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WwTP Impact Assessment

Freshwater WwTP Impact Assessment

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Intertek Metoc
Exchange House, Station Road, Liphook, Hampshire GU30 7DW, United Kingdom

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WwTP Impact Assessment

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Author/s

Shilpa Swaraj

Project Manager	Authoriser
	
Dan Williams	Paul Taylor

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SUMMARY

Intertek Metoc have been tasked by Uisce Éireann through Jacobs with determining the current and future assimilative capacity of the relevant freshwater waterbodies and the Cork Harbour Transitional and Coastal waterbodies within the Cork Metropolitan Area. This is a region requiring an urgent need for strategic enhancements in water supply and wastewater infrastructure to accommodate the significant growth anticipated, to handle increased or additional discharges while meeting environmental objectives and addressing identified pressures. This includes using strategic water quality models for impact assessments across study horizon years (current, 2030, 2055, and 2080) without the requirement for new sampling or analysis, to assess the assimilative capacity of the receiving waters for different timeframes. In addition, Intertek Metoc have also assessed the requirements for new outfall infrastructure, considering ongoing projects, environmental constraints, and future developments. Both river and marine water quality models, built by Intertek Metoc as part of the Cork Harbour Strategic Modelling Study for Uisce Éireann, have been used in the assessment. This effort aligns with Uisce Éireann's Technical Standard for Marine Modelling and encompasses evaluating discharge options against legislative and environmental standards.

This document outlines the impact assessments of the Wastewater Treatment Plants (WwTP) on the water quality of the freshwater waterbodies, to determine the assimilative capacity of the rivers and calculate the maximum Emission Limit Values (ELV) for WwTPs that discharge to the freshwater waterbodies.

Study Approach

To determine the impact of WwTPs on the freshwater waterbodies and calculate the maximum ELVs allowed for the WwTPs that discharge to Cork Harbour via rivers, a detailed modelling approach (Tier 3) has been adopted, using one dimensional (1-D) river hydrodynamic models which were built and calibrated using the industry-standard MIKE11 software under the Cork Harbour Strategic Modelling Study. The MIKE11 ECO Lab module was used for the water quality models, with the key water quality processes included in the model, such as Biochemical Oxygen Demand (BOD), nitrification of ammonia, ammonification, re-aeration, photosynthesis, respiration, Sediment Oxygen Demand (SOD), denitrification, and nutrient uptakes for nitrogen and phosphate.

The modelling approach can be summarised as follows:

1. The 1-D MIKE11 river models have been utilised to carry out the maximum ELV impact assessment. This approach allows for the evaluation of how discharges from individual WwTPs may influence water quality downstream and including potential effects of upstream WwTPs on the downstream WwTPs.
2. The calculation of maximum ELVs for each WwTP is based on the guidance produced by Uisce Éireann (Draft Technical Guidance for Water Quality Impact Assessment (Freshwaters), 2023) which sets out a tiered and risk-based approach to assess the impact of a wastewater discharge on the freshwater receiving environments, to ensure the discharge is compatible with achievement of the Water Framework Directive (WFD) and conservation objectives for receiving waters and Protected Areas, using the Wastewater Assimilative Capacity (WAC) approach.
3. The models were re-run using the maximum ELVs determined for all parameters to simulate a worst-case scenario, where the WwTPs discharge at their highest allowable limits. These model simulations enable assessments of the potential impacts of WwTPs on river water quality and demonstrate there would be low risk of deterioration of water quality status when the WwTPs are operated at the maximum ELVs determined.

Current Condition

Carrignavar WwTP and Knockraha WwTP are predicted to cause a large increase in concentration for BOD, ammonia and Molybdate Reactive Phosphorus (MRP - also referred to as orthophosphate); and Ros Ards WwTP increases ammonia and MRP concentrations in the river. Coole East WwTP has no impact on the water quality in the river. The Environmental Quality Standards (EQS) for Good status is already exceeded upstream of the WwTPs for Glashaboy River for BOD, ammonia and MRP, and therefore ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the Notionally Clean (NC) condition. For Knockraha WwTP, the NC condition was applied to calculate ELVs for BOD and MRP, as the upstream water quality conditions are within the upper 25% in-band WAC.

Owenboy River: Ballygarvan and Halfway WwTPs are predicted to cause minimal increases in the concentration of BOD, ammonia and MRP. The EQS for Good status is already exceeded upstream of the WwTPs for the Owenboy River for MRP, and therefore MRP ELVs for Halfway WwTP and Ballygarvan WwTP were determined using the NC condition.

Owencurra River: Ballincurrig WwTP, Lisgold South WwTP and Dungourney WwTP are predicted to cause increases in concentration for BOD, ammonia and MRP, while Lisgold North WwTP has little impact on the water quality in the river. Owenacurra River has a High status objective and as the upstream river concentration exceeds the High EQS threshold for MRP, the NC condition was applied to calculate ELVs for MRP.

Lee River: On the Blarney River, Whitechurch WwTP is predicted to cause large increases in concentration for BOD, ammonia and MRP; and Killeens WwTP increases ammonia concentrations. The EQS for Good status is already exceeded upstream of Blarney River for BOD, ammonia and MRP, and therefore ELVs for Whitechurch WwTP and Killeens WwTP were determined using the NC condition. Grenagh WwTP shows minimal increases in concentration of BOD, ammonia and MRP. The EQS for Good status is already exceeded upstream of the Grenagh WwTW for MRP and therefore ELVs for MRP were determined using the NC condition. On the Shournagh River, Blarney WwTP leads to a large increase in BOD, ammonia and MRP concentrations whereas the Courtbrack WwTP shows only slight increases in ammonia and MRP. As Shournagh River has a High status objective and the upstream river concentration exceeds the High status threshold for BOD and MRP, the NC condition was applied to calculate ELVs for BOD and MRP for Courtbrack WwTP and Blarney WwTP. Cloughduv WwTP has a negligible effect on water quality, whereas Killumney WwTP contributes to notable increases in BOD, ammonia, and MRP concentrations. For Cloughduv WwTP, the NC condition was applied to calculate ELVs for BOD, ammonia and MRP, as the WwTP discharges to the upstream reach of the River Bride, which has a High status objective and upstream water quality conditions are within the upper 25% in-band WAC. On the Dripsey River, Rylane WwTP and Dripsey WwTP are predicted to cause increases in concentration for BOD, ammonia and MRP, while Aghabullogue WwTP has only a minimal impact on the water quality in the river. As the Dripsey River has a High status objective and the upstream river MRP concentration already exceeds the High EQS threshold, MRP ELVs for Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP were determined using the NC condition. Coachford WWTP and Inniscarra WwTP discharging into the River Lee have minimal impacts on water quality, while Ballincollig WWTW has a large impact on the water quality in the river.

Climate Change Assessment

The river models have also been used to assess climate change effects on the river water quality together with the flow increases at the WwTPS due to population growth for three planning horizons of 2030, 2055, and 2080. Hydrology models have been developed considering climate change for the three planning horizons.

From the model results, the maximum allowable ELVs were determined for 2030, 2055 and 2080. Since the predicted rainfall timeseries including climate change has relatively increased dry flow periods (compared to non-climate change models), maximum allowable ELVs would generally be more stringent under climate change conditions. Therefore, only models representing climate change have been used in calculations of maximum allowable ELVs. Under future climate projections (2030, 2055, and 2080), river-specific assessments revealed varying impacts on water quality:

The 2030 horizon reflects the least stringent ELVs. However, by 2050 and particularly by 2080, the ELVs become progressively more stringent.

For BOD, the ELVs at Dungourney, Killeens, Grenagh, and Rylane WwTPs become significantly more stringent towards 2080. With respect to ammonia, the WwTPs where ELVs become more stringent include Coole East, Ros Ard, Dungourney, Killeens, Grenagh, Kilumney, and Rylane. For MRP, increased stringency in ELVs is observed at Ros Ard, Dungourney, Killeens, Grenagh, Kilumney, and Rylane WwTPs.

Maximum ELVs

The allowable ELVs have been calculated for Current, 2030, 2055, and 2080 horizon years (the effects of climate change on both river and WwTP flows were considered in the assessment), and the tables below provide the maximum allowable ELVs for Current, 2030, 2055, and 2080 horizon years assessed, for BOD, ammonia and MRP respectively.

Allowable ELVs for Current, 2030, 2055 and 2080 horizon years assessed for BOD

WwTP	High Status Objective?	Target Status	Notionally Clean?	BOD (mg/l)				
				Permit	Current	2030	2055	2080
Knockraha - Chapelfield WwTP	Yes	High	Yes	125	29	23.6	20.6	18.6
Knockraha - Village Centre WWTP	Yes	High	Yes	125	29	23.6	20.6	18.6
Carrignavar	No	Good	Yes	25	16.1	13.7	11.2	10.0
Coole East	No	Good	Yes	125	125	86.8	72.5	64.0
Ros Ard WwTP	No	Good	Yes	25	25	25	25	21.2
Halfway	No	High	No	5	5	5	5	5
Ballygarvan	No	High	No	25	25	25	25	25
Ballincurrig Septic Tank (Lisgoold)	Yes	High	No	125	40.6	32.4	26.7	23.9
Lisgoold North WwTP	Yes	High	No	5	5	5	5	5
Lisgoold South WwTP	Yes	High	No	200	194.4	123.2	101.1	90.1
Dungourney	No	High	No	145	145	64.6	55.0	48.7
Whitechurch WwTP	Yes	High	Yes	25	2.6	3.3	2.8	2.6
Killeens WwTP	No	Good	Yes	25	9.6	4.2	2.8	2.6
Grenagh WwTP	No	Good	No	25	22.6	2.7	2.3	2.0

WwTP	High Status Objective?	Target Status	Notionally Clean?	BOD (mg/l)				
				Permit	Current	2030	2055	2080
Courtbrack WwTP	Yes	High	Yes	25	25	25	25	25
Blarney WwTP	Yes	High	Yes	20	5.8	4.2	2.7	2.4
Cloughdov WwTP	Yes	High	Yes	10	10	10	10	10
Kilumney WwTP	No	Good	No	25	25	25	25	25
Rylane WwTP	Yes	High	No	25	25	11.1	9.4	8.4
Agabullogue WwTP	Yes	High	No	25	25	14.0	11.9	10.6
Dripsey WwTP	Yes	High	No	25	25	24.9	21.5	19.2
Coachford WwTP	No	Good	No	21.63	21.63	21.63	21.63	21.63
Inniscarra WwTP	No	Good	No	25	25	25	25	25
Ballincollig WwTP	No	Good	No	25	16.7	20.2	13.2	11.6

Allowable ELVs for Current, 2030, 2055 and 2080 horizon years assessed for Ammonia

WwTP	High Status Objective?	Target Status	Notionally Clean?	Ammonia (mg/l)				
				Permit	Current	2030	2055	2080
Knockraha - Chapelfield WwTP	Yes	High	No	5	1.21	0.98	0.85	0.78
Knockraha - Village Centre WWTP	Yes	High	No	5	1.21	0.98	0.85	0.78
Carrignavar	No	Good	Yes	2	0.92	0.78	0.64	0.57
Coole East	No	Good	Yes	20	20	5.37	4.48	3.96
Ros Ard WwTP	No	Good	Yes	20	6.31	2.10	1.80	1.58
Halfway	No	High	No	2	2	2	2	2
Ballygarvan	No	High	No	5	5	4.10	3.55	3.14

WwTP	High Status Objective?	Target Status	Notionally Clean?	Ammonia (mg/l)				
				Permit	Current	2030	2055	2080
Ballincurrig Septic Tank (Lisgoold)	Yes	High	No	20	1.74	1.39	1.15	1.02
Lisgoold North WwTP	Yes	High	No	5	5	5	4.62	4.10
Lisgoold South WwTP	Yes	High	No	30	6.10	3.91	3.20	2.86
Dungourney	No	High	No	20	4.74	1.63	1.39	1.23
Whitechurch WwTP	Yes	High	Yes	10	0.15	0.19	0.16	0.15
Killeens WwTP	No	Good	Yes	28.4	1.33	0.58	0.39	0.36
Grenagh WwTP	No	Good	No	3	3	0.60	0.51	0.46
Courtbrack WwTP	Yes	High	No	10	4.78	3.84	3.18	2.87
Blarney WwTP	Yes	High	No	1.5	0.31	0.23	0.15	0.13
Cloughdov WwTP	Yes	High	Yes	2	2	2	2	2
Kilumney WwTP	No	High	No	10	4.65	2.45	2.05	1.76
Rylane WwTP	Yes	High	No	10	2.21	0.77	0.66	0.58
Agabullogue WwTP	Yes	High	No	5	5	3.73	3.17	2.82
Dripsey WwTP	Yes	High	No	10	5.34	3.53	3.03	2.74
Coachford WwTP	No	Good	No	6.8	6.8	6.62	5.63	5.01
Inniscarra WwTP	No	High	No	10	10	10	10	10
Ballincollig WwTP	No	High	No	5	0.93	1.13	0.73	0.66

Allowable ELVs for Current, 2030, 2055 and 2080 horizon years assessed for MRP

WwTP	High Status Objective?	Target Status	Notionally Clean?	MRP (mg/l)				
				Permit	Current	2030	2055	2080
Knockraha - Chapelfield WwTP	Yes	High	Yes	3	0.59	0.48	0.42	0.38
Knockraha - Village Centre WWTP	Yes	High	Yes	3	0.59	0.48	0.42	0.38
Carrignavar	No	Good	Yes	1.5	0.48	0.41	0.34	0.30
Coole East	No	Good	Yes	3	3	2.46	2.03	1.84
Ros Ard WwTP	No	Good	Yes	3	2.22	0.74	0.64	0.55
Halfway	No	Good	Yes	1	1	1	1	1
Ballygarvan	No	Good	Yes	3	3	3	3	2.74
Ballincurrig Septic Tank (Lisgoold)	Yes	High	Yes	5	0.87	0.70	0.58	0.51
Lisgoold North WwTP	Yes	High	Yes	0.5	0.5	0.5	0.5	0.5
Lisgoold South WwTP	Yes	High	Yes	3	3	2.77	2.32	1.98
Dungourney	No	Good	No	3	1.70	0.59	0.50	0.44
Whitechurch WwTP	Yes	High	Yes	5	0.06	0.07	0.06	0.06
Killeens WwTP	No	Good	Yes	1	0.60	0.26	0.18	0.16
Grenagh WwTP	No	Good	Yes	1.7	1.70	0.31	0.26	0.23
Courtbrack WwTP	Yes	High	Yes	2	2	1.63	1.34	1.21
Blarney WwTP	Yes	High	Yes	0.8	0.11	0.08	0.05	0.05
Cloughdov WwTP	Yes	High	Yes	0.8	0.8	0.8	0.75	0.65
Kilumney WwTP	No	Good	No	5	1.39	0.73	0.60	0.54
Rylane WwTP	Yes	High	Yes	2	1.1	0.39	0.33	0.29
Agabullogue WwTP	Yes	High	Yes	1	1	0.82	0.71	0.61
Dripsey WwTP	Yes	High	Yes	5	2.43	1.60	1.38	1.24

WwTP	High Status Objective?	Target Status	Notionally Clean?	MRP (mg/l)				
				Permit	Current	2030	2055	2080
Coachford WwTP	No	High	No	0.88	0.88	0.88	0.88	0.88
Inniscarra WwTP	No	High	No	5	5	5	5	5
Ballincollig WwTP	No	Good	No	2	0.51	0.62	0.40	0.36

Optioneering Scenarios

A number of optioneering scenarios have also been assessed to explore alternative configurations aimed at reducing environmental impact through relocating outfalls to more favourable downstream locations, which can provide improved dilution and thereby lower maximum ELVs, or through the transfer of flows to another WwTP. The scenarios assessed in this study are outlined below:

1. Relocation of Blarney WwTP: Evaluates the relocation of the discharge point to a downstream location on the River Shournagh.
2. Relocation of Grenagh WwTP: Evaluates the relocation of the discharge point to a downstream location on the River Martin.
3. Relocation of Carrignavar WwTP: Examines relocation to a downstream location of the Glashaboy River.
4. Flow Transfer from Halfway WwTP to Ballygarvan WwTP: Evaluates the feasibility of rerouting effluent from Halfway WwTP to Ballygarvan WwTP.
5. Relocation of Knockraha WwTPs: Evaluates the relocation of the discharge point from Butlerstown to a downstream location on the River Glashaboy.
6. Ballincollig WwTP Scenarios: Evaluates the feasibility of relocating Ballincollig WwTP discharge to downstream of Shournagh confluence. Two scenarios are assessed: 1 - No changes to upstream discharges; 2 - All upstream WwTPs removed.

The MIKE11 models have been setup and run for those scenarios and from which their new maximum allowable ELVs are calculated. Tables below provide the maximum allowable ELVs calculated for these optioneering scenarios, for BOD, ammonia and MRP respectively.

The relocation of WwTP outfalls and the transfer of flows to other WwTPs resulted in less stringent ELV requirements in all cases.

Allowable ELVs for Optioneering Scenarios: BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	20	25	25	25
Relocation of Grenagh WwTP	No	Good	Yes	25	25	25	25
Relocation of Carrignavar WwTP	No	Good	No	25	25	25	25
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	25	25	25	25
Knockraha WwTP Baseline Scenario	Yes	High	Yes	125	125	125	125
Ballincollig WwTP: Scenario 1	Yes	High	Yes	25	13.1	12.1	20.5
Ballincollig WwTP: Scenario 2	No	Good	No	25	17.3	15.9	25

Allowable ELVs for Optioneering Scenarios: Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	1.5	2.97	2.5	2.16
Relocation of Grenagh WwTP	No	Good	Yes	3	2.97	2.50	2.16
Relocation of Carrignavar WwTP	No	Good	No	2	2	2	2
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	5	3.05	2.69	2.30
Knockraha WwTP Baseline Scenario	Yes	High	Yes	5	5	5	5
Ballincollig WwTP: Scenario 1	Yes	High	Yes	5	1.82	1.18	1.05
Ballincollig WwTP: Scenario 2	No	Good	No	5	1.93	1.24	1.13

Allowable ELVs for Optioneering Scenarios: MRP

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	0.8	1.65	1.65	1.65
Relocation of Grenagh WwTP	No	Good	Yes	1.65	1.65	1.65	1.65
Relocation of Carrignavar WwTP	No	Good	No	2	1.74	1.46	1.25
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	3	0.59	0.51	0.46
Knockraha WwTP Baseline Scenario	Yes	High	Yes	3	3	3	3
Ballincollig WwTP: Scenario 1	Yes	High	Yes	2	0.8	0.8	0.8
Ballincollig WwTP: Scenario 2	No	Good	No	2	2	2	2

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GLOSSARY

BOD
Biochemical Oxygen Demand

CHSMS
Cork Harbour Strategic Modelling Study

CMA
Cork Metropolitan Area

CSO
Combined Sewer Overflows

ELV
Emission Limit Value

EPA
Environmental Protection Agency

EQS
Environmental Quality Standard

NSE
Nash-Sutcliffe Efficiency

SWO
Storm Water Overflow

MRP
Molybdate Reactive Phosphorus

OPW
Office of Public Works

WFD
Water Framework Directive

WwTP
Waste Water Wastewater Treatment Plant

WAC
Wastewater Assimilative Capacity

1. INTRODUCTION

1.1 Background and Purpose of Document

The Cork Metropolitan Area (CMA) is a region poised for significant growth. This anticipated growth underscores the urgent need for strategic enhancements in water supply and wastewater infrastructure to accommodate increased demands and ensure sustainable development. Uisce Éirean has highlighted the necessity for a comprehensive drainage assessment to address the challenges of rapid growth, capacity pressures, deterioration of receiving waters, and the impacts of climate change, and new regulations. A sustainable and integrated approach to wastewater management is essential, aligning with national and international environmental directives and accommodating the evolving climate scenario, to support economic expansion, stakeholder needs, and the resilience of Ireland's wastewater infrastructure amid escalating urbanisation and service demands.

Intertek Metoc have been tasked by Jacobs with determining the current and future assimilative capacity of the relevant freshwater (river) waterbodies and the Cork Harbour Transitional and Coastal (TraC) waterbodies to handle increased or additional discharges while meeting environmental objectives and addressing identified pressures. This includes using strategic water quality models for impact assessments across study horizon years (current, 2030, 2055, and 2080) without the requirement for new sampling or analysis. Intertek Metoc's role extends to reviewing statutory and policy frameworks, assessing the assimilative capacity for different timeframes, and determining effluent standards for alternative receiving waters. Additionally, Intertek have assessed the requirements for new outfall infrastructure, considering ongoing projects, environmental constraints, and future developments. Both river and marine water quality models have been used to assess Wastewater Treatment Plant (WwTP) and Storm Water Overflow (SWO) discharges' impacts. This effort aligns with Uisce Éireann's Technical Standard for Marine Modelling and encompasses evaluating discharge options against legislative and environmental standards. It builds on previous work by Intertek for Uisce Éireann over the past two years, as part of the Cork Harbour Strategic Modelling Study (CHSMS).

