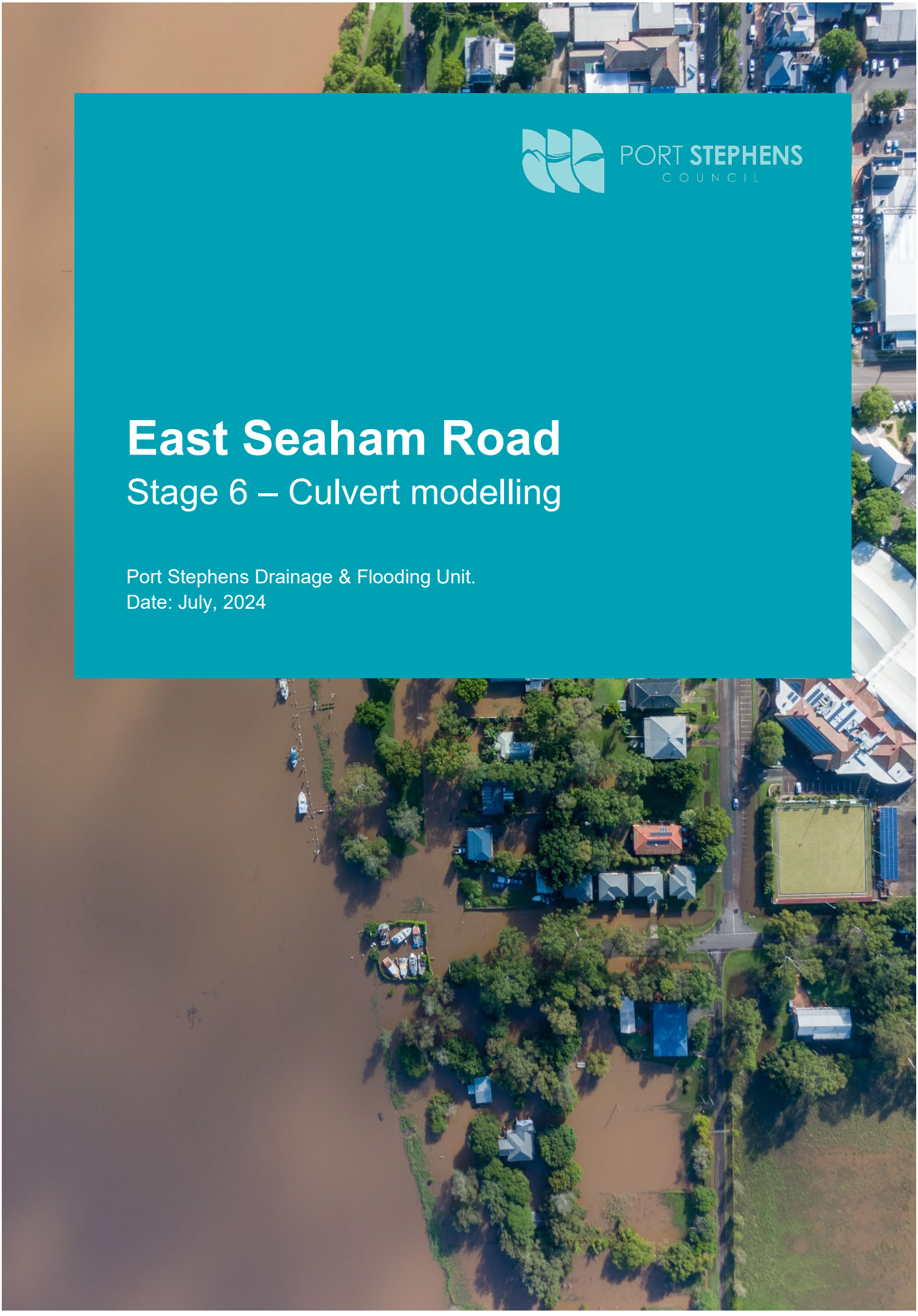

PORT STEPHENS COUNCIL

East Seaham Road

Stage 6 – Culvert modelling

Port Stephens Drainage & Flooding Unit.
Date: July, 2024

Document Control Sheet

Project title: East Seaham Road – Stage 6 – Culvert Modelling

Project number: DF024

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Author: Tully Walker

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1	July 2024	Drainage Concept design	X
X	X	X	X
X	X	X	X

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1. Introduction

This report has been prepared to investigate the drainage along the East Seaham Road Stage 6 road reconstruction project and provide recommendations for suitable culvert crossing upgrades.

2. Background

Port Stephens Council is planning road upgrades to a length of East Seaham Road within the Suburb of East Seaham. The approximate location of the stage 6 road upgrades are shown in **Figures 01**. The stage 6 project area extends to the northern boundary of the Port Stephens local government area and adjoins the recently designed stage 5 road and drainage upgrades as, demonstrated in **Figure 02**.

