BMT WBM

Tamar Lake Inc. Zone 1 Water Quality

Reference: R.B22148.002.01.Zone1WQ.docx
Date: August 2016
Confidential

Document Control Sheet

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia
PO Box 203, Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Document:	R.B22148.002.01.Zone1WQ.docx
Title:	Tamar Lake Inc. Zone 1 Water Quality
Project Manager:	Michael Barry
Author:	Christopher Vos
Client:	Tamar Lake Inc.
Client Contact:	Robin Frith
Client Reference:	

Synopsis: **Scenarios investigating change in water quality within Zone 1 of the Tamar Estuary using a greater release rate from the Cataract Gorge**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	2nd August 2016	CAV		MEB	
1	19th August 2016	CAV		MEB	

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
Tamar Lake Inc.	PDF	PDF									
BMT WBM File	PDF	PDF									
BMT WBM Library	PDF	PDF									

Contents

1 Introduction 1
2 Methodology 4
2.1 Model Description 4
2.1.1 Barrage control rules 4
2.1.2 WWTPs 4
2.1.3 Nutrient Sediment Flux 5
2.1.4 Time period 5
2.2 Scenarios 5
3 Results 7
3.1 Presentation 7
3.1.1 Median contour plots 7
3.2 Contour plots 7
3.3 Contour plots 8
3.4 Temperature 8
3.4.1 Top Layer 8
3.4.2 Bottom Layer 9
3.5 Salinity 10
3.5.1 Top Layer 10
3.5.2 Bottom Layer 11
3.6 TSS 12
3.6.1 Top Layer 12
3.6.2 Bottom Layer 13
3.7 DO (Saturation) 14
3.7.1 Top Layer 14
3.7.2 Bottom Layer 15
3.8 Ammonia 16
3.8.1 Top Layer 16
3.8.2 Bottom Layer 17
3.9 Nitrate 18
3.9.1 Top Layer 18
3.9.2 Bottom Layer 19
3.10 Total Nitrogen 20
3.10.1 Top Layer 20

3.10.2 Bottom Layer 21
3.11 FRP 22
3.11.1 Top Layer 22
3.11.2 Bottom Layer 23
3.12 Total Phosphorus 24
3.12.1 Top Layer 24
3.12.2 Bottom Layer 25
3.13 Chlorophyll-a 26
3.13.1 Top Layer 26
3.13.2 Bottom Layer 27
3.14 Enterococci 28
3.14.1 Top Layer 28
3.14.2 Bottom Layer 29
3.15 Contour Plots 30
3.16 Total Nitrogen 30
3.17 Total Phosphorus 31
4 Discussion 32
5 References 33

List of Figures

Figure 1-1 Locality Map 2
Figure 1-2 Tamar reporting zones 3
Figure 2-1 Extraction locations 6
Figure 3-1 Example thalweg median plot 7
Figure 3-2 Example contour plot 7

List of Tables

Table 2-1 Tamar Estuary Water Quality Targets 4
Table 2-2 Scenarios 5

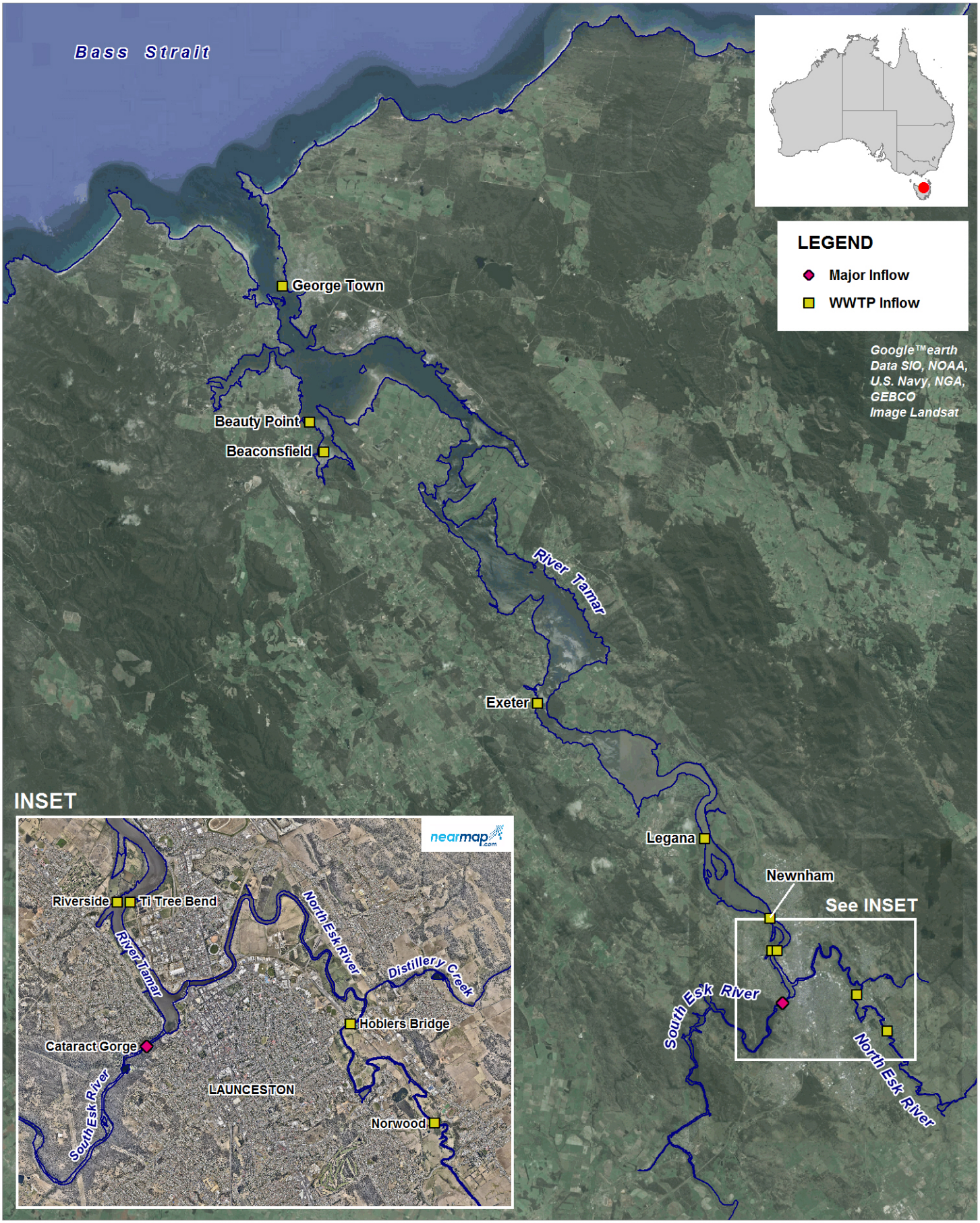
1 Introduction

The Tamar Estuary (see locality map, Figure 1-1), situated in Tasmania's North, is a complex environmental system driven by a number of key processes. The system receives major inflows from the North and South Esk rivers as well as direct inflows from surrounding catchments. Flows from the South Esk are contained by the Trevallyn Dam from which flows are also directed through the Trevallyn Hydro-electric station and downstream tailrace. Complex siltation and scour processes dominate the system and play an important part in controlling estuarine water quality.

The Ecosystem Health Assessment Program (EHAP) generates report cards for five zones within the Tamar Estuary (Figure 1-2). For the most recent (2015) reporting period the system received scores varying from A- to D. The one zone receiving a score of D was zone 1 which covers the most upper reaches of the Tamar Estuary surrounding Launceston. This score indicated that water quality targets were met only 50 to 59% of the time. The components of water quality measured for the report card were total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS) and Enterococci.

BMT WBM Pty Ltd has previously constructed a three dimensional (3D) hydrodynamic, sediment transport and water quality model of the Tamar Estuary on behalf of NRM North. Tamar Lake Inc. (TLI) subsequently commissioned the execution of several scenarios using this model. TLI proposes the installation of a barrage just south of the Rowella area to create a 60km long freshwater lake.

In the current study, BMT WBM Pty Ltd was commissioned by Tamar Lake Inc. to investigate the water quality of Zone 1 within the Tamar Estuary as well as the North Esk River under 'developed case' conditions with an increased discharge rate from the Cataract Gorge to the South Esk.



Title:

Locality Map

Figure: 1-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

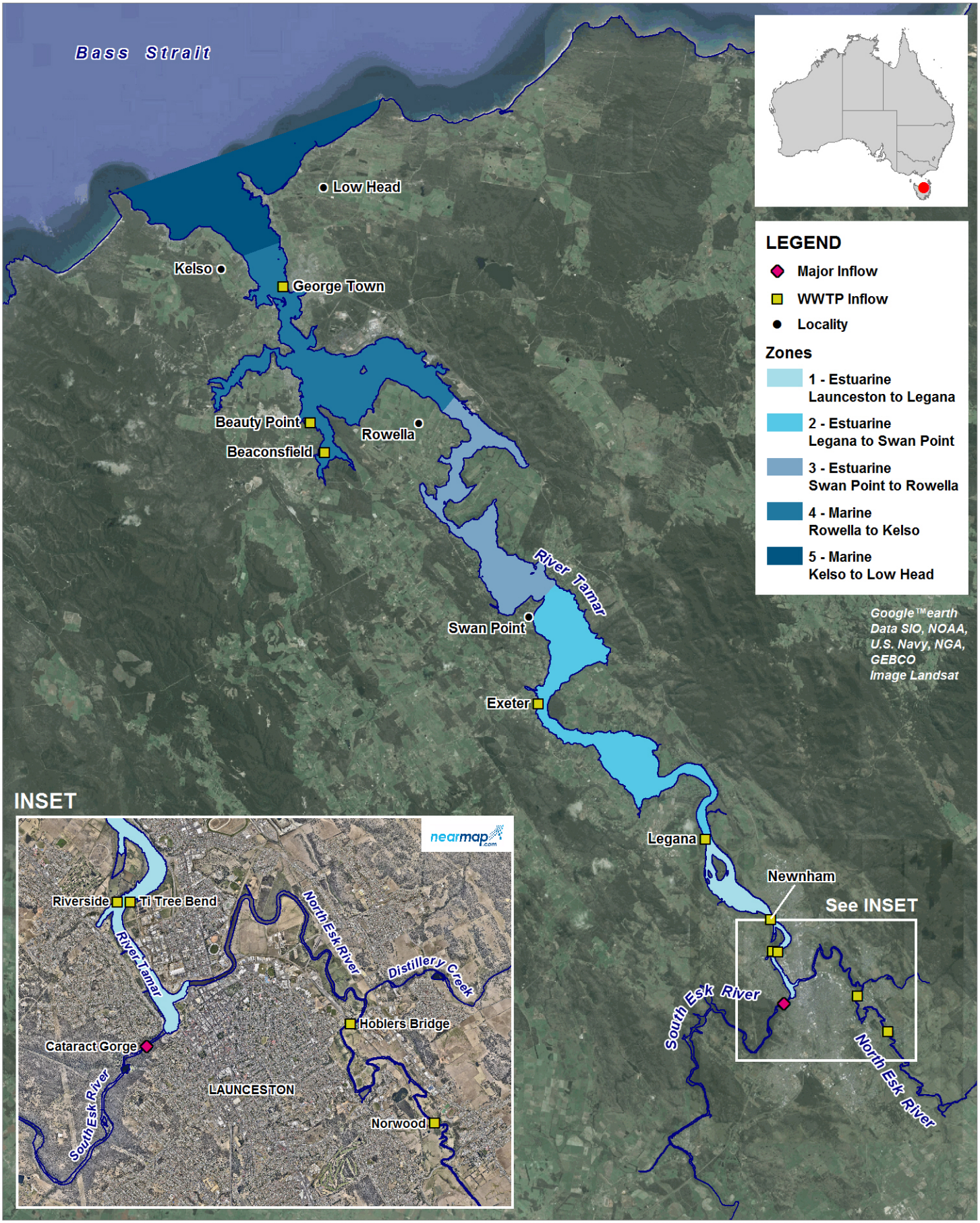
N

0km 5 10
Scale - Main Map

0km 2 4
Scale - Inset

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B22148_I_JLB Tamar Lake Scenarios June 2016 MEB\DRG\CAR_001_160722_Locality Map Zone 1.wor



Title:

Tamar Reporting Zones

Figure: 1-2

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0km 5 10
Scale - Main Map

0km 2 4
Scale - Inset

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B22148_I_JLB Tamar Lake Scenarios June 2016 MEB\DRG\CAR_002_160802_Tamar Reporting Zones Zone 1.wor

2 Methodology

For the purposes of this study a constant discharge of 20m^3/s was applied to the inflows entering the model via the Cataract Gorge from the South Esk, at the instruction of TLI. Two barrage scenarios were executed to compare the water quality within the Tamar estuary under different 'developed case' conditions. The first of which was established under 'as is' conditions with wastewater treatment plant (WWTP) discharges entering the model from their respective locations, and the second with discharges configured in accordance with the Launceston Sewage Infrastructure Plan (LSIP). An additional scenario was executed using the same constant discharge, however applied to existing baseline conditions.

Results were then compared to water quality targets set by NRM North (2016). These targets are presented below in Table 2-1.

Table 2-1 Tamar Estuary Water Quality Targets

Parameter	Chl-a (µg/L)	TP (mg/L)	TN (mg/L)	Turbidity NTU	DO (% Sat)
Estuarine Trigger Level	3.4	0.0274	0.384	6.4	Lower – 78.2 Upper – 102.2
Marine Trigger Level	0.7	0.0036	0.340	5.1	Lower – 91.7 Upper – 102.2

2.1 Model Description

2.1.1 Barrage control rules

The control rules used in this study are the same as those outlined in the Tamar Lake Scenarios report (BMT WBM 2016). The barrage was permitted to release water twice per day on the ebbing tides, using flow controls and artificial structures. Ebb-tide flows were defined to be a sufficient flow rate to achieve a daily balance with the incoming flows from the North Esk the South Esk and the Tailrace. Controls were set in place to adjust this flow to be greater or lesser if the water level upstream of the barrage either exceeded 1mAHD or fell below 0.8m AHD. Flows were applied over the top two meters of the water column.

