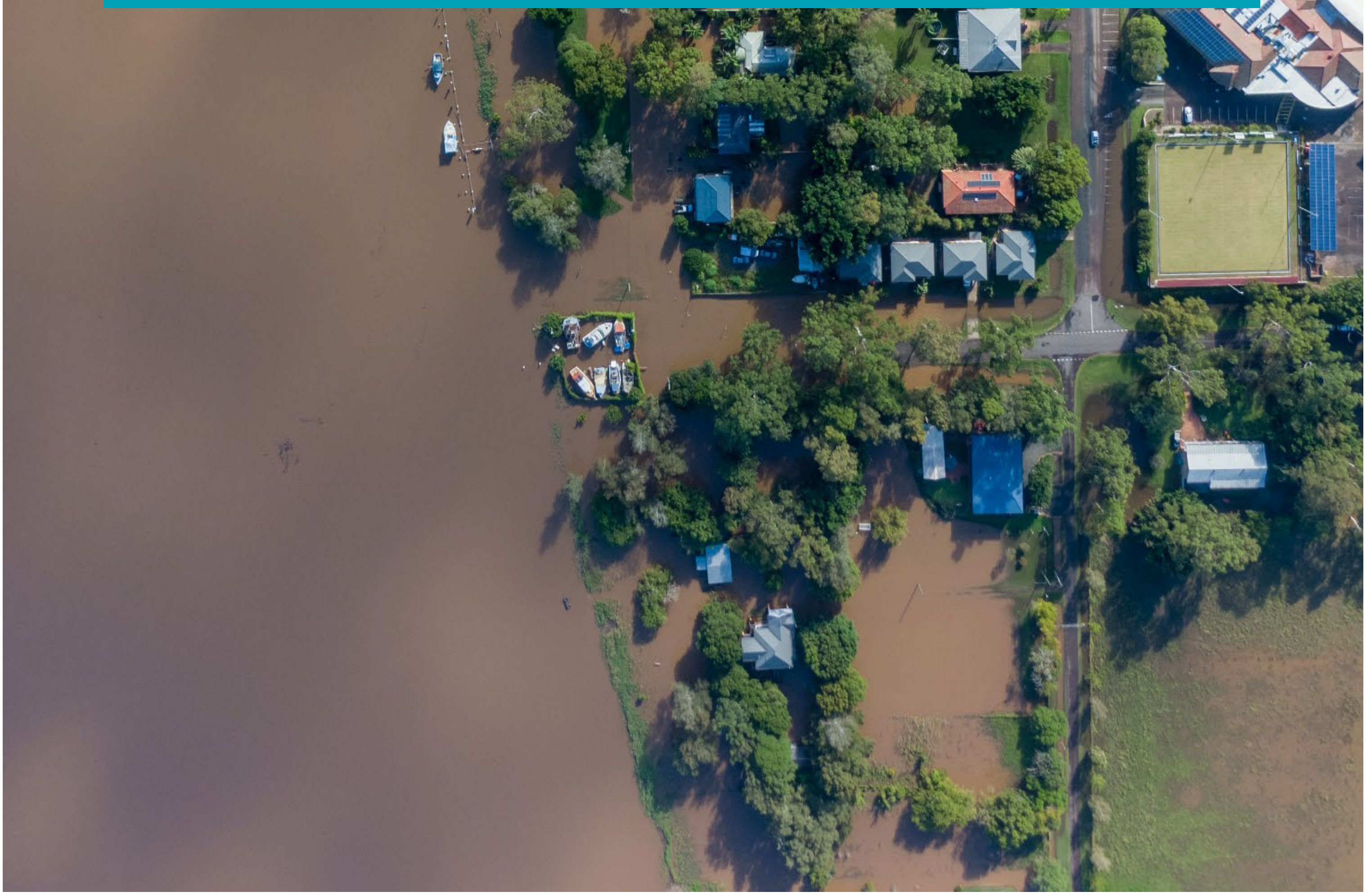
PORT STEPHENS COUNCIL

East Seaham Road

Addendum to Stage 6 Culvert Modelling – Regular Event Modelling and Water Quality Analysis

Port Stephens Drainage & Flooding Unit.
Date: Feb, 2025



Document Control Sheet

Project title: East Seaham Road –Addendum to Stage 6 Culvert Modelling – Small Regular Event Modelling and Water Quality Analysis

Project number: DF024

Revision: Rev1

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Author: Tully Walker

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1	Feb 2025	Modelling	X
X	X	X	X
X	X	X	X

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1. Introduction

This report has been prepared to address the following objectives for East Seaham Road (Stages 5 and 6):

- Undertake DRAINS modelling for the 1yr, 2yr, 5 yr and 10yr ARI events to address the flow changes during smaller events.

- Undertake MUSIC modelling to determine the pollutant load changes.

For further details about the project background and drainage modelling refer to report DF024 *East Seaham Road – Stage 6 – Culvert Modelling* by Port Stephens Council (July 2024) and *Drainage Report – East Seaham Road Stage 5* by BRS (August 2018).

2. Small Event Modelling

2.1 Stage 5

BRS designed the drainage culverts for the East Seaham Road Stage 5 area. Port Stephens Council was provided the developed DRAINS model which reflects the modelling conducted to size the culvert upgrades. However, the pre-developed DRAINS model was not available. To enable the determination of existing flows, the developed model was adjusted to reflect the existing pipe configurations as per **Figure 01** below (extracted from the BRS Stage 5 drainage report).