The river models are retained from the CHSMS for the Lee (including the Bride, Dripsey, Shournagh, Martin and Blarney), Owenboy, Owenacurra/Dungourney and Glashaboy. All models were constructed in MIKE11 using Office of Public Works (OPW) cross section data and supplemented by bespoke surveys. Models were hydraulically calibrated (flow and level) against Environmental Protection Agency (EPA)/OPW gauging data and for water quality against available water quality data of EPA Water Framework Directive (WFD) National Water Monitoring Station network.

This document outlines the impact assessments of WwTPs on the water quality of the freshwater waterbodies, to determine the assimilative capacity of the rivers and calculate the maximum Emission Limit Values (ELV) for WwTPs that discharge to the freshwater waterbodies. The approach of calculating the maximum ELVs for WwTPs are also detailed in this document.

1.2 Study Approach

To determine the impact of WwTPs on the freshwater waterbodies and calculate the maximum ELVs allowed for the WwTPs that discharge to Cork Harbour via rivers, detailed modelling approach (Tier 3) has been adopted, using 1-D MIKE11 models which were built and calibrated under the Cork Harbour Strategic Modelling Study. MIKE11 ECO Lab module was used for the water quality models, with the key water quality processes included in the model, such as Biochemical Oxygen Demand (BOD), nitrification of ammonia, ammonification, re-aeration, photosynthesis, respiration, Sediment Oxygen Demand (SOD), denitrification, nutrient uptakes for nitrogen and phosphate.

The modelling approach involved:

1. The 1-D MIKE11 river models developed during the previous Cork Strategic Area Quality Modelling study were utilised to carry out the maximum ELV impact assessment. This approach allows for the evaluation of how discharges from individual WwTPs may influence water quality downstream, including potential effects of upstream WwTPs on the downstream WwTPs located along the river system.
2. The impact assessment of wastewater discharges is based on the guidance produced by Uisce Éireann (Draft Technical Guidance for Water Quality Impact Assessment (Freshwaters), 2023). In the Uisce Éireann's technical guidance, it sets out a tiered, risk-based approach to assess the impact of a wastewater discharge on the freshwater receiving environments and to determine the appropriate level of wastewater treatment to ensure the discharge is compatible with achievement of WFD and conservation objectives for receiving waters and Protected Areas, using the Wastewater Assimilative Capacity (WAC) approach.
3. The models were re-run using the maximum ELVs determined for all parameters to simulate a worst-case scenario, where the WwTPs discharge at their highest allowable limits. These model simulations enable assessments of the potential impacts of WwTPs on river water quality and demonstrate there would be low risk of deterioration water quality status when the WwTPs are operated at the maximum ELVs determined.

1.3 Study Areas and River Models

1.3.1 Glashaboy River

The River Glashaboy originates in the Nagles Mountains, located north of Cork City in County Cork, Ireland. From these upland beginnings, it flows generally southward through Carrignavar before turning southeast through Glanmire and Sallybrook. Along its course, it gathers waters from tributaries such as the Butlerstown and Glenmore Streams, eventually draining into Cork Harbour.

Figure 1-1 shows the extent of Glashaboy model. This includes Glashaboy River, its tributary Butlerstown and WwTPs that discharge into the river. The upper extent of each tributary in the Glashaboy Model has been chosen to capture all WwTPs discharging to the river, the downstream boundary is set at Glanmire where the river flows into Cork Harbour. The discharges of interest included in the Glashaboy Model are:

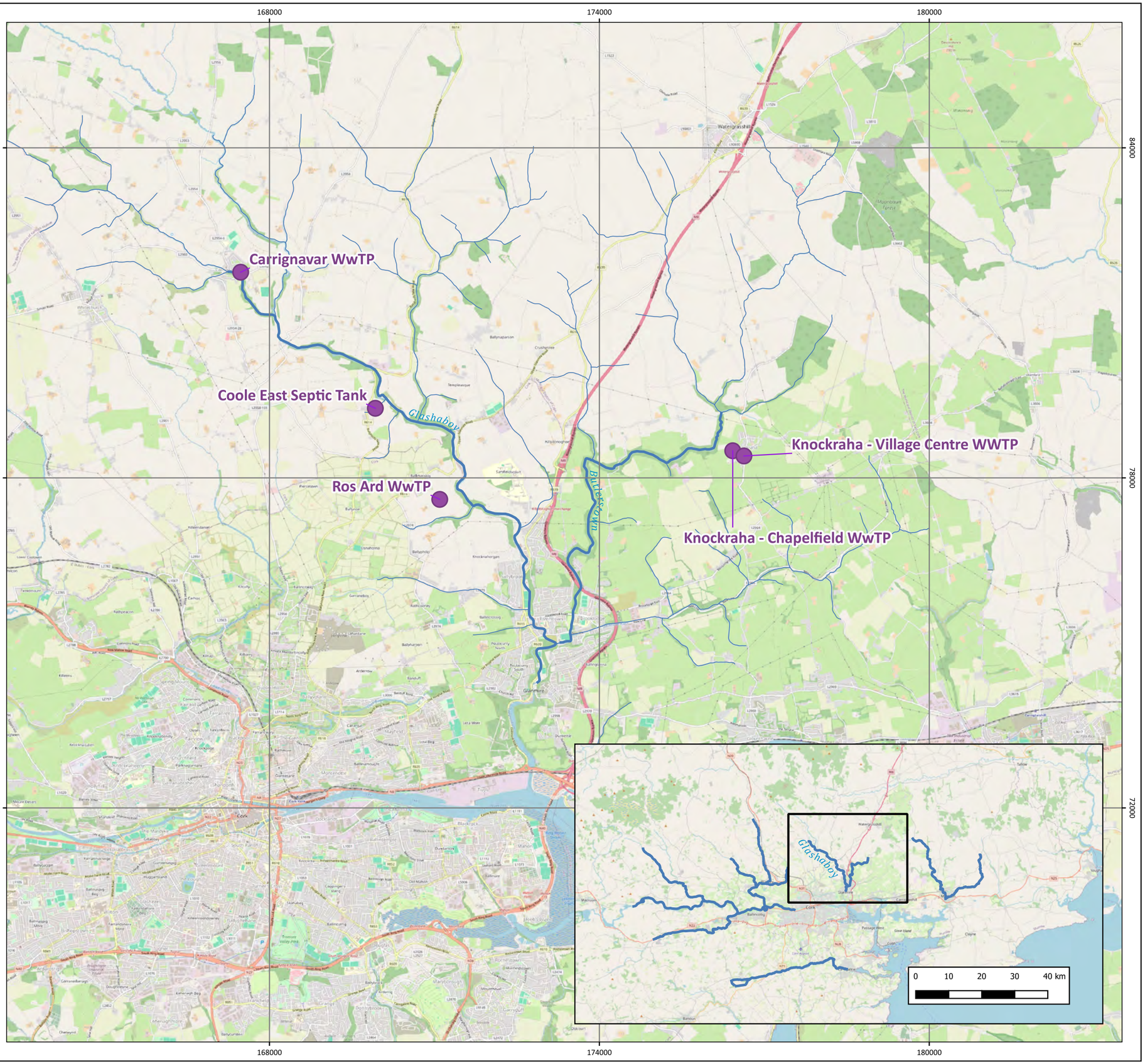
- Knockraha - Village Centre WwTP
- Knockraha - Chapelfield WwTP
- Carrignavar WwTP
- Coole East WwTP
- Ros Ards WwTP

Cork Strategic Drainage Study

Location Overview

River Glashaboy

Drawing No: P2640-LOC-002 | A



Legend

- Glashaboy WwTPs
- River Glashaboy
- Tributaries

N

NOT TO BE USED FOR NAVIGATION

Date	2025-07-10 19:26:44
Coordinate System	TM65 / Irish National Grid
WKID	EPSG:29900
Scale @A3	1:70,000
Data Sources	EPA Ireland, OpenStreetMaps (OSM)
File Reference	J:\P2640\Mxd_QGZ\Rivers.qgz
Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

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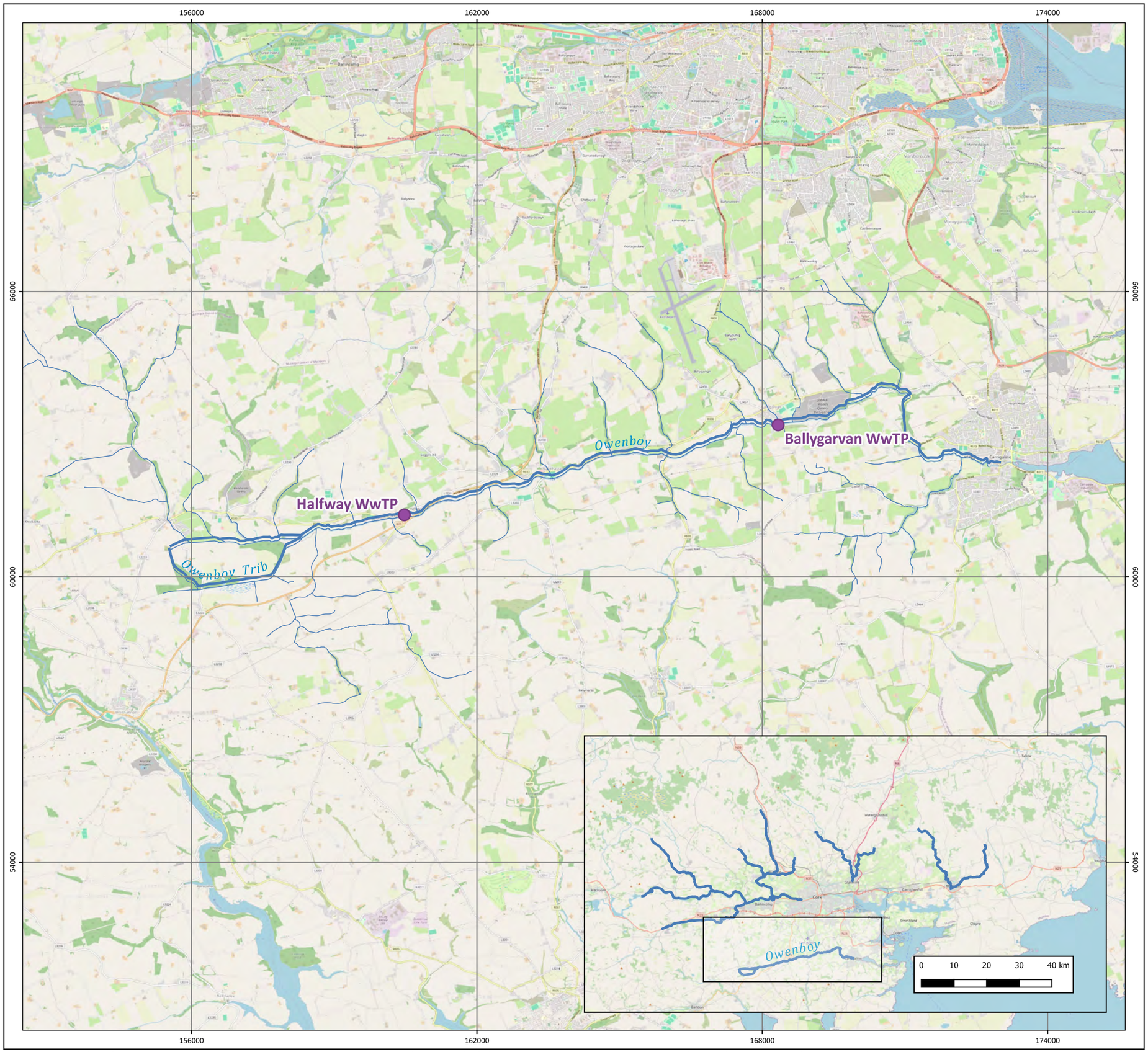
0 1 2 3 4 km

1.3.2 Owenboy River

The River Owenabue (or Owenboy) originates north of Crossbarry in County Cork and flows eastward for approximately 20 miles. Its course passes through Crossbarry, Halfway and Ballinhassig before reaching Cork Harbour near Carrigaline.

Figure 1-2 shows the extent of the Owenboy Model. This includes the Owenboy River, two tributaries that form a loop at Crossbarry and WwTPs that discharge into the river. The upper extent of each tributary in the Owenboy Model has been chosen to capture all WwTPs discharging to the river. The downstream boundary is set at Carrigaline where the river flows into Cork Harbour. The discharges of interest included in the Owenboy Model are:

- Ballygarvan WwTP
- Halfway WwTP



Cork Strategic Drainage Study

Location Overview

River Owenboy

Drawing No: P2640-LOC-001	A

Legend

- Owenboy WwTPs
- Owenboy River
- Tributaries

N

NOT TO BE USED FOR NAVIGATION

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Data Sources	EPA Ireland, OpenStreetMaps (OM)
File Reference	J:\P2640\Mxd_QGZ \Rivers.qgz
Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

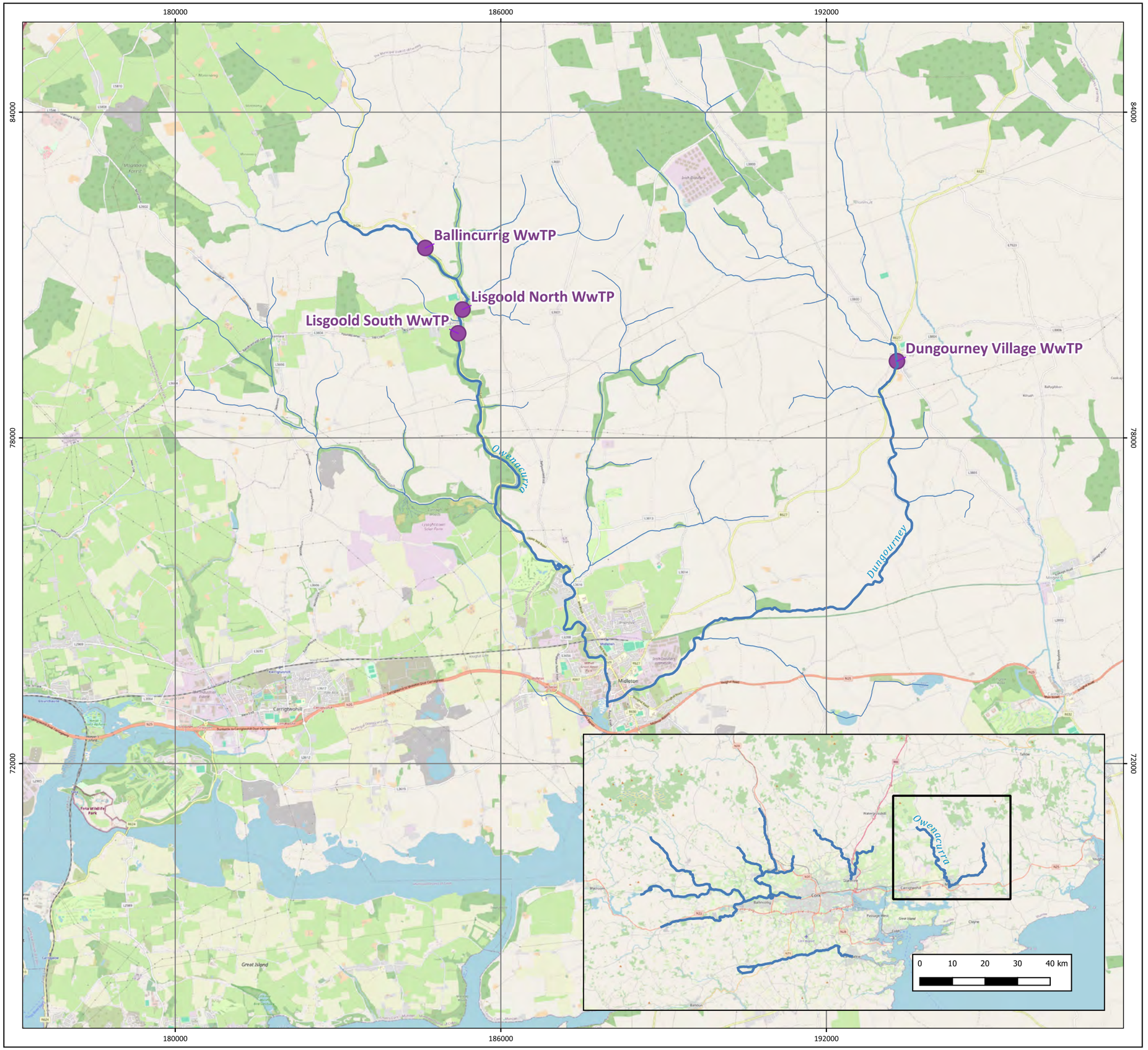
0 1 2 3 4 km

1.3.3 Owenacurra River

The Owenacurra River is located in County Cork and flows predominantly in a southerly direction through a largely rural catchment before entering the town of Midleton. Originating near the northwestern hills, the river traverses a mix of agricultural land, low-lying floodplains, and semi-urban areas before discharging into the upper reaches of Cork Harbour.

Figure 1-3 shows the extent of the Owenacurra Model. This includes the Owenacurra River, its tributary Dungourney and WwTPs that discharge into the river. The upper extent of each tributary in the Owenacurra Model has been chosen to capture all WwTPs discharging to the river and the downstream boundary is set at Midleton where the river flows into Cork Harbour. The discharges of interest included in the Owenacurra Model are:

- Ballincurrig WwTW
- Lisgold North WwTP
- Lisgold South WwTP
- Dungourney Village WwTP



Cork Strategic Drainage Study

Location Overview

River Owencurra

Drawing No: P2640-LOC-003	A

Legend

- Owencurra WwTPs
- River Owenacurra
- Tributaries

N

NOT TO BE USED FOR NAVIGATION

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Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

0 1 2 3 4 km

1.3.4 River Lee

The River Lee is one of the principal rivers in County Cork, Ireland. It originates in the Shehy Mountains near Gougane Barra in the western part of the county and flows in an easterly direction, reaching Cork City and eventually discharging into Cork Harbour at the southern coast.