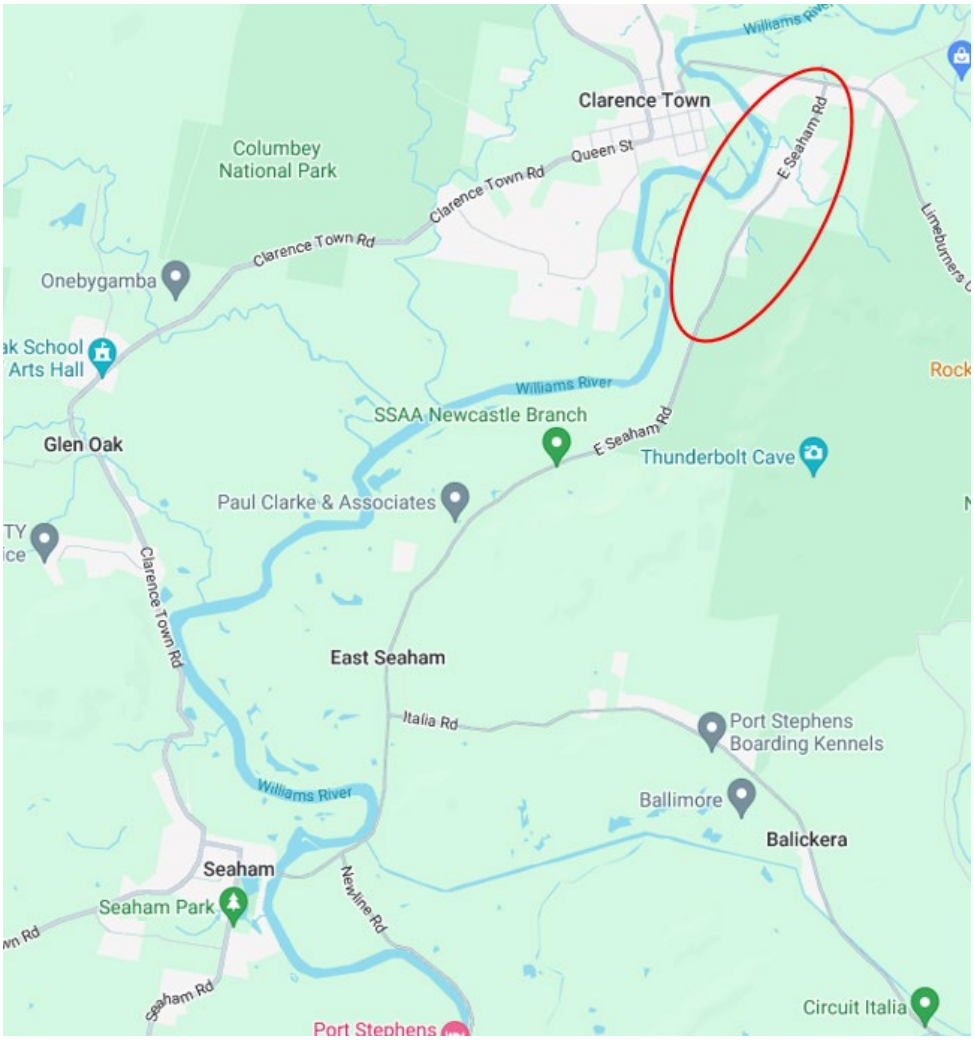


Figure 1 - East Seaham Road Stage works area

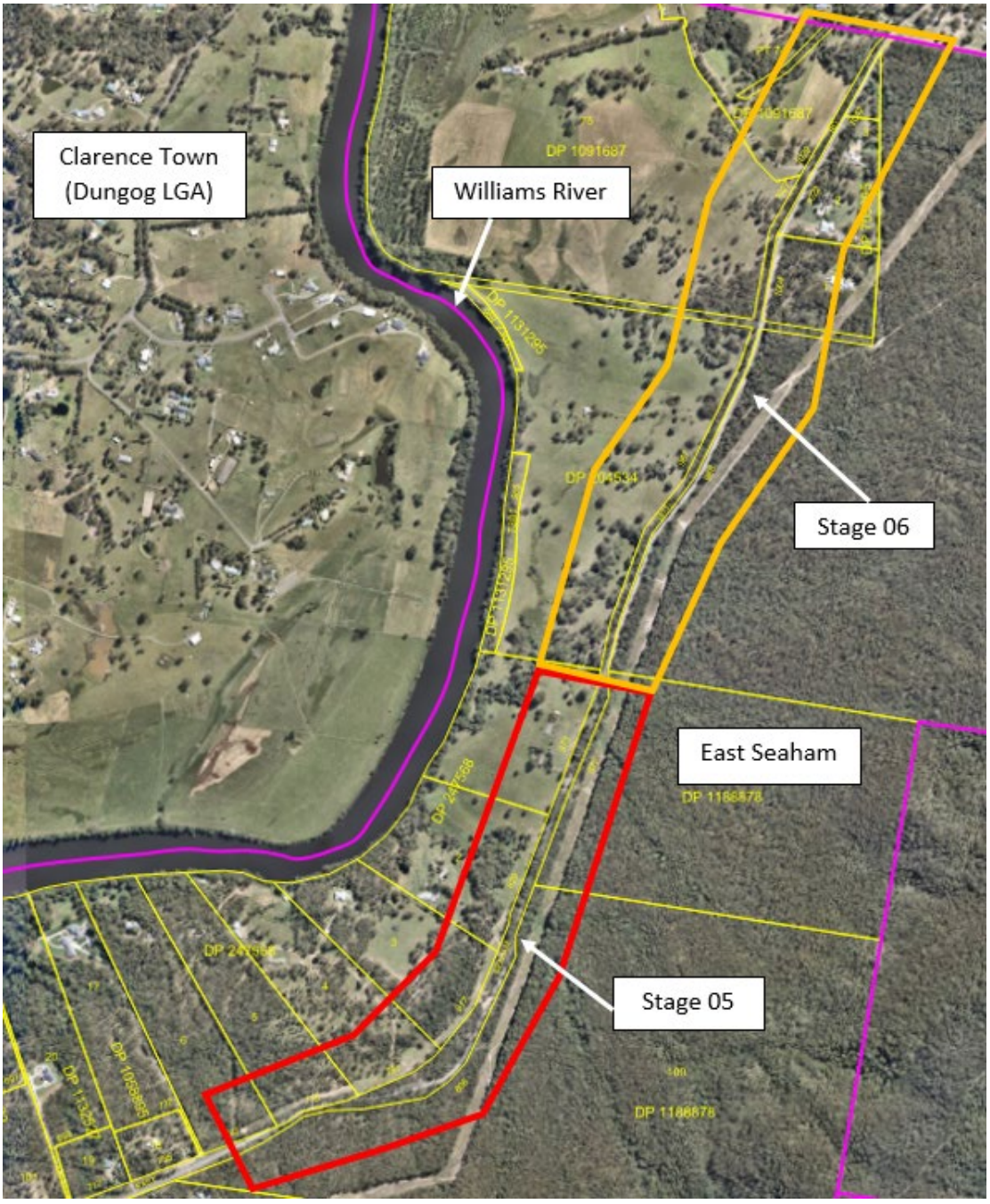


Figure 2 - East Seaham Road project stages

The stage 5 drainage investigation was completed by the engineering consultant Barker Ryan Stewart (BRS). The Stage 5 drainage recommendations were detailed in the report titled *Drainage report – East Seaham Road Stage 5*, dated August 2018 (project no HU170024).

2.1 Catchments and Drainage Infrastructure

East Seaham Road generally runs parallel to the Williams River. The stage 6 works area is rural in nature with rural riverfront properties to the west of the road and a large area of National Park to the east. The landform generally slopes from east to west. A catchment map with approximate flowpaths has been prepared for the stage 6 works extent as presented in **Figure 3**.

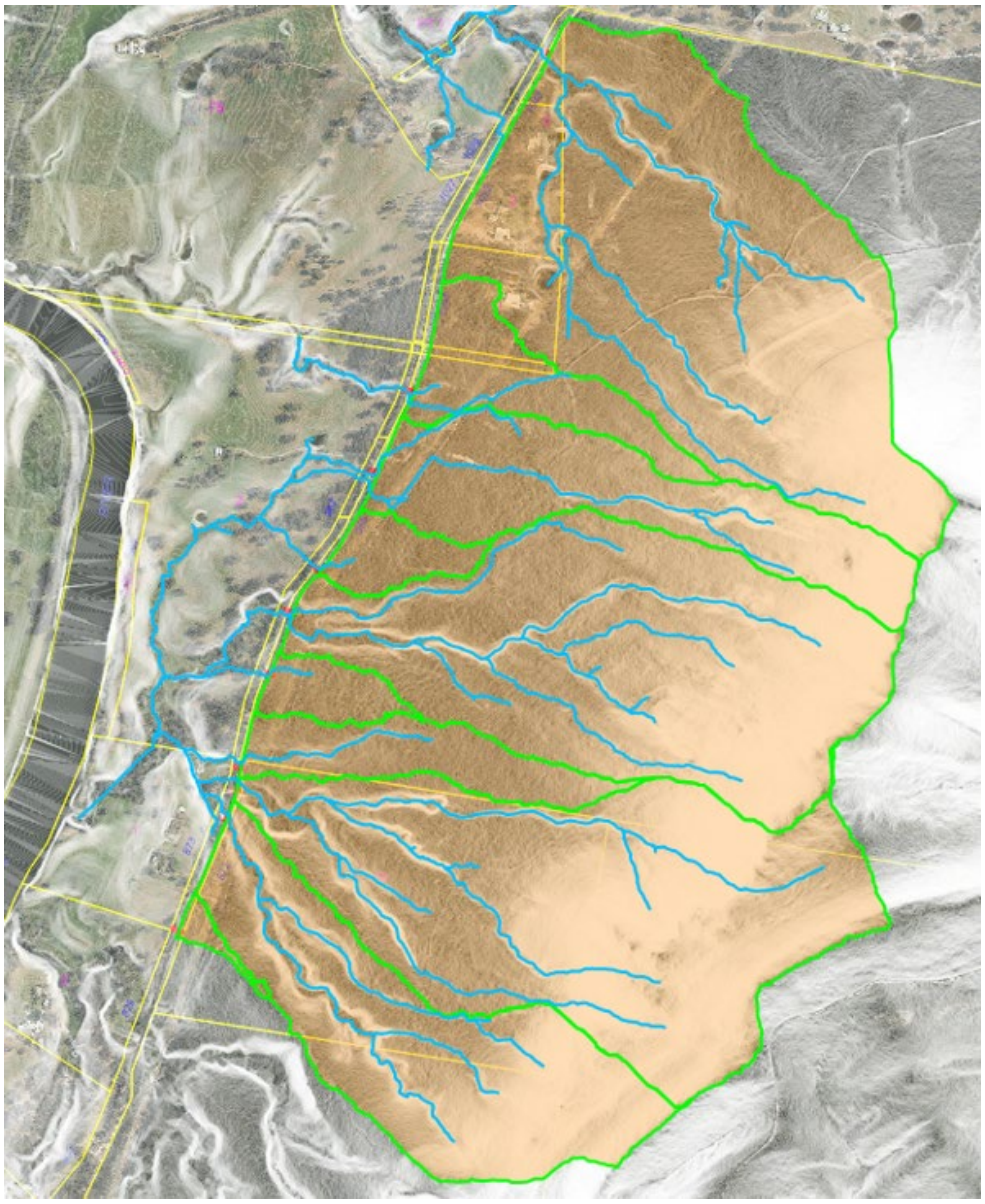


Figure 3 - Catchment and flowpaths

The land to the east of East Seaham Road is mountainous with steep slopes at the upper reaches of the catchment. There are multiple valleys along the extent of East Seaham Road where runoff would form a flowapth. These valleys generally coincide with existing culvert crossing.