Modelling adjustments included;

- Culvert sizes and number of units were changed to reflect existing conditions
- Culvert upstream and downstream invert levels were adjusted to reflect assumption of 600mm cover from the modelled road surface (overflow level).

To ensure that the existing DRAINS model was simulating reasonable results, the existing 2% and 1% AEP modelling was compared to the figures in the BRS Stage 5 Drainage Report. This comparison resulted in similar flows which signifies that the amended BRS model appropriately reflects the existing conditions. See **Appendix A** for the DRAINS results comparison.

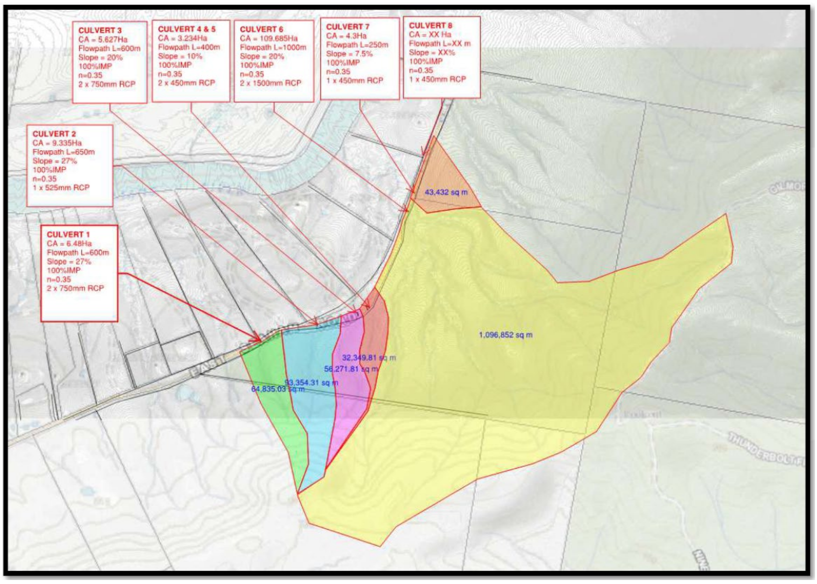


Figure 1 –Stage 5 existing modelling assumptions (*Drainage Report – East Seaham Road Stage 5,* BRS - August 2018)

The existing and developed DRAINS models were simulated for the regular storm events including the 1, 2, 5 and 10 year ARI events (1EY, 50% AEP, 20% AEP and 10% AEP).

Existing and developed flows for the Stage 5 culvert locations are displayed in **Figures 2 & 3**.

Stage 5 **BRS Modelling** Existing DRAINS model not available

* BRS existing model was not provided to Council. These flows were obtained by adjusting the developed model to replicate existing pipe sizes and cover adjusted to 600mm

Existing Model Results				1EY (1 year ARI)			50% AEP (2 year ARI)			20% AEP (5 year ARI)			10% 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)	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	6.5	750	2	0.112	0.112	0	0.203	0.203	0	0.553	0.553	0	0.889	0.889	0
2	9.3	525	1	0.156	0.156	0	0.28	0.28	0	0.761	0.628	0.256	1.19	0.619	0.9
3	5.6	750	2	0.089	0.089	0	0.459	0.159	0	0.452	0.452	0	0.695	0.695	0
4&5	3.2	450	2	0.053	0.053	0	0.095	0.095	0	0.264	0.264	0	0.413	0.413	0
6	109.7	1500	2	1.3	1.3	0	2.4	2.4	0	6.62	6.62	0	10.6	10.6	0
7	3.1	450	1	0.061	0.061	0.166*	0.108	0.108	0	0.304	0.304	0	0.479	0.388	0.09

Figure 2 – Stage 5 Existing Model Results

Developed BRS model

Developed Model Results				1EY (1 year ARI)			50% AEP (2 year ARI)			20% AEP (5 year ARI)			10% 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)	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	6.5	900	1	0.112	0.112	0	0.203	0.203	0	0.553	0.553	0	0.889	0.889	0
2	9.3	900	2	0.156	0.156	0	0.28	0.28	0	0.761	0.761	0	1.19	1.19	0
3	5.6	750	2	0.089	0.089	0	0.159	0.159	0	0.452	0.452	0	0.695	0.695	0
4&5	3.2	600	2	0.053	0.053	0	0.095	0.095	0	0.264	0.264	0	0.413	0.413	0
6	109.7	1650	3	1.3	1.3	0	2.4	2.4	0	6.62	6.62	0	10.6	10.6	0
7	3.1	900	1	0.061	0.061	0.425*	0.108	0.108	0	0.304	0.304	0	0.479	0.479	0

*** Strange modelling result from BRS model? Its unlikely there is overland flow in the 1EY event.**

Figure 3 – Stage 5 Developed Model Results

2.1 Stage 6

Port Stephens Council conducted the modelling for the Stage 6 area. Both the existing and developed models were simulated to determine flows in the regular events.

The existing catchments for the stage 6 area are displayed in **Figure 4**. Results for the existing and developed models are included in **Figures 5 and 6**.