Figure 1-4 shows the extent of the Lee Model. This includes the River Lee, its tributaries Blarney, Bride, Dripsey, Martin, Shournagh and WwTPs that discharge into the river. The upper extent of each tributary in the Lee Model has been chosen to capture all WwTPs discharging to the river and the downstream boundary is set downstream of the weir at the confluence of the River Lee North and South channels the discharges of interest included in the Lee Model are:

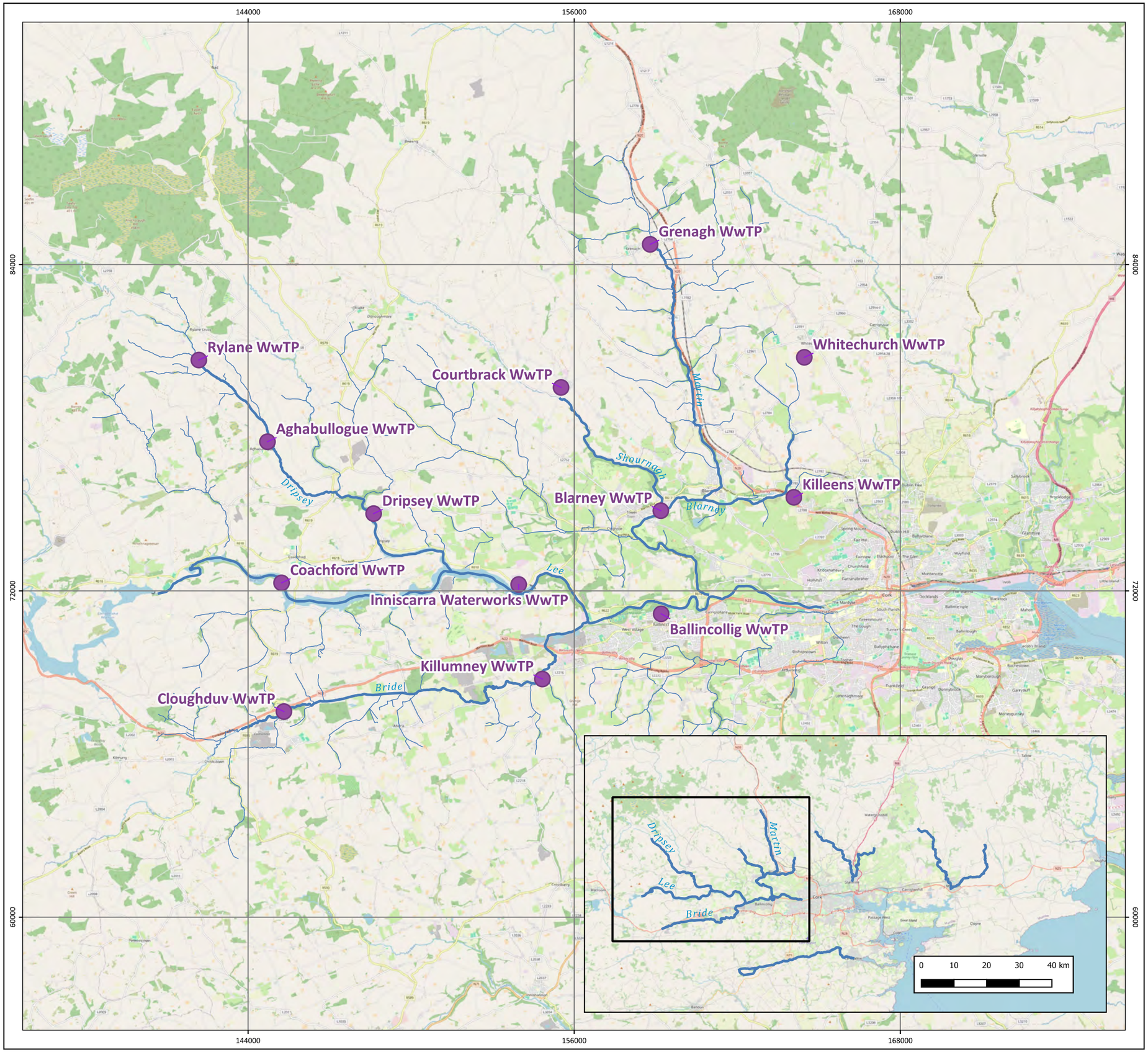
- Blarney: Whitechurch WwTP and Killeens WwTP
- Martin: Grenagh WwTP
- Shournagh: Courtbrack WwTP and Blarney WwTP
- Bride (Lee): Cloughduv WwTP and Kilumney WwTP
- Dripsey: Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP
- Lee: Coachford WwTP, Inniscarra WwTP and Ballincollig WwTP

Cork Strategic Drainage Study

Location Overview

River Lee

Drawing No: P2640-LOC-004 | A



Legend

- Lee WwTPs
- River Lee
- Tributaries

N

NOT TO BE USED FOR NAVIGATION

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Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

0 1 2 3 4 km

1.4 Scope of the Study

This study employs previously calibrated and validated MIKE11 hydrodynamic and water quality models to assess the impacts of WwTPs that discharge into the freshwater waterbodies, i.e. Glashaboy River, Owenboy River, Owenacurra River, River Lee and its tributaries, in County Cork, Ireland. From analysis of the model results, the maximum allowable ELVs for WwTPs are determined across the study horizon years, following the guidance produced by Uisce Éireann for freshwater discharges. These include:

1. Current (Baseline) scenario, representing the water quality condition when WwTPs discharge at their current permit limits
2. Future climate scenarios for the horizon years of 2030, 2055, and 2080, considering projected changes in flow at each WwTPs and climate change effects on river flows
3. Optioneering scenarios, which evaluate the potential benefits of relocating WwTPs to a more favourable discharge point downstream to improve dilution and water quality outcomes.

This study supports the determination of regulatory-compliant ELVs and provides a technical basis for long-term wastewater infrastructure planning in the Glashaboy, Owenboy, Owencurra and Lee catchment.

2. BASELINE ASSESSMENT

2.1 Model Scenarios

The river models have been applied to the following two scenarios, to provide current (baseline) condition and the condition when there is no WWTP discharges into the river, which would help to identify the impact of the WwTPs on the water quality in the river.

Current (Baseline) Scenario

This scenario represents the current water quality condition in the river when WwTPs discharge at the current permit ELVs, showing the impact of WwTPs on the river water quality.

River Only Scenario

This scenario intentionally excludes discharges from WwTPs to predict natural river condition when no WwTP effluents are discharged into the river. By removing the influence of anthropogenic inputs, the model provides insight into the natural behaviour and seasonal variation of water quality parameters, helping to distinguish between the impacts of background environmental factors and those caused by WwTP discharges.

2.2 Standards

The European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (S.I. No. 77 of 2019) are a set of regulations in Ireland that amend previous regulations related to surface water quality and environmental objectives, aligning with the requirements of the EU Water Framework Directive (WFD) and other related directives. These regulations aim to improve and protect the quality of Ireland's surface waters by setting environmental standards and objectives for various water bodies. Table 2-1 provides the WFD standards for BOD, ammonia, and MRP (Molybdate Reactive Phosphorus, also referred to as orthophosphate), which are set out for both mean and 95th percentile values.

Table 2-1 WFD Standards*

Parameter	Standard
BOD	High status ≤ 1.3 (mean) or ≤ 2.2 (95%ile) Good status ≤ 1.5 (mean) or ≤ 2.6 (95%ile)
Ammonia	High status ≤ 0.040 (mean) and ≤ 0.090 (95%ile) Good status ≤ 0.065 (mean) and ≤ 0.140 (95%ile)
MRP	High status ≤ 0.025 (mean) and ≤ 0.045 (95%ile) Good status ≤ 0.035 (mean) and ≤ 0.075 (95%ile)

2.3 Model Setup

2.3.1 Glashaboy River

A MIKE11 hydrodynamic and water quality model of the Glashaboy and Butlerstown Rivers was developed using river cross-section data from existing ISIS flood models and supplemented with bespoke survey data. The model includes the Glashaboy River from Carrignavar to its tidal limit at Glanmire, and the Butlerstown River from north of Knockraha to the same downstream boundary.

The ECO Lab module was used to represent key water quality processes including BOD decay, nitrification, re-aeration, sediment oxygen demand, and nutrient uptakes. Boundary conditions and catchment inflows were derived from EPA HydroTool and water quality monitoring data. Water quality boundary conditions were based on EPA monitoring data at Dunbulloge Bridge on the Glashaboy River (Station ID: RS19G010300) and Butlerstown Bridge on the Butlerstown River (Station ID: RS19B060500). Average concentrations were applied for BOD, ammonia, nitrate, and MRP, while seasonal time series were used for temperature and DO. Where EPA data was unavailable, bespoke survey data was used to supplement the boundary inputs.

The hydrodynamic component was calibrated against long-term EPA gauged flow and water level data at Meadowbrook, and the water quality model was calibrated against EPA water quality data. For more details on the model-setup, calibration and validation of the hydrodynamic and water quality model for the Glashaboy River, refer to model calibration and validation report (P2443_R6269_Rev1).

Five WwTPs, namely, Knockraha Village, Knockraha Chapelfield, Carrignavar, Coole East, and Roas Ards have been included in the model. The flows (average flows) and concentrations (current permit ELVs) for the WwTPS used for the Current condition are summarised in the Table 2-2.

Table 2-2 Flows and Permit ELVs for WwTPs discharging into Glashaboy River

Branch	WwTPs	Flows (m^3/s)	ELVs		
			BOD	Ammonia	MRP
Glashaboy	Carrignavar WwTP	0.0027	25	2	1.5
	Coole East WwTP	0.0001	125	20	3
	Ros Ards WwTP	0.0018	25	20	3
Butlerstown	Knockraha - Village Centre WwTP	0.0006	125	5	3
	Knockraha - Chapelfield WwTP	0.0020	125	5	3

2.3.2 Owenboy River

A MIKE11 hydrodynamic and water quality model of the Owenboy River was developed using cross-section data from existing ISIS models and supplemented with bespoke survey data. The modelled reach extends from Crossbarry to the tidal limit at Carrigaline.

The water quality model was constructed using the MIKE ECO Lab module, to represent key water quality processes including BOD decay, nitrification, re-aeration, sediment oxygen demand, and nutrient uptakes. Water quality boundary conditions were based on EPA monitoring data at the upstream location near Crossbarry. Average concentrations were applied for BOD, ammonia, nitrate, and MRP, while seasonal time series were developed for temperature and DO.

The hydrodynamic component was calibrated against long-term EPA gauged flow and water level data at Ballea monitoring site, and the water quality model was calibrated against EPA water quality data at three sites along the river. For more details on the model-setup, calibration and validation of the hydrodynamic and water quality model for the Owenboy River, refer to model calibration and validation report (P2443_R6171_Rev1).

Two WwTPs, namely, Ballygaravn WwTP and Halfway WwTP have been included in the model. The flows (average flows) and concentrations (current permit ELVs) for the WwTPS used for the Current condition are summarised in the Table 2-3.

Table 2-3 Flows and Permit ELVs for WwTPs discharging into Owenboy River

Branch	WwTPs	Flows (m^3/s)	ELVs		
			BOD	Ammonia	MRP
Owenboy	Ballygaravn WwTP	0.0014	25	5	3
Halfway WwTP	Halfway WwTP	0.0010	5	2	1

2.3.3 Owenacurra River

A MIKE11 hydrodynamic model and water quality model was developed for the Owenacurra River using cross-sections from an existing ISIS model supplemented by bespoke surveys. The modelled domain covers the Owenacurra River from Lisgoold to Midleton and the Dungourney River from Dungourney Village to their tidal limits.

The water quality model was built using MIKE ECO Lab, to represent key water quality processes including BOD decay, nitrification, re-aeration, sediment oxygen demand, and nutrient uptakes. Boundary conditions were based on EPA data near Lisgoold and Dungourney village, using sites Ballinacurra Road Bridge (EPA Station ID: RS19O021500) Dungourney Road Bridge (EPA Station ID: RS19D010600) respectively. Average concentrations were applied for BOD, ammonia, nitrate, and MRP, while seasonal time series were used for DO and temperature based on spot sample data.

The hydrodynamic model was calibrated using flow and level data from the Ballyedmond gauging station and Dungourney spot flows, and the water quality model was calibrated against EPA water quality data available. For more details on the model-setup, calibration and validation of the hydrodynamic and water quality model for the Owenacurra River, refer to model calibration and validation report (P2443_R6186_Rev1).

Four WwTPs, namely, Ballincurrig WwTP, Lisgold North WwTP, Lisgold South WwTP, and Dungourney WwTP have been included in the model. The flows (average flows) and concentrations (current permit ELVs) for the WwTPS used for the Current condition are summarised in Table 2-4.

Table 2-4 Flows and Permit ELVs for WwTPs discharging into Owencurra River

Branch	WwTPs	Flows (m^3/s)	ELVs		
			BOD	Ammonia	MRP
Owencurra	Ballincurrig WwTP	0.0015	125	20	5
	Lisgold North WwTP	0.0006	5	5	0.5
	Lisgold South WwTP	0.0006	200	30	3
Dungourney	Dungourney – Village WwTP	0.0004	145	20	3

2.3.4 River Lee

A MIKE11 model of the River Lee and its tributaries has been developed using cross-section data from a previous ISIS model and additional bespoke surveys to capture the full extent of WwTP discharges within the catchment. The model covers the River Lee from Carrigadrohid to downstream of the confluence of the North and South channels, including the Bride (Lee), Dripsey, Shournagh, Martin, and Blarney Rivers. Upstream boundaries were set using flow inputs derived from surrogate data scaled from adjacent catchments, and the downstream boundary was defined via a Q-H relationship. Tributary inflows were applied as internal point sources.

The water quality model was built in the MIKE11 ECO Lab module and includes processes such as BOD decay, nitrification, denitrification, re-aeration, and nutrient uptakes. Water quality boundary conditions were established at the upstream extents of each river using time-series or average EPA monitoring data, and WwTP inputs were added as point sources with mean concentrations.

The hydrodynamic model was calibrated against water levels at Inniscarra Headrace, Gothic Bridge, and Kilmona Bridge, and validated using scaled flows at five additional gauge locations, showing good agreement and flow continuity. Water quality model was calibrated against EPA monitoring data for DO, BOD, ammonia, nitrate, and MRP at 13 sites. For more details on the model-setup, calibration and validation of the hydrodynamic and water quality model for the River Lee, refer to model calibration and validation report P2443_R6257_Rev1.

Thirteen WwTPs, namely, Whitechurch WwTP, Killeens WwTP, Grenagh WwTP, Courtbrack WwTP, Blarney WwTP, Cloughdov WwTP, Kilumney WwTP, Rylane WwTP, Agabullogue WwTP, Dripsey WwTP, Coachford WwTP, Inniscarra WwTP, Ballincollig WwTP have been included in the model. The flows (average flows) and concentrations (current permit ELVs) for the WwTPS used for the Current condition are summarised in Table 2-5.

Table 2-5 Flows and Permit ELVs for WwTPs discharging into River Lee

Branch	WwTPs	Flows (m^3/s)	ELVs		
			BOD	Ammonia	MRP
Blarney	Whitechurch WwTP	0.0046	25	10	5
	Killeens WwTP	0.0016	25	28.4	1
Martin	Grenagh WwTP	0.0004	25	3	1.7
Shournagh	Courtbrack WwTP	0.0017	25	10	2
	Blarney WwTP	0.0432	20	1.5	0.8
Bride (Lee)	Cloughdov WwTP	0.0013	10	2	0.8
	Kilumney WwTP	0.0055	25	10	5
Dripsey	Rylane WwTP	0.0004	25	10	2
	Agabullogue WwTP	0.0004	25	5	1
	Dripsey WwTP	0.0013	25	10	5
River Lee	Coachford WwTP	0.0022	21.63	6.8	0.88
	Inniscarra WwTP	0.0009	25	10	5
	Ballincollig WwTP	0.1592	25	5	2

2.4 Model Results

Model results are presented as longitudinal plots, showing 95%ile and mean concentrations along the river, for BOD, ammonia and MRP. In each plot, both the Current (Baseline) and River Only scenarios are included to indicate the impacts of the WwTPs. Environmental Quality Standards (EQS) thresholds for High and Good status are also shown as dash lines in the plots.

2.4.1 Glashaboy River

Figure 2-1 to Figure 2-6 present the model results of Glashaboy River for two scenarios: 1 - the Baseline (Permit ELV); 2 - River Only. From the results presented in the figures, the impacts of the WwTPs on the water quality in the river can be evaluated. Table 2-6 provides a comparative evaluation of water quality parameters (BOD, ammonia and MRP) under both scenarios modelled.

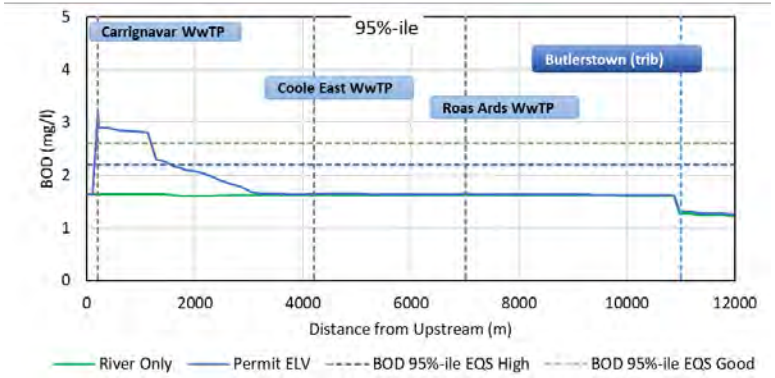
Table 2-6 Results Analysis for Glashaboy River

WQ Parameter	Comments
BOD	**Glashaboy (Figure 2-1)** Both mean and 95th percentile BOD concentrations show a notable increase downstream of the Carrignavar WwTP. The 95th percentile BOD rises sharply from approximately 1.6 mg/l to approximately 3.2 mg/l, exceeding the EQS for Good

WQ Parameter	Comments
	status before gradually declining downstream and reducing below the EQS for High status, due to additional dilution and the decay process. Mean BOD concentrations increase from about 1.6 mg/l to around 2.1 mg/l downstream of Carrignavar WwTP. The EQS for Good status is already exceeded at the upstream of the WwTP, likely due to agriculture runoff. Mean concentration gradually reduces downstream, to below the EQS for Good status and then below the EQS for High status close to the end of the modelled reach, due to additional dilution and the decay process. Coole East, and Ros Ards have little impact on the 95th percentile concentration, but slightly increase the mean concentration. **Butlerstown (Figure 2-2)** The introduction of effluent from Knockraha Village and Knockraha Chapelfield leads to a clear increase in BOD concentrations, due to lack of dilution in the river. Mean BOD concentration rises by 0.7 mg/l to approximately 2 mg/l and the 95th percentile concentration rises by 2.1 mg/l to 3.8 mg/l downstream of the WwTPs. The elevated concentration caused by the WwTPs remains exceeding the EQS for Good status until the confluence with the Glenmore River where High status resumed, showing that Knockraha plants significantly affect water quality in the river.
Ammonia	**Glashaboy (Figure 2-3)** Model results show that Carrignavar and Ros Ards WwTPs lead to increases in ammonia concentrations, with Carrignavar WwTP causing increases of 0.12 mg/l in 95th percentile concentration and 0.04 mg/l in mean concentration. Ros Ards WwTP causes similar increases in concentration, with 95th percentile concentration increased by 0.09 mg/l and mean concentration increased by 0.05 mg/l. Coole East WwTP has little impact on the water quality in the river. The EQS for Good status is already exceeded at the upstream of the WwTPs and the WwTP discharges push the concentration farther away from meeting target status with regulatory standards. **Butlerstown (Figure 2-4)** Ammonia concentration increases noticeably downstream of the Knockraha Village and Knockraha Chapelfield discharges. The 95th percentile concentration rises sharply by 0.09 mg/l to 0.11 mg/l and remain elevated for most of the reach before declining at the Glenmore River confluence. Similarly, mean concentration increases by 0.03 mg/l to about 0.05 mg/l. This elevated concentration by the WwTPs causes exceed the EQS High status threshold downstream of the WwTPs for approximately 2000 m.
MRP	**Glashaboy (Figure 2-5)** concentration increases downstream of Carrignavar and Ros Ards WwTPs, with Carrignavar WwTP causing increases of 0.08 mg/l in 95th percentile concentration and 0.03 mg/l in mean concentration. Ros Ards WwTP only causes small increases in 95th percentile and mean concentrations for MRP. Coole East WwTP has little impact on the water quality in the river. The EQS for Good status is already exceeded at the upstream of the WwTPs and the WwTP discharges push the concentration farther away from meeting target status with regulatory standards. **Butlerstown (Figure 2-6)** Knockraha Village and Knockraha Chapelfield WwTPs cause significantly increases in 90th percentile and mean concentrations, with 95th percentile concentration increased by 0.055 mg/l to 0.08 mg/l and mean concentration by 0.015 mg/l to

WQ Parameter	Comments
	0.04 mg/l. This elevated concentration caused by the WwTP discharges remains high for most of the reach before declining at the Glenmore River, causing failure of Good status.