A total catchment of approximately 220ha was determined to contribute to various locations along the stage 6 works extent. Sub-catchment areas were delineated based on the landform contributing to runoff at each existing culvert crossing. These catchments have been labelled 1 to 10 as demonstrated in **Figure 4.**

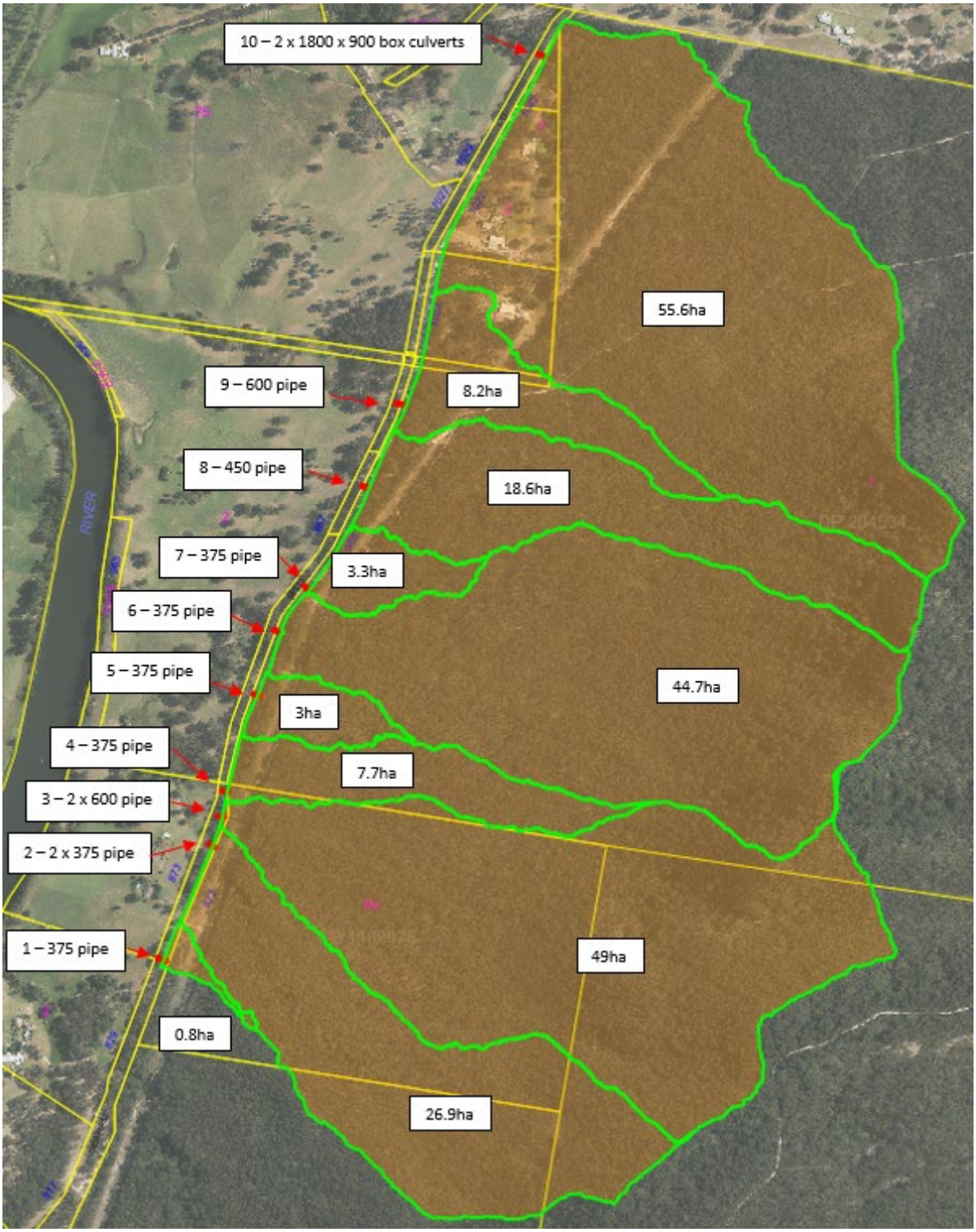


Figure 4 - Catchment areas and culvert crossing details

2.2 Regional Flooding

Flooding of the Williams River impacts East Seaham Road at a number of locations. **Figure 5** shows the Flood Planning Area (FPA) and Probable Maximum Flood (PMF) that impacts the project area.

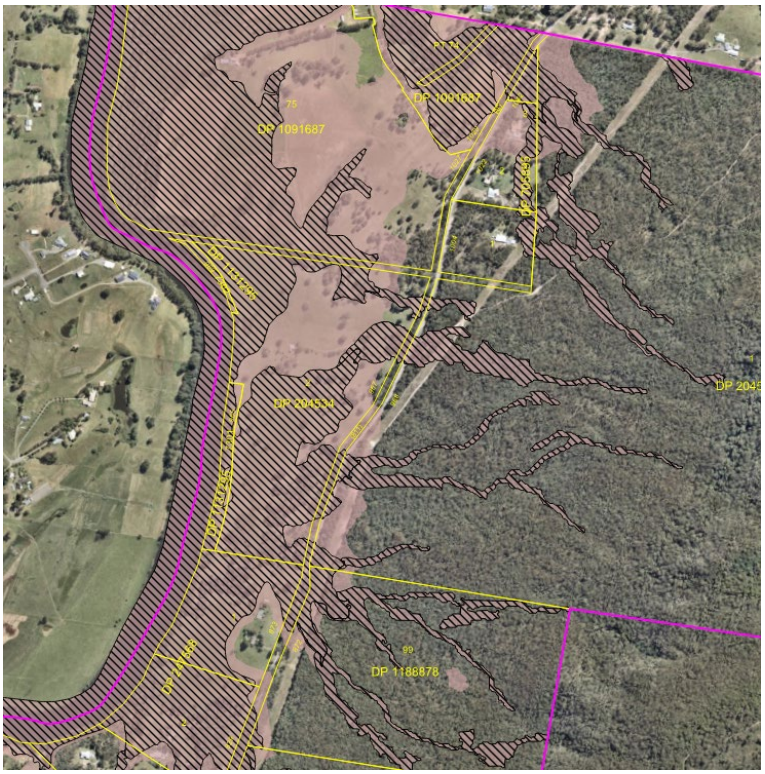


Figure 5 – Flood impacts

Table 1 outlines the impact of the Williams River flooding on the existing road at the ten culvert locations. The section of road around culverts 2, 3 and 4 is relatively low and is inundated during the 5% AEP event to a depth over 0.5m.