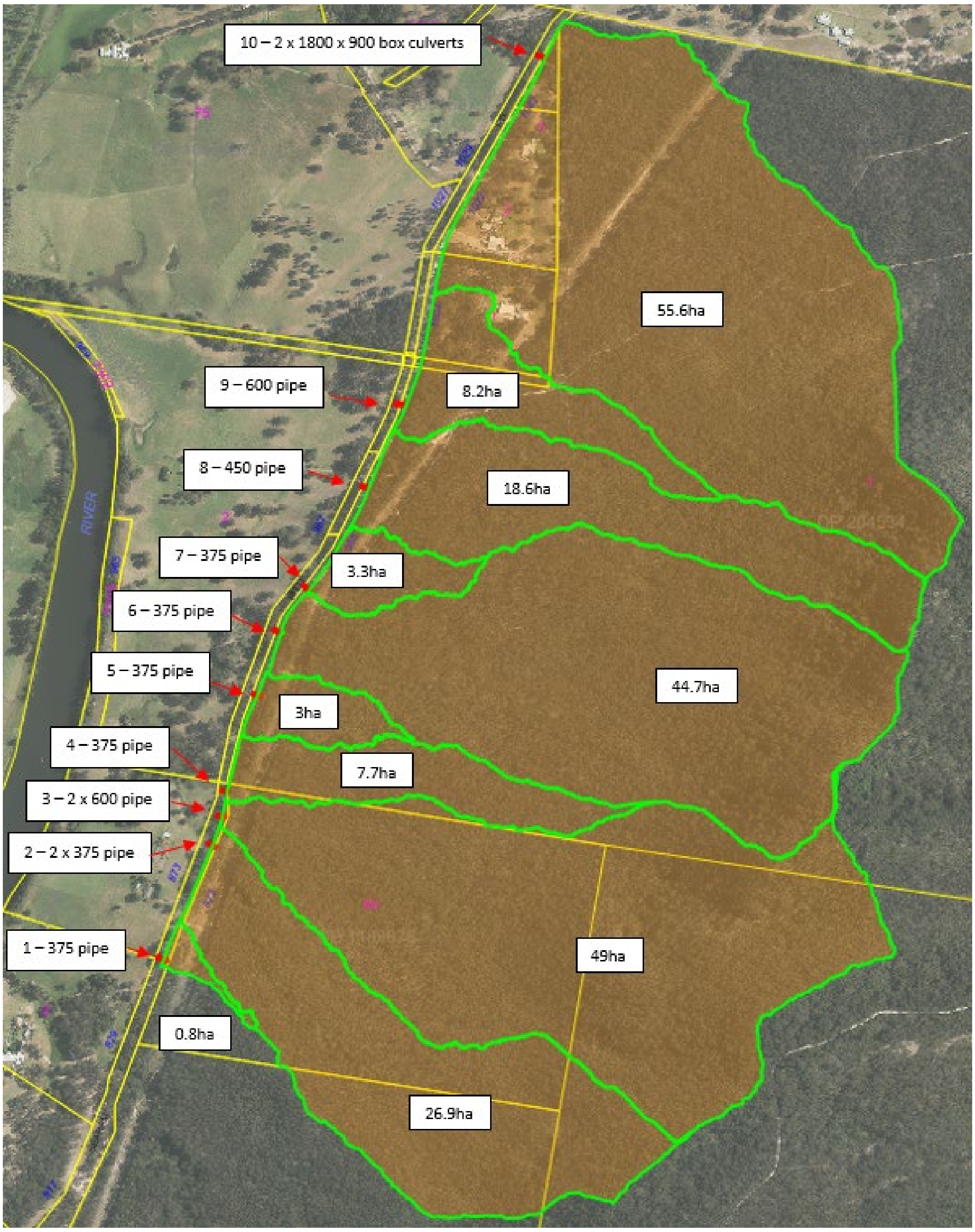


Figure 4 – Stage 6 existing catchment and drainage data

Stage 6	Council Modelling														
Existing Model Results				1EY (1 year ARI)			50% AEP (2 year ARI)			20% AEP (5 year ARI)			10% 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)	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	0.094	0.094	0	0.121	0.122	0	0.204	0.203	0	0.268	0.213	0.053
2	26.9	375	2	1.57	0.59	0.977	2.12	0.599	1.52	3.85	0.619	3.23	5.05	0.631	4.42
3	49.0	600	2	2.52	1.19	1.33	3.48	1.22	2.27	6.37	1.3	5.08	8.16	1.34	6.83
4	7.7	375	1	0.513	0.218	0.295	5.67	0.22	0.432	1.2	0.226	0.978	1.58	0.23	1.35
5	3.0	375	1	0.329	0.198	0.13	0.419	0.2	0.218	0.721	0.205	0.516	0.911	0.207	0.703
6	44.7	375	1	2.3	0.22	2.08	3.18	0.227	2.96	5.81	0.242	5.58	7.45	0.249	7.21
7	3.3	375	1	0.355	0.255	0.099	0.447	0.258	0.189	0.756	0.265	0.49	0.98	0.27	0.71
8	18.6	450	1	1.05	0.572	0.482	1.43	0.582	0.849	2.6	0.605	1.99	3.39	0.618	2.77
9	8.1	600	1	0.571	0.57	0	0.76	0.595	0.163	1.33	0.613	0.716	1.75	0.623	1.13
10	55.6	1850H x 900V	2	2.55	2.55	0	3.53	3.53	0	6.46	6.45	0	8.68	7.72	0.956

Figure 5 – Stage 6 Existing Model Results

Developed Model Results				1EY (1 year ARI)			50% AEP (2 year ARI)			20% AEP (5 year ARI)			10% 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)	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	450	1	0.067	0.067	0	0.1	0.1	0	0.178	0.182	0	0.259	0.259	0
2 to 4	83.6	1800 x 1200	3	2.79	2.77	0	4.3	4.29	0	9.63	9.63	0	12.4	12.4	0
5	3.0	600	2	0.24	0.239	0	0.315	0.315	0	0.61	0.607	0	0.896	0.914	0
6	44.7	1200	3	1.49	1.48	0	2.3	2.3	0	5.15	5.15	0	6.63	6.81	0
7	3.3	600	2	0.253	0.252	0	0.33	0.329	0	0.659	0.658	0	0.888	0.918	0
8	18.6	900	3	0.667	0.666	0	0.937	0.936	0	2.36	2.36	0	3.13	3.18	0
9	8.1	750	2	0.351	0.35	0	0.549	0.547	0	1.18	1.18	0	1.62	1.62	0
10	55.6	2400 X 900	2	1.66	1.65	0	2.79	2.79	0	5.8	5.8	0	7.65	7.65	0

Figure 7 – Stage 6 Developed Model Results

3. Water Quality Analysis

MUSIC modelling has been used to assess the change in pollutant load associated with the upgrade of East Seaham Road Stages 5 and 6.