Figure 2-1 95th Percentile and Mean BOD Results – Glashaboy



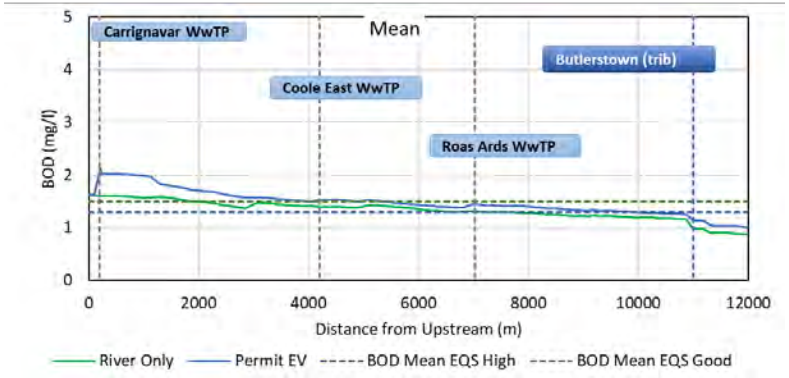
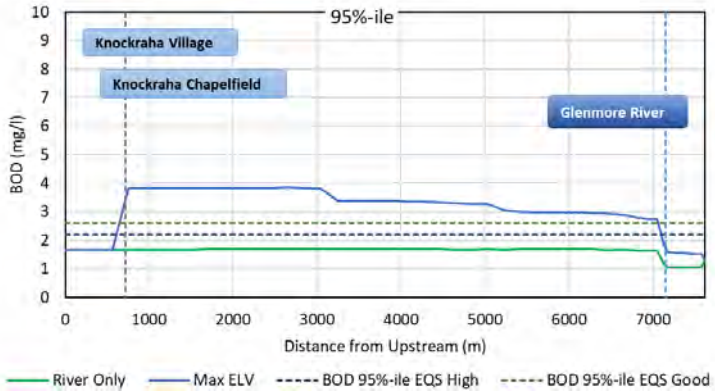


Figure 2-2 95th Percentile and Mean BOD Results - Butlerstown



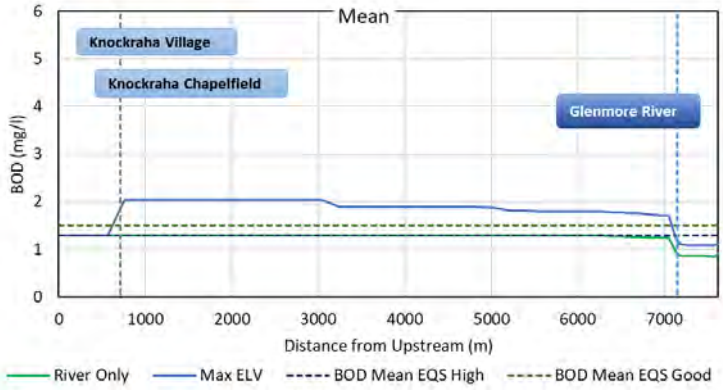
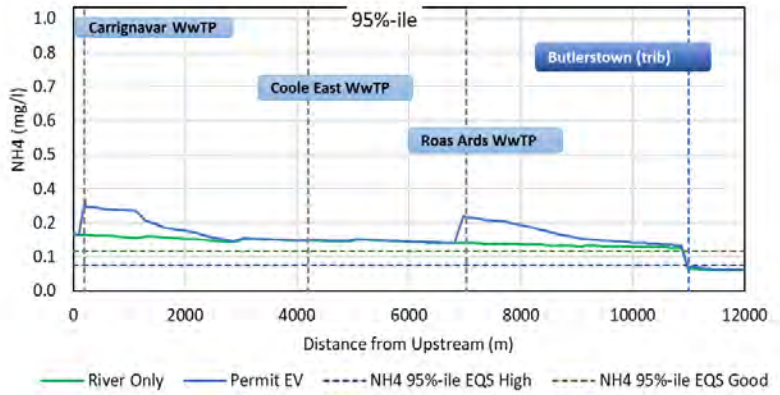


Figure 2-3 95th Percentile and Mean Ammonia Results - Glashaboy



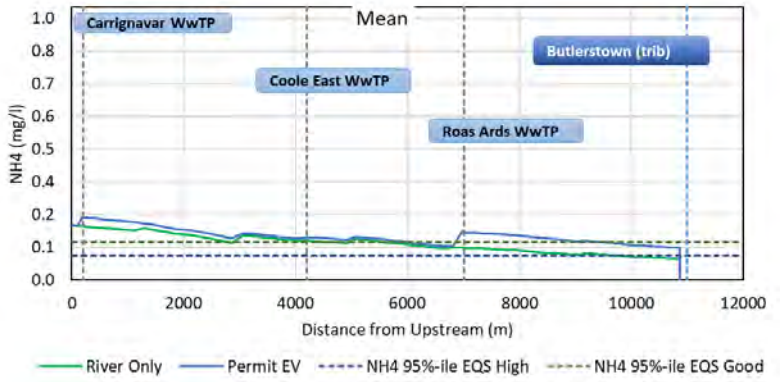
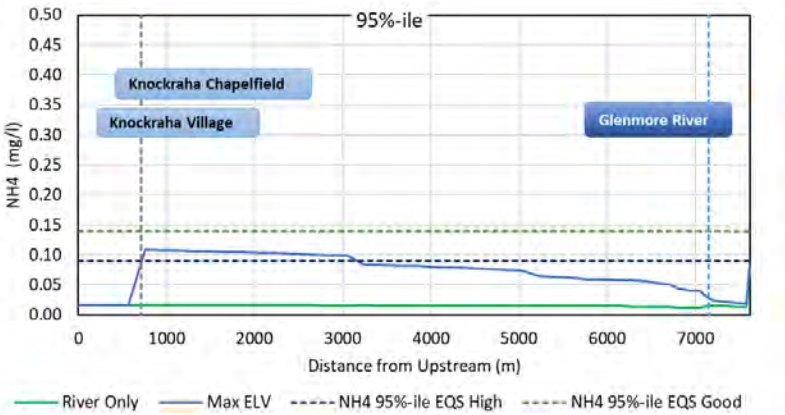


Figure 2-4 95th Percentile and Mean Ammonia Results - Butlerstown



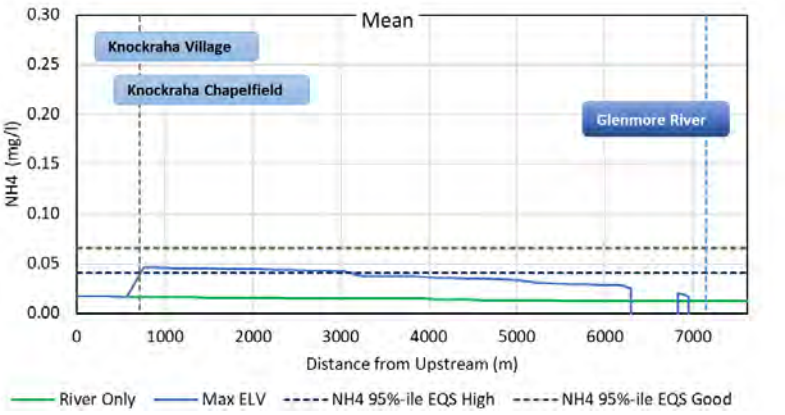
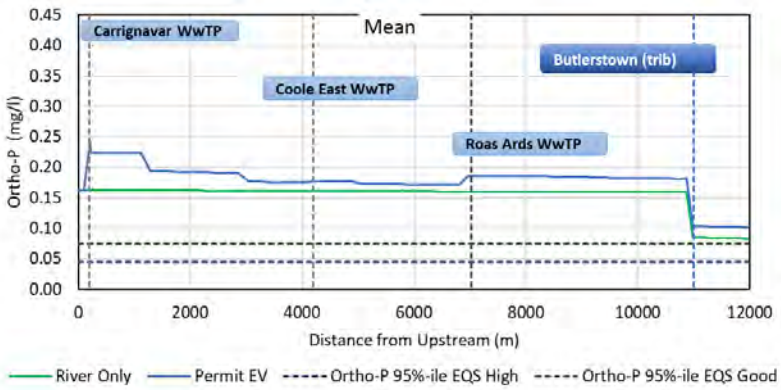


Figure 2-5 95th Percentile and Mean MRP Results - Glashaboy



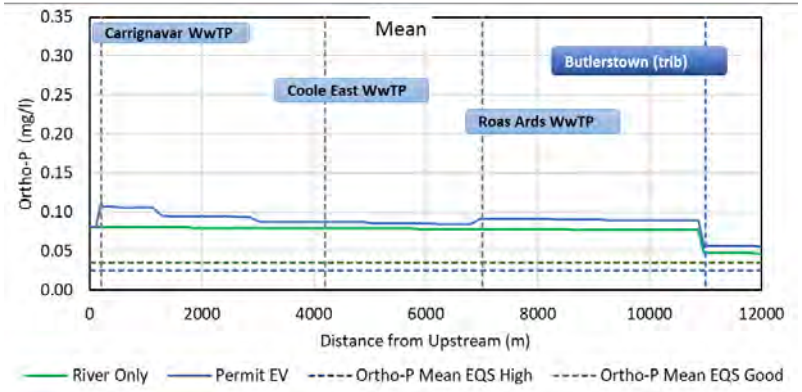
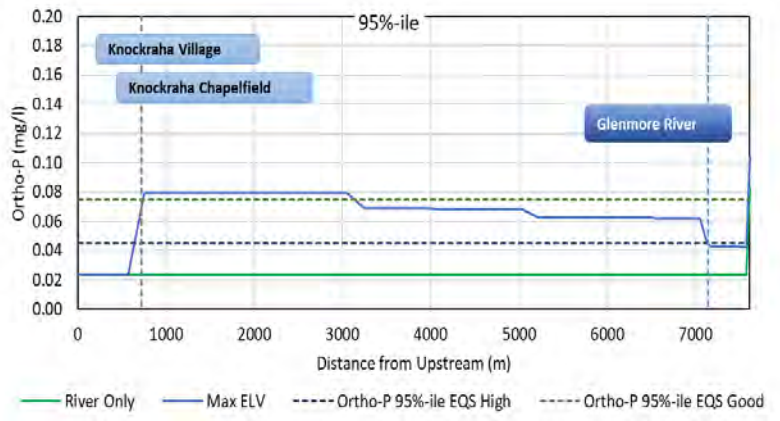
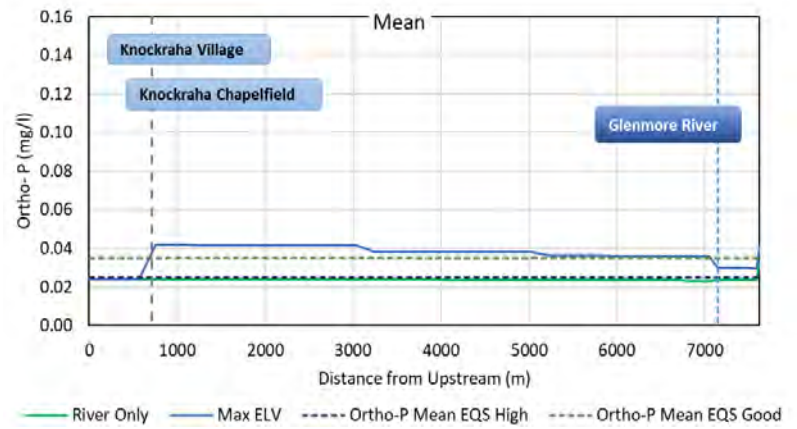


Figure 2-6 95th Percentile and Mean MRP Results – Butlerstown





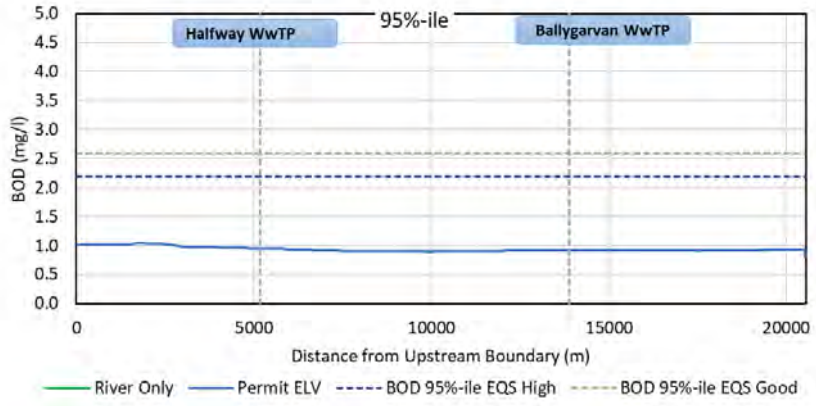
2.4.2 Owenboy River

Figure 2-7 to Figure 2-9 present the model results of Owenboy River for two scenarios: 1 Baseline (Permit ELV); 2 - River Only. From the results presented in the figures, the impacts of the WwTPs on the water quality in the river can be evaluated. Table 2-7 provides a comparative evaluation of water quality parameters (BOD, ammonia and MRP) under both scenarios modelled.

Table 2-7 Results Analysis for Owenboy River

WQ Parameter	Comments
BOD	**Owenboy (Figure 2-7)** Halfway and Ballygarvan WwTPs have little impact on BOD concentration in the river. Mean BOD concentration downstream of Ballygarvan WwTP shows a slight increase by 0.02 mg/l. The marginal increase in BOD concentration observed downstream of Ballygarvan WwTP remains within the bounds of regulatory standards.
Ammonia	**Owenboy (Figure 2-8)** Halfway and Ballygarvan WwTPs have little impact on ammonia concentration in the river. The ammonia concentration is consistently low throughout the 20,000 m river reach. In the upstream section of the reach, mean ammonia concentration exceeds threshold concentration for Good status, from the catchment runoff. However, the concentration gradually declines downstream due to the nutrient uptake process and reduces to be below the High threshold at Halfway WwTP.
MRP	**Owenboy (Figure 2-9)** Ballygarvan WwTP has minimal impact on the 95th percentile MRP concentrations. However, in terms of the mean concentration, elevated levels observed upstream are likely due to agricultural runoff or natural river processes. These concentrations gradually decline downstream until a slight increase is observed downstream of the Ballygarvan WwTP, causing a temporary exceedance of the EQS Good threshold. This is followed by a gradual decrease, with concentrations eventually falling back below the Good EQS limit. Halfway WwTP have little impact on the 95th percentile concentration but slightly increase the mean concentration.

Figure 2-7 95th Percentile and Mean BOD Results - Owenboy



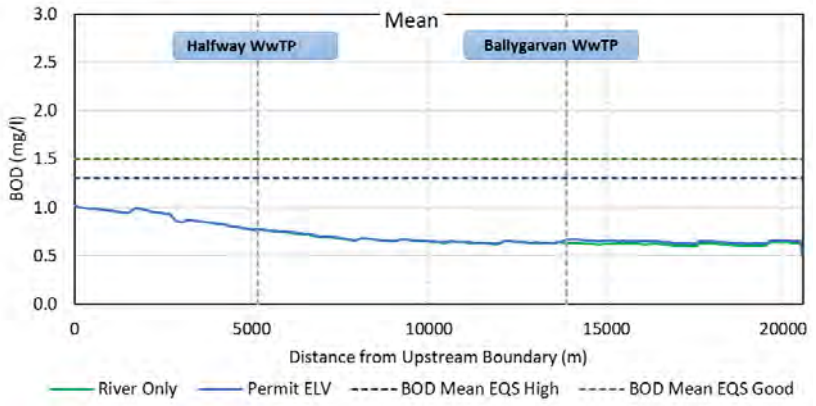
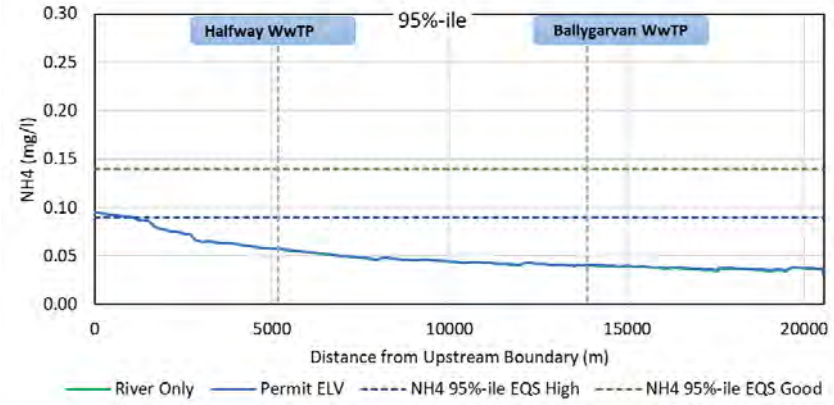


Figure 2-8 95th Percentile and Mean Ammonia Results - Owenboy



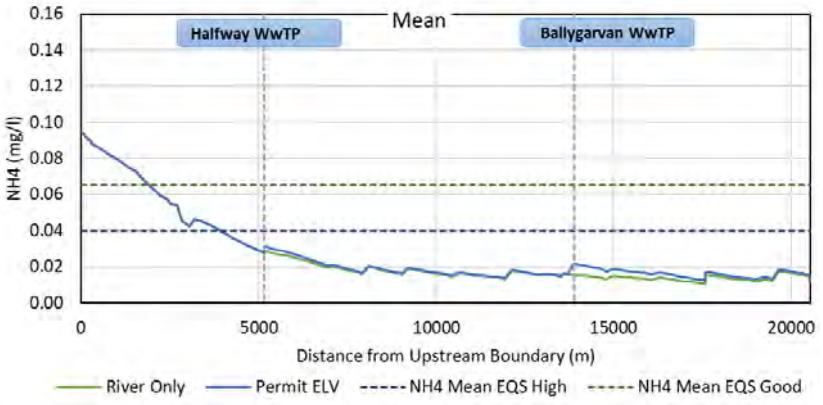
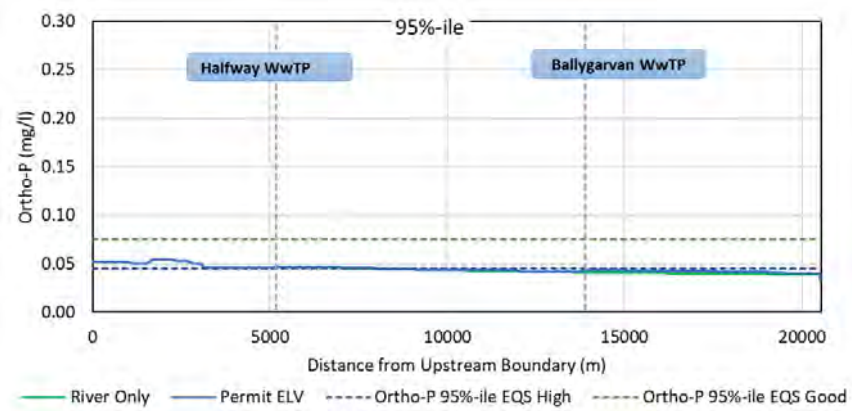
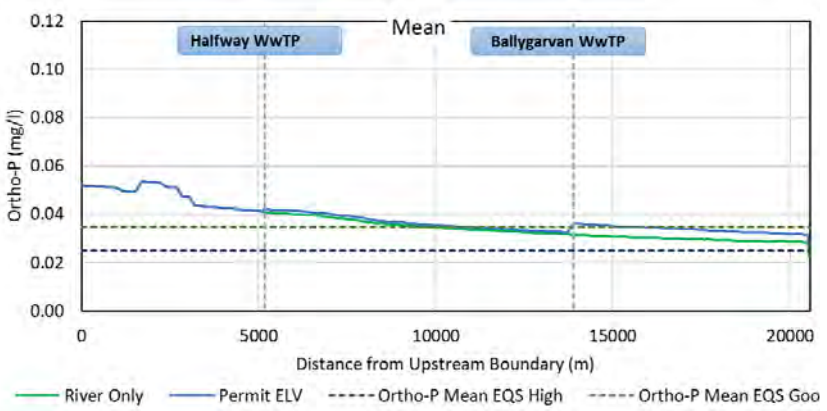


Figure 2-9 95th Percentile and Mean MRP Results - Owenboy





2.4.3 Owenaccura River

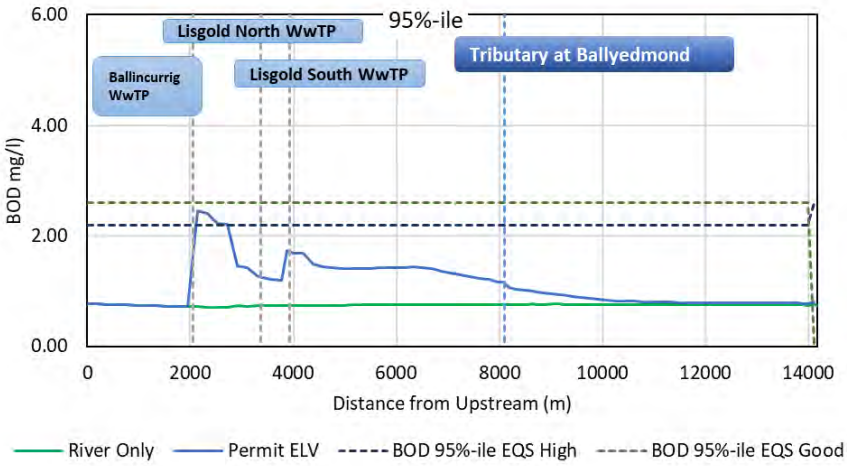
Figure 2-10 to Figure 2-15 present the model results of Glashaboy River for two scenarios: 1 - Baseline (Permit ELV); 2 - River Only . From the results presented in the figures, the impacts of the WwTPs on the water quality in the river can be evaluated. Table 2-8 provides a comparative evaluation of water quality parameters (BOD, ammonia and MRP) under both scenarios modelled.