Table 1 - Regional flood level impacts

					Regional Flood Data - Williams River					
Catchnent no.	Culvert Type	Culvert Size (mm)	No. Conduits	Approx. road surface level - from ALS contours (m AHD)	5% AEP level	1% AEP level	1% AEP (2100) level	5% AEP depth over road (m)	1% AEP depth over road (m)	1% AEP (2100) depth over road (m)
1	RCP	375	1	10.4	6.3	7.5	7.8	0.0	0.0	0.0
2	RCP	375	2	5.8	6.4	7.5	7.9	0.6	1.7	2.1
3	RCP	600	2	5.7	6.4	7.5	7.9	0.7	1.8	2.2
4	RCP	375	1	5.6	6.4	7.5	7.9	0.8	1.9	2.3
5	RCP	375	1	7.8	6.4	7.5	7.9	0.0	0.0	0.1
6	RCP	375	1	8.1	6.4	7.5	7.9	0.0	0.0	0.0
7	RCP	375	1	10.8	6.4	7.5	7.9	0.0	0.0	0.0
8	RCP	450	1	12.8	6.4	7.5	7.9	0.0	0.0	0.0
9	RCP	600	1	13.9	6.6	7.8	8.2	0.0	0.0	0.0
10	RCBC	1850H x 900V	2	7.4	7.0	8.3	8.7	0.0	0.9	1.3

3. Drainage Investigations

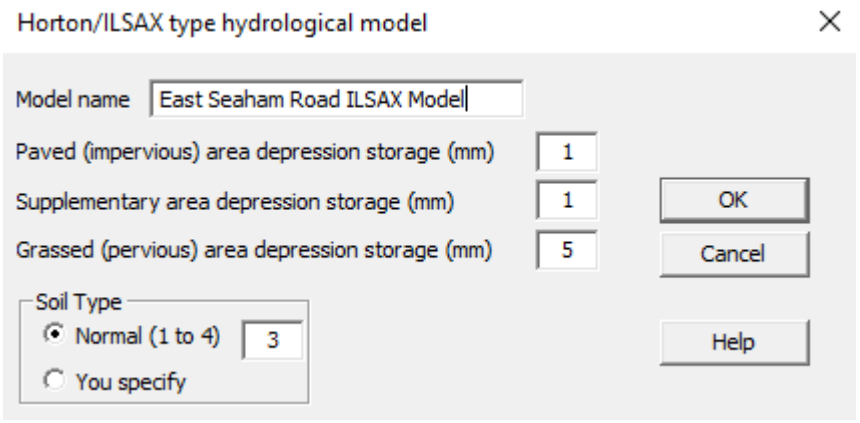
3.1 Model Setup

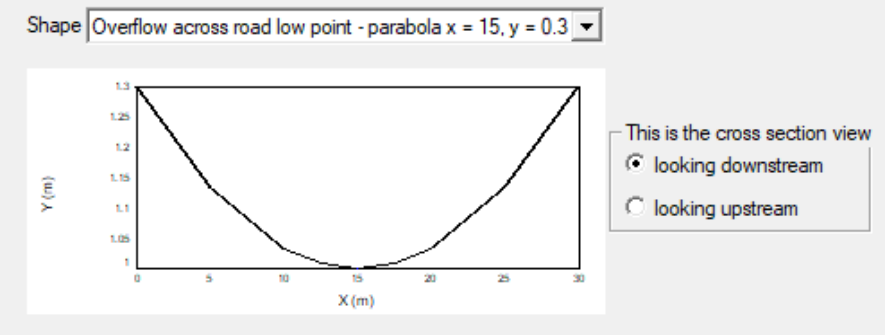
The DRAINS modelling software by Watercom has been utilised to model the drainage along East Seaham Road Stage 6.

Table 02 outlines the DRAINS model inputs and assumptions that have been adopted.

Appendix A includes the survey data that was used to inform the modelling.

Table 2 - DRAINS input parameters

Parameter	Comment/Value
Rainfall	Rainfall ensembles for the local area have been sourced from the Australian Rainfall and Runoff (AR&R) Data Hub and Bureau of Meteorology websites. An AMC value of 3 has been adopted to mimic pre-wetted ground conditions.
Losses	The ILSAX loss model has adopted with values consistent with the East Seaham Stage 5 DRAINs modelling. The ILSAX parameters used are as follows; 
Catchment data	GIS software has been used to define local catchments as shown in Section 2.1. Survey data, ALS contour data (from 2013), aerial imagery, and property cadaster were all used to define catchment areas. Catchments have been modelled as 100% pervious. Times of concentration were estimated based on the *Stream Velocity Method* as outlined in section 4.6.11 of the Queensland Urban Drainage Manual (QUDM). This methodology estimates times of concentration for catchments from 5 to100km in size and

	is based on an 'assumed' average stream velocity for different catchment types and slopes. The times of concentration were adjusted (factored up by approximately one third) to resemble similar critical storm results as were obtained for the stage 5 East Seaham Road DRAINS modelling. This increase in time is reasonable given the highly vegetated natural catchment (ie high roughness) that would likely slow catchment runoff times.
Pit, pipe and overland flow data	Existing pit and pipe asset data has been modelled based on a combination of survey data, Councils asset database and GIS data. Overland flow road crossings at the culvert locations have been modelled as a simplified parabola as per the following cross section. 

3.2 Existing Drainage results

The existing drainage results for the 5% and 1% AEP are included in **Table 3**.

Table 3 - Existing model results

Existing Model Results				5% AEP			1% AEP		
Catchment	Area (ha)	Pipe Size (mm)	No. Pipes	Flow arriving at culvert (m3/s)	Culvert Conveyance (m3/s)	Bypass Flow (m3/s)	Flow arriving at culvert (m3/s)	Culvert Conveyance (m3/s)	Bypass Flow (m3/s)
1	0.8	375	1	0.336	0.214	0.12	0.511	0.218	0.295
2	26.9	375	2	6.35	0.642	5.71	9.67	0.667	9.01
3	49.0	600	2	10.3	1.38	8.97	16.1	1.48	14.7
4	7.7	375	1	1.99	0.233	1.76	3.06	0.241	2.82
5	3.0	375	1	1.14	0.21	0.919	1.76	0.216	1.55
6	44.7	375	1	9.44	0.258	9.2	14.7	0.277	14.5
7	3.3	375	1	1.21	0.274	0.937	1.87	0.283	1.59
8	18.6	450	1	4.28	0.631	3.65	6.45	0.657	5.8
9	8.1	600	1	2.19	0.632	1.56	3.38	0.651	2.74
10	55.6	1850H x 900V	2	11	8.24	2.8	16.9	8.88	8

As is evident from Table 3, all existing drainage assets are unable to fully convey either the 5% or 1% AEP events. DRAINS schematic results for the existing model are included in **Appendix A**.

3.3 Proposed Drainage Upgrades

Given the constrained nature of the existing culvert assets along East Seaham Road, it's suggested that culvert upgrades are implemented as part of the Stage 6 road works.

Culvert crossing upgrades have been investigated to achieve a similar design standard as was ultimately achieved for the Stage 5 works area, that is;

- Convey the 5% AEP local flood event without overtopping
- 1% AEP surface water flow over East Seaham Road is to be considered safe (VD < 0.4 and depth below 200mm).

The existing DRAINS model was used as a base model to iteratively determine culvert upgrades that would achieve the performance criteria.

Given that final road design is yet to be completed, a number of assumptions were required in order to conceptually model the culvert requirements. These assumptions include;

- It's assumed that localised roadside drainage (swales etc) will divert the upstream catchment to the culvert crossing location.
- Following discussions with Councils design team, the existing culvert locations 2, 3 and 4 could be combined into a singular larger crossing location. Hence, these catchments have been combined together when considering concept design. See **Figure 6** overleaf.
- Finished road heights at crossing locations were generally estimated based on the upstream existing culvert invert level plus the proposed upgraded culvert size and 500mm cover.
- Culvert sizes were kept below 1200mm in height to minimise the requirement to significantly raise road segments.
- Road overflow cross sections have been modelled in DRAINS as a simplified parabola (similar to existing model assumptions)
- Catchments have been modelled with 'free outflow' tailwater conditions (ie assuming local catchment flooding only with low Williams River flood levels)

It's expected that the modelling will need to be adjusted as the road design progresses and finished road surface levels, culvert invert levels, roadside drainage details etc are firmed up.