The Stage 5 and 6 section of East Seaham Road is located in a Hunter Water Drinking Water Catchment. Hence, the NorBE (Neutral or Beneficial Effect) water quality criteria apply.

To model the road upgrades, the areas of the existing unsealed road and final sealed road were extracted from design plans

- Area of existing unsealed road = 1.75ha
- Area of designed sealed road = 2.63ha

In order to compare the same areas in both the pre and post development models an additional area of approximately 0.87ha of undeveloped land (reflected as a forest node in MUSIC) was included in the pre-developed model.

The source nodes used to model the pre (unsealed) and post (sealed) road design were modified to reflect the pollution generation parameters set out in the Water

NSW Guidance ‘Using Music in the Sydney Drinking Water Catchment’ (Feb 2023), specifically tables 4.1, 4.2, 4.3, 4.6 and 4.7.

A third model was created that included water quality treatment measures including swales and buffer strips. The road design includes grassed channels along a large portion of the road length. To model the water quality impacts of these grassed swales, the total length of roadside swales was determined from design plans and equated to approximately 2961m (including both sides of the road). A typical swale cross section as taken from the design plans was then used to reflect the average swale dimension. See **Figures 8 and 9** which shows the swale details from the Stage 6 design plans. **Figure 10** shows the swale properties in MUSIC.

