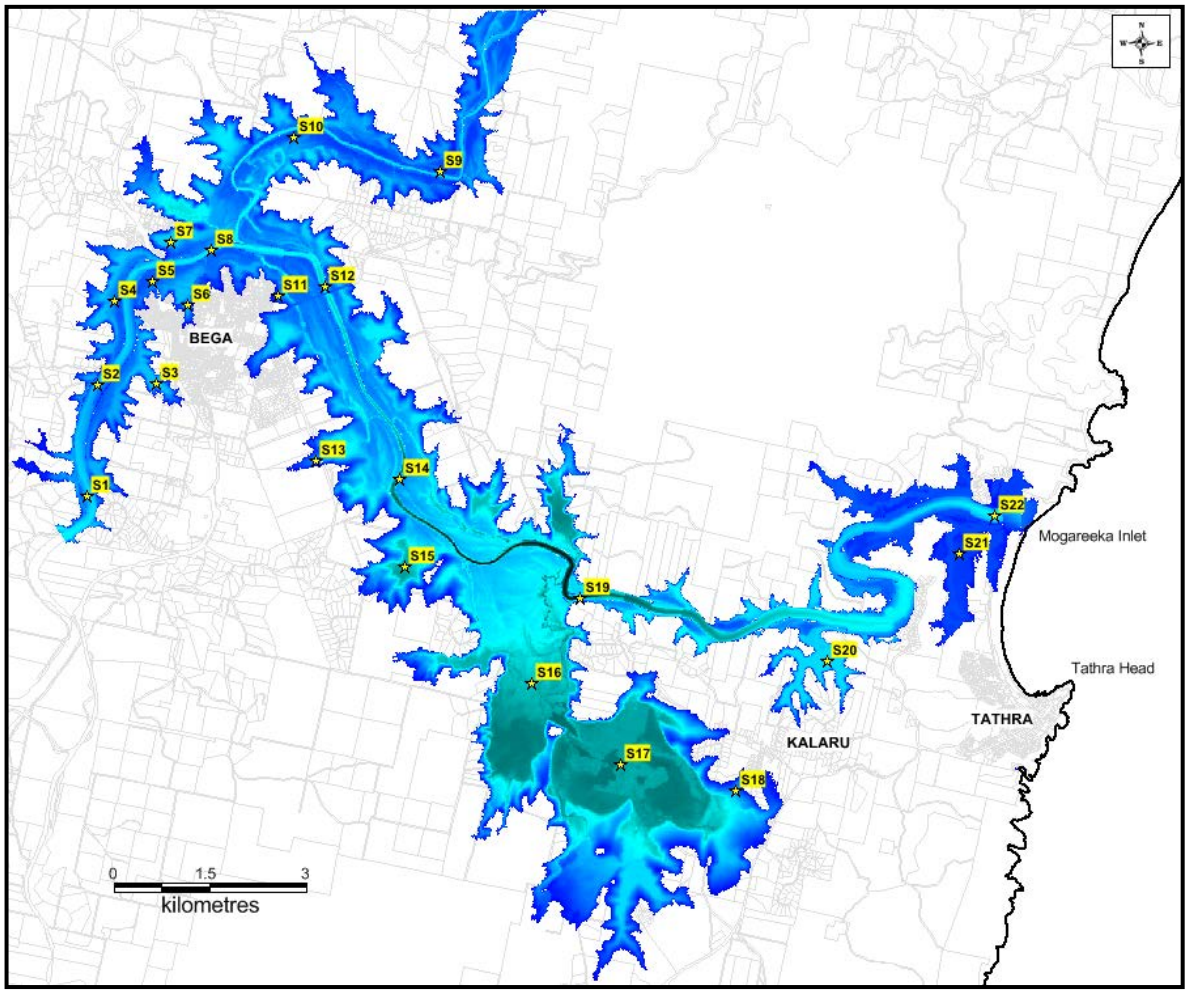
16 SENSITIVITY ANALYSIS

16.1 Varying Model Parameters

A sensitivity analysis of model results was conducted by varying model parameters and assessing the impact on water levels and velocities within the project area. The results of the simulations were compared to the 1% AEP design event as the base case in conjunction with a 5%AEP tailwater condition based on joint probability assessment as per FRM Guidelines. The analysis was carried out for a number of control locations along the rivers presented in Figure 16.1.

Figure 16.1: Check Locations Used in the Sensitivity Analysis



A total of 18 sensitivity runs were undertaken for assessment of changes at check locations.

Table 16.1: Scenarios Used in Sensitivity Analysis

PARAMETER	SCENARIO IDENTIFIER	DETAILS
Base Case	Base	1%AEP catchment flows Downstream conditions as per the base case design scenario (based on joint probability assessment in line with FRM guidelines – peak tailwater level = 5%AEP 2.18mAHD) Initial Berm closed (level 2.9mAHD)
Rainfall Intensity (Climate Change Scenario)	1A	10% increase in rainfall intensity using analogy with the results from 0.2%AEP model run (based on peak flowrates at Bega/Brogo River junction)
	1B	30% increase in rainfall intensity
Sea Level Rise (Climate Change Scenario)	2A	0.4m sea level rise, 0.4m berm increase
	2B	0.9m sea level rise, 0.9m berm increase
Rainfall Losses	3A	Initial loss 10mm, continuing loss 1.5mm/hr
	3B	Initial loss 0mm, continuing loss 1.5mm/hr
Rainfall storage/lag	4A	25% increase in catchment roughness (PERN) hydrology
	4B	25% decrease in catchment roughness (PERN) hydrology
Surface Roughness	5A	30% increase in design parameter range
	5B	30% decrease in design parameter range
Blockage at Bridges	6A	30% increased (increase applied to design blockage value)
	6B	No blockage
Effects of sedimentation of river bed and debris build-up	7A	0.5m increase in invert level (including sandbar height and Jellat Jellat Flats)
	7B	1.0m increase in invert level (including sandbar height and Jellat Jellat Flats)
Downstream tailwater conditions	8A	0.5m increase in initial water level in lagoon + conservative dynamic tailwater levels as per Fig 7.1 of the FRM Guideline (i.e peak level 2.6mAHD)
	8B	0.5m increase in initial water level in lagoon + no managed trigger level (i.e. no management intervention thus sandbar starts scouring only when overtopped at the current level of 2.9mAHD)
	8C	0.5m increase in initial water level in lagoon + no managed trigger level (i.e. no management intervention thus sandbar starts scouring only when overtopped at an increased level of 3.9mAHD)

16.2 Variations in Results from Sensitivity Analysis

The comments regarding the model sensitivity for the specific parameter groups are presented in the following sections. The resulting water levels, changes to water levels and velocities for the 22 check locations used in the analysis are shown in Tables 16.7-16.10.