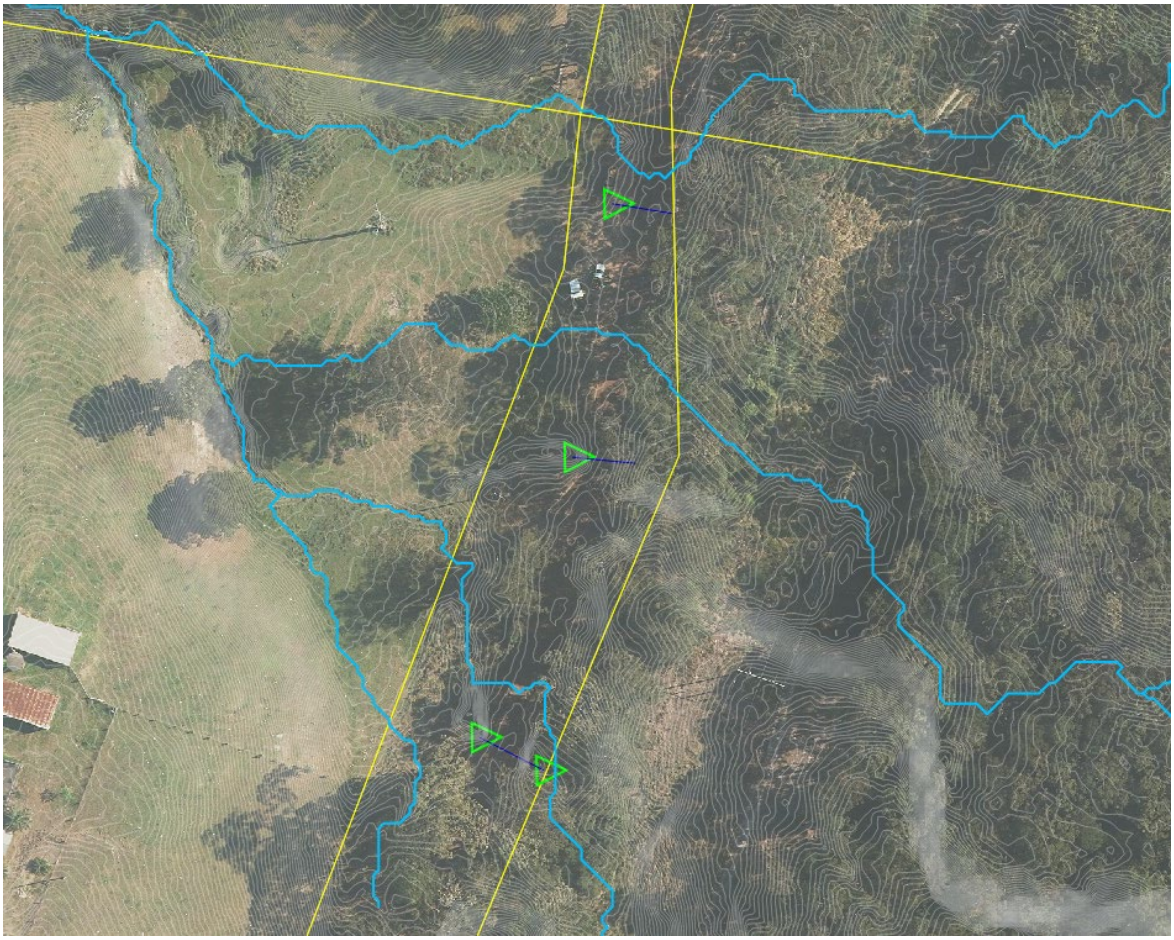


Figure 6 - Existing culverts 2, 3 and 4

4. Results and Discussion

Figure 7 demonstrates the proposed conceptual culvert upgrades required to safely cater for the local catchment flows up to the 1% AEP event.

Tables 4 and 5 demonstrate the DRAINS modelling results for the 5% and 1% AEP events respectively.

DRAINS schematic results for the conceptual upgrades are included in **Appendix C**.