2.1.2 WWTPs

For the first scenario, treatment plants were incorporated into the model using data provided by TasWater for current flows and loads. These flows and loads are the same as those used in the NRM North, Tamar Estuary 3D model. The second scenario incorporated the implementation of the LSIP. Under the LSIP scenario the six decommissioned WWTPs were removed and flows and loads were redirected through the New Northern WWPT which is proposed to be constructed alongside the existing plant at Ti-Tree Bend (as presented in Figure 1-2). Flows and loads from Ti-Tree Bend remained unchanged for the second scenario in accordance with the LSIP.

2.1.3 Nutrient Sediment Flux

For the purposes of TLI scenarios, sediment flux parameters were applied upstream of the barrage that were representative of a lake system. These sediment flux parameters are presented in the Tamar Lake Scenarios report (BMT WBM, 2016).

2.1.4 Time period

To capture seasonal variability for each scenario the model was simulated over a winter to winter period. The timeframe used was 01/07/2010 to 01/07/2011.

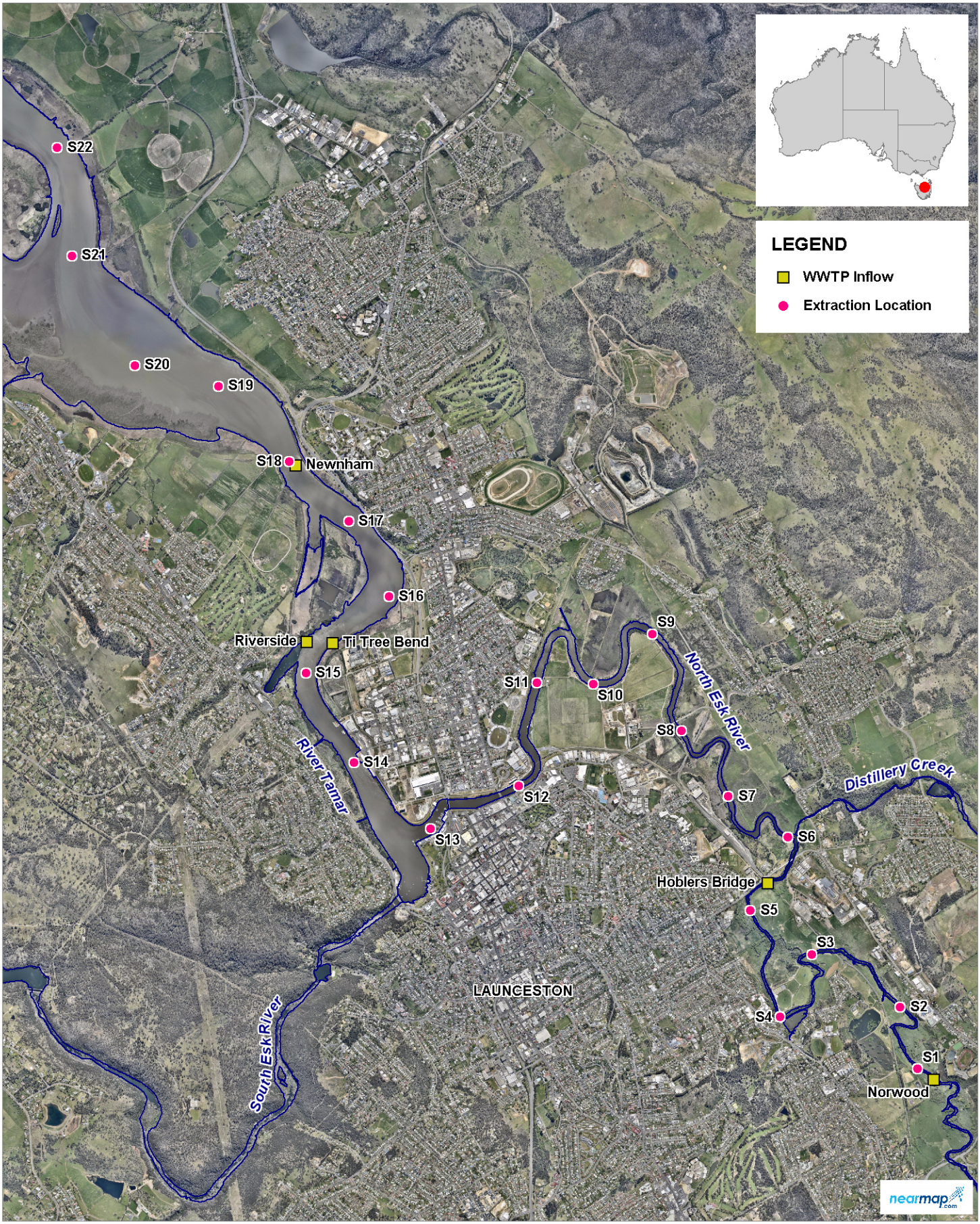
2.2 Scenarios

The scenarios and their corresponding inputs are presented below in

Table 2-2 Scenarios

Scenario	Scenario	WWTPs
Baseline	Baseline	Unchanged
As current	1	Unchanged
LSIP applied	2	LSIP

Predictions from these scenarios were extracted at 21 different locations within Zone 1. These results are presented Figure 2-1.



Title:

Extraction Locations

Figure: 2-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0km 1 2

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B22148_I_JLB Tamar Lake Scenarios June 2016 MEB\DRG\CAR_006_160802_Extraction Locations Zone1.wor

3 Results

3.1 Presentation

3.1.1 Median contour plots

To provide a spatial comparison between extraction points, model predications have been recast as medians for the various sites within Zone 1. An example median plot is presented in Figure 3-1. Medians are presented along the thalweg, with the darker blue dots representative of scenarios using the current WWTP configuration and the lighter blue represent concentrations under the LSIP configuration. The yellow dots indicate the baseline scenario that was simulated using a 20m^3/s discharge rate from the Cataract Gorge. The red line indicates the water quality objective outlined for the Tamar Estuary. All scenarios are plotted on all figures, however in some instances the model predictions are unchanged from one scenario to another, and as such not all points are visible on every plot due to overlap.

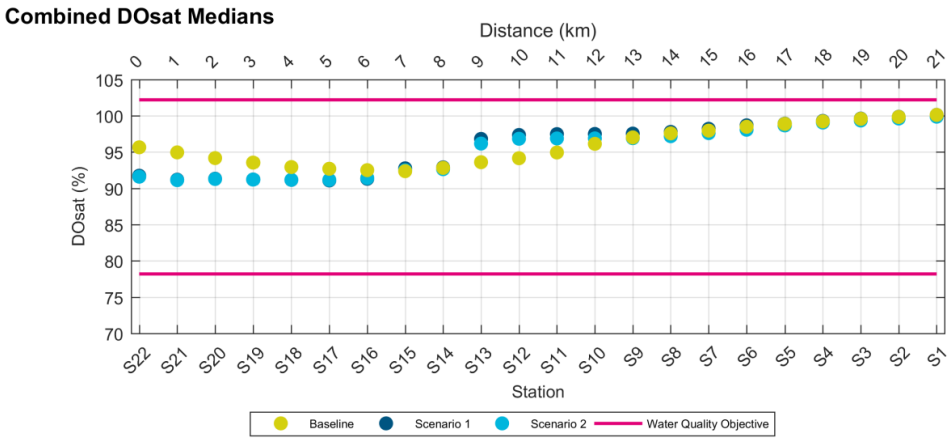


Figure 3-1 Example thalweg median plot

3.2 Contour plots

An example contour plot is presented below in. This plot represents the concentration in TN as an average over the full winter to winter period. The inset is a close up of Zone 1. These plots have been generated for all scenarios for both TN and TP.

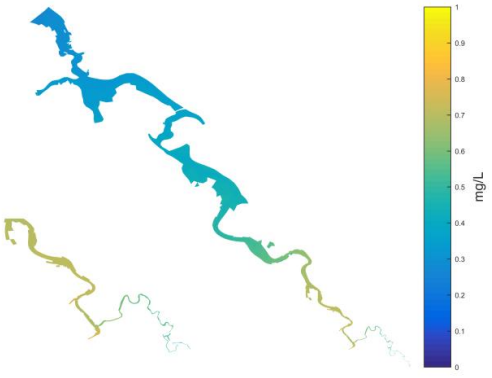
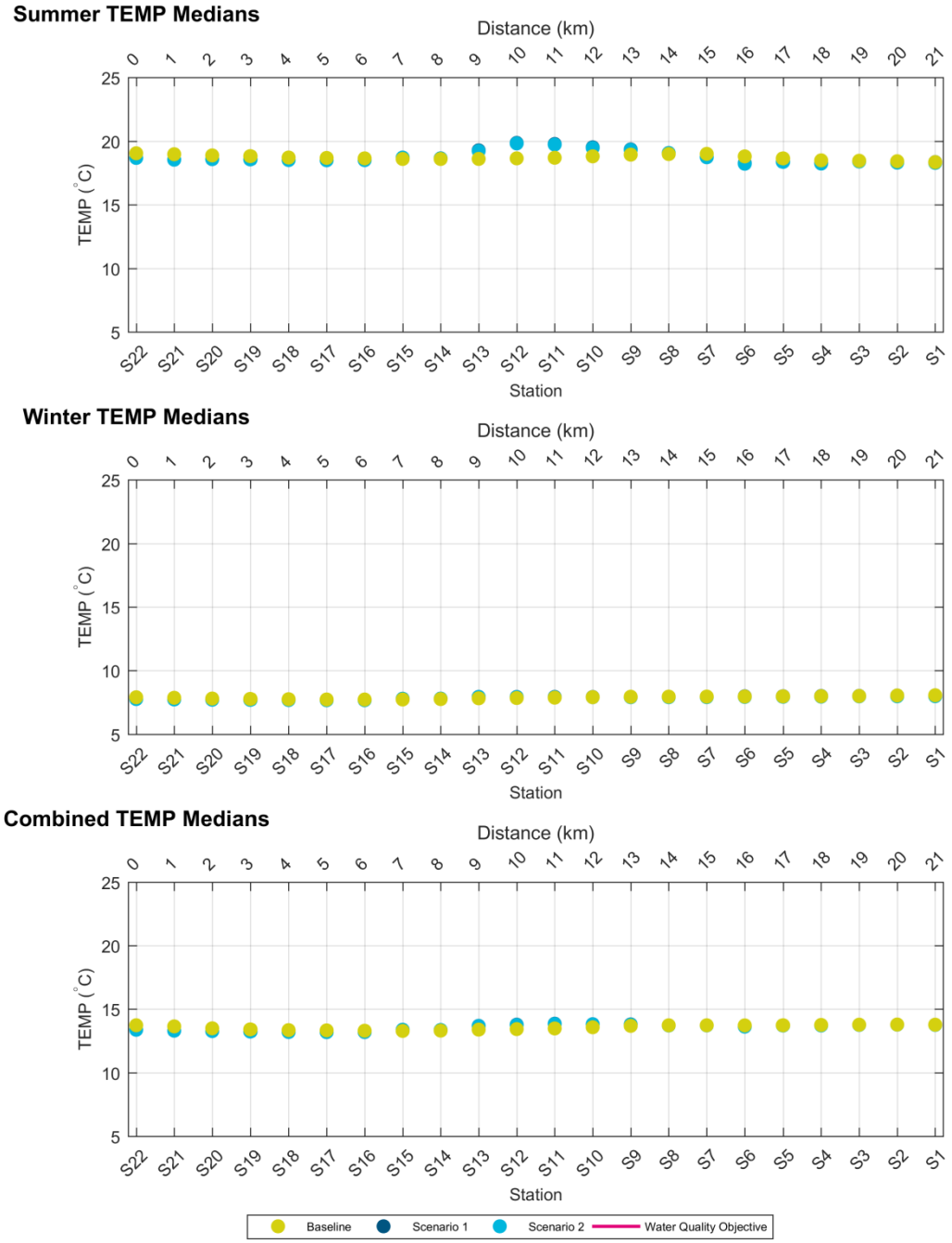