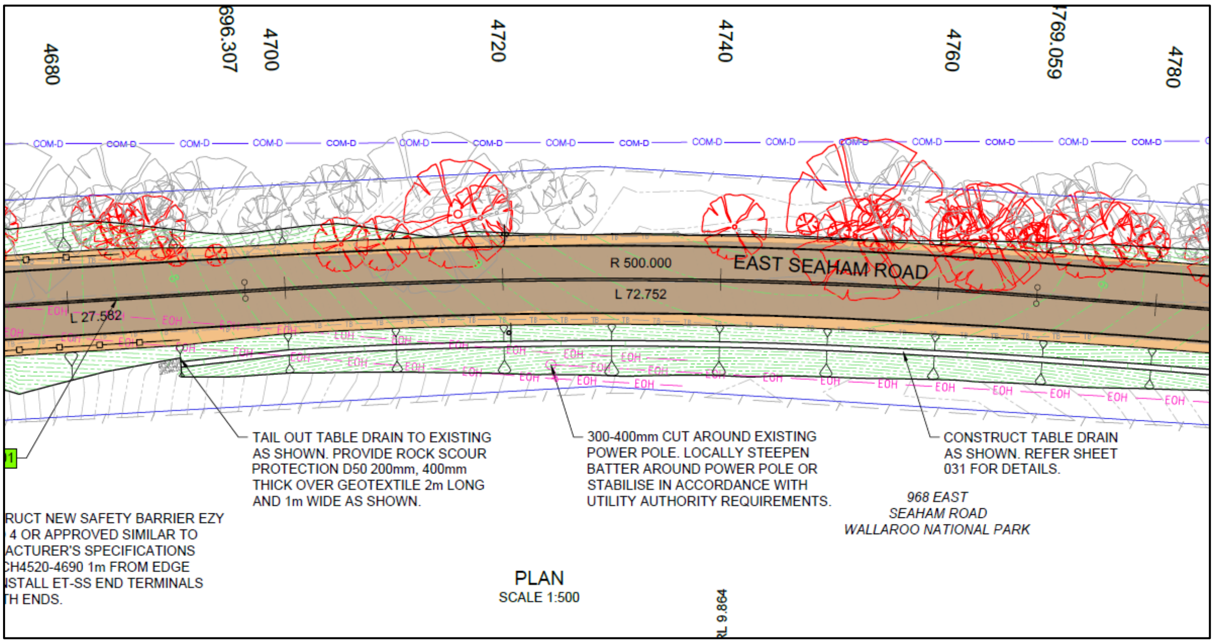


Figure 8 – Example of swale on southern side of East Seaham Road

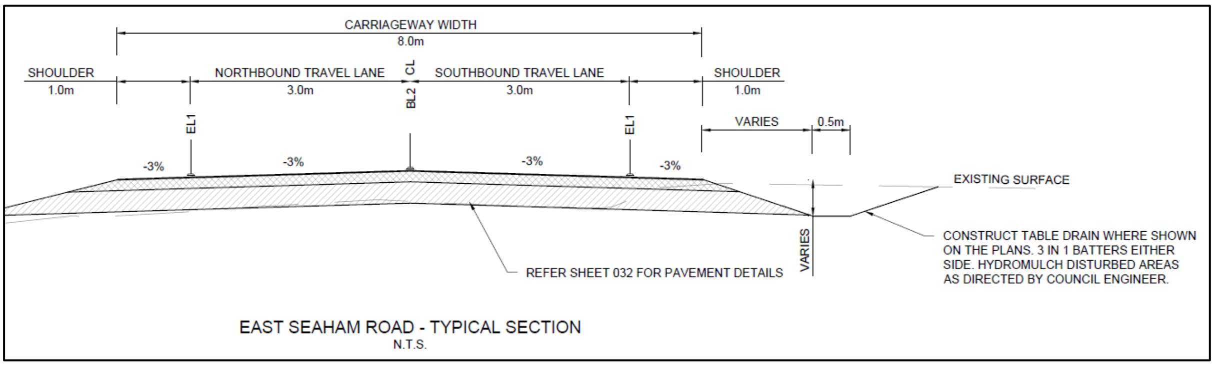


Figure 9 – Typical Swale Cross Section From Design Plans

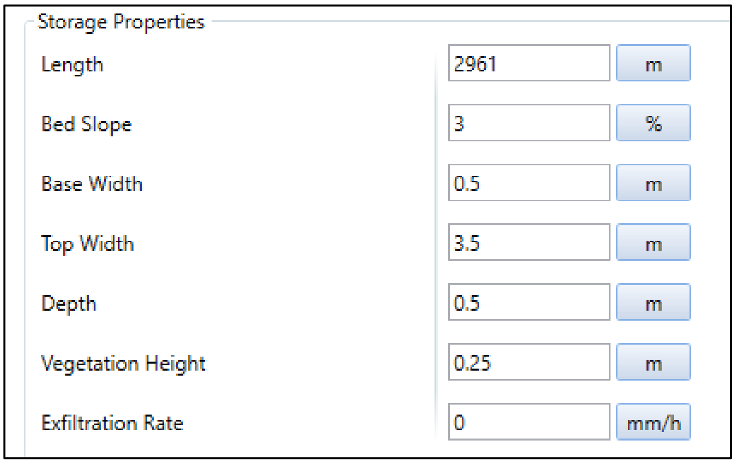


Figure 10 – MUSIC model swale properties

For the ‘treatment’ model the area of the unsealed road was split up into an area that drains to a swale and the remaining area. To determine a likely area of road that drains towards a swale it was assumed that half the road width would contribute to flow in the swale for the entire length of swale. Given runoff from the remaining road areas generally sheet flows from the road over grassed/ vegetated land, a buffer treatment node was included to treat the remaining area.

The MUSIC model setup is displayed in **Figure 11** and the music modelling results are displayed in **Figure 12**.

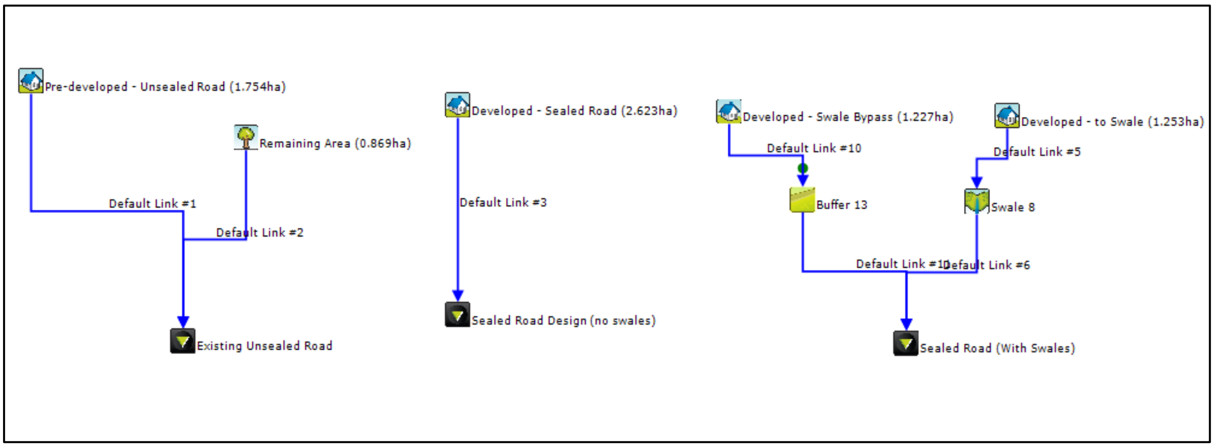


Figure 11 – MUSC model configuration

	Existing	Road Upgrade (No Treatment)			Road Upgrade (Swales and Buffer)		
Pollutant	Unsealed Road	Sealed Road	Increase from existing	% Increase from existing	Sealed Road	Increase from existing	% Increase from existing
Flow (ML/yr)	11.41	22.75	11.34	99.39	21.58	10.17	89.13
TSS (kg/yr)	12230	7894	-4336	-35.45	1186	-11044	-90.30
TP (kg/yr)	5.617	13.45	7.833	139.45	4.726	-0.891	-15.86
TN (kg/yr)	24.22	55.22	31	127.99	34.98	10.76	44.43
GP (kg/yr)	269.8	616.8	347	128.61	288.5	18.7	6.93

Figure 12 – MUSIC model results

The MUSIC model results demonstrate the change in pollution load when considering the existing unsealed road compared to the ultimate road design. Pollution loads for both TSS (Total Suspended Solids) and TP (Total Phosphorus) have reduced and achieve the NorBE criteria. The pollution loads for TN (Total Nitrogen) and GP (Gross Pollutants) have both increased by approximately 44% for TN and 7% for GP.

Figure 12 demonstrates that the treatment systems in place do provide a substantial decrease in pollutants when compared to an upgrade of the road surface only.

