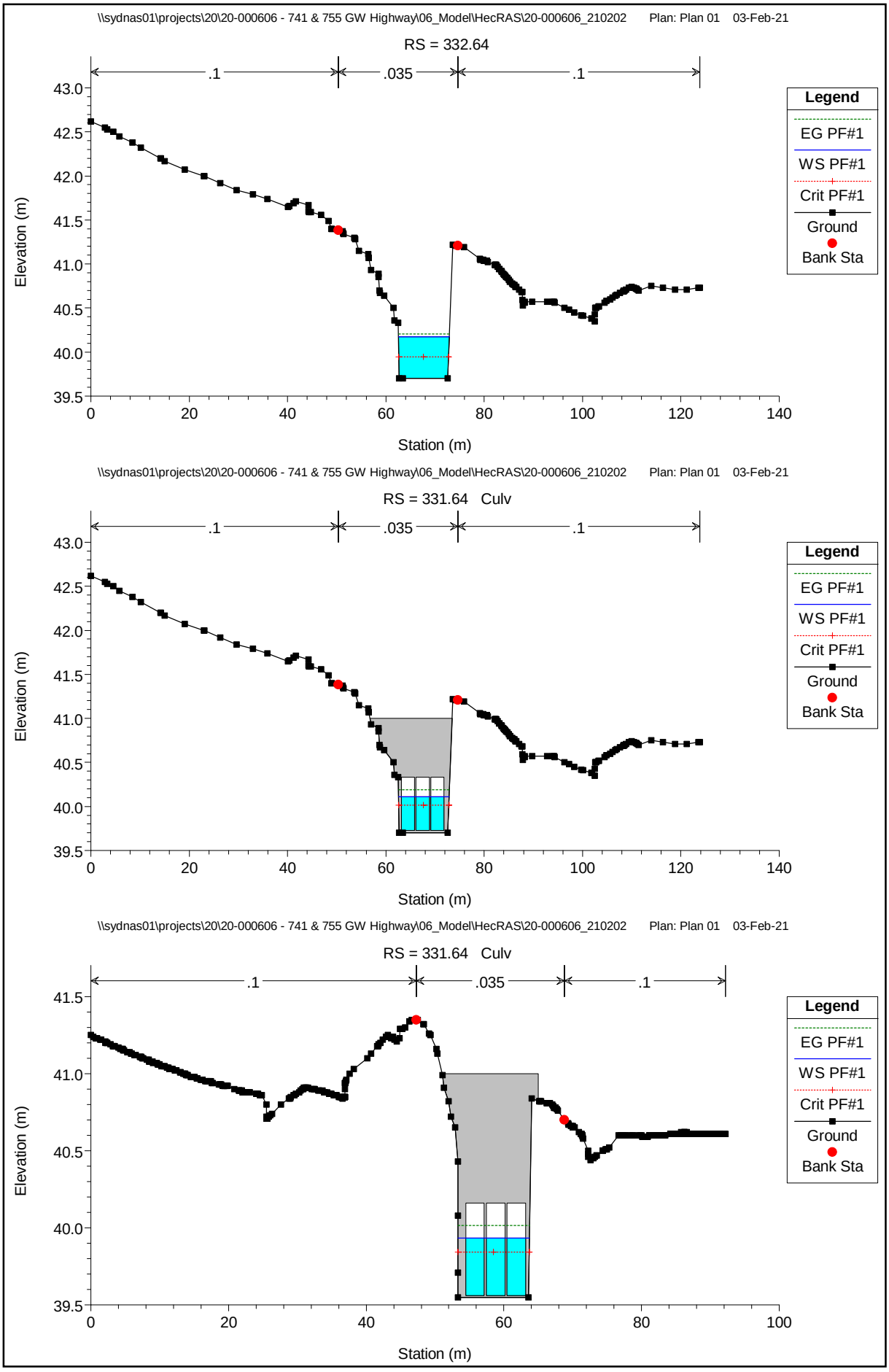
Troy Eyles
Principal Engineer – Water & Environment