Figure 3-2 Example contour plot

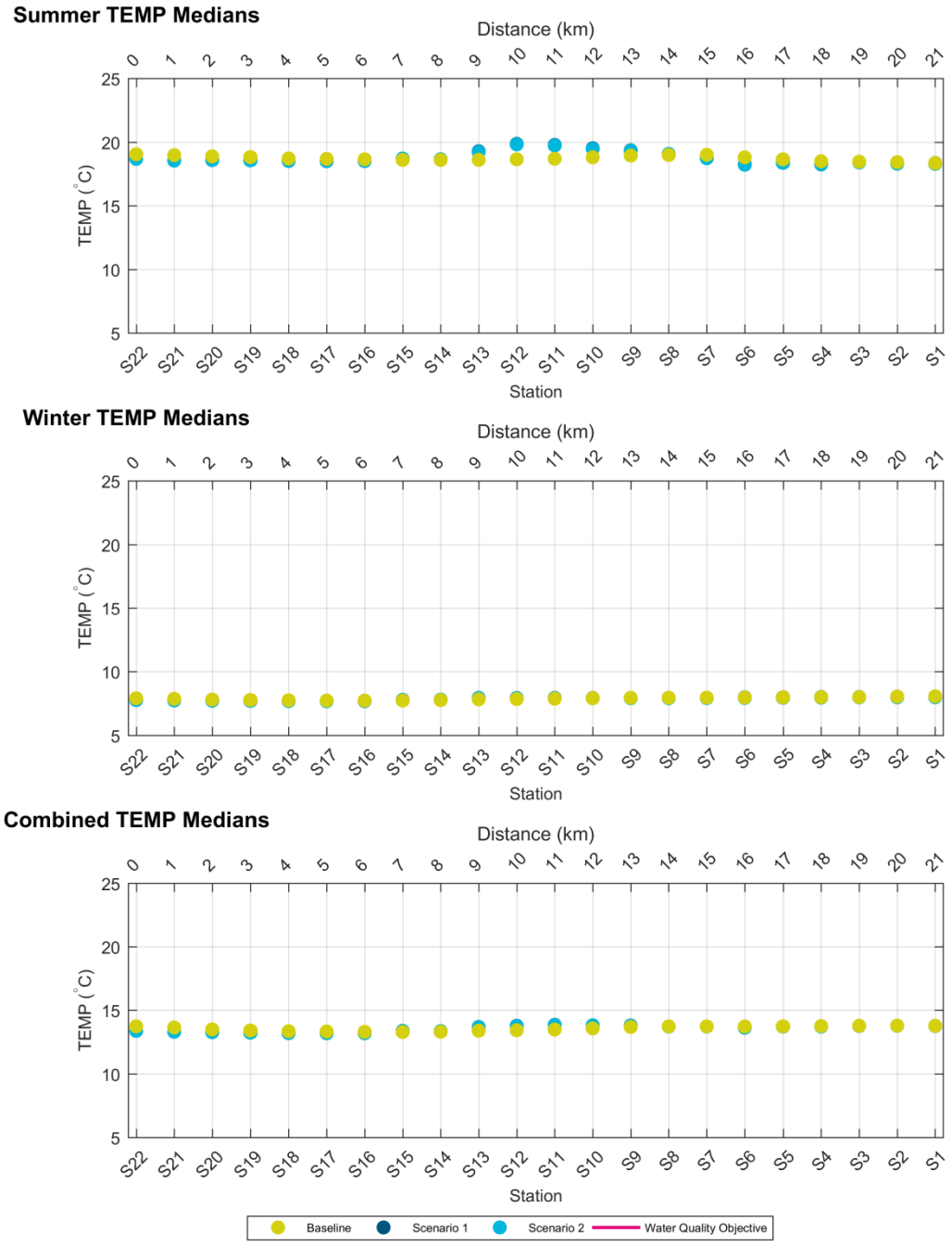
3.3 Contour plots

3.4 Temperature

3.4.1 Top Layer

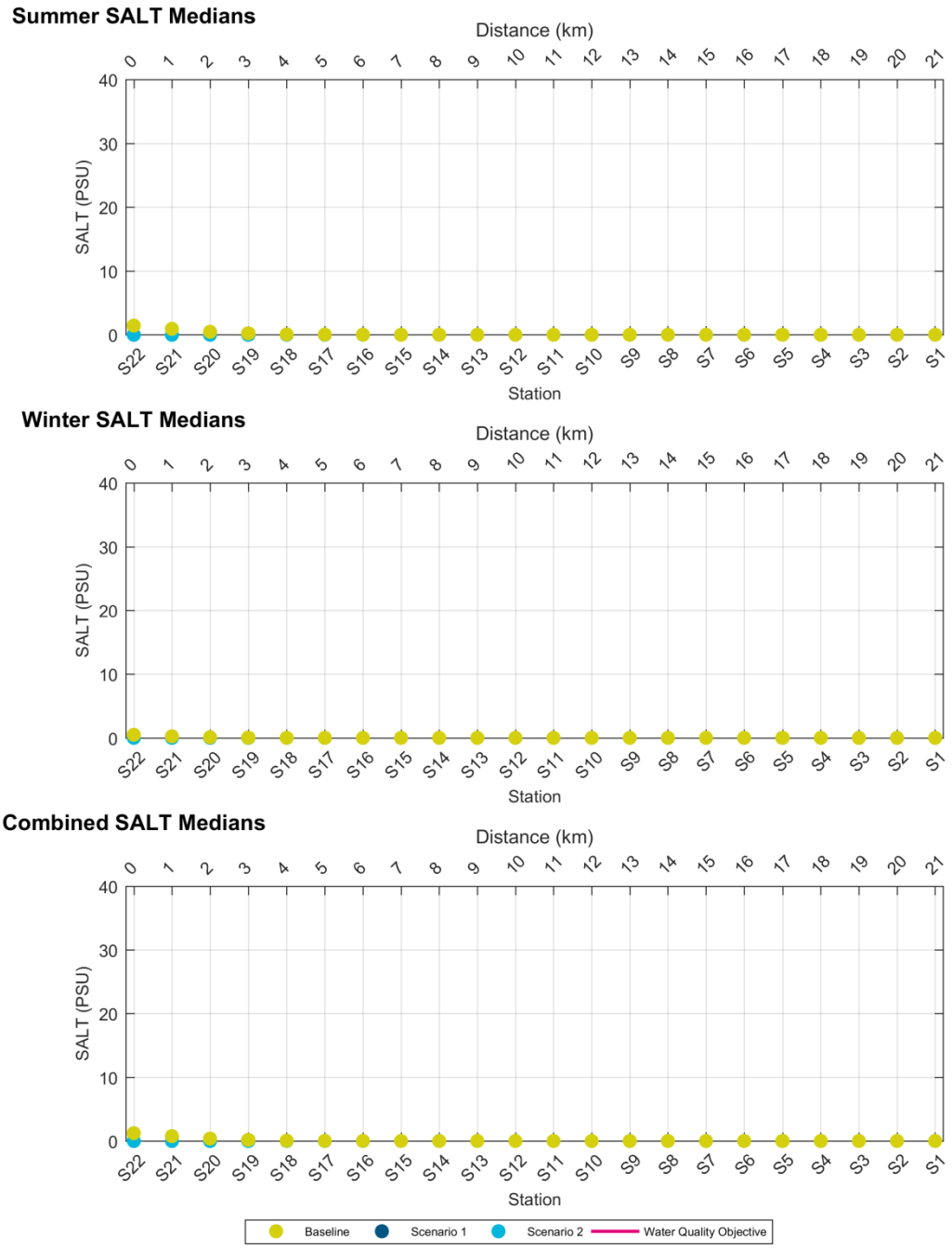


3.4.2 Bottom Layer

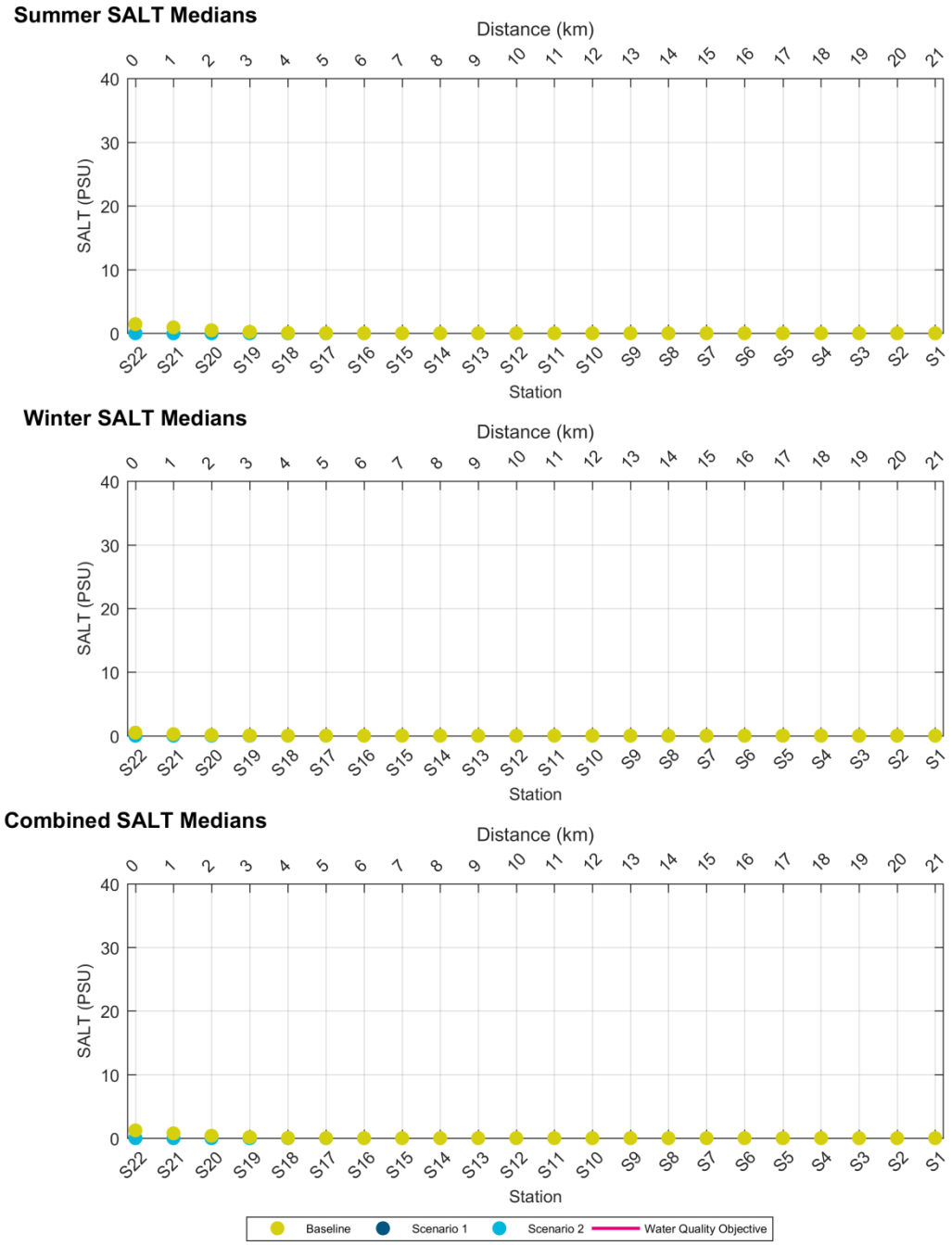


3.5 Salinity

3.5.1 Top Layer

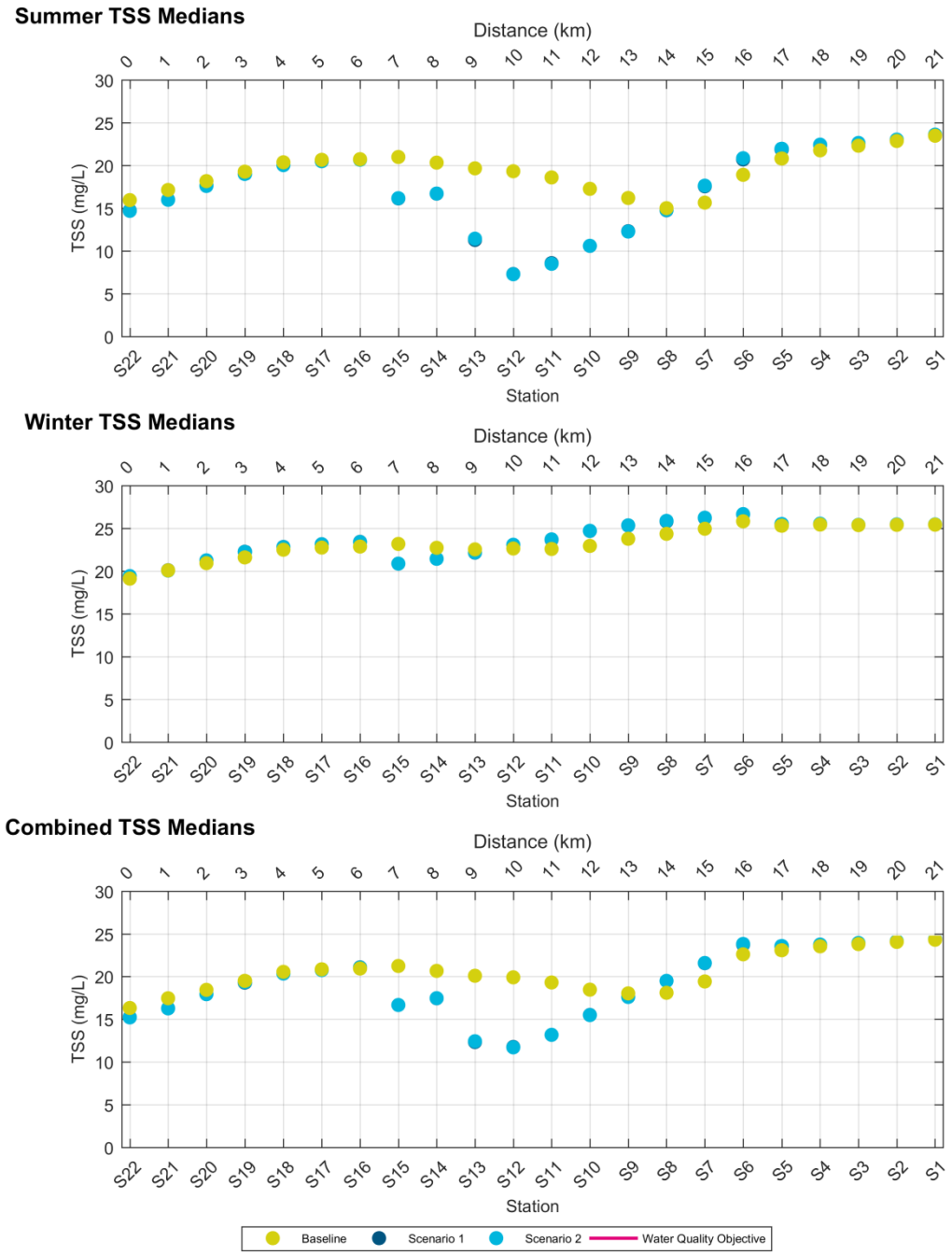


3.5.2 Bottom Layer

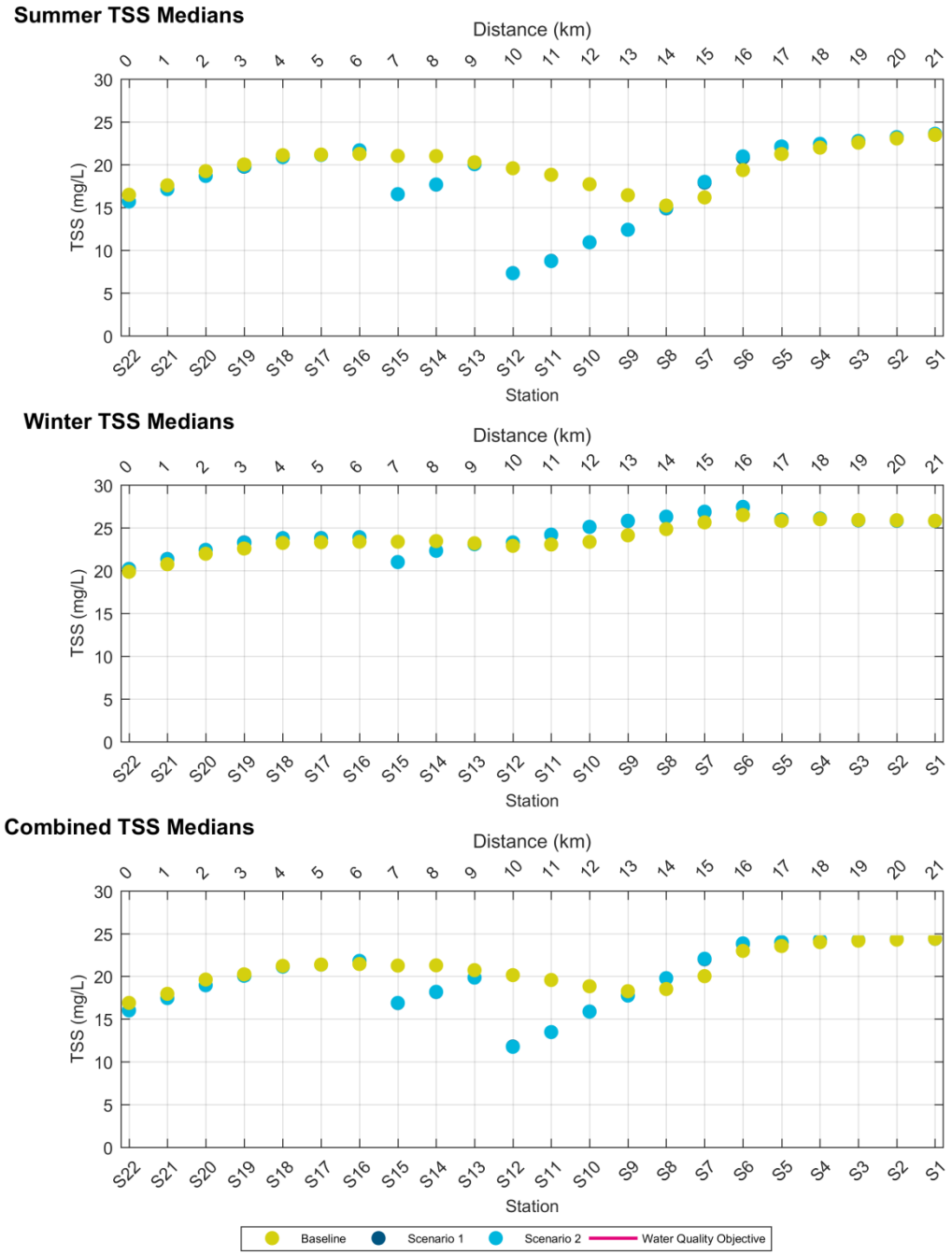


3.6 TSS

3.6.1 Top Layer

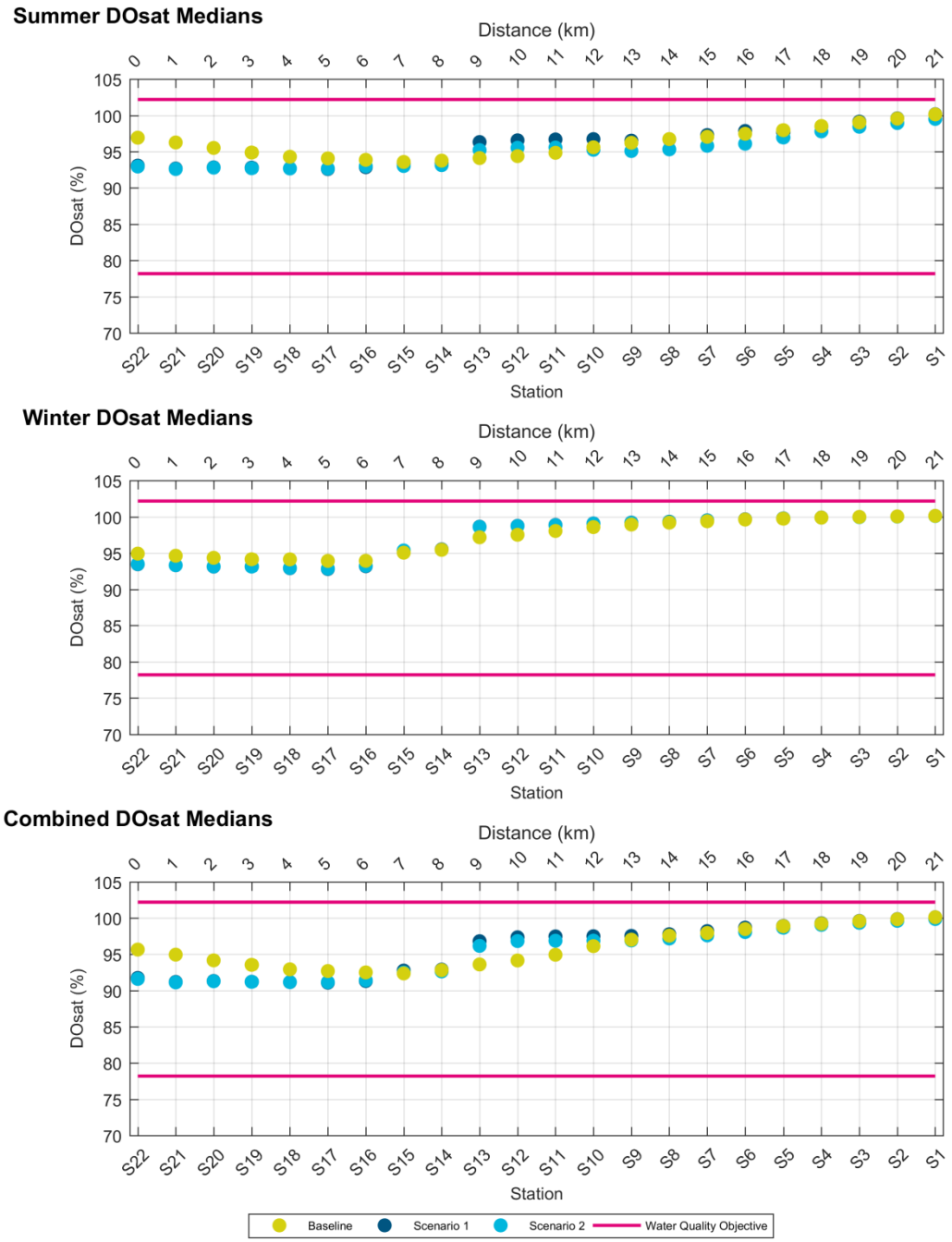


3.6.2 Bottom Layer

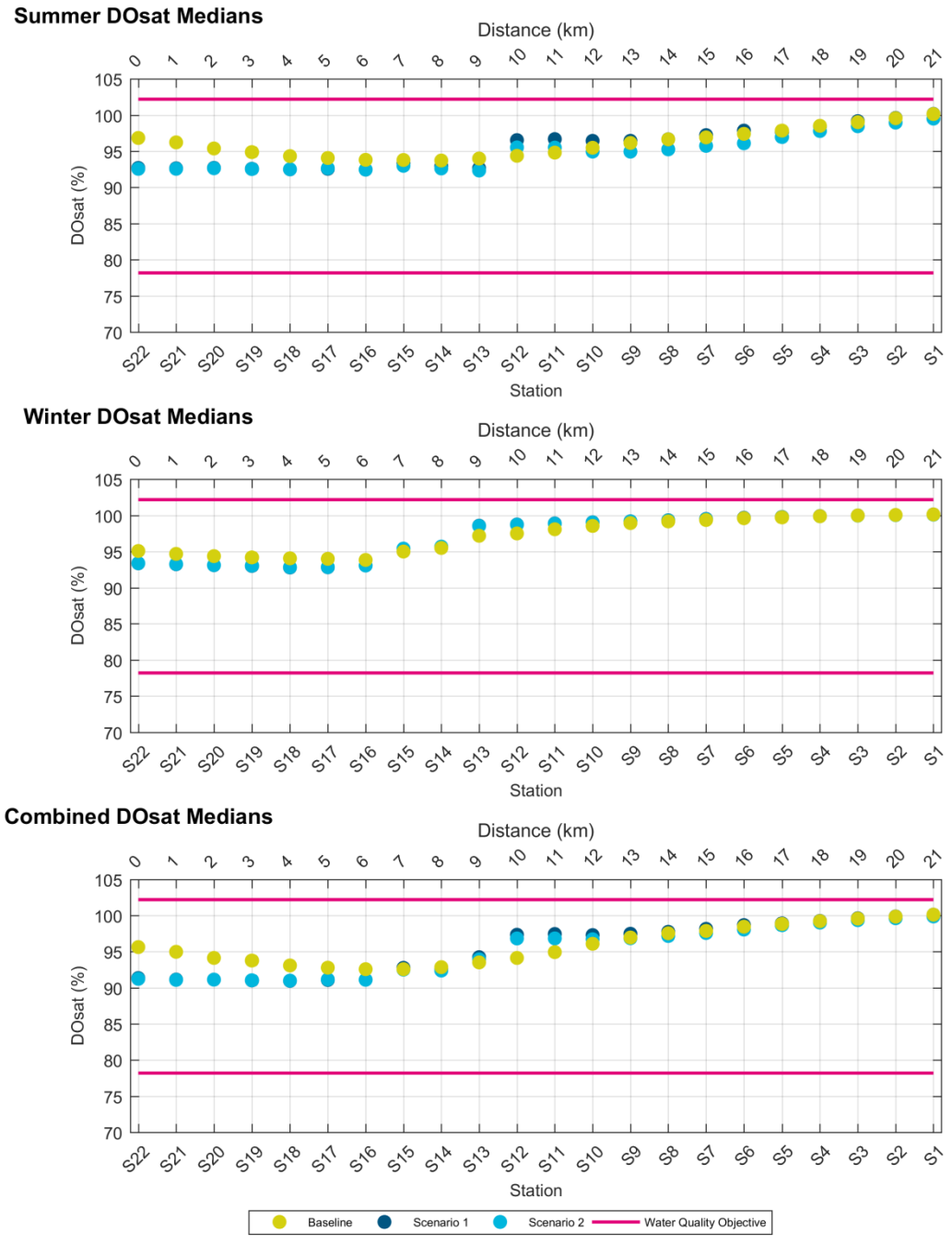


3.7 DO (Saturation)

3.7.1 Top Layer

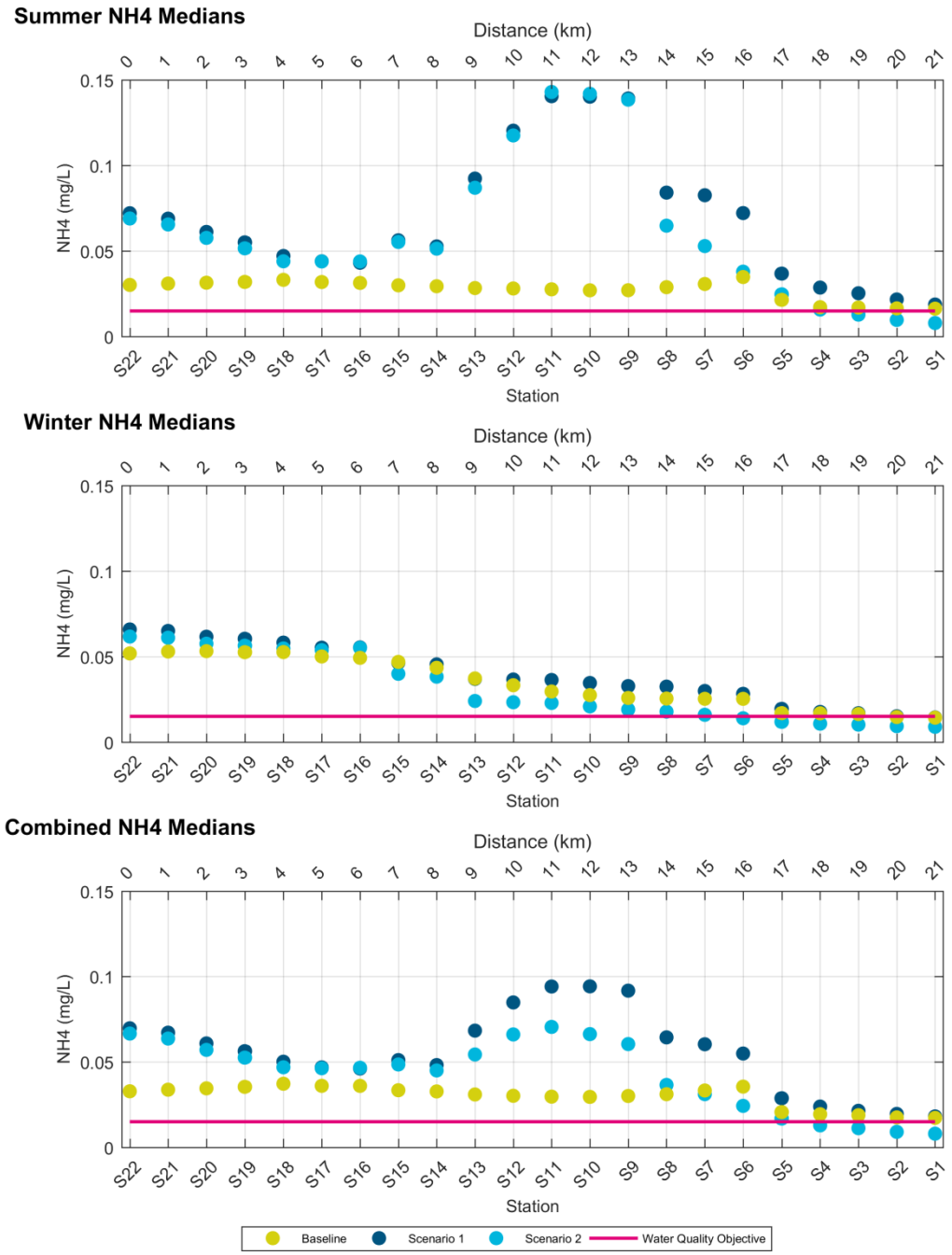


3.7.2 Bottom Layer

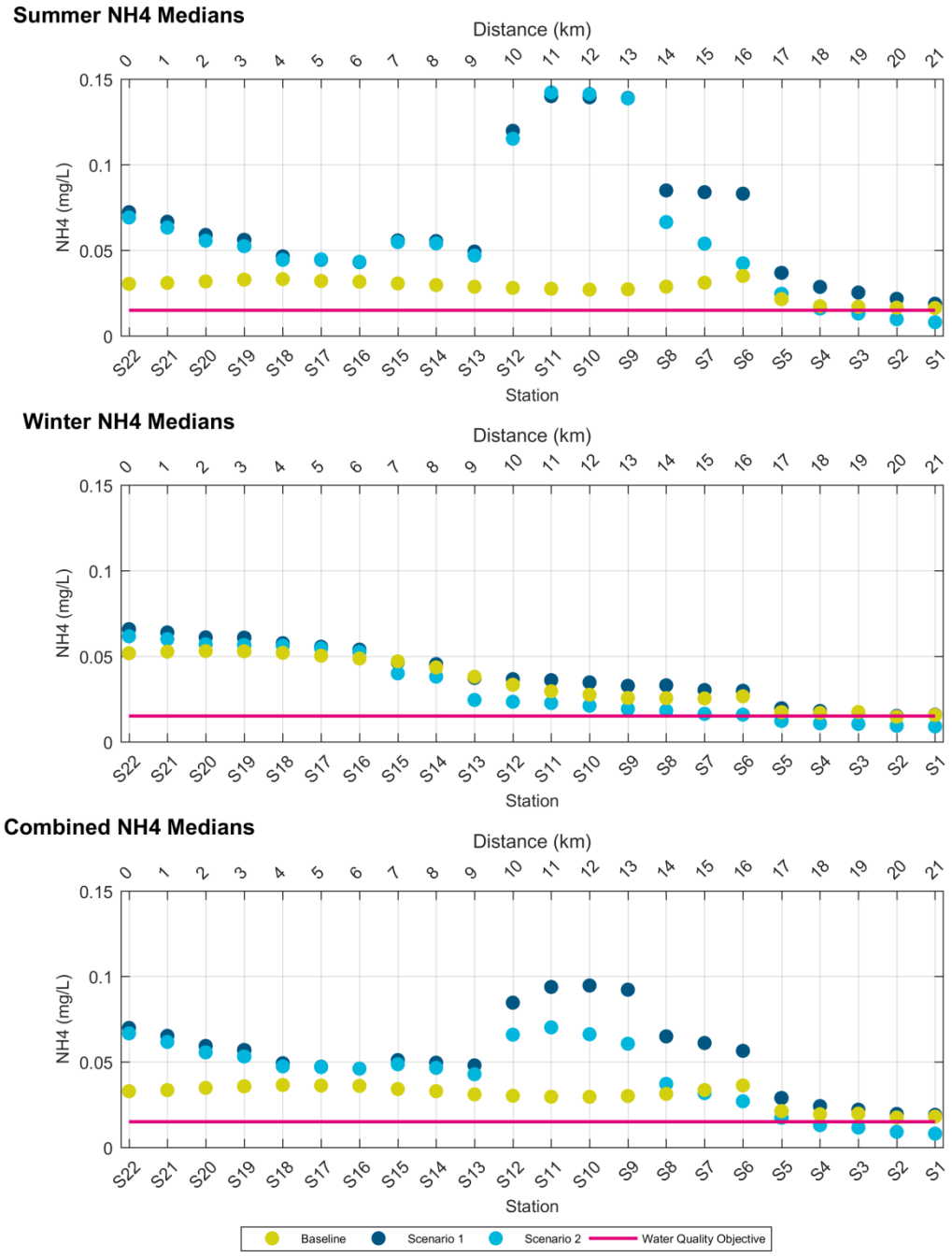


3.8 Ammonia

3.8.1 Top Layer

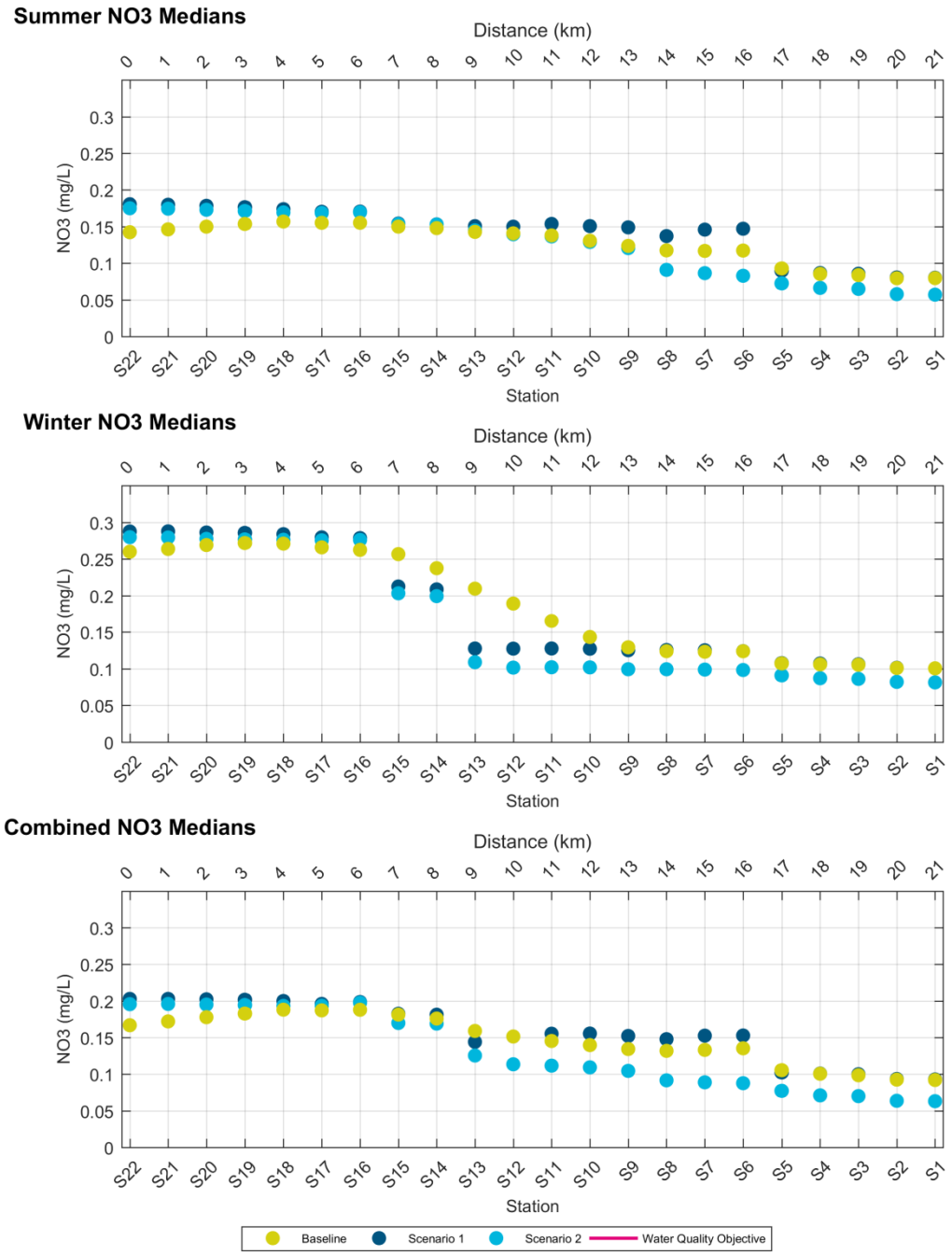


3.8.2 Bottom Layer

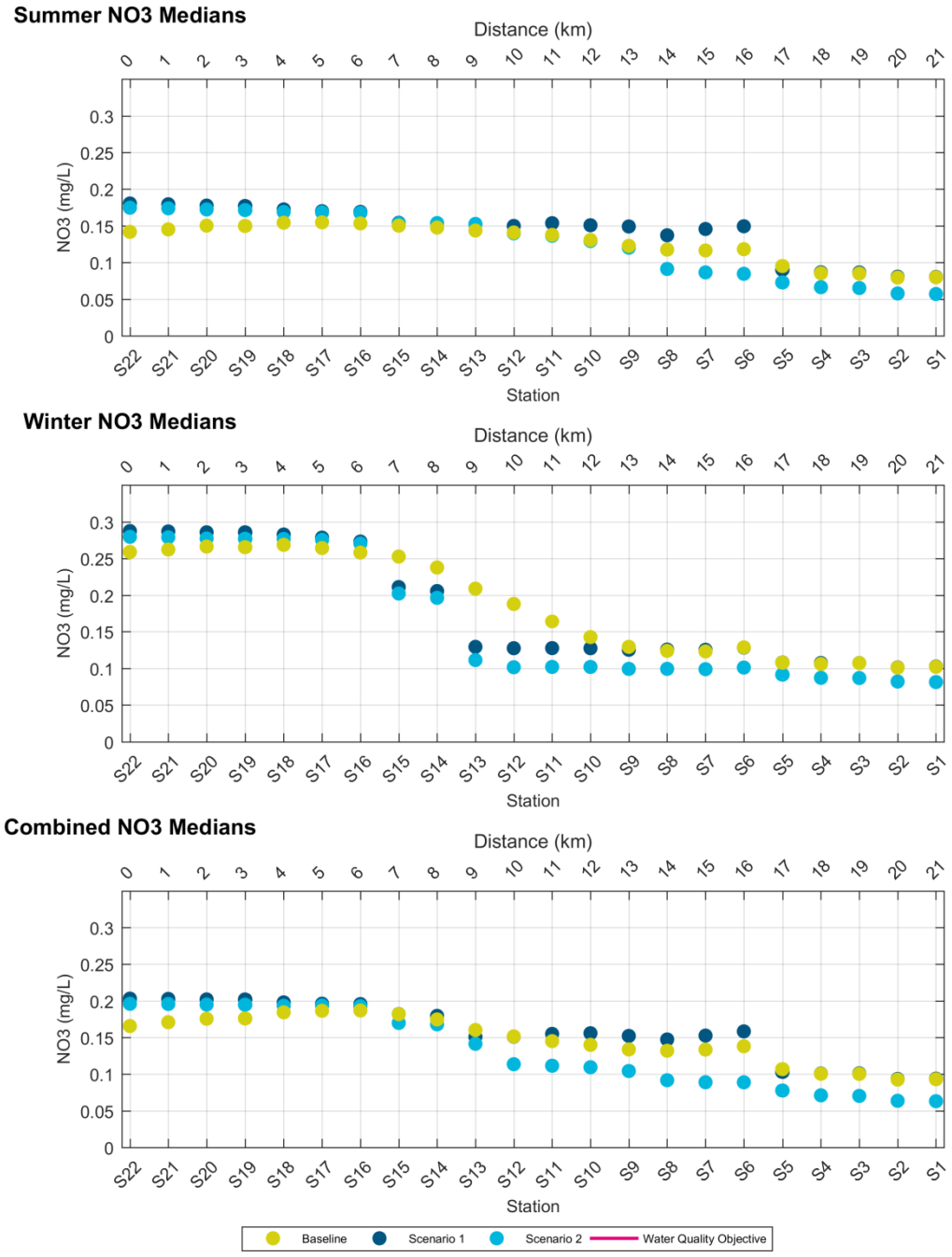


3.9 Nitrate

3.9.1 Top Layer

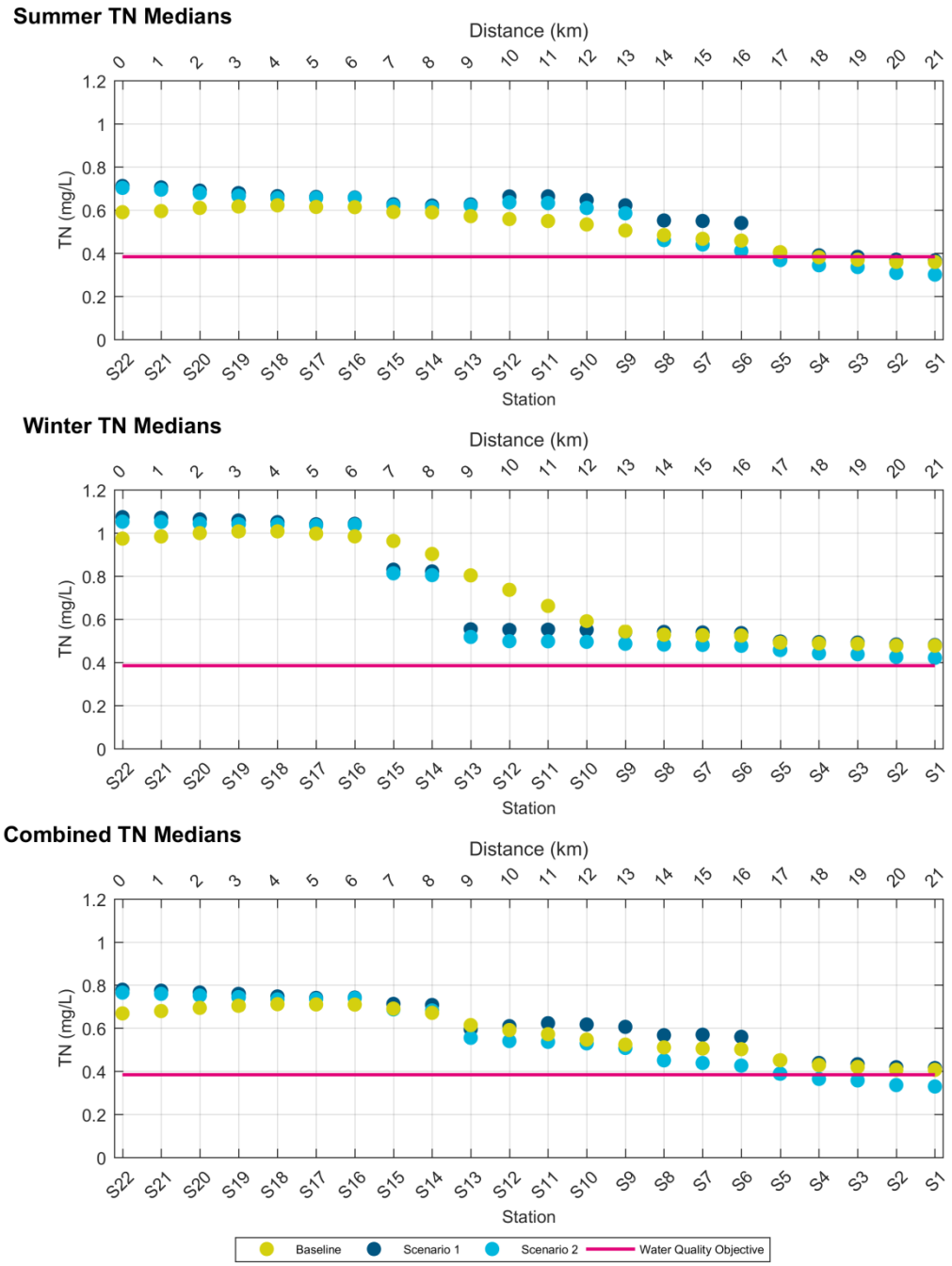


3.9.2 Bottom Layer

