# Appendix D

# Memorandum

SUBJECT: North Byron FRMS&P – Roughness Sensitivity Test
PROJECT NUMBER: 117098

## 1. INTRODUCTION

As part of the peer review undertaken by WMA Water (March 2018) of the hydrologic model developed by BMT WBM for the North Byron Shire Flood Study (2016), it was identified that the roughness (Manning's 'n') values were considered reasonable, although it was noted they were marginally lower than commonly adopted variables. As such, a sensitivity test on these values was recommended to determine the influence it may have on the resulting flows. Table 1 presents the adopted Manning's 'n' values for various ground cover conditions in the BMT WBM hydrologic model for the North Byron catchment.

**Table 1: 2016 Flood Study (NBFS) Hydrologic Model Manning's 'n' values**

| Ground cover | Manning's 'n' |
|---|---|
| **Urban** | 0.025 |
| **Rural** | 0.04 |
| **Forested** | 0.06 |

This memo presents the findings of the sensitivity analysis on the Manning's 'n' values of the XP-RAFTS hydrologic model. Manning's 'n' values were varied by ± 0.01 (see Table 2) and the results have been analysed for the 20% AEP, 1% AEP and PMF design flood events.

**Table 2: Manning's 'n' values adopted in sensitivity tests**

| Ground cover | Min. manning's values (-0.01) | NBFS model Manning's n | Max. manning's values (+0.01) |
|---|---|---|---|
| **Urban** | 0.015 | 0.025 | 0.035 |
| **Rural** | 0.03 | 0.04 | 0.05 |
| **Forested** | 0.05 | 0.06 | 0.07 |

# 2. SENSITIVITY ANALYSIS

## 2.1. 1% AEP DESIGN EVENT

Table 3 and Figure 1 show the modelled flow at various locations within the catchment for the 1% AEP design event. This has been done for the three Manning's 'n' scenarios.

On average, an increased Manning's 'n' value reduces flow by 11% across the creek / river systems, and a reduced Manning's 'n' increases flow by 8%. However, looking at the individual systems, it is apparent that Manning's 'n' value has a larger impact on Simpsons Creek and Yelgun Creek than it does on the Brunswick River and Marshalls Creek. Whilst a Manning's 'n' change of ±0.01 has an impact on flow of less than 10% on the larger catchments, for Simpsons Creek the flows are reduced by 27% as roughness increases. For Yelgun Creek, the flow increases by 13% as roughness values decrease. This is likely due to the smaller catchment size, as well simpler rural/forested delineations.

**Table 3: Impact of Manning's 'n' values on 1% AEP flow at different locations**

| Location | 1% AEP Peak Flow, $m^3/s$ (% change from NBFS) | | |
|---|---|---|---|
| | NBFS Manning's 'n' values | Increased Manning's 'n' (+0.01) | Decreased Manning's 'n' (-0.01) |
| **Durrumbul Gauge (Brunswick River)** | 740 | 710 (-4%) | 790 (+7%) |
| **Federation Bridge (Brunswick River)** | 1140 | 1030 (-10%) | 1150 (+1%) |
| **Brunswick Head (Brunswick River)** | 1250 | 1160 (-7%) | 1320 (+6%) |
| **Billinudgel (Marshalls Creek)** | 360 | 320 (-11%) | 380 (+6%) |
| **Kallaroo Circuit (Yelgun Creek)** | 110 | 100 (-9%) | 130 (+13%) |
| **Sth Beach Rd (Simpsons Creek)** | 520 | 380 (-27%) | 590 (+13%) |