Table 2-8 Results Analysis for Owencurra River

WQ Parameter	Comments
BOD	**Owenacurra (Figure 2-10)** Model results show that Ballincurrig and Lisgold South WwTPs contribute to increased BOD concentrations in the receiving watercourse. Downstream of Ballincurrig WwTP, the 95th percentile BOD concentration rises significantly from approximately 0.7 mg/l to 2.4 mg/l, exceeding the EQS threshold for High status. However, BOD levels gradually decrease further downstream due to dilution, eventually returning below the High EQS limit. Similarly, the mean BOD concentration increases from about 0.6 mg/l to 1.3 mg/l, marginally exceeding the regulatory High threshold downstream of Ballincurrig WwTP before declining, likely aided by dilution from tributaries such as the Ballyedmond stream. Lisgold South WwTP also shows to cause an increase in BOD levels, with the 95th percentile concentration rising by approximately 0.5 mg/l and the mean increasing by around 0.2 mg/l. Despite these increases, BOD concentrations remain within the permissible regulatory limits. In contrast, Lisgold North WwTP has negligible impact on both the 95th percentile and mean BOD concentrations. **Dungourney (Figure 2-11)** The introduction of effluent from Dungourney Village WwTP leads to small increase in BOD concentrations, due to lack of dilution in the river. Mean BOD concentration rises by 0.5 mg/l approximately and 95th percentile rises by 0.2 mg/l. However, these rises in BOD concentration do not exceed the EQS standards.
Ammonia	**Owencurra (Figure 2-12)** Model results show that both mean and 95th percentile ammonia concentrations increase significantly downstream of Ballincurrig WwTP. The 95th percentile ammonia concentration rises from approximately 0.01 mg/l to 0.32 mg/l, exceeding the EQS threshold for Good status. Although concentrations decline further downstream due to dilution, they rise again downstream of the Lisgold South WwTP before gradually decreasing along the lower stretch of the river, eventually falling below the EQS for High status. Similarly, the mean ammonia concentration downstream of Ballincurrig WwTP increases from around 0.01 mg/l to 0.12 mg/l, also breaching the EQS for Good status before following a similar declining trend. Lisgold South WwTP contributes to a moderate increase in ammonia levels, with the 95th percentile concentration rising by approximately 0.08 mg/l and the mean increasing by around 0.02 mg/l. Despite these changes, ammonia concentrations remain within regulatory thresholds. Lisgold North WwTP has a negligible effect on both the 95th percentile and mean ammonia concentrations. **Dungourney (Figure 2-13)**

WQ Parameter	Comments
	Ammonia concentration increases noticeably downstream of the Dungourney Village WwTP. The 95th percentile concentration rises sharply by 0.07 mg/l to 0.10 mg/l. Similarly, mean concentration increases by 0.03 mg/l to about 0.06 mg/l. These increases in the 95th percentile and mean ammonia concentrations causes exceedance of High EQS standard. The ammonia concentration gradually decreases downstream of river stretch and reducing below the EQS for High status, showing Dungourney Village WwTP affects the water quality in the river.
MRP	**Owencurra (Figure 2-14)** concentration increases downstream of Ballincurrig and Lisgold South WwTPs, with Ballincurrig WwTP causing increases of 0.08 mg/l in 95th percentile concentration and 0.03 mg/l in mean concentration. Lisgold South WwTP only causes small increases in 95th percentile and mean concentrations for MRP, Lisgold North WwTP has little impact on the water quality in the river. The Good EQS status is exceeded downstream of Ballincurrig WwTP. While MRP concentrations show a gradual downstream decline due to dilution and nutrient uptake processes, they remain above the Good EQS threshold for a considerable stretch. Further downstream, levels eventually fall below the Good status threshold, yet still exceed the EQS required for High status. **Dungourney (Figure 2-15)** concentrations increase downstream of Dungourney Village WwTP, with the 95th percentile showing an increase of 0.01 mg/l, remaining within the applicable EQS thresholds. However, the mean MRP concentration increases by approximately 0.003 mg/l, just exceeding the EQS for High status. Notably, the EQS for High status is already exceeded upstream of the WwTP discharge point, likely due to diffuse agricultural runoff, and this exceedance persists along the downstream stretch of the river, indicating limited dilution within the river reach.

Figure 2-10 95th Percentile and Mean BOD Results - Owencurra



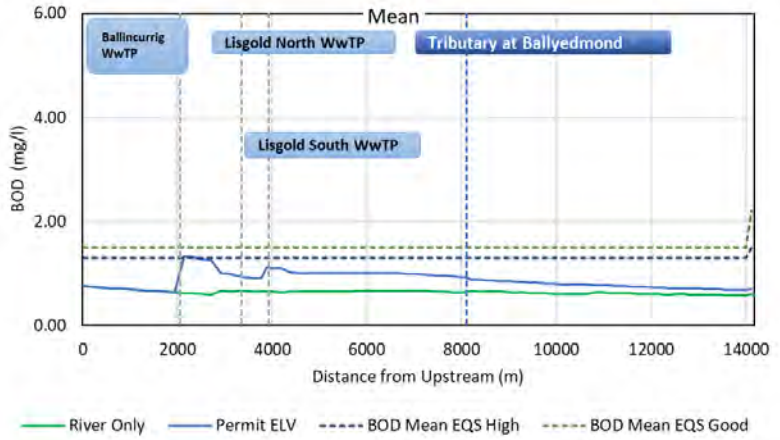
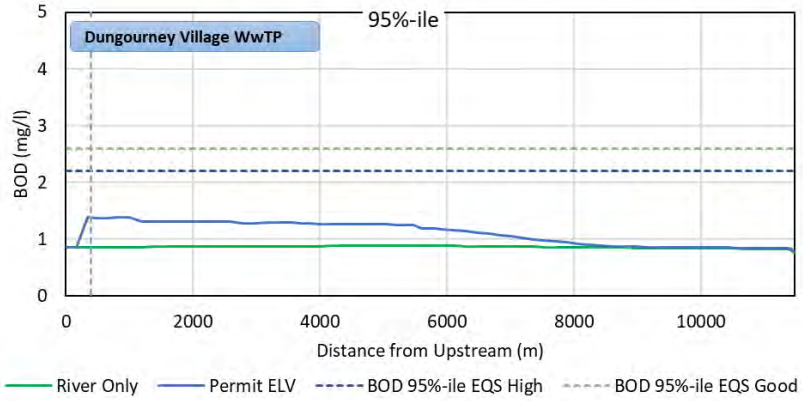


Figure 2-11 95th Percentile and Mean BOD Results - Dungourney



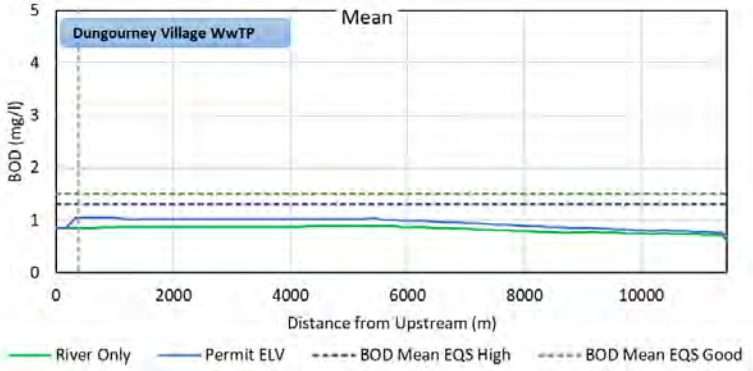
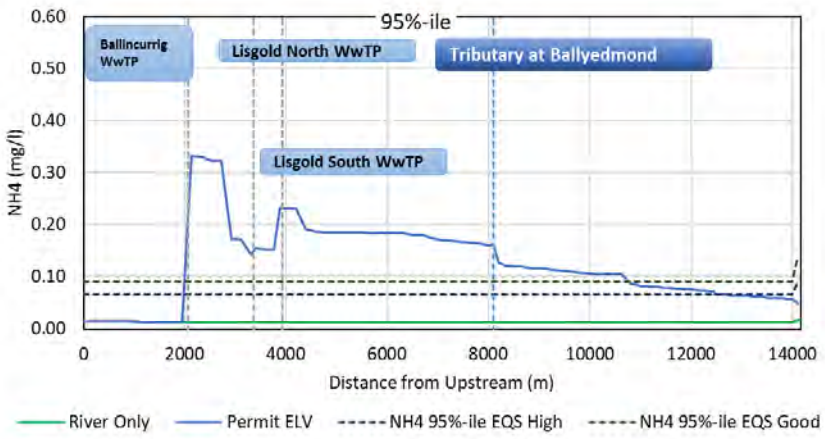


Figure 2-12 95th Percentile and Mean Ammonia Results - Owencurra



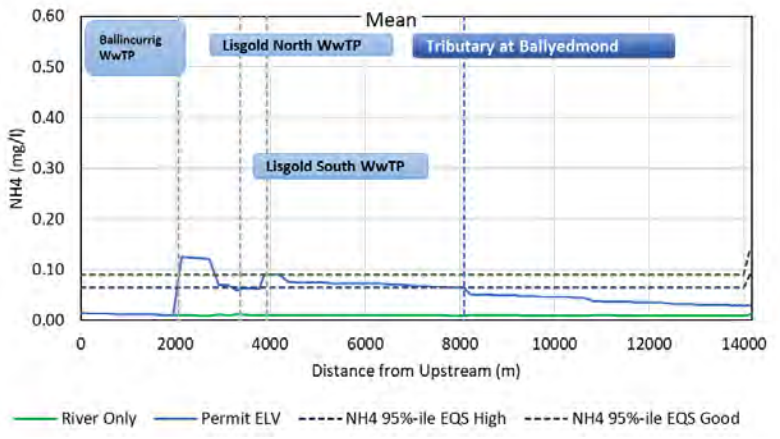
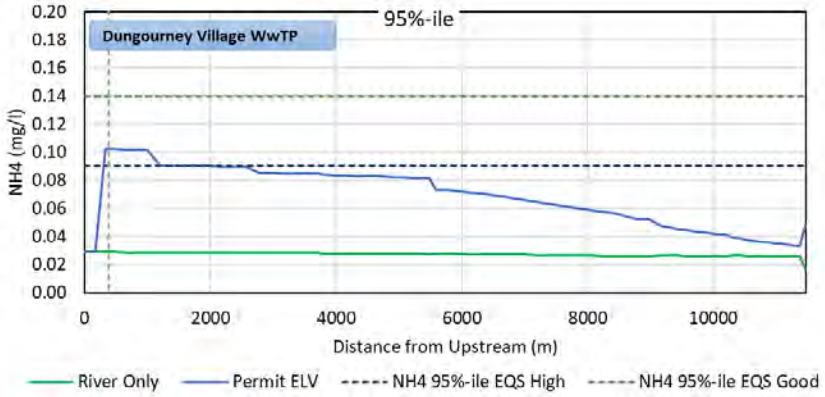


Figure 2-13 95th Percentile and Mean Ammonia Results - Dungourney



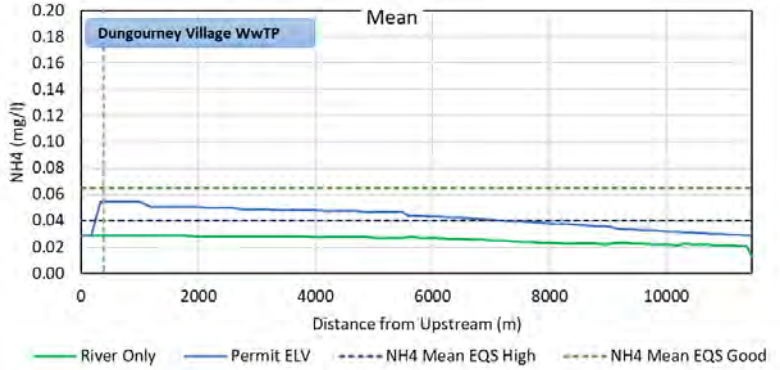
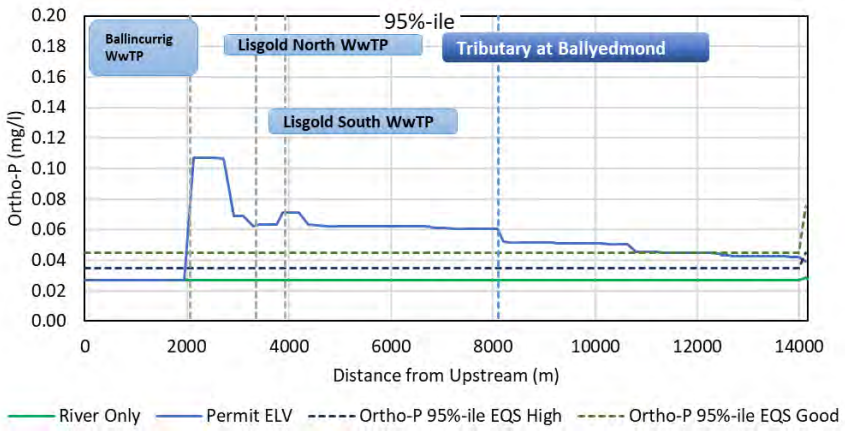


Figure 2-14 95th Percentile and Mean MRP Results - Owencurra



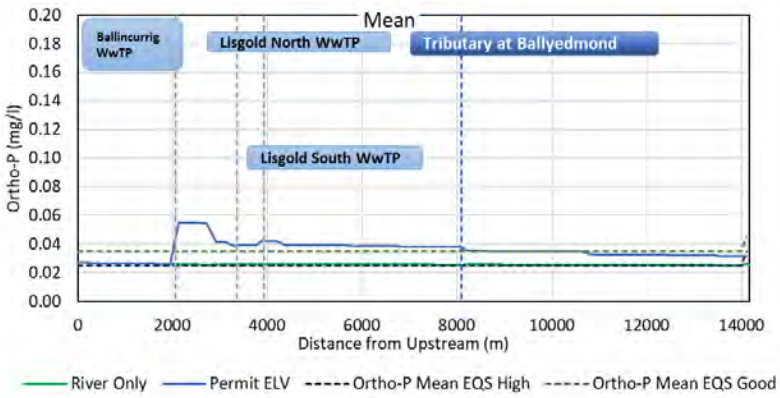
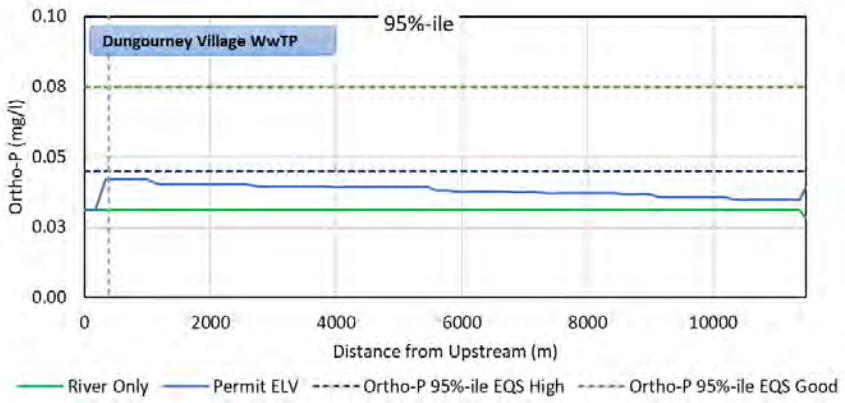
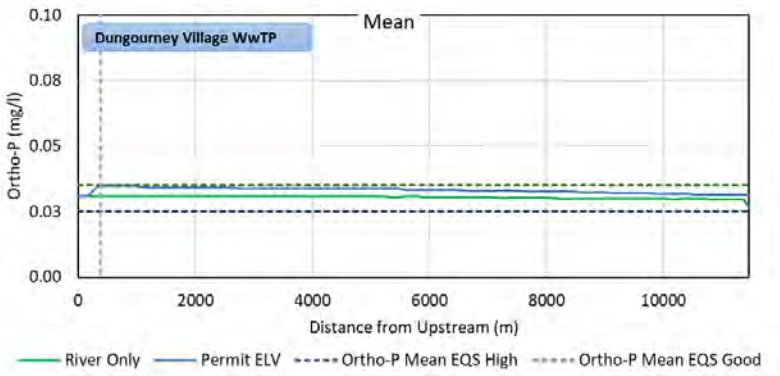


Figure 2-15 95th Percentile and Mean MRP Results – Dungourney





2.4.4 River Lee

Figure 2-16 to Figure 2-33present the model results of Glashaboy River for two scenarios: 1 - Baseline (Permit ELV); 2 - River Only. From the results presented in the figures, the impacts of the WwTPs on the water quality in the river can be evaluated. Table 2-9 provides a comparative evaluation of water quality parameters (BOD, ammonia and MRP) under both scenarios modelled.

Table 2-9 Results Analysis for Lee River

WQ Parameter	Comments
BOD	**Blarney (Figure 2-16)** Model results show that BOD concentrations increase significantly downstream of Whitechurch WwTP. The 95th percentile BOD rises sharply from 3.3 mg/l to 6.2 mg/l. Similarly, the mean concentration increases from 1.7 mg/l to 3 mg/l. The upstream river concentration already exceeds EQS for Good status, and these increases in BOD concentrations caused by Whitechurch WwTP push the water quality in the river further away from Good status. Elevated concentrations persist until where River Martin joins. Killeens WwTP does not cause increase in BOD concentration, showing that this WwTP contributes minimally to the BOD load. **Martin (Figure 2-17)** Model results show that Grenagh WwTP has a minimal impact on BOD concentration in the River Martin. The 95th percentile remains relatively stable along the river reach, with only a slight increase of 0.3 mg/l observed downstream of Grenagh WwTP. BOD concentrations consistently remain below High EQS threshold. The mean BOD concentrations slightly increase downstream of Grenagh WwTP and consistently exceed EQS High status, but below the Good threshold. It should be noted that the upstream river concentration already exceeds EQS for Good status. Notably, at the downstream end of the reach, BOD levels increase caused by higher concentration in Blarney. **Shournagh (Figure 2-18)** The Courtbrack WwTP contributes a little increase in the 95th percentile with BOD concentrations remaining within the EQS thresholds. The mean BOD concentration exceeds EQS High standard upstream of WwTP, due to diffuse agricultural runoff within the catchment. Both mean and 95th percentile BOD concentrations show a large increase downstream of the Blarney WwTP. The 95th percentile BOD rises sharply from approximately 1.4 mg/l to approximately 2.9 mg/l, exceeding the EQS for Good status. Mean BOD concentrations downstream of Blarney WwTP increase from about 1.4 mg/l to around 1.8 mg/l downstream of Blarney WwTP. **Dripsey (Figure 2-19)** A slight increase in BOD levels, both at the 95th percentile and in the mean concentration, was observed downstream of the three wastewater treatment plants—Rylane, Aghabullogue, and Dripsey. However, BOD concentrations along the entire river stretch remained within the High EQS thresholds, indicating that these WWTPs had no significant impact on the watercourse. **Bride (Figure 2-20)**

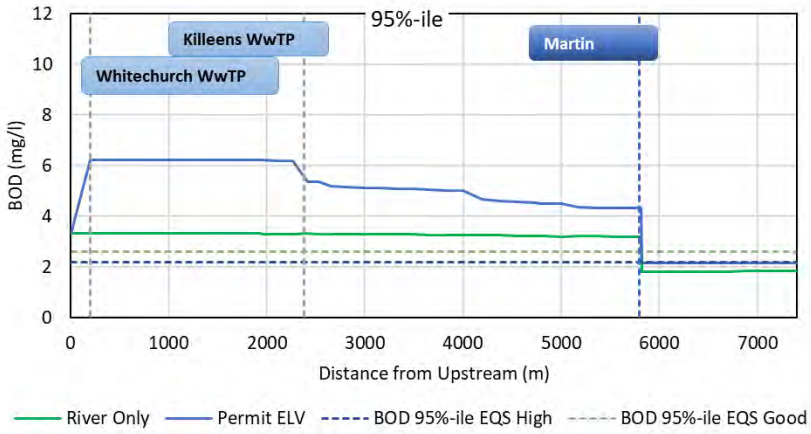
WQ Parameter	Comments
	The Cloughduv WwTP shows negligible impact in the 95th percentile and mean BOD Concentrations. Model results show that Killumney WwTP leads to increase in BOD concentrations. The 95th percentile shows an increase of 0.1 mg/l and mean concentrations show an increase of 0.07 mg/l downstream of Killumney WwTP. Despite these increases, BOD concentrations remain within the EQS thresholds for both metrics, and EQS standards is maintained throughout the entire river stretch. **Lee (Figure 2-21)** Both mean and 95th percentile BOD concentrations show an increase downstream of the Ballincollig WwTP. The 95th percentile BOD rises from approximately 1.3 mg/l to approximately 1.7 mg/l, while the mean concentration increases from about 0.8 mg/l to around 1.2 mg/l downstream of Ballincollig WwTP. Despite these increases in BOD concentration downstream of Ballincollig WwTP, BOD levels remain within the limits for High EQS status for 95th percentile and mean concentration. Coachford and Inniscarra WwTP have little impact on the 95th percentile and mean concentration.
Ammonia	**Blarney (Figure 2-22)** Ammonia concentration increases significantly downstream of the Whitechurch WwTP. The 95th percentile concentration rises sharply by 1.6 mg/l to 1.9 mg/l and remain elevated for most of the reach before declining at the Martin River confluence. Similarly, mean concentration increases by 0.56 mg/l to about 0.74 mg/l. Killumney WwTP also contributes to elevated ammonia levels, though to a lesser extent than Whitechurch. Downstream of Killumney, the 95th percentile increases from about 1.6 mg/l to 2.0 mg/l, while the mean concentration rises from 0.58 mg/l to 0.73 mg/l This elevated concentration by the WwTPs causes exceed the EQS Good status threshold downstream of the WwTPs throughout the river reach. **Martin (Figure 2-23)** Model results show that the Grenagh WwTP has an impact on ammonia levels in the River Martin. The 95th percentile remains largely stable throughout the river reach, with only a slight increase of 0.03 mg/l observed downstream of the Grenagh WwTP, and concentrations consistently stay below the High EQS threshold. However, mean ammonia levels increase downstream of the WwTP to approximately 0.08 mg/l, marginally exceeding the EQS Good status before gradually declining downstream and reducing below the EQS for High status, due to nitrification and nutrient uptakes. At the far downstream end of the reach, conference with Blarney River, 95th percentile and mean ammonia concentrations rise sharply due to the high concentration in Blarney. **Shournagh (Figure 2-24)** Model results show that the Courtbrack has a notable impact on water quality. Downstream of Courtbrack WwTP, the 95th percentile ammonia concentrations increase from around 0.02 mg/l to approximately 0.07 mg/l, while the mean concentrations rise from about 0.02 mg/l to 0.04 mg/l. A significant increase in ammonia concentration is observed downstream of the Blarney WwTP. The 95th percentile concentration rises by 0.09 mg/l to reach 0.14 mg/l and remains elevated over much of the river stretch before