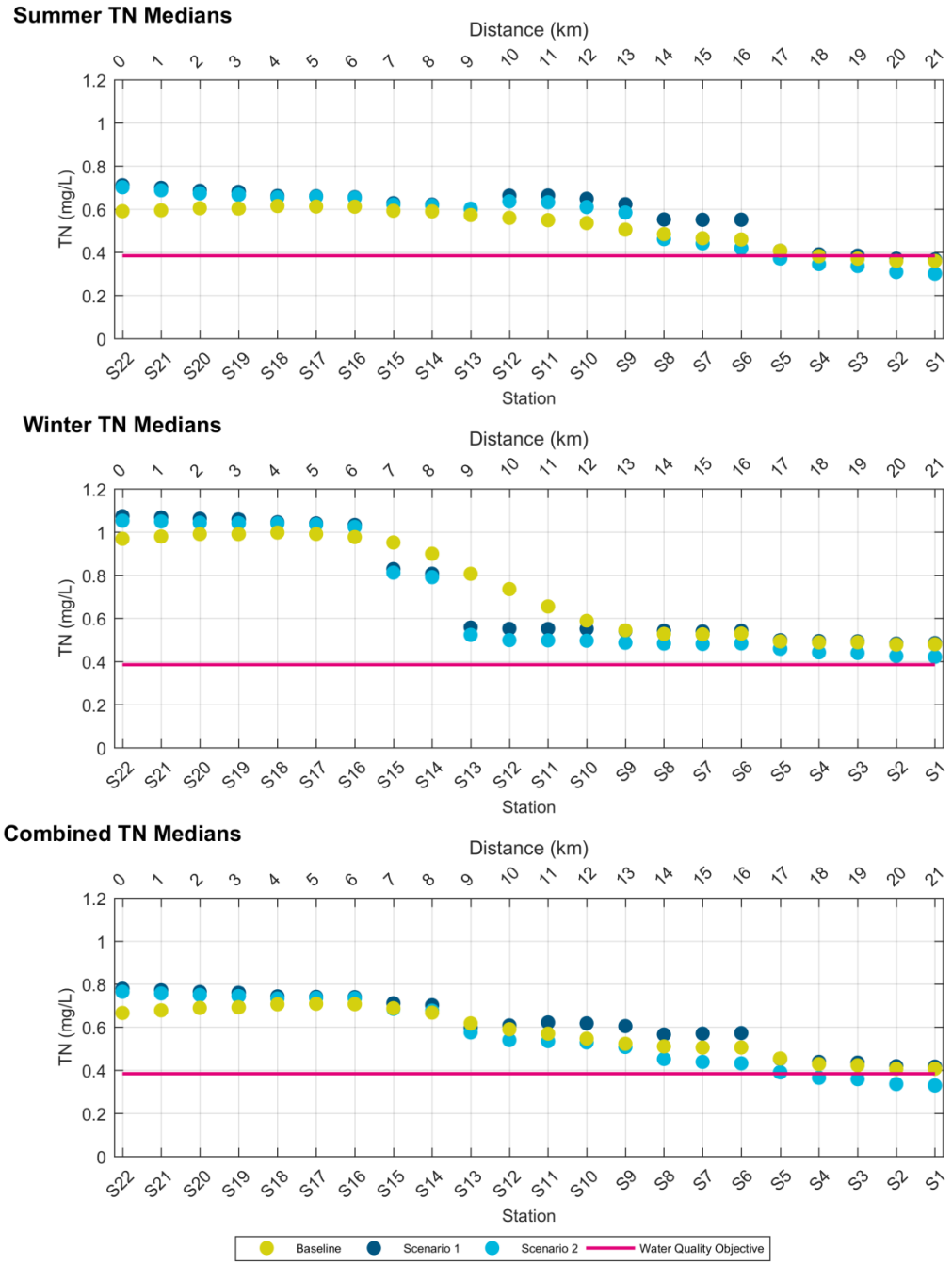


3.10 Total Nitrogen

3.10.1 Top Layer

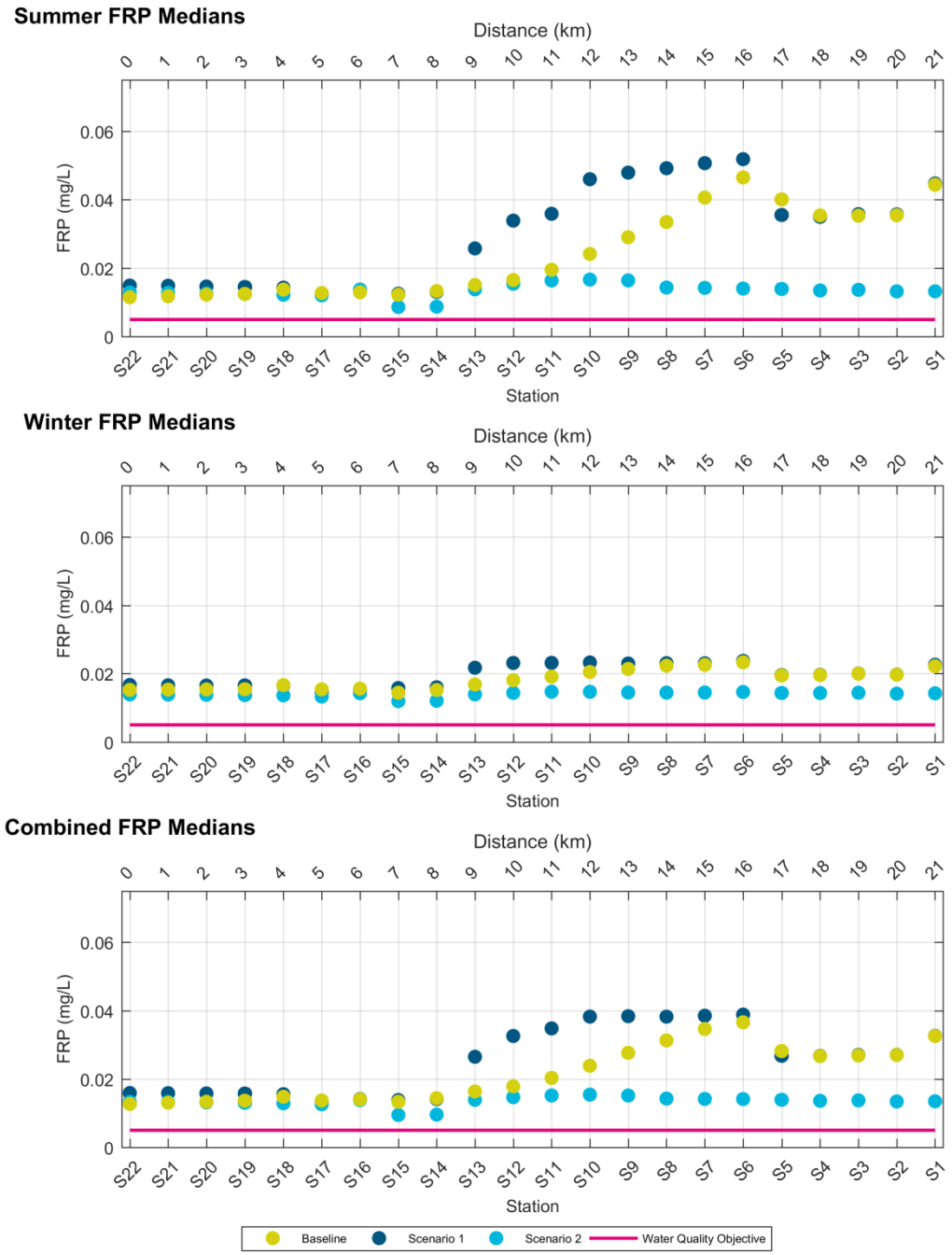


3.10.2 Bottom Layer

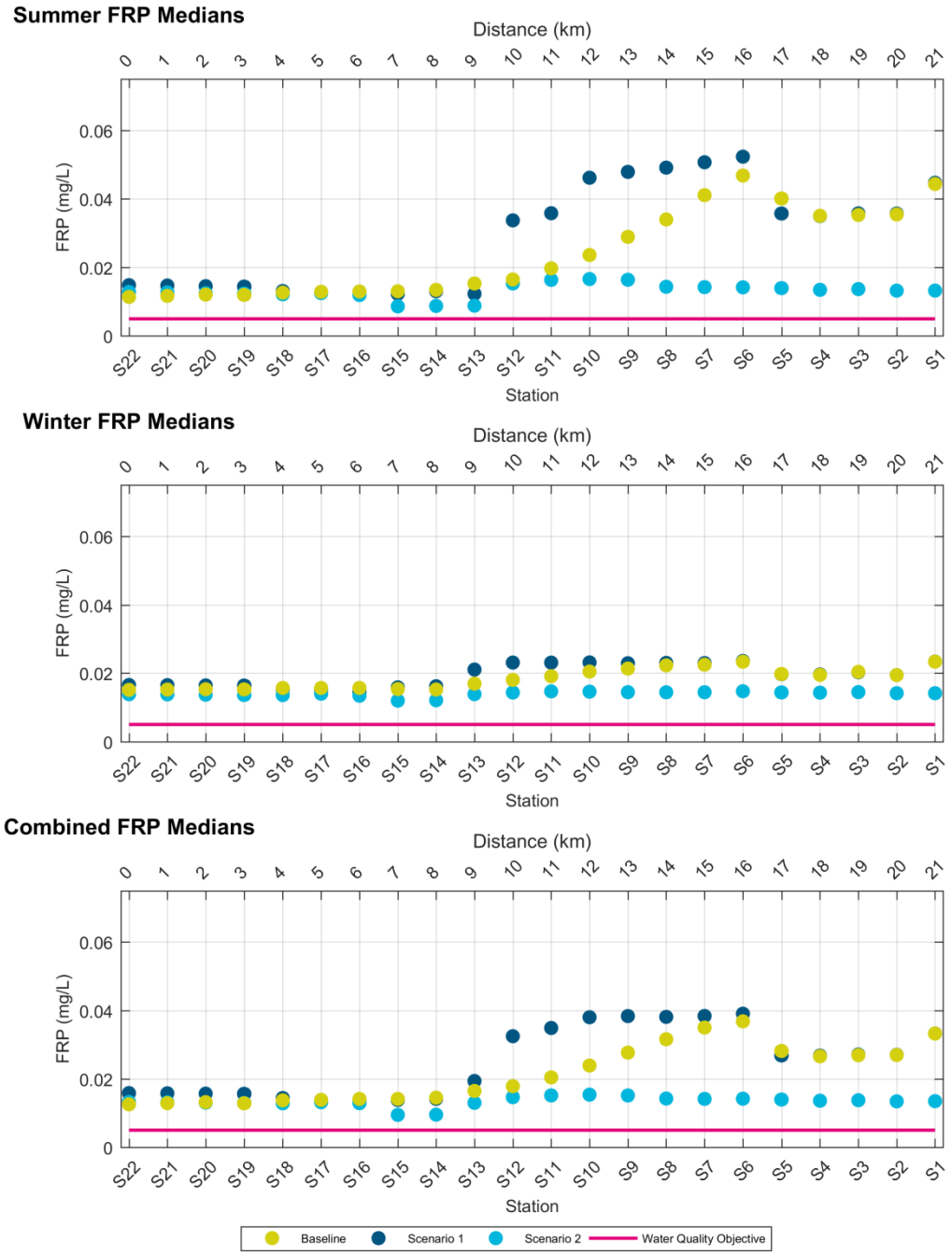


3.11 FRP

3.11.1 Top Layer

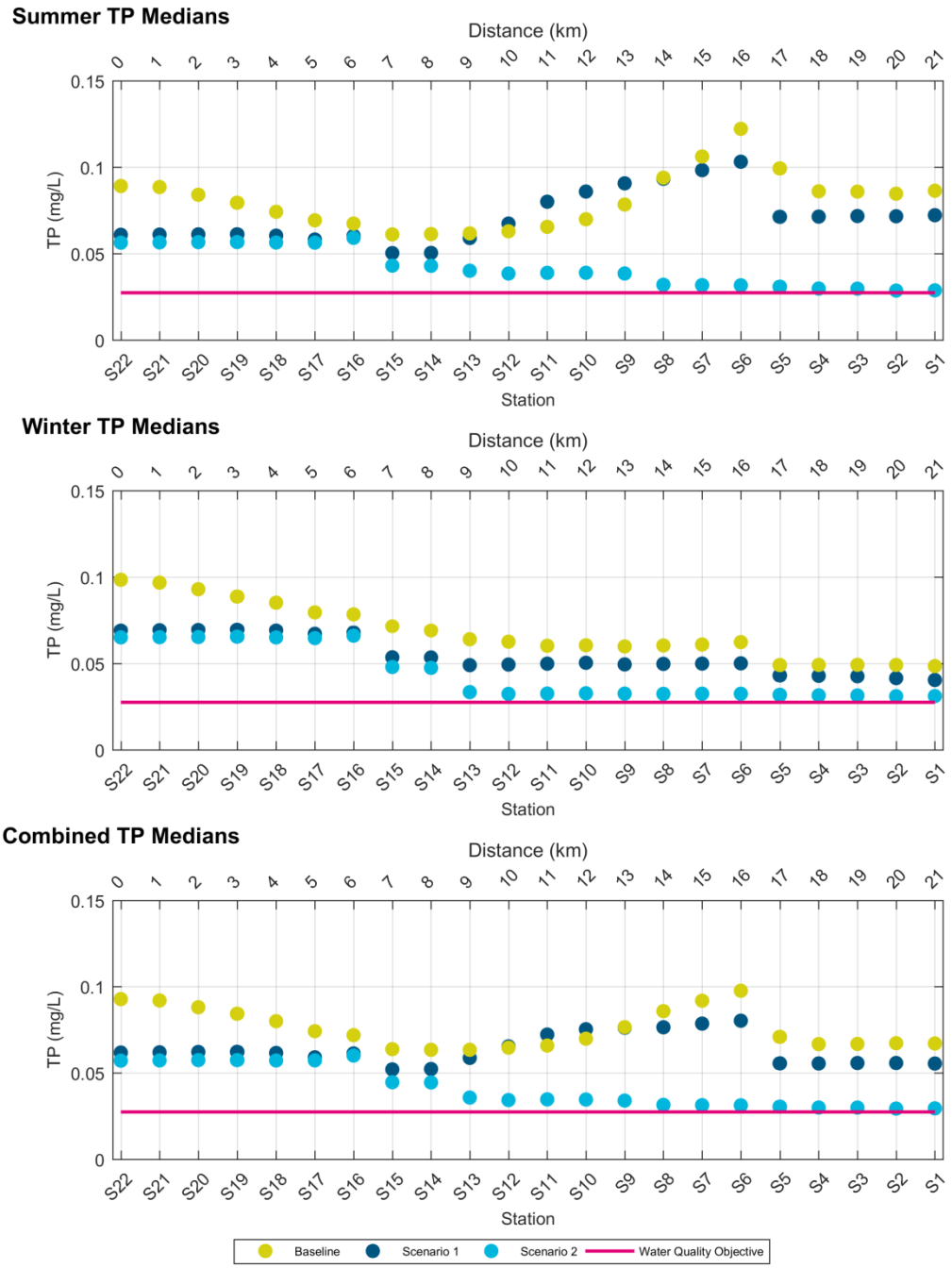


3.11.2 Bottom Layer

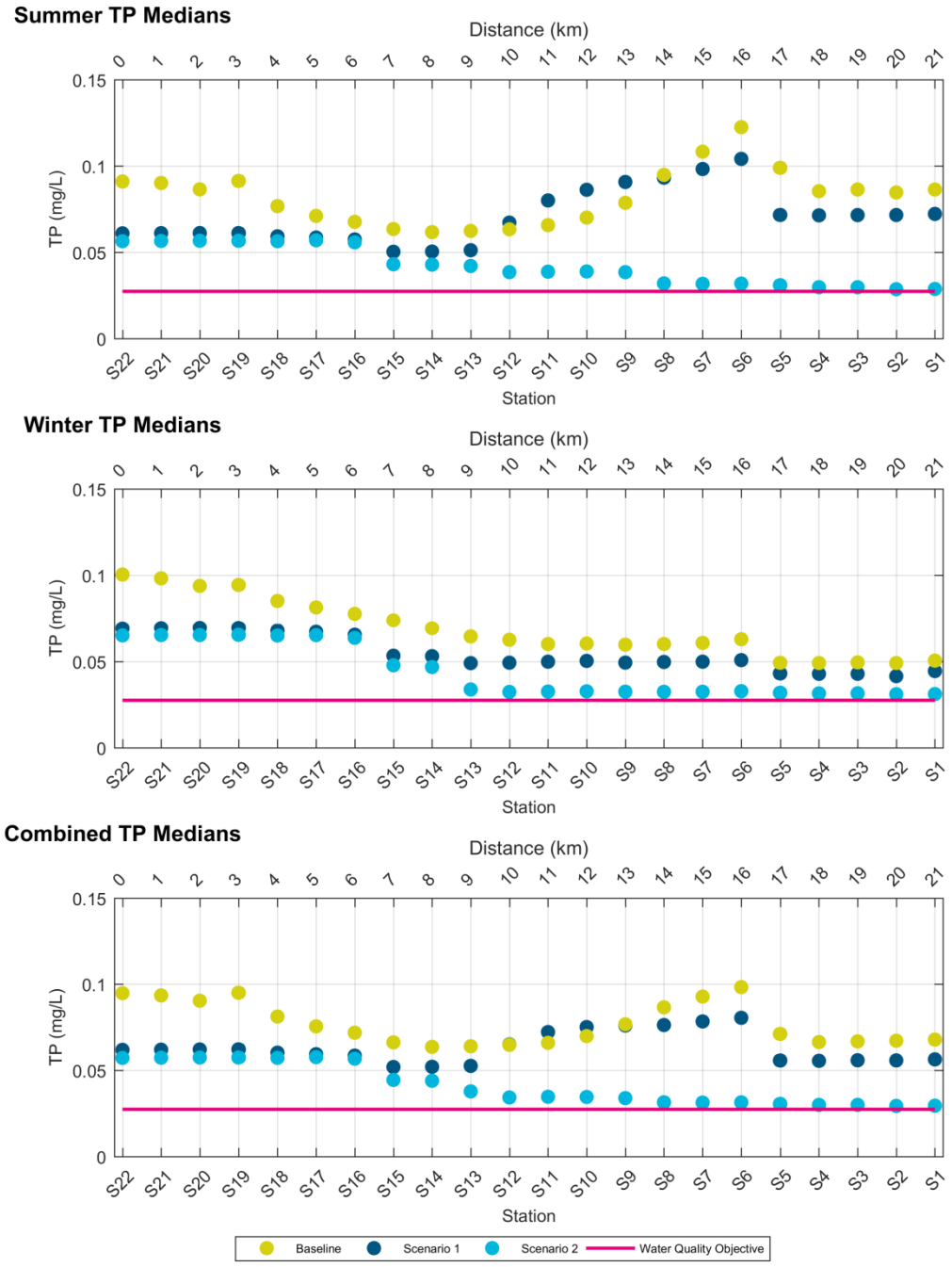


3.12 Total Phosphorus

3.12.1 Top Layer

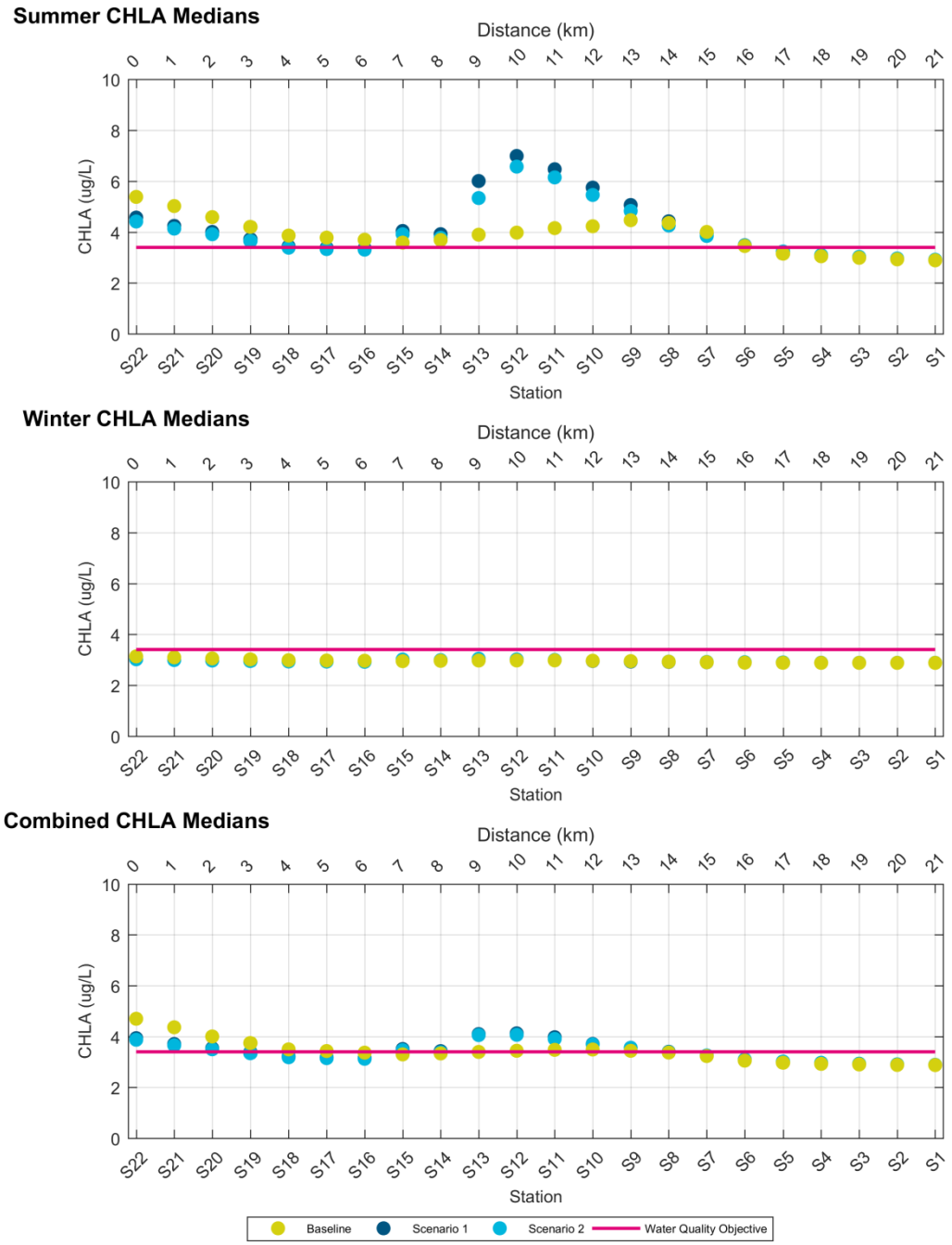


3.12.2 Bottom Layer

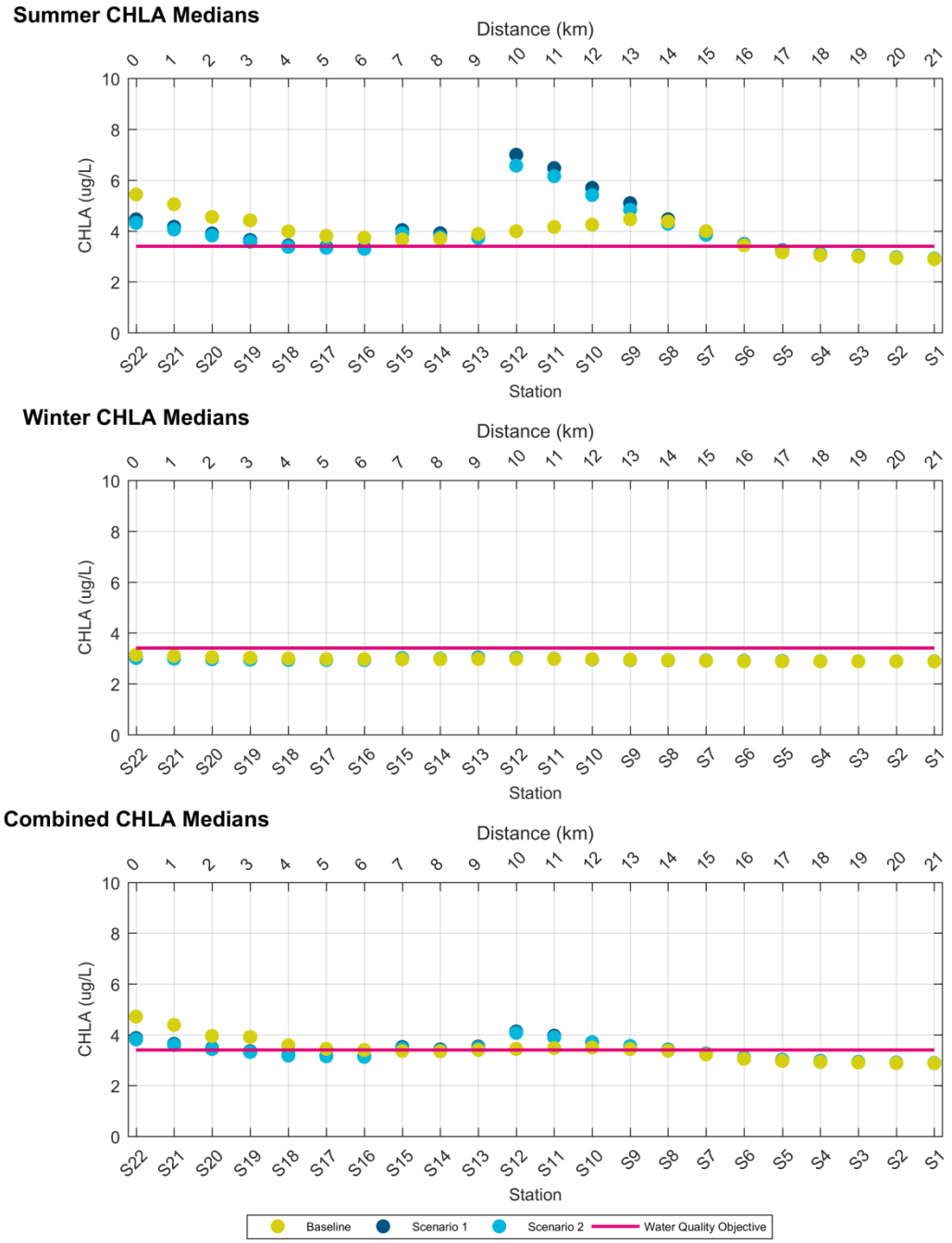


3.13 Chlorophyll-a

3.13.1 Top Layer

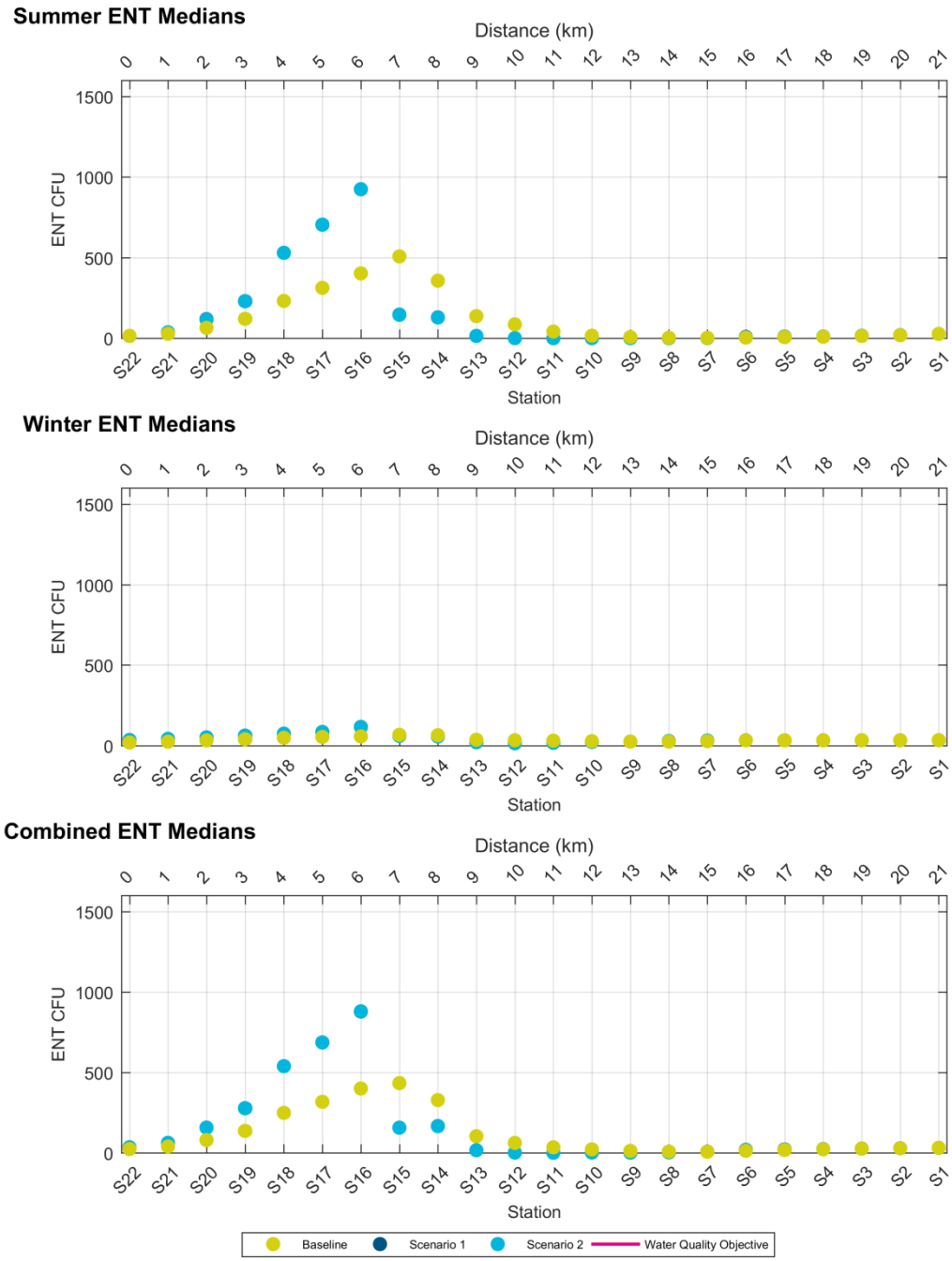


3.13.2 Bottom Layer

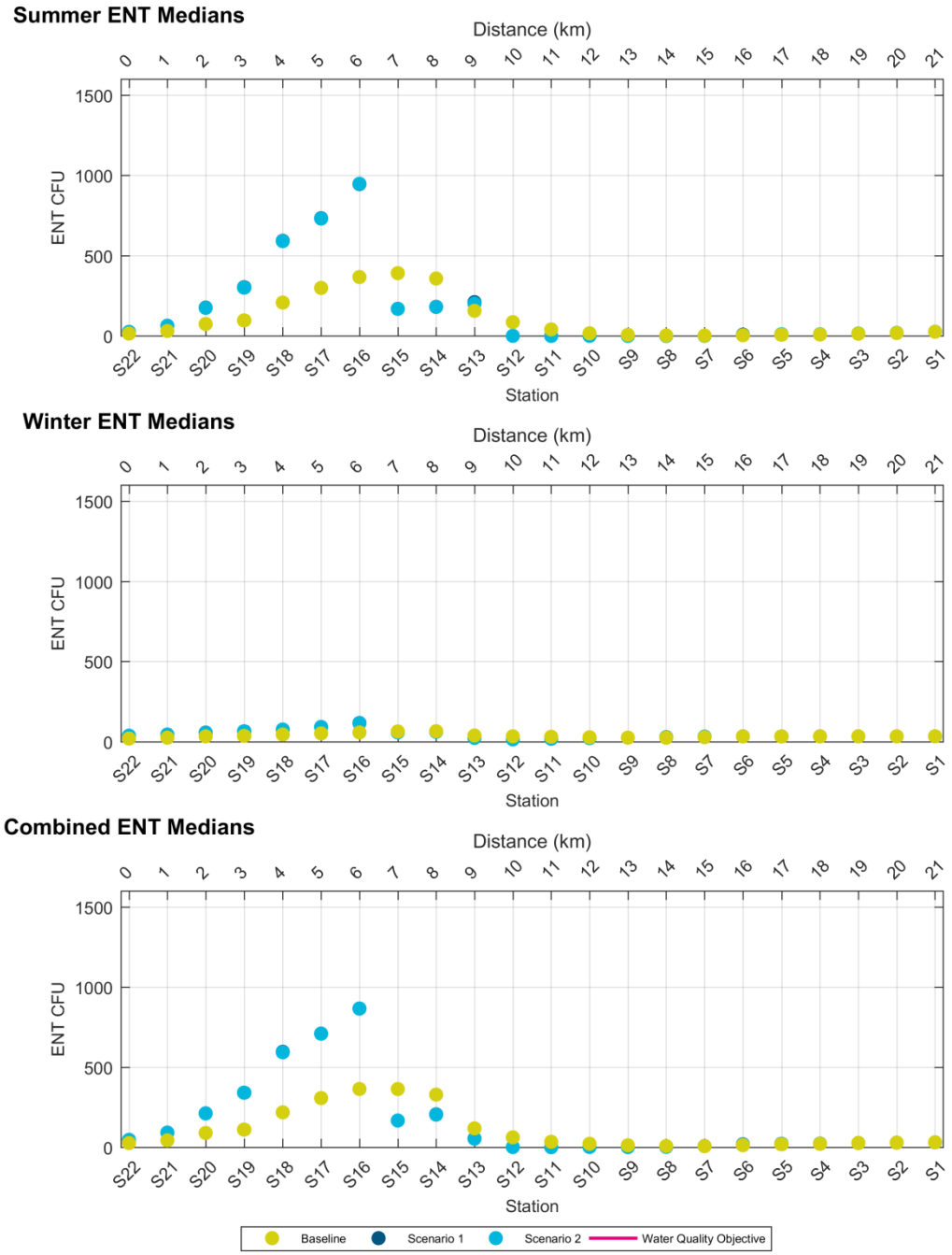


3.14 Enterococci

3.14.1 Top Layer



3.14.2 Bottom Layer



3.15 Contour Plots

3.16 Total Nitrogen

Scenario	
20m^3/s Baseline	
Scenario 1	
Scenario 2	

3.17 Total Phosphorus

Scenario	
20m^3/s Baseline	
Scenario 1	
Scenario 2	

4 Discussion