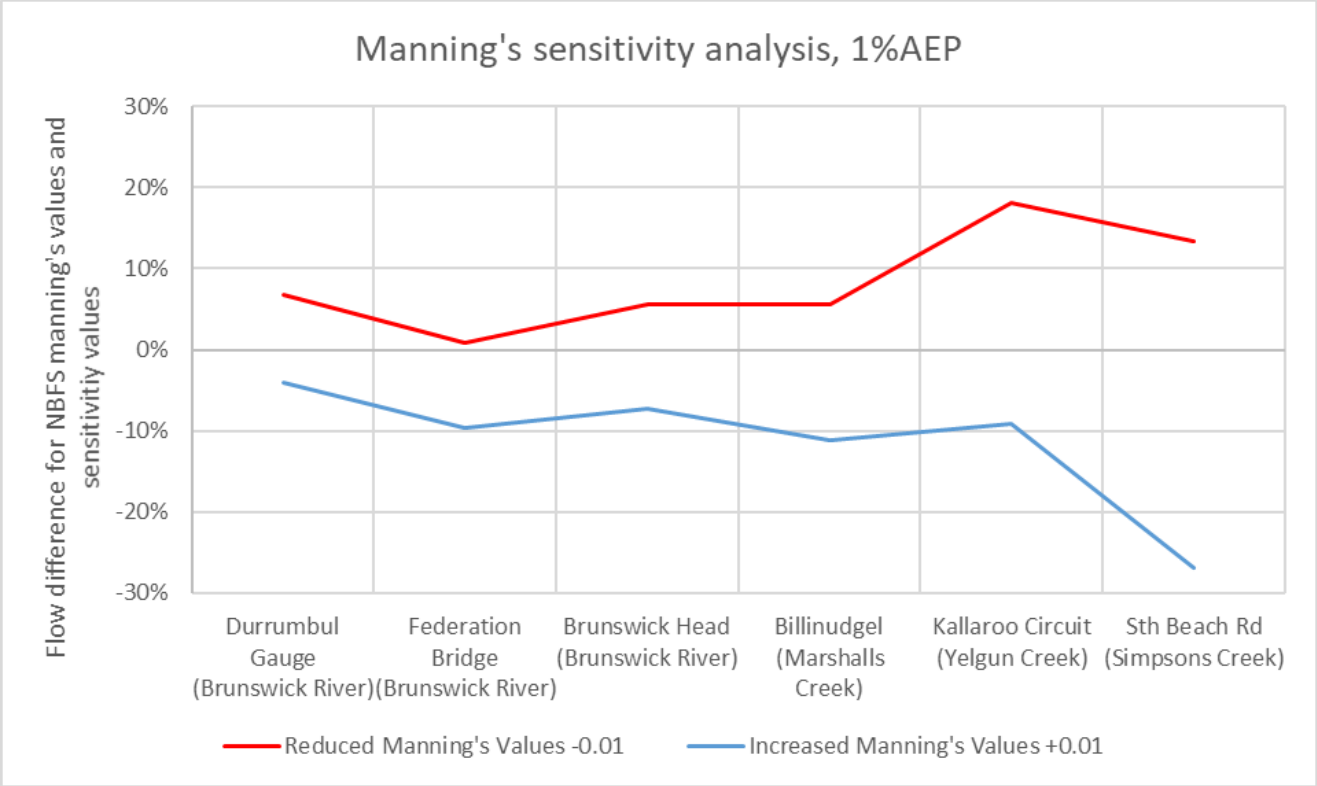


**Figure 1: Manning's Sensitivity Analysis, 1% AEP**

## 2.2. 5% AEP DESIGN EVENT

For the 5% AEP design event, the impact on flow is less than 20% across the catchments, except for Simpsons Creeks where an increased manning value of +0.01 reduces the flow of 30% at South Beach Road. Similar to the 1% AEP event, flow is more sensitive to Manning's 'n' changes along Simpsons Creek and Yelgun Creek than for Brunswick River and Marshalls Creek.

The average impact for increased Manning's 'n' values is -15%, and +9% for reduced roughness values.

**Table 4: Impact of Manning's values on 5%AEP Flow for different location**

| Location | 5% AEP Peak Flow, $m^3/s$ (% change from NBFS) | | |
|---|---|---|---|
| | NBFS Manning's 'n' values | Increased Manning's 'n' (+0.01) | Decreased Manning's 'n' (-0.01) |
| **Durrumbul Gauge (Brunswick River)** | 340 | 270 (-21%) | 300 (-12%) |
| **Federation Bridge (Brunswick River)** | 470 | 410 (-13%) | 510 (+9%) |
| **Brunswick Head (Brunswick River)** | 540 | 470 (-13%) | 570 (+6%) |
| **Billinudgel (Marshalls Creek)** | 170 | 150 (-12%) | 190 (+12%) |
| **Kallaroo Circuit (Yelgun Creek)** | 50 | 50 (0%) | 60 (+20%) |
| **Sth Beach Rd (Simpsons Creek)** | 260 | 180 (-30%) | 310 (+19%) |