There is a substantial buffer area between East Seaham Road and the ultimate discharge locations at various points along the Williams River (See **Figure 13**). Runoff from all areas of East Seaham Road will generally flow overland for at least another 300m via existing overland flow paths in private properties before discharging to the river. It's likely that the designed rock scour protection at culvert crossings and the grassed overland flow areas to the river will provide additional water quality treatment that has not been included in the current MUSIC model and would further reduce both GP and TN loads.

Figure 13 – Distance Between East Seaham Road and The Williams River

Its also noted that MUSIC determines pollution loads based solely on a defined surface type. For a road system, the main source of pollution is generated from traffic volume. The upgrading of the existing unsealed road to a sealed road may attract additional traffic volume, however the usage of the existing road system (single lane in a rural area) remains largely unchanged. Hence, it is possible that the projected change in pollution generation could be slightly inflated.

Appendix A – Stage 5 DRAINS Model Comparison

BRS Report Figure – Existing 2% AEP Results

East Seaham Road Stage 5 Drainage Report

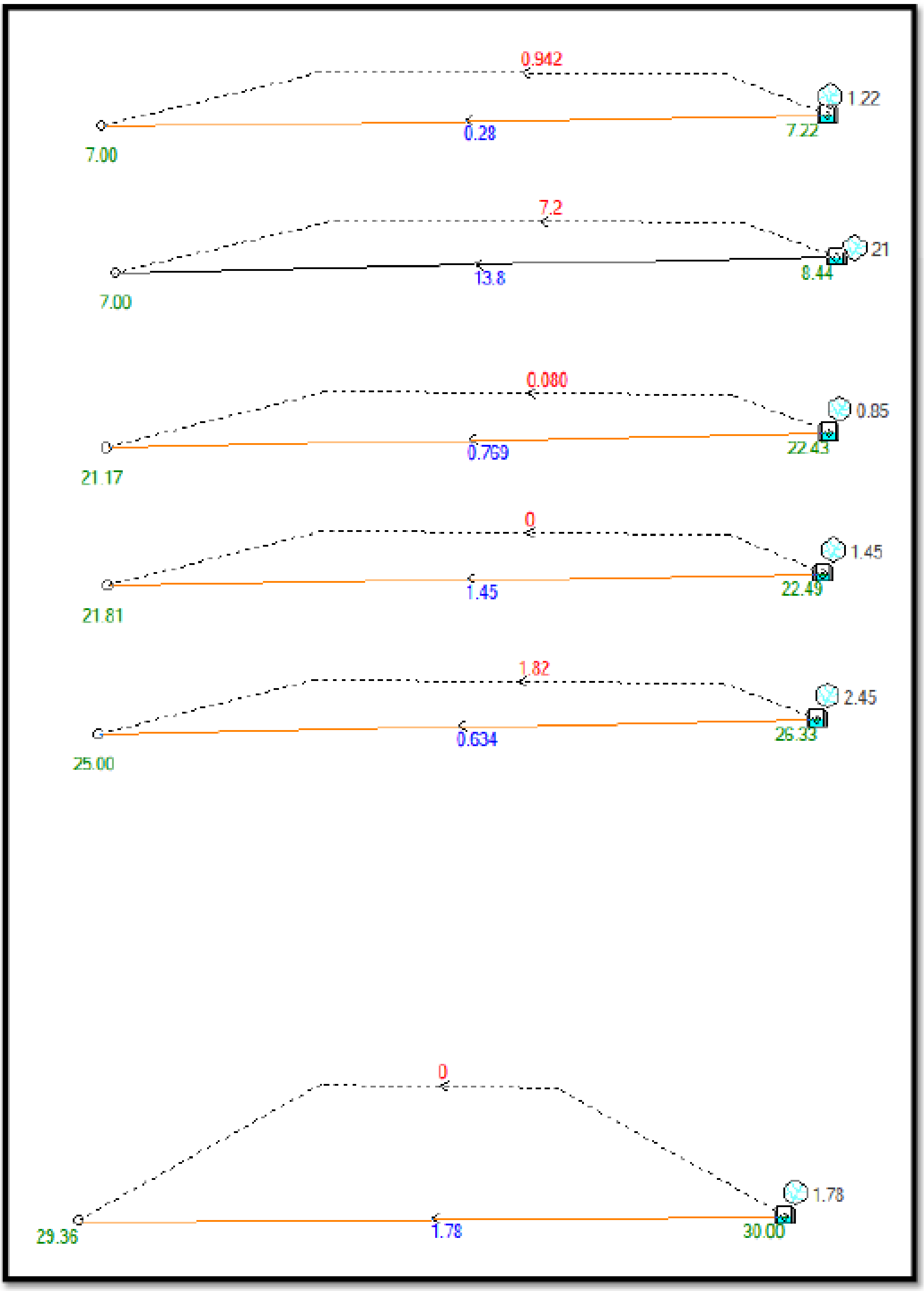
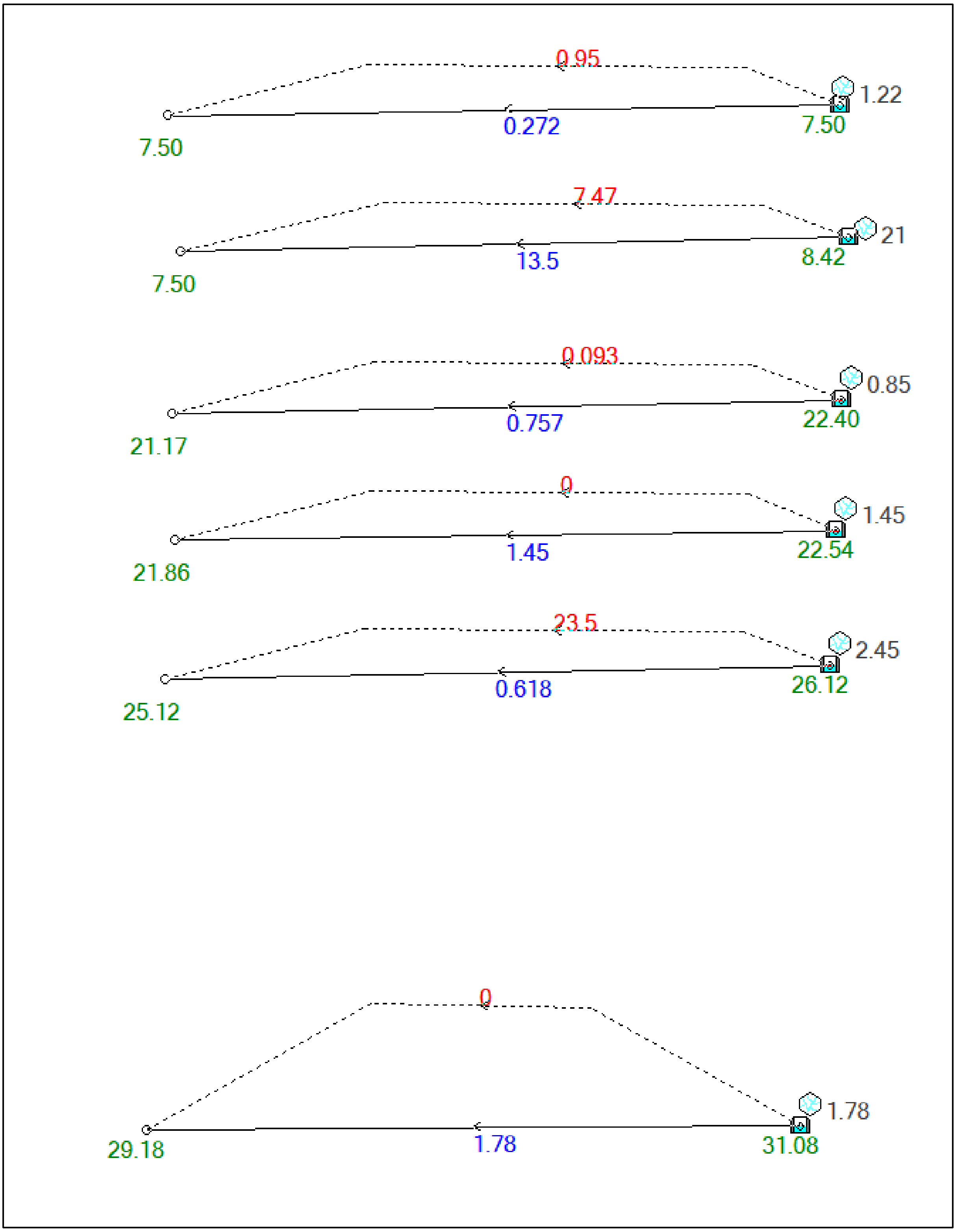