The variation of predictions from the model is consistent across all water quality parameters. Concentrations presented for both S1 and S2 are dominated by the inflows entering the model from Cataract Gorge on the South Esk. As both the flow and concentration entering the model from the South Esk remained consistent across modelling scenarios there is little difference. The same can be said about S8 being dominated by the inflows and concentrations from the Tailrace.

The removal of both Norwood and Hoblers Bridge from the North Esk improves the water quality of inflows into the Tamar. This is noticeable at sites S3 through to S7. The increase in concentrations noticed in predictions through sites S8 to S11 is due to the larger volumes of effluent being discharged in this region.

With the implementation of the barrage and the constant inflows from the North Esk, various WQOs are met whilst others are not. Median concentrations in both TN and TP do not fall below the WQO for either summer or winter. Chlorophyll-a concentrations fall below the WQO during the winter months however the summer algal blooms cause the summer and combined medians to exceed the specified WQO. The percent saturation DO however, falls within the WQO limits.

One key aspect of the modelling undertaken in this study is the parameterisation of sediment fluxes. Sediment fluxes have been set as per the assumptions of previous studies, and are reflective of the large historical pollution loading to which the Tamar River sediments have been subjected. In reality, it is likely that over time the sediment releases will decrease in response to decreasing WWTP loads, and as they purge themselves of their accumulated historical loadings. The modelling has not included this process, and so predictions