16.2.1 Rainfall Intensities /Climate Change Scenario

The effects of potential changes to rainfall intensities associated with climate change have been simulated as part of the sensitivity analysis by increasing the rainfall intensities (and volumes) in the XP-RAFTS hydrologic model by 30%, and assessing the impact to water levels and velocities by running the new hydrographs through the XPSWMM-2D model. A less critical case with 10% increase in rainfall intensities was assessed as analogous to the 0.2%AEP event based on peak flows at the Bega/Brogo Rivers confluence and was not re-modelled in XP-SWMM2D.

The impact of a 30% increase in rainfall intensity associated with climate change consistently increased flood levels throughout the model area with increases ranging between 0.9m and 2.5m throughout the modelling area. At Tathra Bridge flood levels increased by 0.9m, at Jellat Jellat Flats by 2.5m while near the Princes Hwy anabranch flood levels rose by 1.2m. In the town of Bega, at the western end of Upper Street, peak flood levels increased by 1.6m and near the Bega/Brogo River confluence by 1.7m. Approximately 4km upstream of the Princes Hwy, Bega River levels increased by 1.2m and 5km upstream of Bega/Brogo confluence, Brogo River levels increased by 1.4m.

Changes to peak velocities were generally less noticeable than the increases to peak flood levels as a result of the increased rainfall intensities, however peak velocities generally increased as a result of increased flows. At Jellat Jellat Flats (point 16) velocities increased only marginally (by 0.03m/s). Upstream of Tathra Bridge velocities increased by 0.01m/s while upstream of Tarraganda Bridge the increase was 0.20m/s. The largest increase in velocity of 0.58m/s was noted at point 5 (Table 16.8) near the Princes Hwy anabranch crossing of Bega River. Near the Bega/Brogo River confluence (point 8) there was no noticeable change to the peak velocity. A reduction of 0.07m/s was noted at point 3 – pondage on western side of Ravenswood Ave. Approximately 4km Upstream of Princes Hwy, Bega River (point 1) peak velocities increased within the channel by 0.42m/s.

The changes to water levels and velocities are primarily driven by changes to flowrates. Flows at the Bega/Brogo River confluence increased from 9,223m3/s in the base case to 10,379m3/s in Scenario 1A and 12,665m3/s in Scenario 1B. Table 16 shows the peak flows for the scenarios considered in the sensitivity analysis.

Table 16.2: Peak Flowrates from Sensitivity Analysis of Rainfall Intensities

Description	100 year ARI PEAK (m^3/s)*		
	Base case	Sensitivity Run 1A (10% intensity increase)	Sensitivity Run 1B (30% intensity increase)
Bega River Upstream of Confluence	6166	6893	8352
Brogo River Upstream of Confluence	3155	3568	4411
Bega Brogo Rivers Junction	9233	10379	12665

*Extracted as quickflows from XP-RAFTS

The peak flowrate associated with Scenario 1A is approximately equivalent to the peak for the 0.5% AEP (10,424m3/s) flood events under current conditions, while the peak flowrate associated with Scenario 1B lies between the 0.5% AEP and PMF flood events under current conditions. These two scenarios (Sensitivity Run 1A and Sensitivity Run 1B) had a significant impact on potential flood levels, while the change of water velocities is relatively minor.

The results indicate that areas near the 1%AEP event flood extent that are not prone to flooding under current conditions may become prone to 1%AEP flooding under potential climate change conditions. In addition areas currently prone to flooding within the 1%AEP flood extent, may undergo larger depths (0.9-2.5m), velocities, and flow hazards under future climate change conditions.

16.2.2 Sea Level Rise /Climate Change Scenario

Sensitivity runs incorporating sea level rises (SLR) to tailwater conditions were included in Sensitivity Run 2A and 2B. Sea level rises of 0.4m and 0.9m were applied respectively to reflect the projected 2050 and 2100 ocean level changes. Based on joint probability estimates with the 1%AEP catchment flows in conjunction with 5%AEP ocean levels, the 5%AEP tailwater levels were increased to 2.58mAHD and 3.08mAHD respectively to test the sensitivity of the base case design event. Under these joint probability conditions and including management intervention, flood levels immediately upstream of Tathra Bridge increased by 0.05m and 0.34m respectively while changes to levels further upstream generally diminished or were less significant. At the lagoon the increases was 0.33m and 0.75m respectively.

The effects of sea level rise were further assessed as part of the estimation of Preliminary Flood Planning Levels. The envelope of impacts also included 5%AEP catchment in conjunction with 1%AEP ocean levels, no management intervention, sea level rise, and increases to berm levels associated with sea level rise (refer Appendix H). During these envelope runs, water levels increased by 0.33m and 0.76m at the lagoon and 0.06m and 0.33m upstream of Tathra bridge for the year 2050 and 2100 respectively. As in previous scenarios the increases in water level were reduced in the upper river reaches. At the Bega/Brogo confluence, the level increase was 0.01m in the 2100 case. The resulting area of influence extended 4.1km upstream of the inlet (between Mogareeka and Jellat Jellat Flats) for 2050 conditions and 21 km (about 3km along Brogo River upstream of the Bega/Brogo confluence) for 2100 conditions.