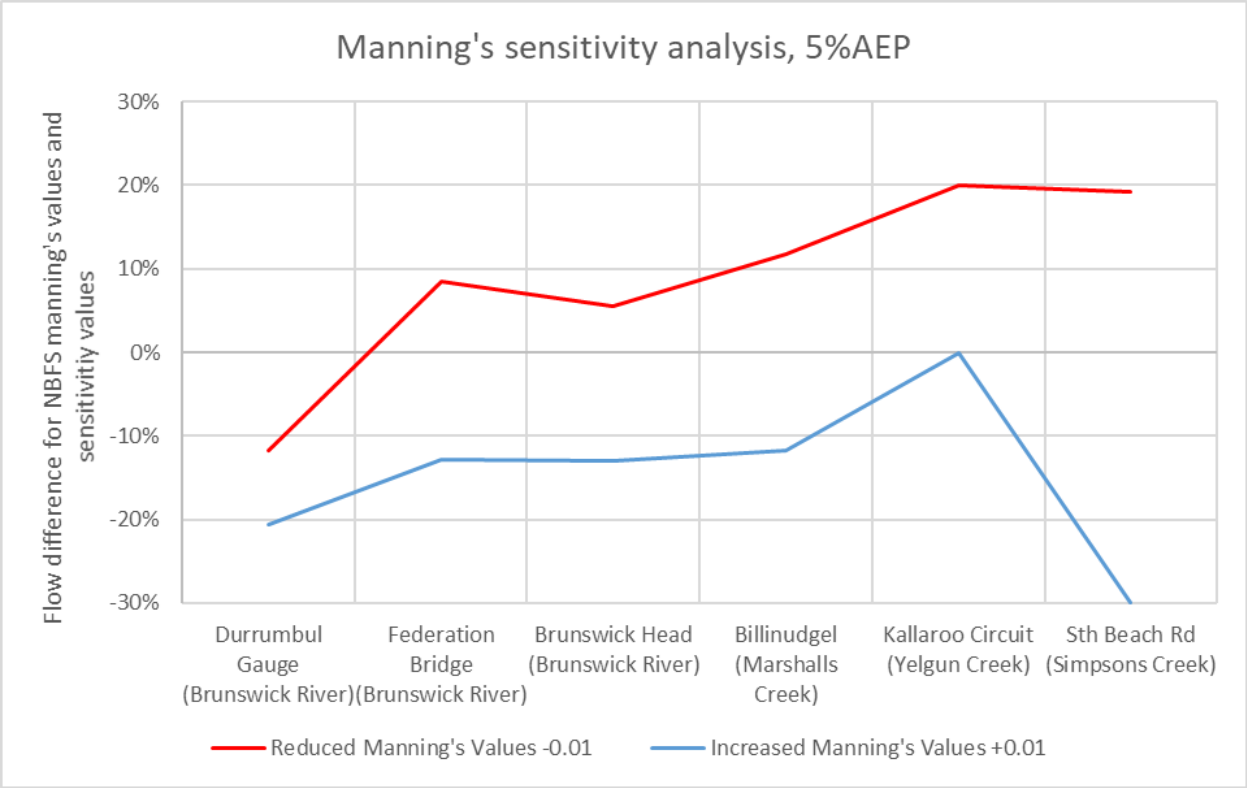


**Figure 2: Manning's Sensitivity Analysis, 5% AEP**

## 2.3. PMF DESIGN EVENT

For the PMF, sensitivity tests show that whilst a roughness change of -0.01 can cause an increase of 210 $m^3/s$ downstream of Simpsons Creek, this only represents an increase of 8%. For Brunswick River, both increasing and decreasing Manning's n values results in a reduction in flow (varying between 0% and -19%). On Marshalls Creek and Yelgun Creek, the impact is approximately ±10% for Marshalls Creek and Yelgun Creek.

The average impact for increased Manning 'n' values is -9%, and +1% for reduced Manning's 'n' values.