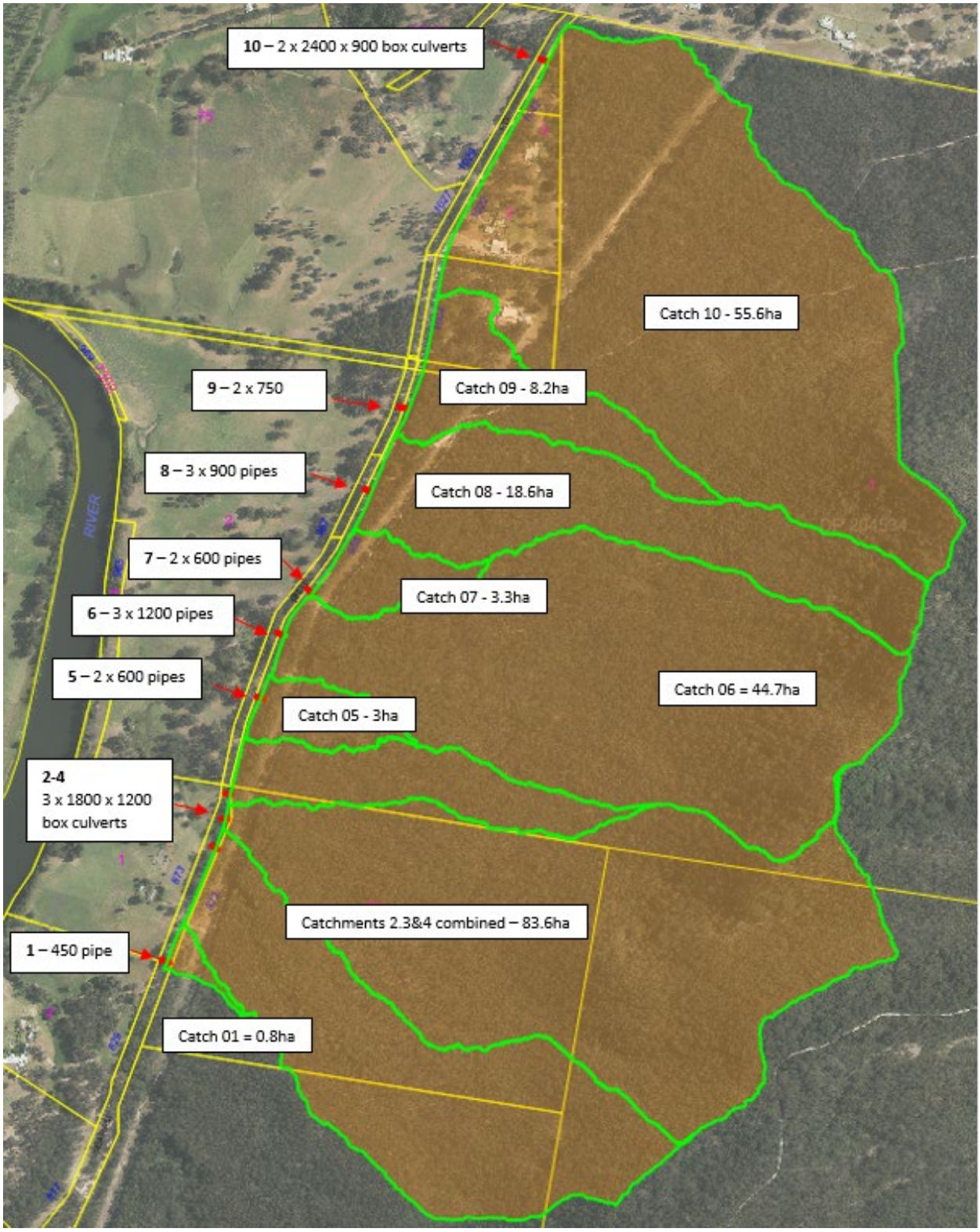


Figure 7 - Conceptual culvert upgrade requirements

Table 4 - Conceptual culvert upgrades - 5% AEP

Developed Option 01 - Model Results				5% AEP			
Catchment	Area (ha)	Pipe Size (mm)	No. Pipes	Flow arriving at culvert (m3/s)	Culvert Conveyance (m3/s)	Bypass Flow (m3/s)	Median critical Storm
1	0.8	450	1	0.318	0.318	0	15min stm5
2 to 4	83.6	1800 x 1200	3	16.5	16.5	0	30min stm10
5	3.0	600	2	1.11	1.11	0	10min stm7
6	44.7	1200	3	8.84	8.82	0	30min stm10
7	3.3	600	2	1.15	1.14	0	10min stm7
8	18.6	900	3	4.04	4.03	0	30min stm8
9	8.1	750	2	2.13	2.12	0	20min stm9
10	55.6	2400 X 900	2	9.8	9.79	0	30min stm5

Table 5 - Conceptual culvert upgrades - 1% AEP

Developed Option 01 - Model Results				1% AEP				
Catchment	Area (ha)	Pipe Size (mm)	No. Pipes	Flow arriving at culvert (m3/s)	Culvert Conveyance (m3/s)	Bypass Flow (m3/s)	Bypass Flow VD	Median critical Storm
1	0.8	450	1	0.466	0.345	0.12	0.02	10min stm1
2 to 4	83.6	1800 x 1200	3	26.1	20	6.09	0.38	30min stm9
5	3.0	600	2	1.67	1.28	0.397	0.05	10min stm1
6	44.7	1200	3	13.9	9.75	4.19	0.29	30min stm9
7	3.3	600	2	1.81	1.28	0.526	0.06	10min stm7
8	18.6	900	3	6.32	4.88	1.44	0.13	25min stm6
9	8.1	750	2	3.33	2.28	1.05	0.1	20min stm2
10	55.6	2400 X 900	2	16.1	12.1	4.04	0.28	30min stm9

As is evident from Tables 4 and 5, the proposed culvert upgrades are able to convey the 5% AEP event without the road overtopping. Furthermore, overland flow during the 1% AEP event is maintained to a safe velocity depth product.

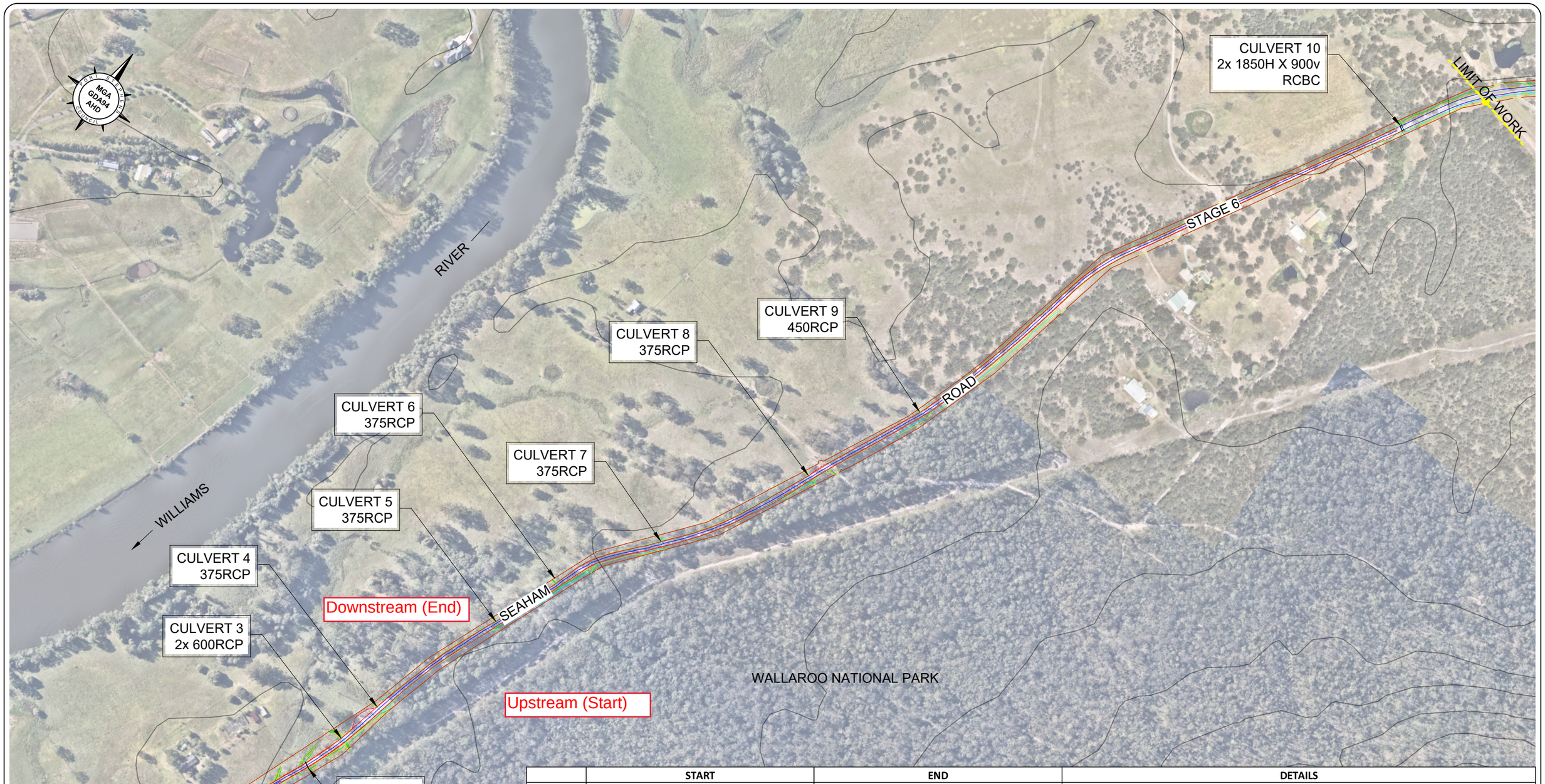
Its noted that the size, type and number of conduits are conceptual only and will likely need to be altered as the road design progresses and important details such as finished road heights are realised.

With respect to regional flood impacts, it's noted that the Williams River 5% AEP event inundates the existing low section of East Seaham Road around existing culverts 2, 3 and 4. This part of the road would need to be raised by over 0.5m to be flood free in a 5% AEP event and by 2m to be flood free in a regional 1% AEP event.

Depending on the final road design, it may be beneficial to conduct a sensitivity model run with the 5% AEP regional tailwater level adopted for the 1% AEP local catchment simulation (specifically for existing low culvert locations 2, 3, and 4 which are inundated by the Williams River 5% AEP).