16.2.3 Rainfall Loss

Sensitivity runs were undertaken by running the hydrologic model with reduced rainfall losses, which produced larger peak flows and volumes. Reduced rainfall losses can be associated with increased antecedent moisture conditions and increased saturation of the soil after prolonged wet periods. Sensitivity Run 3A used an initial loss of 10mm and continuing loss of 1.5 mm/hr, where the continuing loss was reduced compared to design loss of 2.5 mm/hr. Sensitivity Run 3B applied an initial loss of 0mm and continuing loss of 1.5mm/hr which can be associated with a highly saturated soil condition.

Table 16.3 shows the peak flows obtained by running the XP-RAFTS hydrologic model for the two sensitivity runs associated with reduced rainfall losses.

Table 16.3: Peak Flowrates from Sensitivity Analysis of Rainfall Losses

Description	100 year ARI PEAK FLOW (m^3/s)*		
	Base Case	Sensitivity Run 3A	Sensitivity Run 3B
Bega River Upstream of Confluence	6166	6464	6477
Brogo River Upstream of Confluence	3155	3383	3417
Bega Brogo Rivers Junction	9233	9756	9813

*Extracted as quickflows from XP-RAFTS

In terms of peak flowrates along the Bega River, Sensitivity Run 3A and 3B are both approximately equivalent to flood events with Annual Exceedance Probability between the 1% and 0.2% AEP. The results indicate relatively significant increases in flood levels and minor changes to velocities. Changes in levels at

the 22 check points varied from about 0.2m to 0.6m. Flow velocities variations were -0.05m/s to 0.09m/s with decreased values in some locations being a result of flow distribution. Of all the points considered, Sensitivity Run 3B produced an average change in water levels of +0.37m and an average change in velocities of +0.01m/s.

16.2.4 Catchment Roughness

Scenarios 4A and 4B modelled the increase and decrease of the catchment roughness or PERN factor, which impacts storage/ lag routing. An increased storage will produce increased attenuation and reduced peak flows from each subarea throughout the catchment, and vice versa for decreased storage effects. Scenarios 4A and 4B include a 25% increase and decrease in roughness factor respectively.

Table 16.4: Peak Flowrates from Sensitivity Analysis of Catchment Roughness (PERN)

Description	100 year ARI PEAK FLOW (m^3/s)*		
	Base Case	Sensitivity Run 4A	Sensitivity Run 4B
Bega River Upstream of Confluence	6166	5931	6386
Brogo River Upstream of Confluence	3155	2878	3456
Bega Brogo Rivers Junction	9233	8721	9788

*Extracted as quickflows from XP-RAFTS

The resulting flood levels and velocities provide a moderate sensitivity to results associated with changes to catchment roughness with maximum flood level variations of up to 0.3m in height, and average of about 0.2m. There were also relatively minor changes to velocity as a result of the changes to catchment roughness that affect hydrology.

16.2.5 Surface Roughness in Hydraulic Model

Based on past experience, surface roughness particularly in the hydraulic modelling can have a major influence on flood levels particularly in areas with significant hydraulic gradient. In areas with significant backwater effects such as near Jellat Jellat Flats where the friction slope is minor due to low flow velocities, the roughness coefficient is expected to have a minor impact on flood levels. Changes in roughness for the area downstream of Jellat Jellat Flats to Mogareeka are expected to have a significant impact on flood levels upstream by producing a large backwater up the Bega River.

Impacts can potentially include changes to flow distributions, velocities and flood levels. The modelling of changes in roughness for the current study applied a global increase and decrease of roughness coefficient by varying the base values by -/+ 30% (Scenario 5A, 5B). Scenario 5A applied lower roughness coefficients that may represent clearing or thinning of vegetative cover during prolonged periods of drought, and minimal debris, while Scenario 5B used an increased roughness, which may represent a development of a more dense vegetative cover.

Increased roughness can be associated with a reduced flow carrying capacity, raising levels and decreasing velocities and scour potential, while a reduced roughness can increase flow carrying capacity, lower flood levels, and increase velocities and scour potential. However localised variations to roughnesses and other factors can redistribute flows, which can also change the flood effects.

Scenario 5A and 5B results confirmed that variations in roughness had a significant impact on the variability of model results as indicated by inspection of levels at control locations. Decreased roughness in Scenario 5A reduced water levels at all control locations with changes to flood levels ranging between -0.3m to -1.4m

(average -0.8m) and average changes to velocities of +0.4m/s with a maximum of +1.9m/s. At the channel immediately downstream of Jellat Jellat Flats (point 19) levels decreased by 1.4m due to the increased flow carrying capacity between Jellat Jellat Flats and Mogareeka, resulting in decreased flood levels at Jellat Jellat Flats (point 17) of 0.6m.

Vice Versa in Scenario 5B where there was an increase in roughnesses, water levels increased at all control locations ranging between +0.1m to +1.1m (average +0.8m). Changes to velocities reduced significantly due to the reduced flow carrying capacity, with reductions averaging 0.2m/s and up to 0.9m/s change in velocity at point 19 immediately downstream of Jellat Jellat Flats. At this location flood levels increased by 0.9m due to the decreased flow carrying capacity between Jellat Jellat Flats and Mogareeka, resulting in increased flood levels at Jellat Jellat Flats (point 17) of 1.0m.

In other areas, Scenario 5B resulted in flood levels increasing by 0.4m at Tathra Bridge, 0.8m near the Princes Hwy anabranch, 0.7m in the town of Bega at the western end of Upper Street, and 0.8m near the Bega/Brogo River confluence. Approximately 4km upstream of the Princes Hwy Bega River levels increased by 1.1m and approximately 5km upstream of Bega/Brogo confluence Brogo River levels increased by 0.7m.

Therefore surface roughness can significantly impact on flood levels in the Bega/Brogo River model area with changes to flood levels and flow velocities.