WQ Parameter	Comments
	decreasing near the Blarney River confluence. Similarly, the mean concentration increases by 0.03 mg/l, reaching approximately 0.06 mg/l. Both WwTPs influence water quality, with Blarney WwTP having the more pronounced effect. However, ammonia levels (both 95th percentile and mean) decline downstream of the WwTPs and fall below the EQS threshold for High status. **Dripsey (Figure 2-25)** The 95th percentile ammonia concentration downstream of Rylane WwTP shows a sharp increase from approximately 0.02 mg/l to 0.12 mg/l, exceeding the EQS High threshold before gradually decreasing below this level along the rest of the river reach. Similarly, the mean ammonia concentration rises from around 0.02 mg/l to 0.05 mg/l, also exceeding the EQS High standard before declining downstream to fall within EQS High standards. Aghabullogue WwTP have a little impact, with a slightly increase in the mean concentration. Dripsey WwTP impacts both 95th percentile and mean ammonia concentrations, though the increases remain within EQS limits and do not result in any exceedance of EQS. **Bride (Figure 2-26)** The Cloughduv WwTP shows negligible impact in the 95th percentile with ammonia concentrations remaining within the EQS thresholds. The 95th percentile ammonia concentrations increase from approximately 0.05 mg/l to 0.09 mg/l downstream of Killumney WwTP, slightly exceeding the threshold for High EQS status. However, the levels gradually decrease due to dilution, eventually returning to within the High EQS. Similarly, mean ammonia concentrations rise from around 0.01 mg/l to 0.04 mg/l, again marginally exceeding the High EQS threshold before gradually declining to below the High threshold. **Lee (Figure 2-27)** Both mean and 95th percentile ammonia concentrations increase downstream of the Ballincollig WwTP. The 95th percentile values rise from approximately 0.04 mg/l to around 0.2 mg/l, exceeding the threshold for Good EQS status. These concentrations then gradually decrease, falling below the High EQS threshold toward the downstream end of the river reach, aided by dilution from tributaries such as the Shournagh. Similarly, mean ammonia concentrations increase from about 0.01 mg/l to approximately 0.09 mg/l downstream of the Ballincollig WwTP, also exceeding the Good EQS threshold and following a similar declining trend as seen in the 95th percentile results. Coachford and Inniscarra WwTPs have little impact on the 95th percentile and mean concentration.
MRP	**Blarney (Figure 2-28)** Model results show that MRP concentrations increase downstream of Whitechurch WwTP. The 95th percentile MRP rises sharply from 0.1 mg/l to 0.9 mg/l. Similarly, the mean concentration increases from 0.07 mg/l to 0.36 mg/l. These increases in MRP concentration for both 95th percentile and

WQ Parameter	Comments
	mean results in exceedance of EQS Good standards. However, no additional increase in MRP is observed downstream of Killeens WwTP, showing that this WwTP contributes minimally to the MRP load. concentrations at upstream of the river already exceeds Good EQS limits and Whitechurch WwTP increases the MRP concentration much further above the EQS thresholds. **Martin (Figure 2-29)** Model results indicate that the Grenagh WwTP impacts MRP levels in the River Martin. The 95th percentile rises by 0.02 mg/l downstream of the plant, temporarily exceeding the EQS Good status, before gradually declining further downstream and falling back below the Good threshold. The 95th percentile MRP concentration remains within the EQS Good range for approximately 2000 meters downstream but then increases sharply at the downstream end of the reach, due to high concentration in Blarney River. Mean MRP concentrations also show a small increase downstream of the Grenagh WwTP. Notably, EQS Good status for MRP is already exceeded upstream of the WwTP. **Shournagh (Figure 2-30)** The 95th percentile and mean concentrations for the Shournagh River show that both Courtbrack and Blarney WwTPs contribute to elevated nutrient levels, with Blarney having a more significant impact. Courtbrack WwTP causes a moderate rise in MRP concentration. Downstream of Blarney WwTP, the 95th percentile MRP concentration rises sharply from 0.06 mg/l to 0.14 mg/l, surpassing the Good EQS threshold and remaining elevated for the rest of the river reach. The mean concentration also increases, from 0.06 mg/l to 0.08 mg/l. Mean concentration at upstream of the river is already above the Good EQS limit. **Dripsey (Figure 2-31)** The 95th percentile MRP concentration downstream of Rylane WwTP increases from approximately 0.028 mg/l to 0.05mg/l, exceeding the EQS High status, before gradually declining until the influence of Dripsey WwTP. The mean concentration upstream of Rylane already exceeds the EQS High threshold, and downstream it increases slightly from around 0.02 mg/l to 0.03 mg/l, approaching but not surpassing the High EQS limit. Aghabullogue WwTP shows a minimal impact on both the 95th percentile and mean concentrations, with only slight variations observed. Following the discharge from Dripsey WwTP, the 95th percentile concentration again increases from about 0.03 mg/l to 0.05 mg/l, exceeding the High EQS threshold before decreasing downstream, ultimately falling below the EQS High limit by the end of the river reach. Similarly, the mean MRP concentration, already above the High EQS threshold upstream, shows a small increase from 0.02 mg/l to 0.03 mg/l downstream of Dripsey WwTP but does not exceed the Good threshold and shows a similar declining trend downstream. **Bride (Figure 2-32)** The Cloughduv WwTP shows little impact in the 95th percentile and mean MRP Concentrations.

WQ Parameter	Comments
	Model results indicate that Killumney WwTP contributes to elevated MRP concentrations in the receiving watercourse. The 95th percentile values increase from approximately 0.04 mg/l to 0.07 mg/l downstream of the discharge point, exceeding the High threshold. Similarly, the mean concentrations rise from around 0.02 mg/l to 0.04 mg/l, exceeding EQS Good limit. **Lee (Figure 2-33)** Both mean and 95th percentile MRP concentrations increase downstream of the Ballincollig WwTP. The 95th percentile values rise from approximately 0.02 mg/l to around 0.08 mg/l, exceeding the threshold for Good EQS status. Similarly, mean MRP concentrations increase from about 0.01 mg/l to approximately 0.05 mg/l downstream of the WwTP, also exceeding the Good EQS threshold. concentrations remain above the EQS Good threshold downstream of the Ballincollig WwTP for both 95th percentile and mean concentration. This suggests limited dilution capacity and elevated MRP inputs from the Ballincollig discharges. Coachford and Inniscarra WwTP have little impact on the 95th percentile and mean concentration.

Figure 2-16 95th Percentile and Mean BOD Results – Blarney



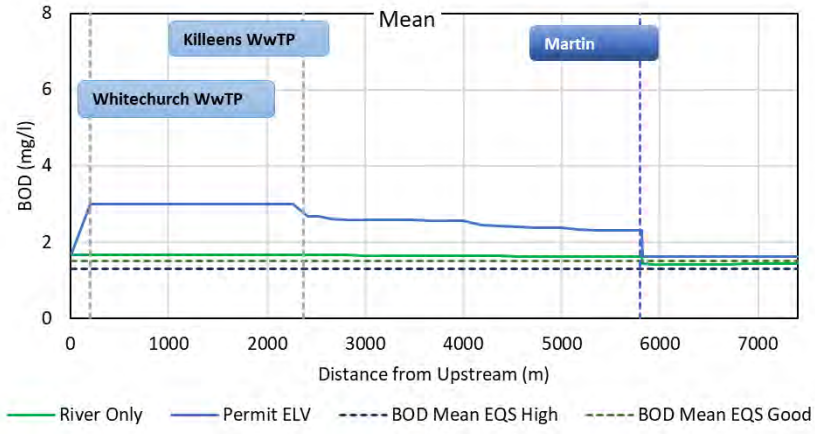
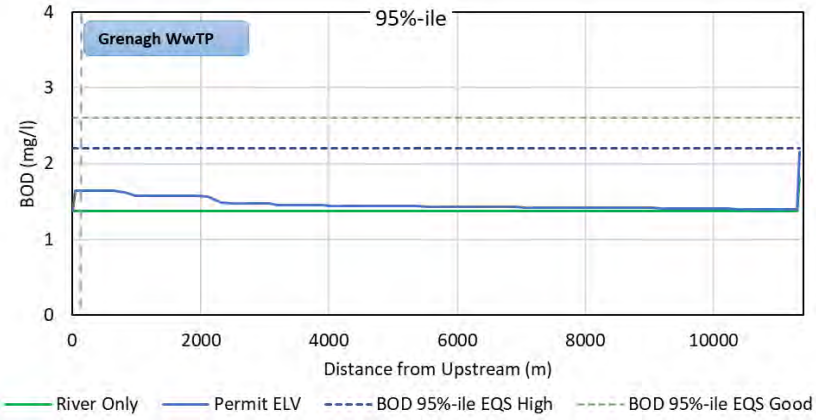


Figure 2-17 95th Percentile and Mean BOD Results – Martin



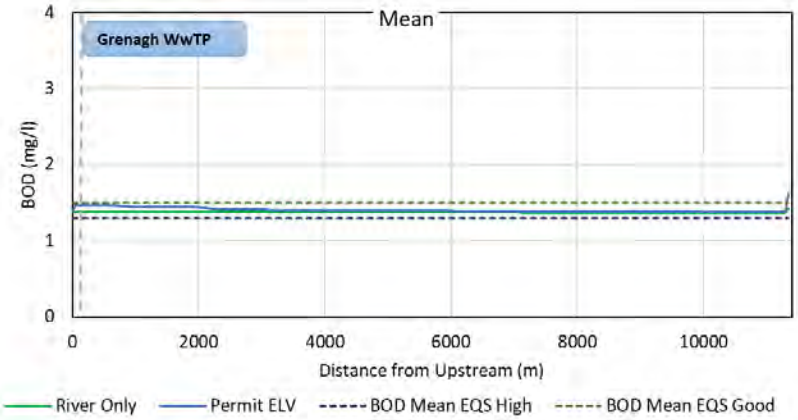
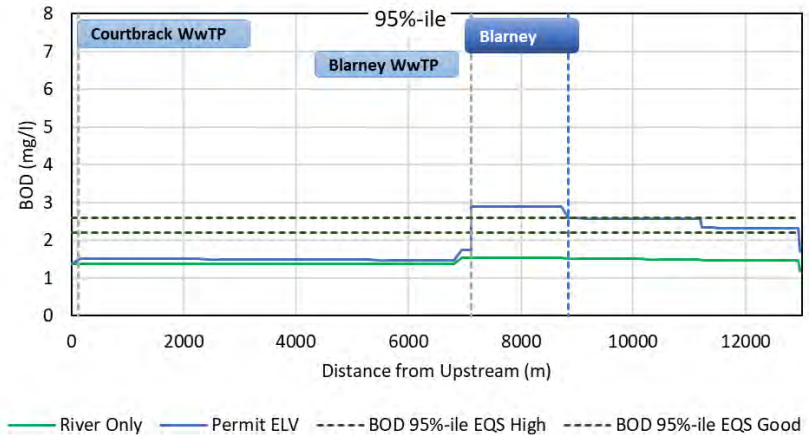


Figure 2-18 95th Percentile and Mean BOD Results – Shournagh



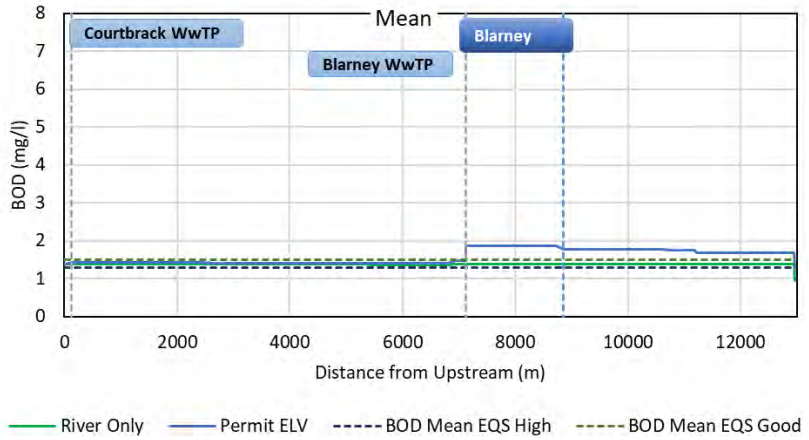
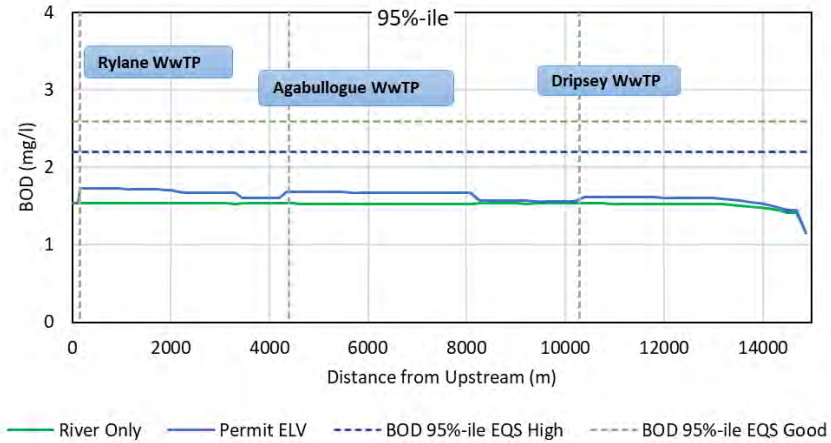


Figure 2-19 95th Percentile and Mean BOD Results – Dripsey



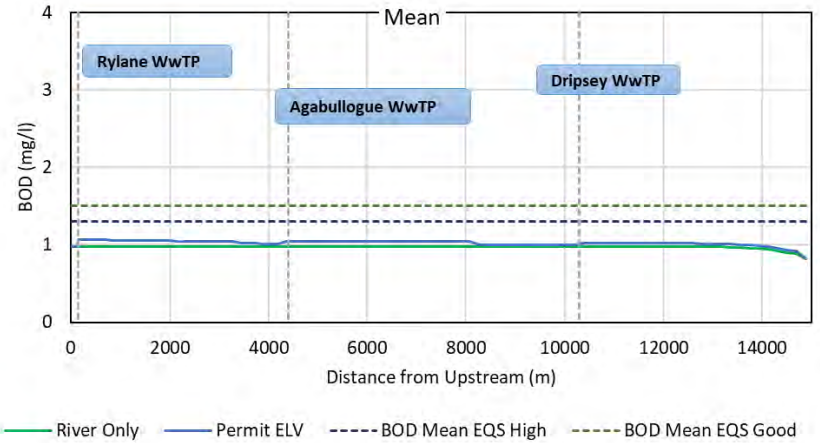
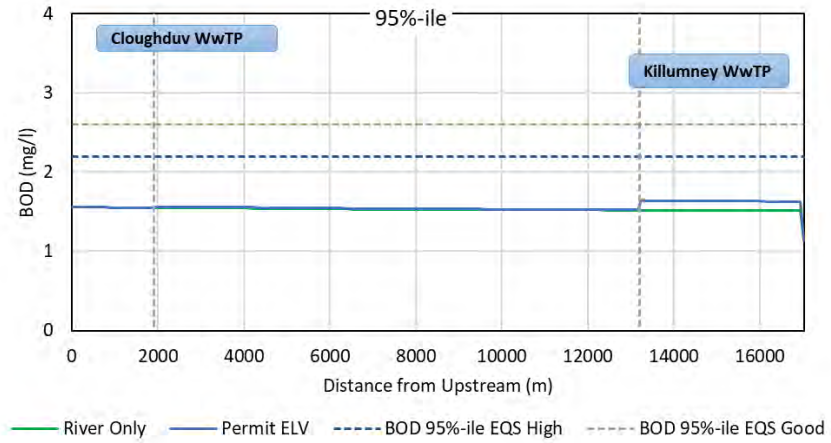


Figure 2-20 95th Percentile and Mean BOD Results – Bride



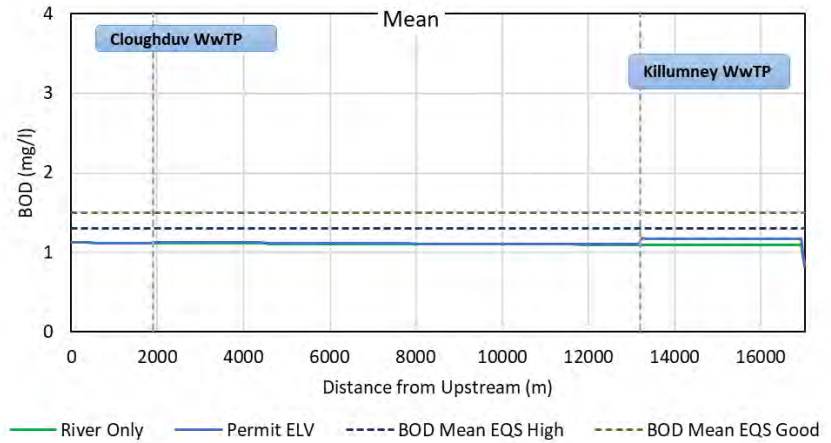
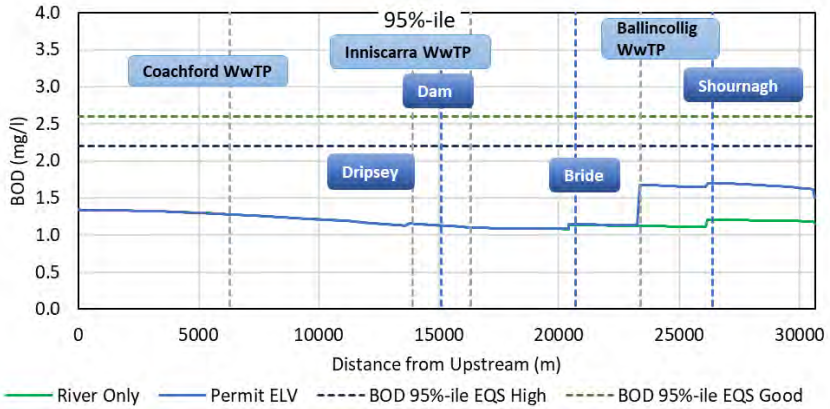


Figure 2-21 95th Percentile and Mean BOD Results – Lee



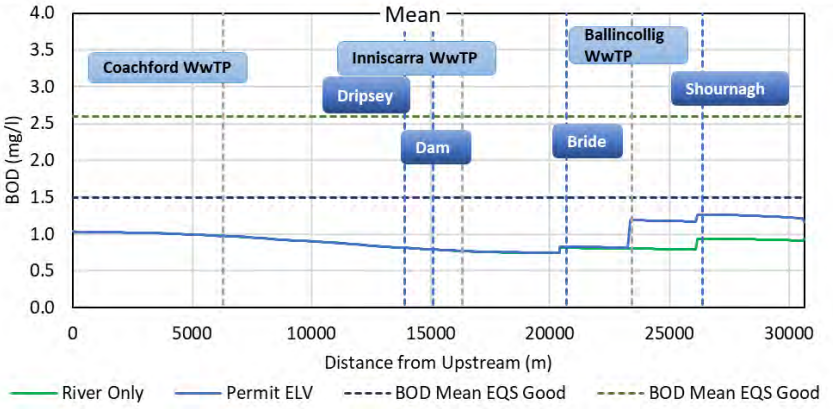
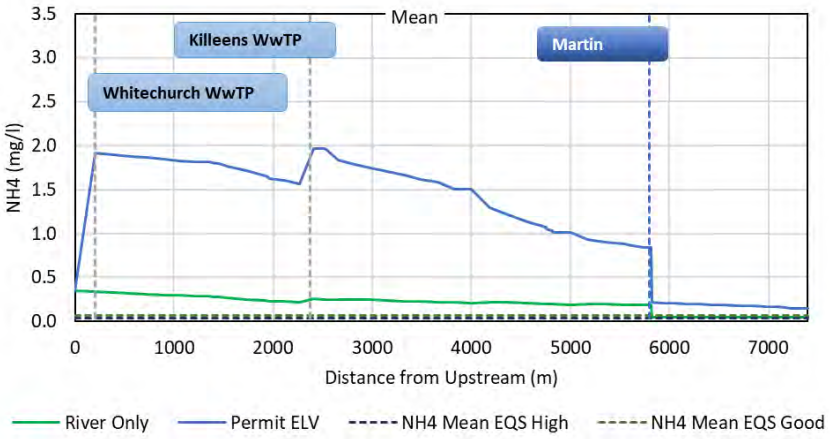