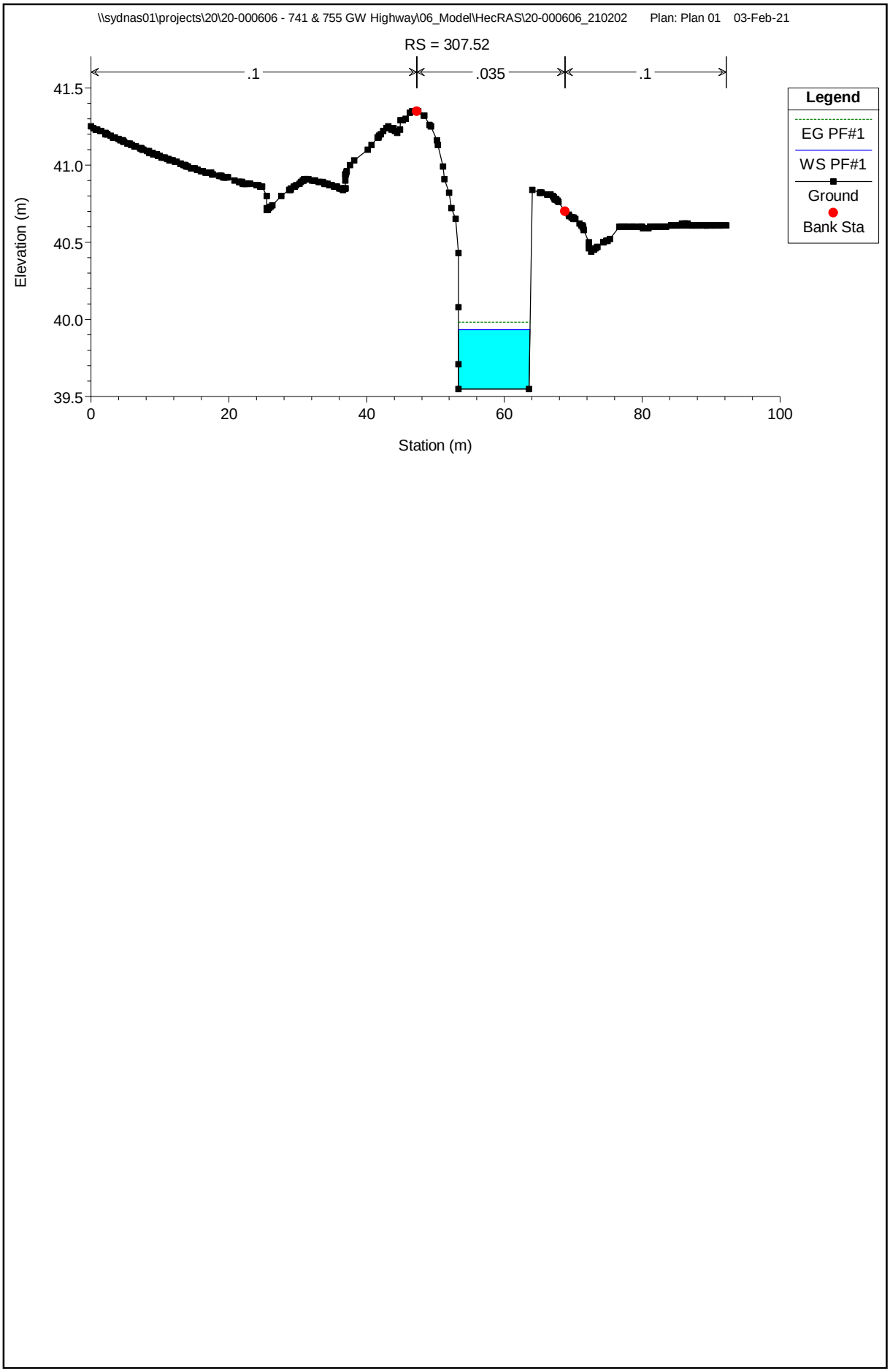
APPENDIX HEC-RAS CROSS SECTION OUTPUTS











APPENDIX TUFLOW FLOOD MAPPING

LEGEND

Flood Depth (m)

- 0.00 - 0.05 (nulled)
- 0.05 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

Drawing Title:
Existing Depth with 50mm Nulling

DRAWING NO: Fig 01

ISSUE: 01

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	09/05/21	-

EPSG:28356

J:\20\20-000606 - 741 & 755 GW Highway\06_Model\GIS\Tuflow

EPSG:28356

P:\20\20-000606 - 741 & 755 GW Highway\06_Model\GIS\Tuflow

calibre

LEGEND

Velocity (m/sec)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

DrawingTitle:
Existing Velocity with 50mm Nulling

DRAWINGNO: Fig 02

ISSUE: **01**

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	09/05/21	-

LEGEND

Flood Depth (m)

- 0.00 - 0.05 (nulled)
- 0.05 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

DrawingTitle:
Developed Depth with 50mm Nulling

DRAWINGNO: Fig 03

ISSUE: 01

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	26/05/21	-

EPSG:28356

P:\20\20-000606 - 741 & 755 GW Highway\06_Model\GIS\Tuflow

LEGEND

Velocity (m/sec)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

DrawingTitle:
Developed Velocity with 50mm Nulling

DRAWINGNO: Fig 04

ISSUE: **01**

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	26/05/21	-

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EPSG:28356

LEGEND

Flood Afflux (m)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.015
- -0.015 - 0.00
- 0.00 - 0.015
- 0.015 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

DrawingTitle:
Developed Flood Afflux with 50mm Nulling

DRAWINGNO: Fig 05

ISSUE: 01

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	26/05/21	-

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LEGEND

Flood Change

- Areas Now Flood Free
- Areas Unchanged
- Areas Now Flooded

NOTES:

-

20 0 20 40 60 m

1:2500 (A3)

N

PROJECT:
20-000606 - 741 & 755 Great Western Highway, Werrington

CLIENT:
State Wide Planning Pty Ltd

DrawingTitle:
Flood Change areas

DRAWINGNO: Fig 06

ISSUE: 01

ISS	BY	CHK	DATE	DETAILS
01	DKH	-	26/05/21	-

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EPSG:28356