16.2.6 Blockage at Bridges

The effects of blockages at bridges can significantly contribute to flooding at bridges and at other locations. The modelling of blockages at bridges in the base case followed a comprehensive analysis of blockages for application to design flood events. In the current sensitivity analysis the two scenarios included a 30% increase to design blockages (Scenario 6A) and a zero blockage factor (Scenario 6B). Scenario 6B was run to investigate the case where blockage does not attenuate flows and increase downstream flooding, a condition that simulates the debris having been washed away by high flows. Increased blockage can be associated with additional vegetative overgrowth and debris and a smaller available bridge opening.

Local changes to model results at the 5 bridges are presented in Tables 16.5 and 16.6.

Table 16.5: Sensitivity Analysis Results for Blockage Through Bridges - Velocities

Description	100yr ARI PEAK VELOCITIES (m/s)		
	Base Case	Sensitivity Run 6A	Sensitivity Run 6B
Princes Hwy – Bega River	2.53	2.66	2.15
Princes Hwy – Anabranch	2.99	3.15	2.52
Tarraganda Lane – Bega River	2.25	2.22	2.07
Tarraganda Lane – Anabranch	0.30	0.26	0.41
Tathra Bridge	4.54	4.96	3.15

Table 16.6: Sensitivity Analysis Results for Blockage Through Bridges – Upstream Water Levels

Description	100yr ARI WATER LEVEL (mAHD)		
	Base Case	Sensitivity Run 6A	Sensitivity Run 6B
Princes Hwy – Bega River	16.11	16.24	15.84
Princes Hwy – Anabranch	16.02	16.15	15.76
Tarraganda Lane – Bega River	14.07	14.08	14.05
Tarraganda Lane – Anabranch	14.19	14.22	14.20
Tathra Bridge	4.20	4.56	3.70

Generally, variations in blockage at bridges produced local changes near the bridge sites with relatively minor impact at sites away from the bridges. There were only minor changes to flood levels at Tarraganda Lane likely due to the significant depth of overtopping the road at these sites. More noticeable changes to flood levels were noted at Princes Hwy and Tathra Bridges.

In other areas, as noted by assessing the control points, the XP-SWMM2D model results indicated that changes to blockage generally had a minor impact on both levels and velocities. The largest impact was immediately upstream of Tathra bridge where levels varied by +0.4 to -0.5m for Scenario 6A and 6B respectively. About 800m upstream of Princes Hwy at point 4 levels increased by 0.11m due to additional blockage (Sensitivity Run 6A) and decreased by 0.21m with no blockage (Sensitivity Run 6B) due to changes in conveyance capacity. Local impacts near Princes Hwy can increase levels at point 5 at the anabranch with changes of +0.13m/-0.26m respectively.

To consider the impact of blockage on potential changes of flood attenuation, point 19 was assessed (refer Figure 16.1) indicating that flood levels varied only slightly, by +0.01m and -0.01m for Scenario 6A and 6B respectively. This could be due to the impact from the backwater from Tathra Bridge rather than attenuation of the flood hydrograph from blockage upstream. Point 14 along the Bega River is situated downstream of the Princes Hwy and Tarraganda Lane bridges and indicates that the blockages had no impact on peak water levels and flood attenuation.

16.2.7 Sedimentation

Sensitivity runs were also used to consider the effects of increased sedimentation associated with a build-up of material along the channel of the Bega and Brogo Rivers, Jellat Jellat Flats, and the sand bar at Mogareeka.

Information was obtained from Fryirs and Brierley (1998), including volumes in lowland areas of the catchment, sediment balance calculations, and grain size distributions. These figures were used to estimate levels of sediment build-up for use in sensitivity runs. Subsequent sensitivity runs applied 0.5m and 1.0m increases in invert levels for sensitivity runs 7A and 7B respectively, in conjunction with raised initial berm levels (to 3.4mAHD and 3.9mAHD respectively).

Both sensitivity runs 7A and 7B associated with increased sedimentation, resulted in increased flood levels at all control points considered, with average increases of 0.22m and 0.47m respectively. This is due to a combination of less channel capacity and increased flows to the floodplain, with flows redistributed from the channel. The maximum increase in water level occurred at point 19 (channel downstream of Jellat Jellat Flats), again due to the sensitive nature of the channel capacity between Jellat Jellat Flats and Mogareeka and its impact on upstream levels.

The impacts of sedimentation was not isolated but increased levels throughout the whole model area. Changes to peak velocities varied with some values increasing and others decreasing due to the distribution of flows. With increases in sedimentation of +1.0m (Scenario 7B) velocities varied from the base case, with an average change of +0.08m/s, although the changes were variable throughout the model area.

The changes to velocities associated with sedimentation were generally more significant than the sensitivity runs for sea level rise, rainfall losses, catchment roughness/PERN affecting hydrology, and blockages at bridges; and less significant than variations associated with changes of surface roughness and rainfall intensity. However, considering that the estimates for sedimentation build-up were based on information collated from previous reports assessing long term sedimentation process, the levels of sedimentation can be considered as upper values, more relevant to long term effects on the floodplain.

16.2.8 Downstream Tailwater Condition

For the assessment of impact of variation in downstream tailwater condition, the initial water levels used in the lower reaches of the study were increased by 0.5m together with:

- An increased ocean tailwater level using the conservative 1%AEP default levels with a peak of 2.6mAHD (Scenario 8A);
- No managed intervention and scouring beginning only once the berm is overtopped at the current 2.9mAHD level (Scenario 8B);
- No managed intervention and scouring beginning only once the berm is overtopped at an increased level of 3.9mAHD (Scenario 8C).

Based on the sensitivity analysis, the impacts of initial water levels in conjunction with increased berm heights and tailwater levels primarily affects levels downstream of Tathra Bridge, with levels further upstream affected to a lesser degree. The largest change was associated with Sensitivity Run 8C where the berm height was raised. At point 19 levels increased by 0.02m, 0.03, 0.05m for Scenarios 8A, 8B, and 8C respectively.