Figure 2-22 95th Percentile and Mean Ammonia Results - Blarney



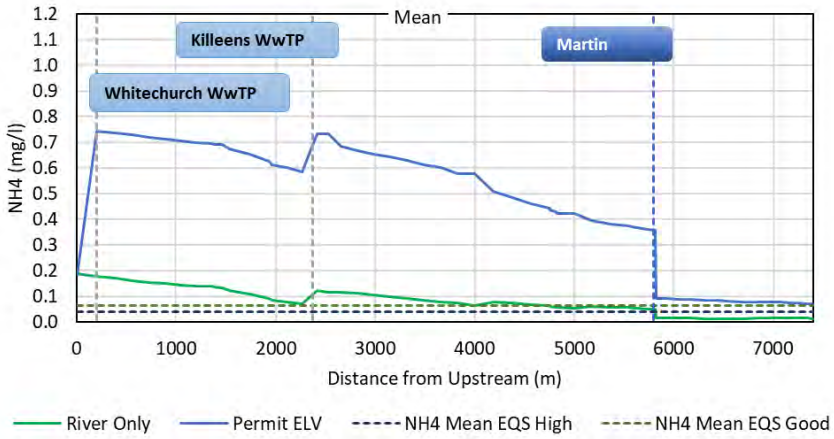
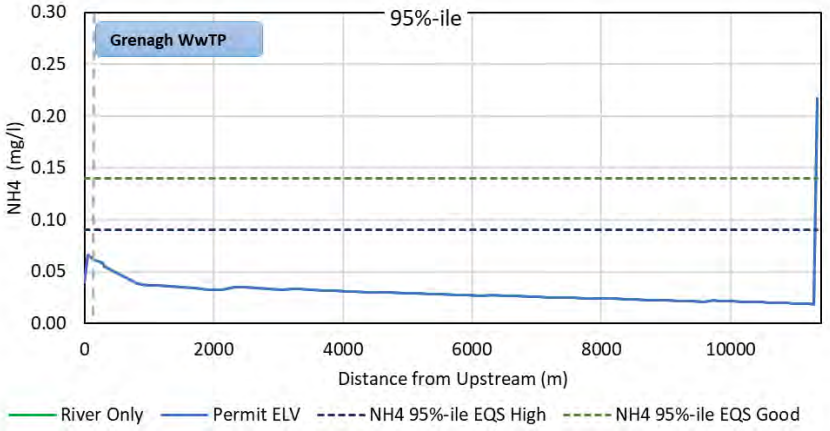


Figure 2-23 95th Percentile and Mean Ammonia Results – Martin



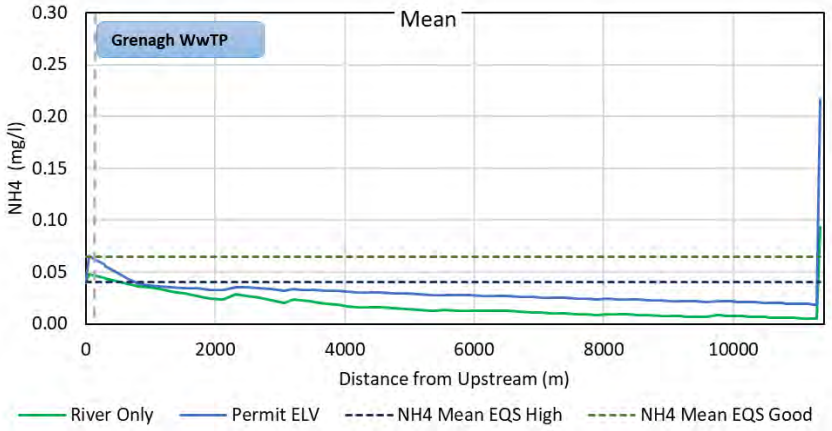
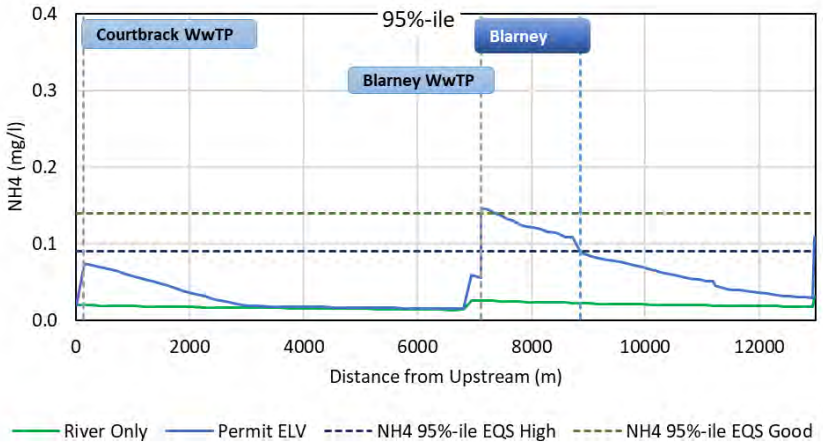


Figure 2-24 95th Percentile and Mean Ammonia Results – Shournagh



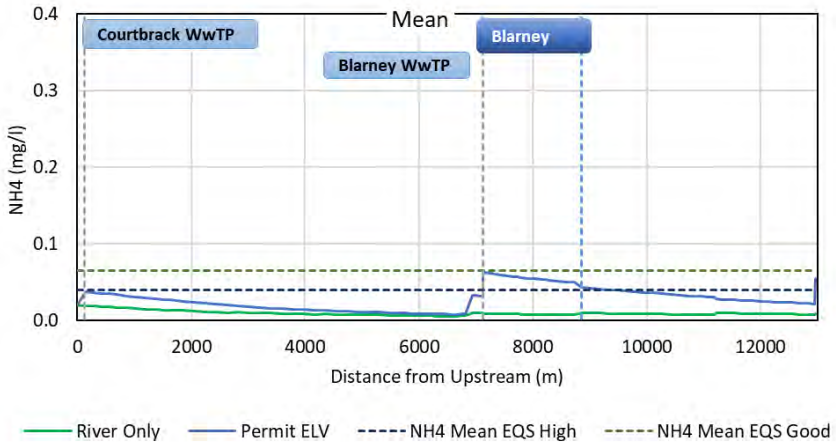
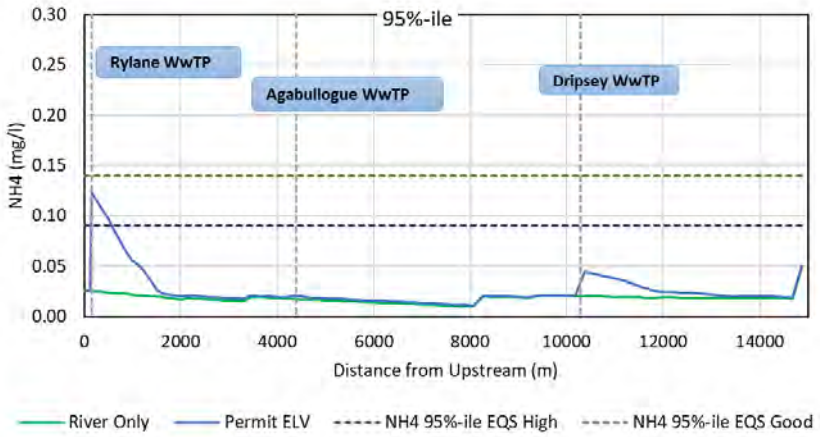


Figure 2-25 95th Percentile and Mean Ammonia Results – Dripsey



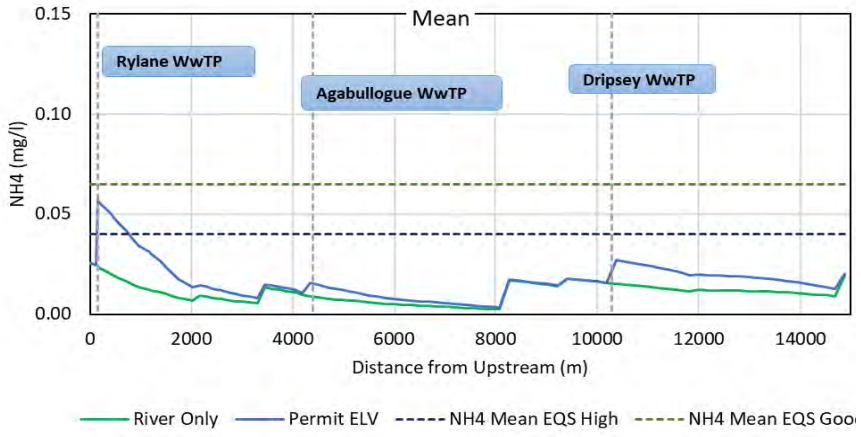
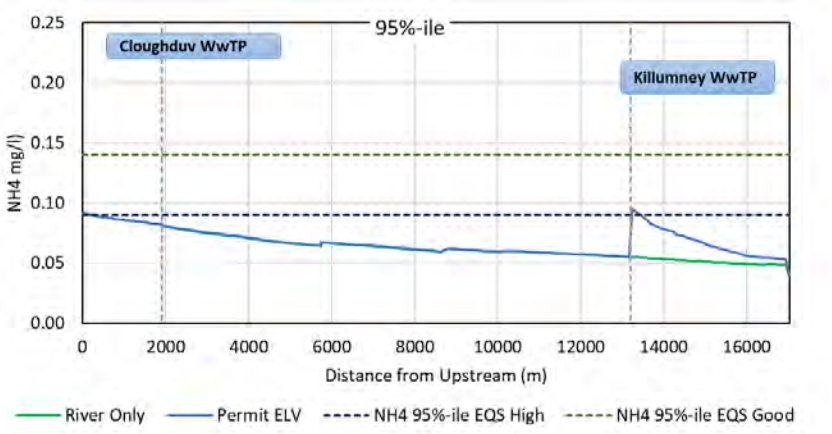


Figure 2-26 95th Percentile and Mean Ammonia Results – Bride



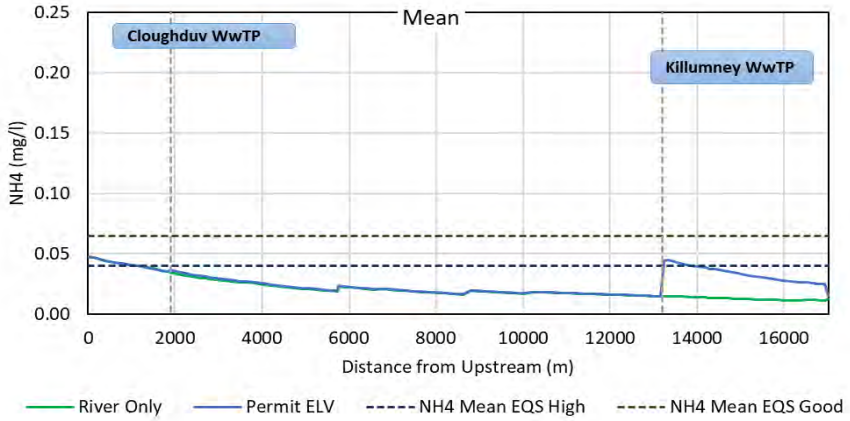
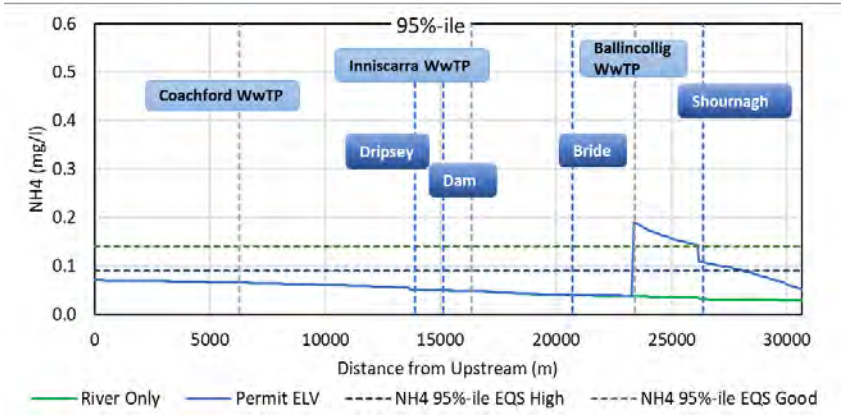


Figure 2-27 95th Percentile and Mean Ammonia Results – Lee



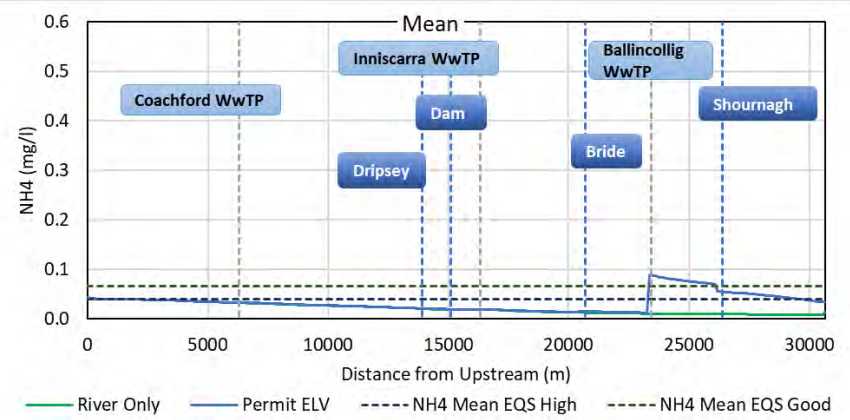


Figure 2-28 95th Percentile and Mean MRP Results - Blarney

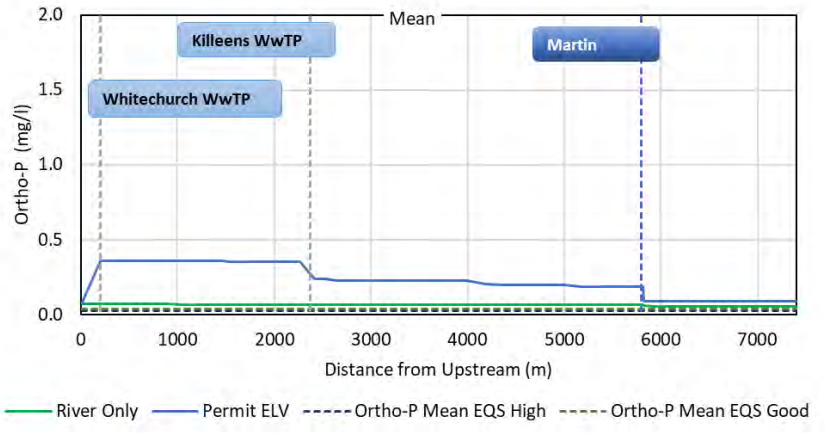
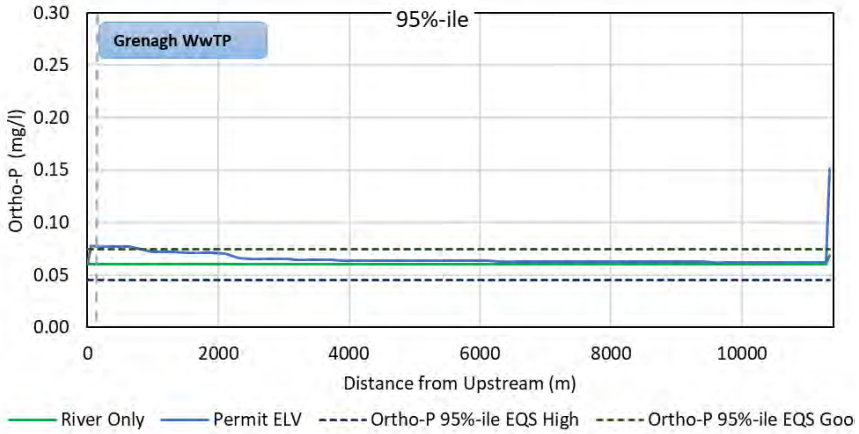


Figure 2-29 95th Percentile and Mean MRP Results – Martin



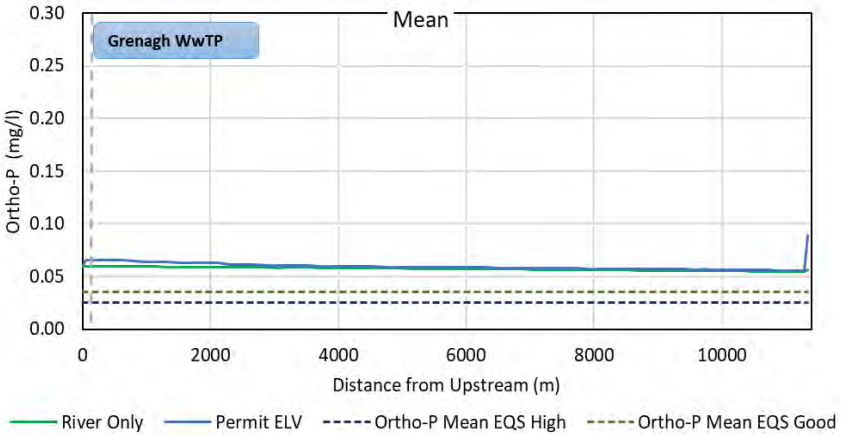
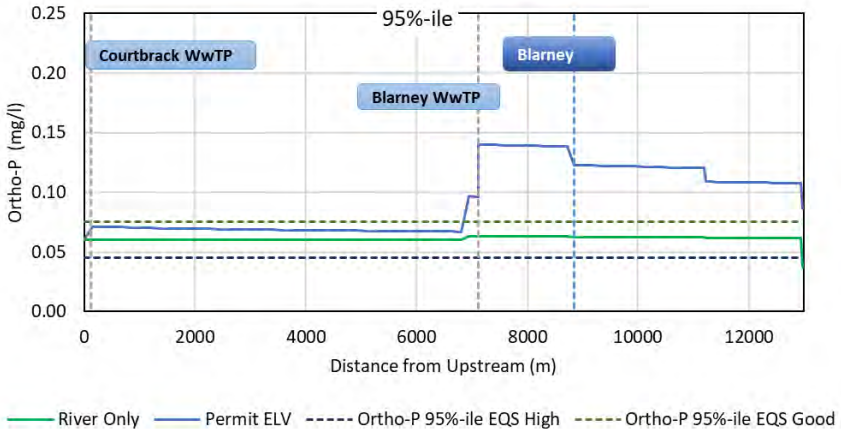


Figure 2-30 95th Percentile and Mean MRP Results – Shournagh



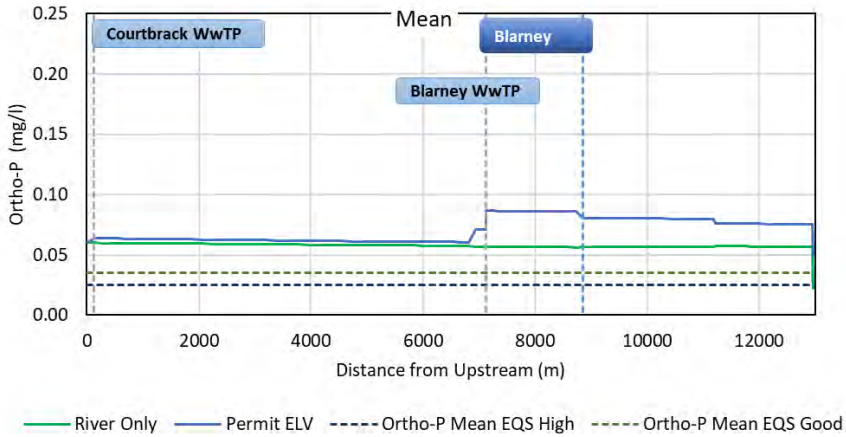
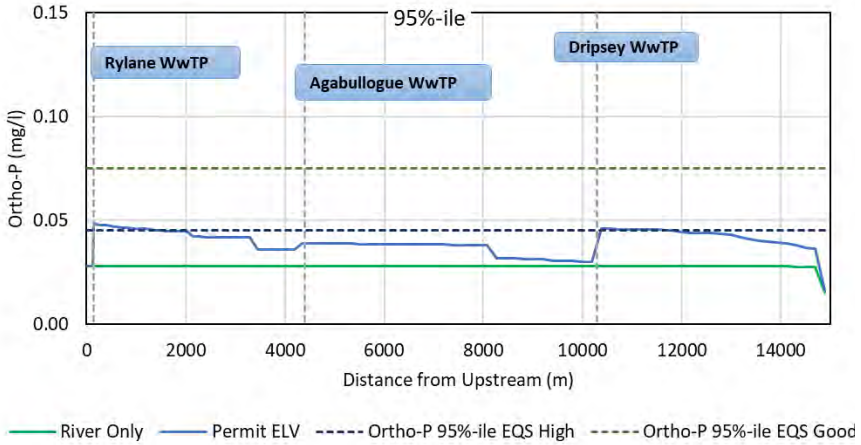