**Table 5: Impact of Manning's values on PMF Flow for different location**

| Location | PMF Peak Flow, $m^3/s$ (% change from NBFS) | | |
|---|---|---|---|
| | NBFS Manning's 'n' values | Increased Manning's 'n' (+0.01) | Decreased Manning's 'n' (-0.01) |
| **Durrumbul Gauge (Brunswick River)** | 2930 | 2880 (-2%) | 2380 (-19%) |
| **Federation Bridge (Brunswick River)** | 4450 | 4350 (-2%) | 4430 (+0%) |
| **Brunswick Head (Brunswick River)** | 5000 | 4800 (-4%) | 4960 (-1%) |
| **Billinudgel (Marshalls Creek)** | 1510 | 1310 (-13%) | 1600 (+6%) |
| **Kallaroo Circuit (Yelgun Creek)** | 470 | 420 (-11%) | 510 (+9%) |
| **Sth Beach Rd (Simpsons Creek)** | 2510 | 1970 (-22%) | 2720 (+8%) |

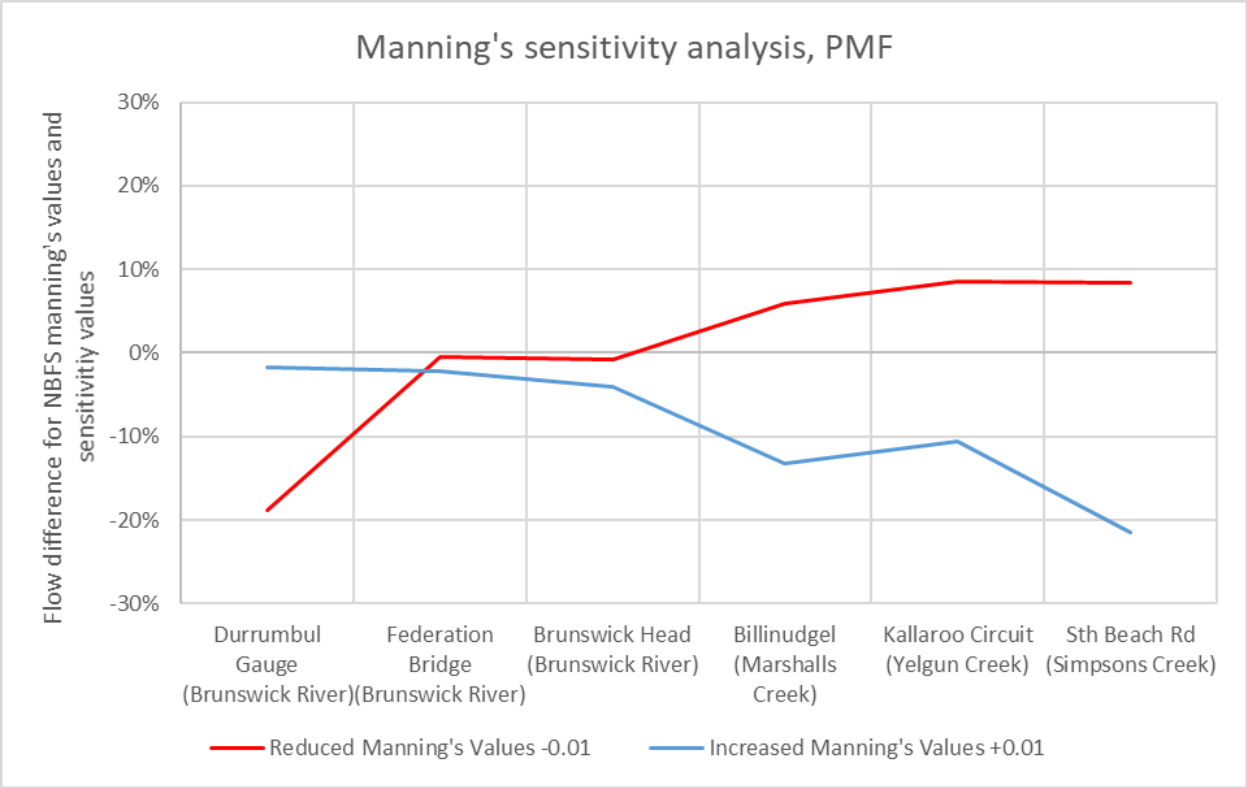


**Figure 3: Manning's Sensitivity Analysis, PMF**

## 3. CONCLUSION

Sensitivity tests on the XP-RAFTS hydrologic model show that altering Manning's 'n' values have a greater impact on the flows of smaller design events than the larger more extreme events. A change in Manning's 'n' values of ±0.01 has an average impact on flow of 10% for the 1% AEP, 12% for the 5% AEP, and 5% for the PMF.

Overall, the hydrologic model is not particularly sensitive to changes in Manning's 'n' values. As the adopted values are based on calibration to historical events, and are marginally conservative, they are considered appropriate and no further changes recommended.

## List of Figures



## Reference

North Byron Shire Flood Study (BMT WBM, 2016)