The impact of Sensitivity Run 8C produced increases of up to +0.05m and changes in velocity of up to +0.01m/s, -0.49m/s near Tathra Bridge, and -0.08m/s at point 15 between Tarraganda Lane and Jellat Jellat Flats. At Bega, near Tarraganda Lane levels increased by about 0.04m, and at Jellat Jellat Flats flood levels increased by 0.04m. In the upper parts of Bega such as near Princes Hwy, or near the Bega/Brogo River confluence levels increased by about 0.01m. Approximately 4km upstream of the Princes Hwy – Bega River levels did not change, and approximately 5km upstream of Bega/Brogo confluence – Brogo River, levels increased by 0.01m.

Table 16.7: Water Levels at Control Locations Used in Sensitivity Analysis

Location	Description		1%AEP WATER LEVELS (mAHD)																
		Base Case	SENS 1A	SENS 1B	SENS 2A	SENS 2B	SENS 3A	SENS 3B	SENS 4A	SENS 4B	SENS 5A	SENS 5B	SENS 6A	SENS 6B	SENS 7A	SENS 7B	SENS 8A	SENS 8B	SENS 8C
S1	Bega River (4.0km upstream of Princes Hwy) near Max Slater Dr	20.65	21.36	21.87	20.65	20.65	20.84	20.85	20.52	20.79	19.59	21.70	20.67	20.64	20.94	21.20	20.65	20.65	20.65
S2	Bega River (2.3km upstream of Princes Hwy) near Daisy Hill Rd	17.81	18.39	18.97	17.81	17.81	17.98	17.99	17.67	17.94	16.78	18.72	17.86	17.71	18.02	18.24	17.81	17.81	17.81
S3	Farm Dam – North of Charlotte St, West of Ravenswood St	17.42	18.00	18.63	17.42	17.42	17.59	17.60	17.28	17.56	16.41	18.32	17.48	17.30	17.64	17.88	17.42	17.42	17.42
S4	Bega River (0.8km upstream of Princes Hwy)	16.51	17.03	17.72	16.51	16.51	16.69	16.70	16.36	16.66	15.61	17.36	16.62	16.30	16.74	17.00	16.51	16.51	16.51
S5	Bega River at Poplar St – upstream of Princes Hwy	16.03	16.47	17.21	16.03	16.03	16.20	16.22	15.88	16.18	15.38	16.83	16.16	15.77	16.31	16.63	16.03	16.03	16.03
S6	North of Dowling St, Bega	15.54	16.03	17.11	15.54	15.54	15.77	15.80	15.35	15.75	14.92	16.27	15.55	15.52	15.65	15.77	15.54	15.55	15.55
S7	Bega River between Old Hwy St and Parrabell St	15.14	15.57	16.73	15.14	15.14	15.37	15.40	14.95	15.34	14.35	15.98	15.14	15.13	15.23	15.33	15.14	15.14	15.15
S8	Bega River (1.0km downstream of Princes Hwy)	15.02	15.53	16.70	15.02	15.02	15.27	15.31	14.82	15.24	14.20	15.85	15.03	15.01	15.12	15.23	15.03	15.03	15.03
S9	Brogo River (near Murrays Flat Rd)	15.98	16.31	17.36	15.98	15.98	16.20	16.24	15.74	16.23	15.10	16.71	15.98	15.97	16.06	16.15	15.98	15.98	15.99
S10	Brogo River (2.6km upstream of Bega River junction near Corridgeree Rd)	15.15	15.63	16.77	15.15	15.15	15.39	15.43	14.93	15.38	14.28	15.97	15.15	15.14	15.24	15.35	15.15	15.15	15.16
S11	Upstream of Tarraganda Lane Anabranch	14.21	15.12	16.31	14.22	14.22	14.62	14.68	13.96	14.49	13.32	15.11	14.22	14.20	14.41	14.63	14.23	14.24	14.25
S12	Bega River - Upstream of Tarraganda Lane main crossing	14.11	15.06	16.28	14.11	14.12	14.53	14.60	13.84	14.40	13.25	15.00	14.12	14.09	14.32	14.54	14.13	14.13	14.14
S13	Tathra Rd between Boundary Rd and WAR&Ragburra Ln	13.52	14.63	15.92	13.53	13.54	14.01	14.09	13.21	13.84	12.49	14.54	13.53	13.52	13.81	14.10	13.54	13.55	13.57
S14	Bega River north of WAR&Ragburra Ln	13.50	14.61	15.91	13.5	13.51	13.99	14.07	13.18	13.82	12.48	14.51	13.50	13.49	13.78	14.08	13.51	13.52	13.54
S15	Tathra Rd northeast of NAR&Rawa Pl	13.42	14.55	15.85	13.43	13.43	13.92	14.00	13.10	13.75	12.41	14.44	13.43	13.41	13.72	14.02	13.44	13.45	13.47
S16	Jellat Jellat Flats south of Tathra Rd – western area	13.33	14.48	15.80	13.34	13.35	13.84	13.93	13.01	13.66	12.74	14.37	13.34	13.33	13.64	13.95	13.35	13.36	13.38
S17	Jellat Jellat Flats south of Tathra Rd – eastern area	13.34	14.48	15.80	13.34	13.35	13.84	13.93	13.01	13.67	12.79	14.37	13.34	13.33	13.64	13.95	13.35	13.36	13.38
S18	Jellat Jellat Flats – Old Wallagoot Rd	13.34	14.48	15.80	13.34	13.35	13.84	13.93	13.01	13.67	12.80	14.37	13.34	13.33	13.64	13.95	13.36	13.36	13.38
S19	Bega River – downstream of Jellat Jellat Flats	12.68	13.71	14.88	12.69	12.7	13.14	13.21	12.39	12.98	11.30	13.59	12.69	12.67	13.02	13.35	12.70	12.71	12.73
S20	Bega River lagoon northof Kalaru	9.11	9.82	10.60	9.11	9.12	9.42	9.47	8.90	9.30	7.86	9.64	9.13	9.08	9.44	9.78	9.12	9.12	9.13
S21	Bega River downstream end near Tathra Beach Golf Course	4.26	4.71	5.16	4.32	4.57	4.45	4.48	4.15	4.38	3.92	4.39	4.61	3.78	4.34	4.74	4.33	4.27	4.28
S22	Bega river Upstream of Tathra Bridge	4.21	4.65	5.10	4.26	4.55	4.39	4.42	4.09	4.32	3.91	4.32	4.56	3.70	4.31	4.71	4.27	4.21	4.22