Appendix A

Survey Data



	START				END				DETAILS					
Culvert No.	PT No.	EASTING	NORTHING	HEIGHT	PT No.2	EASTING3	NORTHING4	HEIGHT5	DESC.6	LENGTH	GRADE	SIZE	TYPE	NOTES
1	564	385687.24	6391036.343	9.61					PIPED	?	?	375	RCP	END OF PIPE COULD NOT BE LOCATED
2	5497	385770.832	6391255.941	4.454	5460	385779.709	6391251.499	4.431	PIPED	9.9263535	-0.00232	375	RCP	PARTIALLY BLOCKED
2	5496	385771.104	6391256.461	4.461	5461	385779.97	6391252.012	4.429	PIPED	9.9196551	-0.00323	375	RCP	PARTIALLY BLOCKED
3	6127	385799.1	6391307.348	4.7814	6129	385789.2305	6391309.158	4.6714	PIPEG	10.034044	-0.01096	600	RCP	PARTIALLY BLOCKED
3	6128	385799.349	6391309.047	4.7541	6130	385789.4803	6391310.451	4.6908	PIPEG	9.9681704	-0.00635	600	RCP	BLOCKED
4	6245	385810.42	6391368.282	4.8108	6244	385801.126	6391370.014	4.688	PIPED	9.4539411	-0.01299	375	RCP	PARTIALLY BLOCKED
5	6610	385865.544	6391549.189	7.08	6611	385858.4537	6391551.734	6.9166	PIPED	7.533549	-0.02169	375	RCP	PARTIALLY BLOCKED
6	6853	385897.888	6391636.534	7.4436	6852	385890.8258	6391638.132	7.3827	PIPED	7.2410204	-0.00841	375	RCP	PARTIALLY BLOCKED
7	7227	385974.658	6391758.458	10.1566	7228	385967.0368	6391764.441	10.1009	PIPED	9.6891613	-0.00575	375	RCP	PARTIALLY BLOCKED
8	7679	386076.142	6391944.957	11.9352	7680	386069.3537	6391947.696	11.882	PIPED	7.3200683	-0.00727	375	RCP	PARTIALLY BLOCKED
9	8065	386143.93	6392098.331	12.9215	8064	386134.7586	6392101.839	12.8085	PIPEE	9.8191706	-0.01151	450	RCP	BLOCKED
10	9550	386418.512	6392771.84	6.1643	9548	386409.8448	6392776.553	6.0544	BOXH	9.8653357	-0.01114	1850H x 900V	RCBC	CL OF RCBC
10	9551	386419.423	6392773.517	6.1753	9549	386410.847	6392778.323	6.0648	BOXH	9.830442	-0.01124	1850H x 900V	RCBC	CL OF RCBC

DATUM : MGA56
A.H.D. : GDA94

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DESIGNED : –
CHECKED : –

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DIMENSIONS AND SETTING OUT: REDUCED LEVELS AND CHAINAGES ARE IN METRES, ALL OTHER DIMENSIONS ARE IN MILLIMETRES. SETOUT DIMENSIONS ON THE DRAWINGS SHALL BE VERIFIED ON SITE. DIMENSIONS SHALL NOT BE OBTAINED BY SCALING THE DRAWINGS.

Date	Amendment	Rev	Officer

PORT STEPHENS COUNCIL

Project:
East Seaham Road Stage 6
East Seaham

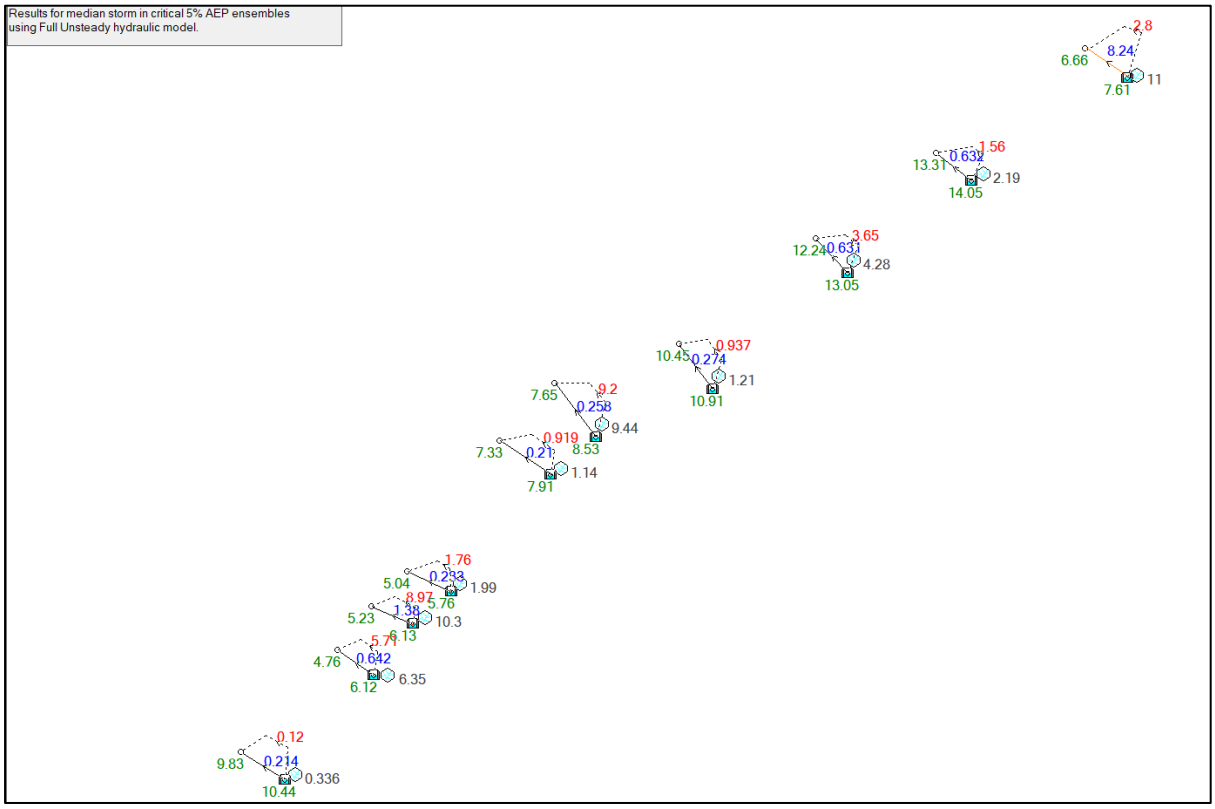
Drawing Title:
Culvert Details

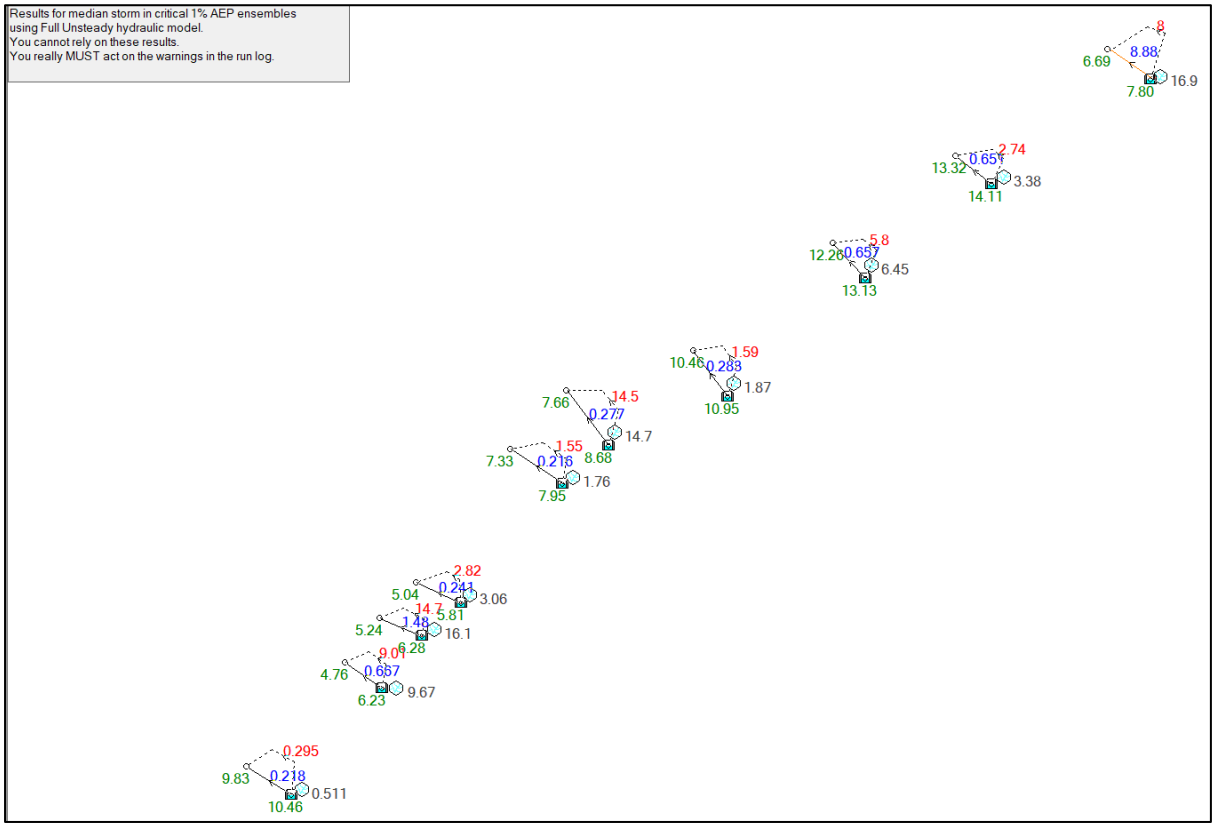
EDRMS No:

Revision: 0
Sheet No: 1 of 1
Date: 25/10/2023
Sheet Size: A1

Appendix B

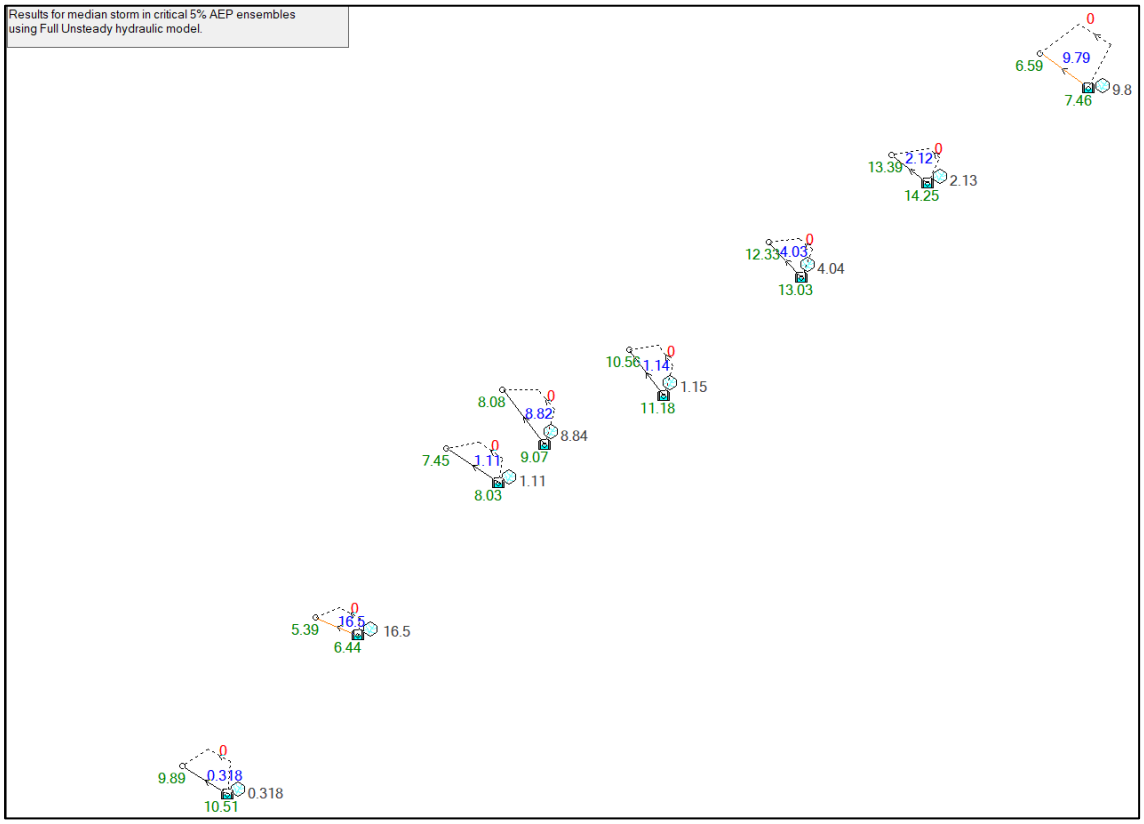
DRAINS results – Existing Model (5% and 1% AEP)

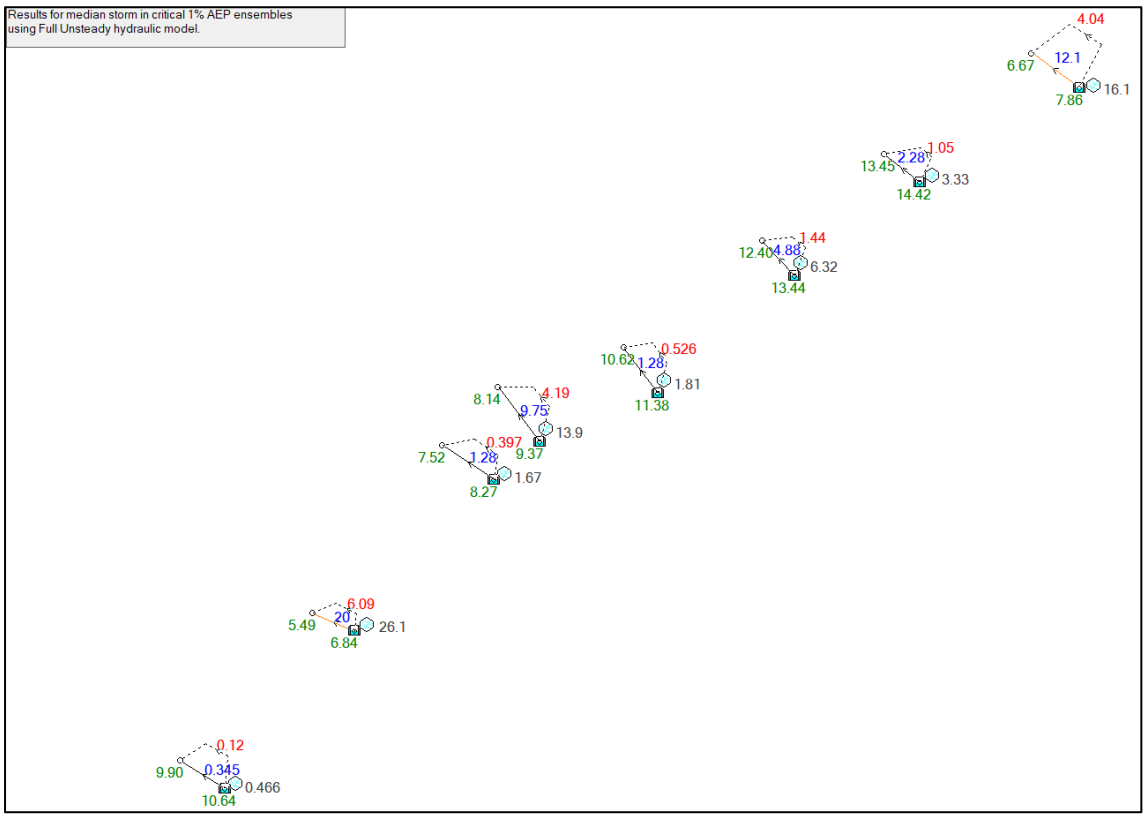




Appendix C

DRAINS results – Conceptual Culvert Upgrades (5% and 1% AEP)





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