of water quality presented herein cannot be interpreted as the final state of water quality in the Tamar in response to LSIP. Additional modelling that examines the response of the Tamar to LSIP, including a range of sensitivity analyses around long term sediment dynamics, is needed to fully explore this final state.

5 References

BMT WBM 2015. **Tamar Estuary 3D Modelling**. Prepared for NRM North. Ref. no. R.B20921.001.04.

BMT WBM 2015. **Scenarios Update**. Prepared for TLI. Ref. no. M.B20921.001.

NRM North 2016, **Water Quality Targets**, [ONLINE] Available at: http://www.nrmnorth.org.au/water-quality-targets, [Accessed 1 August 2016].

BMT WBM Bangalow
6/20 Byron Street, Bangalow 2479
Tel +61 2 6687 0466 Fax +61 2 66870422
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Brisbane
Level 8, 200 Creek Street, Brisbane 4000
PO Box 203, Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
8200 S. Akron Street, #B120
Centennial, Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com

BMT WBM London
International House, 1st Floor
St Katharine's Way, London E1W 1AY
Email london@bmtwbm.co.uk
Web www.bmtwbm.com

BMT WBM Mackay
PO Box 4447, Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street, Melbourne 3000
PO Box 604, Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street, Broadmeadow 2292
PO Box 266, Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Level 3, 20 Parkland Road, Osborne, WA 6017
PO Box 1027, Innaloo WA 6918
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Suite G2, 13-15 Smail Street, Ultimo, Sydney 2007
Tel +61 2 8960 7755 Fax +61 2 8960 7745
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
Suite 401, 611 Alexander Street
Vancouver British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com