Table 16.8: Change in Water Levels at Control Locations Used in Sensitivity Analysis

Location	Description		CHANGE IN 1%AEP WATER LEVELS (m)																
		Base Case	SENS 1A	SENS 1B	SENS 2A	SENS 2B	SENS 3A	SENS 3B	SENS 4A	SENS 4B	SENS 5A	SENS 5B	SENS 6A	SENS 6B	SENS 7A	SENS 7B	SENS 8A	SENS 8B	SENS 8C
S1	Bega River (4.0km upstream of Princes Hwy) near Max Slater Dr	-	0.71	1.22	0.00	0.00	0.19	0.20	-0.13	0.14	-1.06	1.05	0.02	-0.01	0.29	0.55	0.00	0.00	0.00
S2	Bega River (2.3km upstream of Princes Hwy) near Daisy Hill Rd	-	0.58	1.16	0.00	0.00	0.17	0.18	-0.14	0.13	-1.03	0.91	0.05	-0.10	0.21	0.43	0.00	0.00	0.00
S3	Farm Dam – North of Charlotte St, West of Ravenswood St	-	0.58	1.21	0.00	0.00	0.17	0.18	-0.14	0.14	-1.01	0.90	0.06	-0.12	0.22	0.46	0.00	0.00	0.00
S4	Bega River (0.8km upstream of Princes Hwy)	-	0.52	1.21	0.00	0.00	0.18	0.19	-0.15	0.15	-0.90	0.85	0.11	-0.21	0.23	0.49	0.00	0.00	0.00
S5	Bega River at Poplar St – upstream of Princes Hwy	-	0.44	1.18	0.00	0.00	0.17	0.19	-0.15	0.15	-0.65	0.80	0.13	-0.26	0.28	0.60	0.00	0.00	0.00
S6	North of Dowling St, Bega	-	0.49	1.57	0.00	0.00	0.23	0.26	-0.19	0.21	-0.62	0.73	0.01	-0.02	0.11	0.23	0.00	0.01	0.01
S7	Bega River between Old Hwy St and Parrabell St	-	0.43	1.59	0.00	0.00	0.23	0.26	-0.19	0.20	-0.79	0.84	0.00	-0.01	0.09	0.19	0.00	0.00	0.01
S8	Bega River (1.0km downstream of Princes Hwy)	-	0.51	1.68	0.00	0.00	0.25	0.29	-0.20	0.22	-0.82	0.83	0.01	-0.01	0.10	0.21	0.01	0.01	0.01
S9	Brogo River (near Murrays Flat Rd)	-	0.33	1.38	0.00	0.00	0.22	0.26	-0.24	0.25	-0.88	0.73	0.00	-0.01	0.08	0.17	0.00	0.00	0.01
S10	Brogo River (2.6km upstream of Bega River junction near Corridgeree Rd)	-	0.48	1.62	0.00	0.00	0.24	0.28	-0.22	0.23	-0.87	0.82	0.00	-0.01	0.09	0.20	0.00	0.00	0.01
S11	Upstream of Tarraganda Lane Anabranch	-	0.91	2.10	0.01	0.01	0.41	0.47	-0.25	0.28	-0.89	0.90	0.01	-0.01	0.20	0.42	0.02	0.03	0.04
S12	Bega River - Upstream of Tarraganda Lane main crossing	-	0.95	2.17	0.00	0.01	0.42	0.49	-0.27	0.29	-0.86	0.89	0.01	-0.02	0.21	0.43	0.02	0.02	0.03
S13	Tathra Rd between Boundary Rd and WAR&Ragburra Ln	-	1.11	2.40	0.01	0.02	0.49	0.57	-0.31	0.32	-1.03	1.02	0.01	0.00	0.29	0.58	0.02	0.03	0.05
S14	Bega River north of WAR&Ragburra Ln	-	1.11	2.41	0.00	0.01	0.49	0.57	-0.32	0.32	-1.02	1.01	0.00	-0.01	0.28	0.58	0.01	0.02	0.04
S15	Tathra Rd northeast of NAR&Rawa Pl	-	1.13	2.43	0.01	0.01	0.50	0.58	-0.32	0.33	-1.01	1.02	0.01	-0.01	0.30	0.60	0.02	0.03	0.05
S16	Jellat Jellat Flats south of Tathra Rd – western area	-	1.15	2.47	0.01	0.02	0.51	0.60	-0.32	0.33	-0.59	1.04	0.01	0.00	0.31	0.62	0.02	0.03	0.05
S17	Jellat Jellat Flats south of Tathra Rd – eastern area	-	1.14	2.46	0.00	0.01	0.50	0.59	-0.33	0.33	-0.55	1.03	0.00	-0.01	0.30	0.61	0.01	0.02	0.04
S18	Jellat Jellat Flats – Old Wallagoot Rd	-	1.14	2.46	0.00	0.01	0.50	0.59	-0.33	0.33	-0.54	1.03	0.00	-0.01	0.30	0.61	0.02	0.02	0.04
S19	Bega River – downstream of Jellat Jellat Flats	-	1.03	2.20	0.01	0.02	0.46	0.53	-0.29	0.30	-1.38	0.91	0.01	-0.01	0.34	0.67	0.02	0.03	0.05
S20	Bega River lagoon northof Kalaru	-	0.71	1.49	0.00	0.01	0.31	0.36	-0.21	0.19	-1.25	0.53	0.02	-0.03	0.33	0.67	0.01	0.01	0.02
S21	Bega River downstream end near Tathra Beach Golf Course	-	0.45	0.90	0.06	0.31	0.19	0.22	-0.11	0.12	-0.34	0.13	0.35	-0.48	0.08	0.48	0.07	0.01	0.02
S22	Bega river Upstream of Tathra Bridge	-	0.44	0.89	0.05	0.34	0.18	0.21	-0.12	0.11	-0.30	0.11	0.35	-0.51	0.10	0.50	0.06	0.00	0.01