Figure 2 - DRAINS Output - 2% AEP Minor Storm

Amended BRS DRAINS model – 2% AEP results



BRS Report Figure – Existing 1% AEP

East Seaham Road Stage 5 — Drainage Report

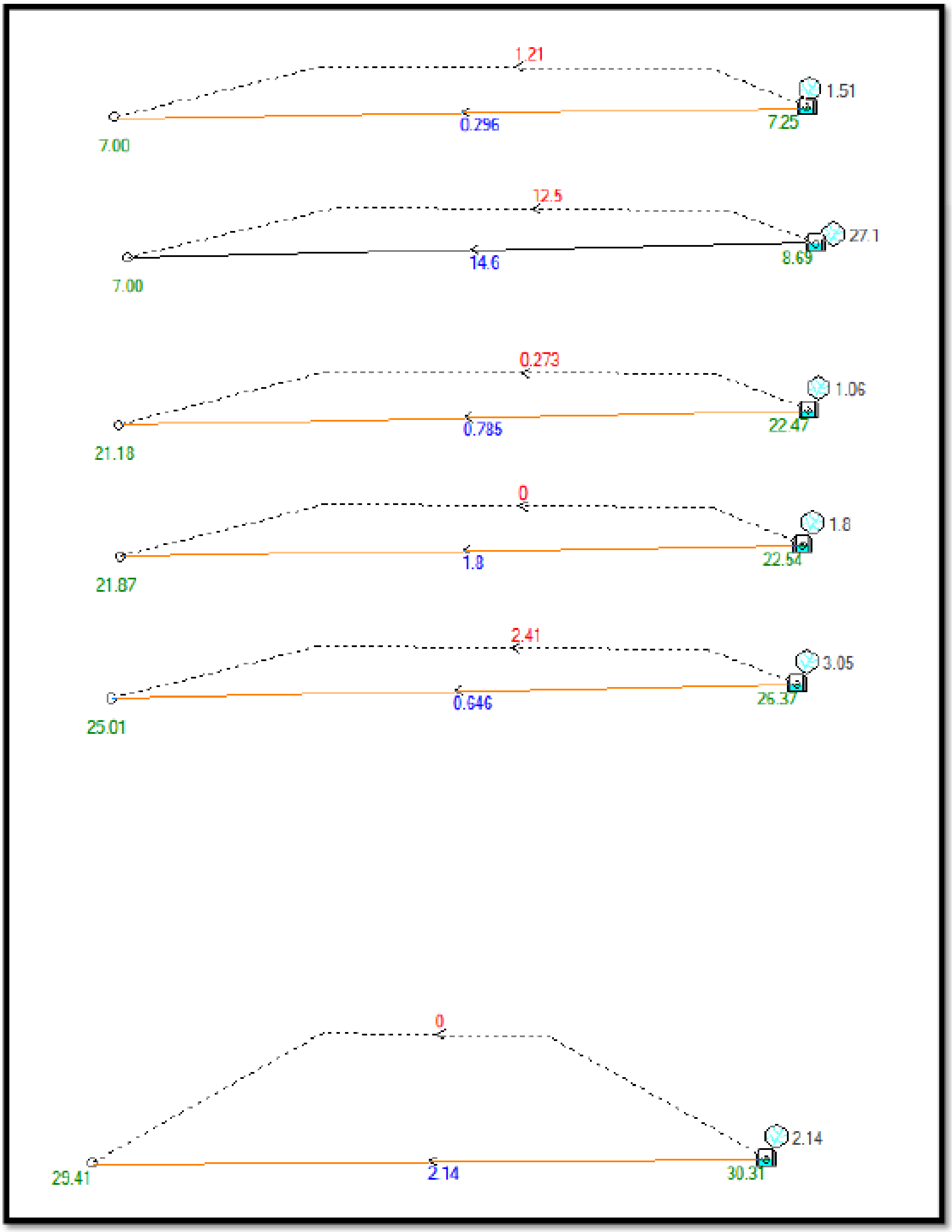
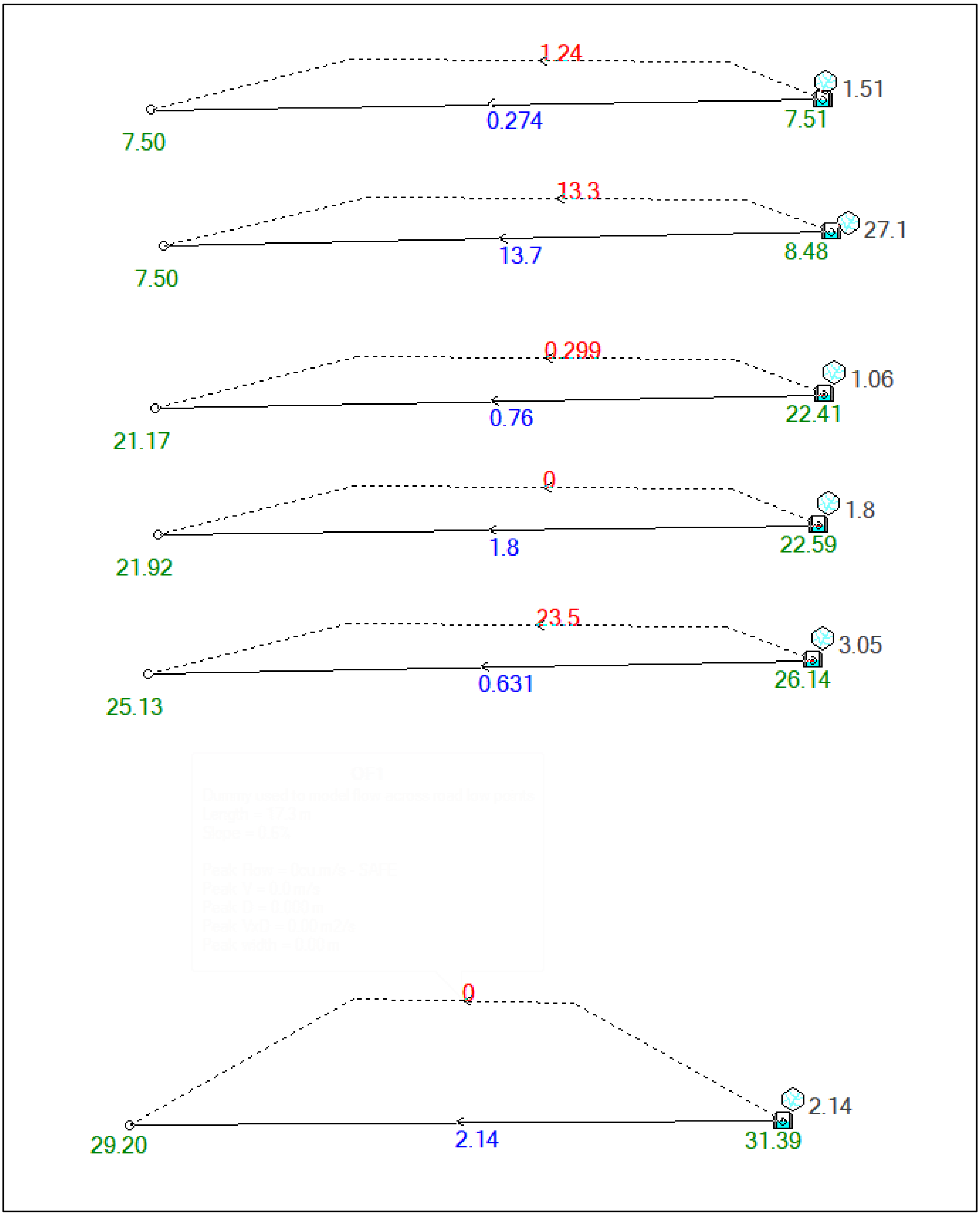


Figure 3 - DRAINS Output - 1% AEP Major Storm

Amended BRS DRAINS model – 1% AEP results



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