Table 16.9: Velocities at Control Locations Used in Sensitivity Analysis

Location	Description		1%AEP WATER LEVELS (mAHD)																
		Base Case	SENS 1A	SENS 1B	SENS 2A	SENS 2B	SENS 3A	SENS 3B	SENS 4A	SENS 4B	SENS 5A	SENS 5B	SENS 6A	SENS 6B	SENS 7A	SENS 7B	SENS 8A	SENS 8B	SENS 8C
S1	Bega River (4.0km upstream of Princes Hwy) near Max Slater Dr	3.27	3.47	3.69	3.27	3.27	3.32	3.32	3.25	3.30	4.34	2.77	3.26	3.28	3.18	3.05	3.27	3.27	3.27
S2	Bega River (2.3km upstream of Princes Hwy) near Daisy Hill Rd	2.32	2.47	2.47	2.32	2.32	2.35	2.35	2.30	2.34	3.29	1.86	2.29	2.38	2.21	2.09	2.32	2.32	2.32
S3	Farm Dam – North of Charlotte St, West of Ravenswood St	0.43	0.62	0.36	0.43	0.43	0.43	0.39	0.42	0.44	0.58	0.32	0.43	0.43	0.17	0.37	0.43	0.43	0.43
S4	Bega River (0.8km upstream of Princes Hwy)	1.63	1.85	1.97	1.63	1.63	1.68	1.68	1.59	1.66	1.88	1.46	1.61	1.66	1.69	1.75	1.63	1.63	1.63
S5	Bega River at Poplar St – upstream of Princes Hwy	1.77	2.09	2.35	1.77	1.77	1.85	1.86	1.72	1.83	2.32	1.62	1.77	1.79	1.73	2.55	1.77	1.77	1.77
S6	North of Dowling St, Bega	0.54	0.88	0.58	0.54	0.54	0.56	0.53	0.53	0.56	0.67	0.47	0.53	0.54	0.53	0.5	0.54	0.54	0.54
S7	Bega River between Old Hwy St and Parrabell St	0.22	0.36	0.17	0.22	0.22	0.22	0.22	0.22	0.22	0.48	0.15	0.22	0.22	0.15	0.12	0.22	0.22	0.22
S8	Bega River (1.0km downstream of Princes Hwy)	2.42	2.76	2.42	2.42	2.42	2.44	2.38	2.40	2.43	3.08	1.93	2.34	2.52	2.44	2.37	2.42	2.42	2.42
S9	Brogo River (near Murrays Flat Rd)	1.37	1.42	1.47	1.37	1.37	1.40	1.41	1.32	1.43	1.72	1.03	1.37	1.38	1.41	1.44	1.37	1.37	1.37
S10	Brogo River (2.6km upstream of Bega River junction near Corridgeree Rd)	0.64	0.65	0.74	0.64	0.64	0.66	0.66	0.60	0.68	0.88	0.53	0.64	0.64	0.64	0.64	0.64	0.64	0.64
S11	Upstream of Tarraganda Lane Anabranch	0.09	0.14	0.10	0.09	0.09	0.09	0.09	0.08	0.09	0.29	0.14	0.09	0.09	0.09	0.09	0.09	0.09	0.09
S12	Bega River - Upstream of Tarraganda Lane main crossing	3.14	3.29	3.34	3.14	3.14	3.17	3.17	3.09	3.18	3.67	2.57	3.13	3.17	3.12	3.1	3.13	3.13	3.13
S13	Tathra Rd between Boundary Rd and WAR&Ragburra Ln	0.29	0.30	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.42	0.27	0.29	0.29	0.3	0.3	0.29	0.42	0.3
S14	Bega River north of WAR&Ragburra Ln	1.56	1.76	1.66	1.56	1.56	1.57	1.55	1.53	1.59	1.61	1.25	1.56	1.56	1.41	1.26	1.55	1.55	1.54
S15	Tathra Rd northeast of NAR&Rawa Pl	0.12	0.43	0.10	0.1	0.10	0.10	0.10	0.10	0.09	0.23	0.11	0.08	0.10	0.07	0.1	0.04	0.04	0.04
S16	Jellat Jellat Flats south of Tathra Rd – western area	0.65	0.92	0.68	0.64	0.64	0.66	0.63	0.65	0.65	2.56	0.59	0.66	0.62	0.65	0.66	0.64	0.6	0.61
S17	Jellat Jellat Flats south of Tathra Rd – eastern area	0.49	0.79	0.52	0.49	0.49	0.47	0.44	0.48	0.49	1.19	0.44	0.50	0.49	0.58	0.59	0.47	0.46	0.46
S18	Jellat Jellat Flats – Old Wallagoot Rd	0.09	0.12	0.09	0.09	0.10	0.10	0.11	0.09	0.09	0.12	0.09	0.09	0.10	0.08	0.09	0.11	0.08	0.09
S19	Bega River – downstream of Jellat Jellat Flats	3.49	3.50	3.57	3.48	3.48	3.51	3.51	3.47	3.50	4.68	2.61	3.48	3.49	3.46	3.43	3.49	3.49	3.49
S20	Bega River lagoon northof Kalaru	0.09	0.12	0.11	0.09	0.09	0.09	0.09	0.09	0.09	0.13	0.06	0.09	0.09	0.09	0.1	0.09	0.09	0.09
S21	Bega River downstream end near Tathra Beach Golf Course	0.11	0.15	0.12	0.14	0.13	0.12	0.12	0.12	0.12	0.10	0.09	0.10	0.10	0.12	0.2	0.09	0.1	0.08
S22	Bega river Upstream of Tathra Bridge	0.58	0.59	0.59	0.58	0.58	0.58	0.59	0.58	0.59	0.56	0.48	0.38	1.09	0.49	2.26	0.1	0.09	0.09

Table 16.10: Change in Velocities at Control Locations Used in Sensitivity Analysis

Location	Description		CHANGE IN 1%AEP WATER LEVELS (m)																
		Base Case	SENS 1A	SENS 1B	SENS 2A	SENS 2B	SENS 3A	SENS 3B	SENS 4A	SENS 4B	SENS 5A	SENS 5B	SENS 6A	SENS 6B	SENS 7A	SENS 7B	SENS 8A	SENS 8B	SENS 8C
S1	Bega River (4.0km upstream of Princes Hwy) near Max Slater Dr	-	0.20	0.42	0.00	0.00	0.05	0.05	-0.02	0.03	1.07	-0.50	-0.01	0.01	-0.09	-0.22	0.00	0.00	0.00
S2	Bega River (2.3km upstream of Princes Hwy) near Daisy Hill Rd	-	0.15	0.15	0.00	0.00	0.03	0.03	-0.02	0.02	0.97	-0.46	-0.03	0.06	-0.11	-0.23	0.00	0.00	0.00
S3	Farm Dam – North of Charlotte St, West of Ravenswood St	-	0.19	-0.07	0.00	0.00	0.00	-0.04	-0.01	0.01	0.15	-0.11	0.00	0.00	-0.26	-0.06	0.00	0.00	0.00
S4	Bega River (0.8km upstream of Princes Hwy)	-	0.22	0.34	0.00	0.00	0.05	0.05	-0.04	0.03	0.25	-0.17	-0.02	0.03	0.06	0.12	0.00	0.00	0.00
S5	Bega River at Poplar St – upstream of Princes Hwy	-	0.32	0.58	0.00	0.00	0.08	0.09	-0.05	0.06	0.55	-0.15	0.00	0.02	-0.04	0.78	0.00	0.00	0.00
S6	North of Dowling St, Bega	-	0.34	0.04	0.00	0.00	0.02	-0.01	-0.01	0.02	0.13	-0.07	-0.01	0.00	-0.01	-0.04	0.00	0.00	0.00
S7	Bega River between Old Hwy St and Parrabell St	-	0.14	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.26	-0.07	0.00	0.00	-0.07	-0.10	0.00	0.00	0.00
S8	Bega River (1.0km downstream of Princes Hwy)	-	0.34	0.00	0.00	0.00	0.02	-0.04	-0.02	0.01	0.66	-0.49	-0.08	0.10	0.02	-0.05	0.00	0.00	0.00
S9	Brogo River (near Murrays Flat Rd)	-	0.05	0.10	0.00	0.00	0.03	0.04	-0.05	0.06	0.35	-0.34	0.00	0.01	0.04	0.07	0.00	0.00	0.00
S10	Brogo River (2.6km upstream of Bega River junction near Corridgeree Rd)	-	0.01	0.10	0.00	0.00	0.02	0.02	-0.04	0.04	0.24	-0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S11	Upstream of Tarraganda Lane Anabranch	-	0.05	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S12	Bega River - Upstream of Tarraganda Lane main crossing	-	0.15	0.20	0.00	0.00	0.03	0.03	-0.05	0.04	0.53	-0.57	-0.01	0.03	-0.02	-0.04	-0.01	-0.01	-0.01
S13	Tathra Rd between Boundary Rd and WAR&Ragburra Ln	-	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.13	-0.02	0.00	0.00	0.01	0.01	0.00	0.13	0.01
S14	Bega River north of WAR&Ragburra Ln	-	0.20	0.10	0.00	0.00	0.01	-0.01	-0.03	0.03	0.05	-0.31	0.00	0.00	-0.15	-0.30	-0.01	-0.01	-0.02
S15	Tathra Rd northeast of NAR&Rawa Pl	-	0.31	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	0.11	-0.01	-0.04	-0.02	-0.05	-0.02	-0.08	-0.08	-0.08
S16	Jellat Jellat Flats south of Tathra Rd – western area	-	0.27	0.03	-0.01	-0.01	0.01	-0.02	0.00	0.00	1.91	-0.06	0.01	-0.03	0.00	0.01	-0.01	-0.05	-0.04
S17	Jellat Jellat Flats south of Tathra Rd – eastern area	-	0.30	0.03	0.00	0.00	-0.02	-0.05	-0.01	0.00	0.70	-0.05	0.01	0.00	0.09	0.10	-0.02	-0.03	-0.03
S18	Jellat Jellat Flats – Old Wallagoot Rd	-	0.03	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.03	0.00	0.00	0.01	-0.01	0.00	0.02	-0.01	0.00
S19	Bega River – downstream of Jellat Jellat Flats	-	0.01	0.08	-0.01	-0.01	0.02	0.02	-0.02	0.01	1.19	-0.88	-0.01	0.00	-0.03	-0.06	0.00	0.00	0.00
S20	Bega River lagoon northof Kalaru	-	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	-0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00
S21	Bega River downstream end near Tathra Beach Golf Course	-	0.04	0.01	0.03	0.02	0.01	0.01	0.01	0.01	-0.01	-0.02	-0.01	-0.01	0.01	0.09	-0.02	-0.01	-0.03
S22	Bega river Upstream of Tathra Bridge	-	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	-0.02	-0.10	-0.20	0.51	-0.09	1.68	-0.48	-0.49	-0.49