Figure 2-31 95th Percentile and Mean MRP Results – Dripsey



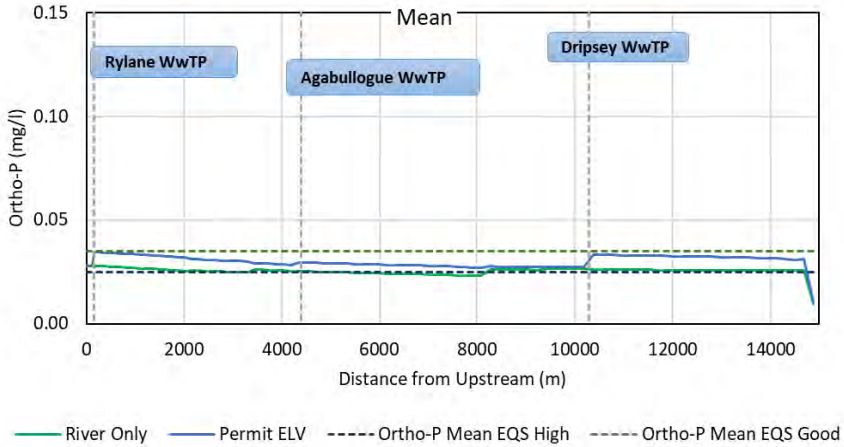
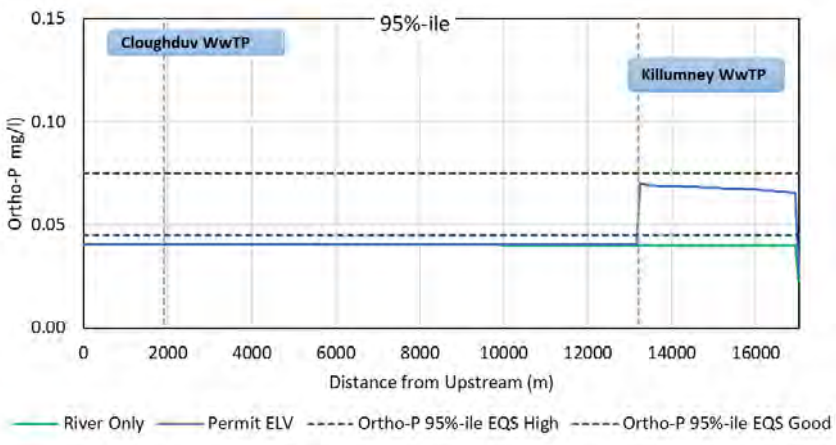


Figure 2-32 95th Percentile and Mean MRP Results – Bride



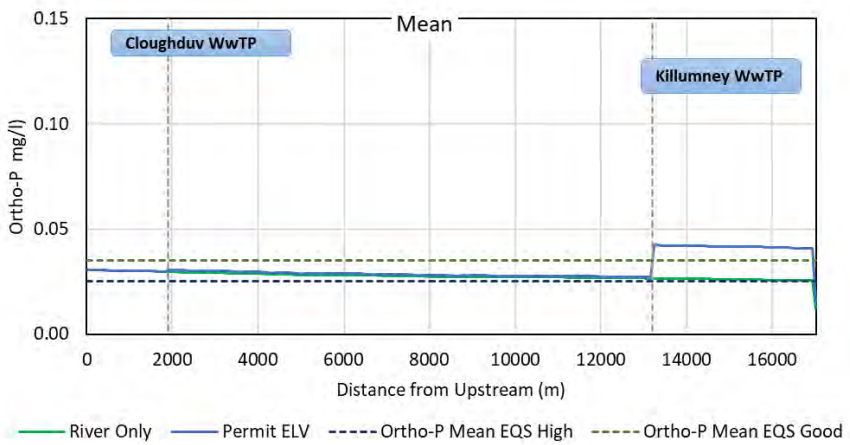
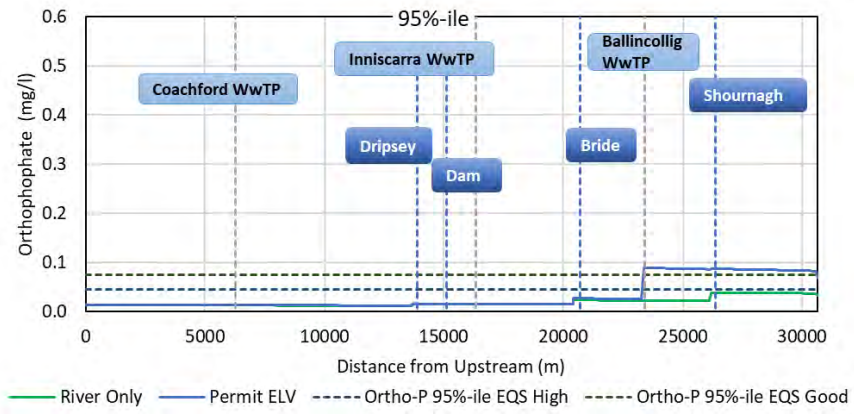
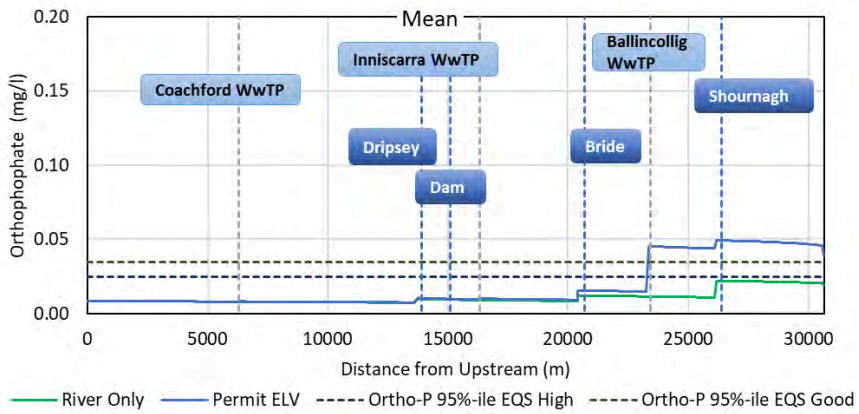


Figure 2-33 95th Percentile and Mean MRP Results – Lee





2.5 Maximum ELV Assessment

Intertek Metoc have undertaken assessments to calculate the maximum ELV allowed for the WwTPs that discharge to Cork Harbour via rivers. The approach adopted in the assessment is based on the draft technical guidance document on the impact assessment of wastewater discharges on the water quality of freshwater receiving environments produced by Uisce Éireann (Draft Technical Guidance for Water Quality Impact Assessment (Freshwaters), 2023). In the Uisce Éireann's technical guidance, it sets out a tiered, risk-based approach to assess the impact of a wastewater discharge on the freshwater receiving environments and to determine the appropriate level of wastewater treatment to ensure the discharge is compatible with achievement of WFD and conservation objectives for receiving waters and Protected Areas, using the WAC approach.

2.5.1 Assessment Approach

To determine the maximum ELVs allowed for the WwTPs that discharge to Cork Harbour via rivers, detailed modelling approach (Tier 3) has been adopted, using 1-D MIKE11 models. The following steps have been taken to calculate the maximum ELV allowed for a WwTP:

Step 1: Determination of Target Water Quality Status

The first step in the assessment is to establish the target water quality status for each receiving waterbody, which serves as the benchmark for determining acceptable pollutant levels downstream of the WwTP discharge. This is based on two factors: (1) the WFD status objective set for the waterbody, and (2) the current upstream water quality.

If the waterbody has a designated High status objective or if the upstream water quality falls within the lower 75% of its respective EQS band, then the target status is set as High. In cases where neither of these conditions is met, the target is set at Good status. This distinction is fundamental to the assessment, as it directly influences the permissible pollutant concentrations and, consequently, the ELVs assigned to the WwTP.

Step 2: Application of Notionally Clean (NC)

The calculation of available assimilative capacity in watercourses is predicated on the assumption that the ambient water quality is less than the EQS for each pollutant. This may not be the case in all circumstances as often a waterbody may have other upstream pressures impacting on water quality. In such circumstances a NC approach is required to determine appropriate ELVs. The NC scenario assumes that upstream sources of pollutants to the waterbody shall be mitigated by the respective pressure owners such that ambient water quality upstream of the outfall is equal to 1/5th of the High/Good EQS boundary.

The use of NC condition can only be applied when the upstream ambient condition is already exceeding the target EQS limits or within the upper 25% of the High/Good for a High objective waterbody or the upper 25% of the in-band WAC (High/Good boundary to Good/Moderate boundary) for a Good objective waterbody. As pollutants were regulated using both mean and 95 percentile conditions, the NC condition can be applied if either mean or 95 percentile is within the upper 25% of the relevant band.

NC approach must be applied on a parameter-specific basis, and it may be necessary to use typical (non-notionally clean) and NC approaches for the same waterbody for different water quality parameters. The aim of the NC scenario is to allow determination of ELV limits which would ensure to meet EQS standards following improvements to upstream water quality. As such it can only be used in cases where the waterbody is failing to meet, or is at-risk of meeting, the EQS of a WFD supporting quality element.

Step 3: Calculation of Available WAC

The available WAC is calculated as the difference between the EQS threshold concentration and the concentration at the upstream of the WwTP. In the case of using NC condition, 1/5th of the High/Good EQS boundary is used for the upstream condition if there is no WwTP upstream the WwTP in question. If there is WwTPs upstream of the WwTP in question, the upstream condition should be determined from the model results to consider the impact of the upstream WwTP, which has been agreed with Uisce Éireann through discussion. When the upstream concentration is less than the 1/5th of the High/Good EQS boundary due to in river water quality processes such as nutrient uptakes, the 1/5th of the High/Good EQS boundary is used.

Step 4: Determination of Allowed WAC to be Considered

The allowed WAC to be taken by a WwTP is calculated as percentage WAC allowed, following the scoring system developed by Uisce Éireann, which suggests an appropriate limit for available WAC utilisation from a single outfall based on the environmental sensitivity of the watercourse and the distance over which additional dilution occurs as the catchment area increases. The calculation of percentage utilisation for a WwTP is detailed in Table 1 and Table 2 in the Uisce Éireann's technical guidance.

Step 5: Calculation of the Maximum ELV

The maximum ELV is determined from the increase in concentration (downstream concentration - upstream concentration) caused by the WwTP calculated by the model; WwTP concentration used in the model; and the allowed WAC to be taken determined in Step 4. The maximum ELV is calculated as the concentration of the WwTP to cause an increase of concentration of maximum allowed (the allowed WAC to be taken):

Max ELV = Max Allowed /Concentration Increase*Concentration Used in the Model

This calculation is performed for both mean and 95th percentile flow conditions to ensure meeting EQS standards normal and low-flow scenarios. The more conservative (i.e., lower) ELV from the two conditions is selected to provide an adequate safety margin.

It is important to note that if the calculated ELV exceeds the WwTP's existing permit limits, the ELV is capped at the current permitted value to ensure to meet regulatory standards and prevent potential overloading of the receiving environment.

2.5.2 Maximum ELV

Following the above steps the maximum allowable ELVs were calculated based on the model results presented in Section 2.4, for Current condition. Table 2-10, Table 2-11 and Table 2-12 provide the maximum allowable ELVs calculated for BOD, ammonia and MRP respectively.

Table 2-10 Maximum Allowable ELVs for Current Condition: BOD

WwTP	High Status Objective?	Target Status	Notionally Clean?	BOD (mg/l)	
				Permit	Current
Knockraha - Chapelfield WwTP	Yes	High	Yes	125	29
Knockraha - Village Centre WWTP	Yes	High	Yes	125	29

WwTP	High Status Objective?	Target Status	Notionally Clean?	BOD (mg/l)	
				Permit	Current
Carrignavar	No	Good	Yes	25	16.1
Coole East	No	Good	Yes	125	125
Ros Ard WwTP	No	Good	Yes	25	25
Halfway	No	High	No	5	5
Ballygarvan	No	High	No	25	25
Ballincurrig Septic Tank (Lisgoold)	Yes	High	No	125	40.6
Lisgoold North WwTP	Yes	High	No	5	5
Lisgoold South WwTP	Yes	High	No	200	194.4
Dungourney	No	High	No	145	145
Whitechurch WwTP	Yes	High	Yes	25	2.6
Killeens WwTP	No	Good	Yes	25	9.6
Grenagh WwTP	No	Good	No	25	22.6
Courtbrack WwTP	Yes	High	Yes	25	25
Blarney WwTP	Yes	High	Yes	20	5.8
Cloughdov WwTP	Yes	High	Yes	10	10
Kilumney WwTP	No	Good	No	25	25
Rylane WwTP	Yes	High	No	25	25
Agabullogue WwTP	Yes	High	No	25	25
Dripsey WwTP	Yes	High	No	25	25
Coachford WwTP	No	Good	No	21.63	21.63
Inniscarra WwTP	No	Good	No	25	25
Ballincollig WwTP	No	Good	No	25	16.7

Table 2-11 Maximum Allowable ELVs for Current Condition: Ammonia

WwTP	High Status Objective?	Target Status	Notionally Clean?	Ammonia (mg/l)	
				Permit	Current
Knockraha - Chapelfield WwTP	Yes	High	No	5	1.21
Knockraha - Village Centre WWTP	Yes	High	No	5	1.21

WwTP	High Status Objective?	Target Status	Notionally Clean?	Ammonia (mg/l)	
				Permit	Current
Carrignavar	No	Good	Yes	2	0.92
Coole East	No	Good	Yes	20	20
Ros Ard WwTP	No	Good	Yes	20	6.31
Halfway	No	High	No	2	2
Ballygarvan	No	High	No	5	5
Ballincurrig Septic Tank (Lisgoold)	Yes	High	No	20	1.74
Lisgoold North WwTP	Yes	High	No	5	5
Lisgoold South WwTP	Yes	High	No	30	6.10
Dungourney	No	High	No	20	4.74
Whitechurch WwTP	Yes	High	Yes	10	0.15
Killeens WwTP	No	Good	Yes	28.4	1.33
Grenagh WwTP	No	Good	No	3	3
Courtbrack WwTP	Yes	High	No	10	4.78
Blarney WwTP	Yes	High	No	1.5	0.31
Cloughdov WwTP	Yes	High	Yes	2	2
Kilumney WwTP	No	High	No	10	4.65
Rylane WwTP	Yes	High	No	10	2.21
Agabullogue WwTP	Yes	High	No	5	5
Dripsey WwTP	Yes	High	No	10	5.34
Coachford WwTP	No	Good	No	6.8	6.8
Inniscarra WwTP	No	High	No	10	10
Ballincollig WwTP	No	High	No	5	0.93

Table 2-12 Maximum Allowable ELVs for Current Condition: MRP

WwTP	High Status Objective?	Target Status	Notionally Clean?	MRP (mg/l)	
				Permit	Current
Knockraha - Chapelfield WwTP	Yes	High	Yes	3	0.59
Knockraha - Village Centre WWTP	Yes	High	Yes	3	0.59

WwTP	High Status Objective?	Target Status	Notionally Clean?	MRP (mg/l)	
				Permit	Current
Carrignavar	No	Good	Yes	1.5	0.48
Coole East	No	Good	Yes	3	3
Ros Ard WwTP	No	Good	Yes	3	2.22
Halfway	No	Good	Yes	1	1
Ballygarvan	No	Good	Yes	3	3
Ballincurrig Septic Tank (Lisgoold)	Yes	High	Yes	5	0.87
Lisgoold North WwTP	Yes	High	Yes	0.5	0.5
Lisgoold South WwTP	Yes	High	Yes	3	3
Dungourney	No	Good	No	3	1.70
Whitechurch WwTP	Yes	High	Yes	5	0.06
Killeens WwTP	No	Good	Yes	1	0.60
Grenagh WwTP	No	Good	Yes	1.7	1.70
Courtbrack WwTP	Yes	High	Yes	2	2
Blarney WwTP	Yes	High	Yes	0.8	0.11
Cloughdov WwTP	Yes	High	Yes	0.8	0.8
Kilumney WwTP	No	Good	No	5	1.39
Rylane WwTP	Yes	High	Yes	2	1.1
Agabullogue WwTP	Yes	High	Yes	1	1
Dripsey WwTP	Yes	High	Yes	5	2.43
Coachford WwTP	No	High	No	0.88	0.88
Inniscarra WwTP	No	High	No	5	5
Ballincollig WwTP	No	Good	No	2	0.51

3. CLIMATE CHANGE SCENARIOS

3.1 Model Scenarios

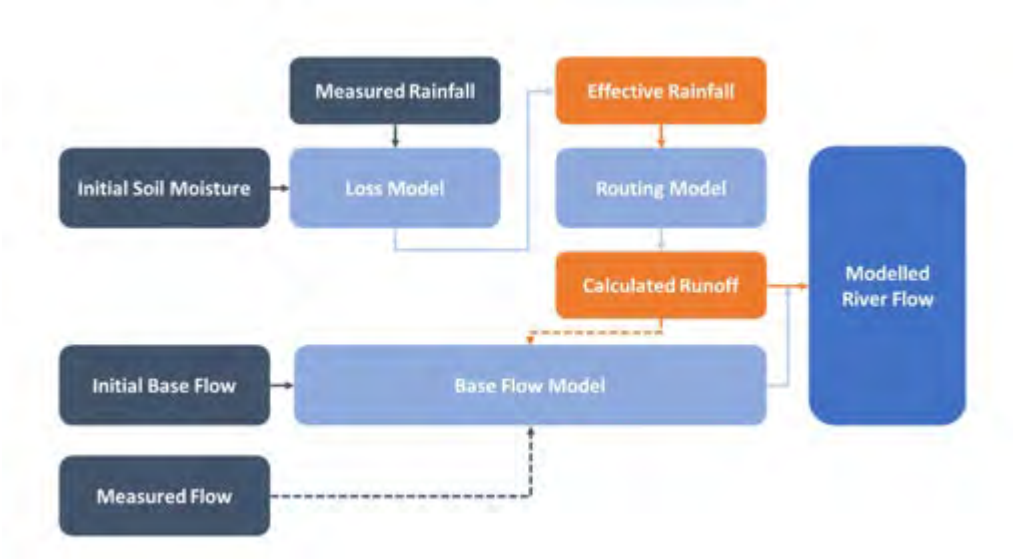
MIKE11 modelling has been carried out to assess the impacts of WwTPs on the river water quality for the planning horizons of 2030, 2055, and 2080, considering the projected flow increases at WwTPs and changes in river flows as results of climate changes.

3.2 Hydrology Models

To consider climate change effects on the river flows, hydrology models have been developed to derive river flows for the planning horizons of 2030, 2055, and 2080, using the hydrology model system developed by Intertek.

The hydrology model system is based on the 'Revitalised Flood Studies Report (FSR)/FEH Rainfall-Runoff Method' (Kjeldsen, 2007; Kjeldsen & Fry, 2006). A schematic of the hydrology run-off model is shown in Figure 3-1.

Figure 3-1 Schematic Representation of the Hydrology Model



Hydrology models are required to be calibrated before applying them to derive river flows for the planning horizons using stochastic rainfall data generated for 2030, 2055, and 2080. These stochastic rainfall timeseries included the predicted impacts of climate change on rainfall. Relative to the current rainfall timeseries, rainfall is generally predicted to become more extreme, i.e. that summers are typically predicted to be drier and winters are typically predicted to be wetter. Since ELVs are usually defined by the dry periods, where there is less volume to dilute the impact of the discharges, the maximum allowable ELVs would be more stringent under climate change scenarios. Therefore, only rainfall timeseries that include climate change have been taken forward into further modelling.

Percentile distributions of flows (commonly presented as flow duration curves) were employed to assess the performance of the hydrological model calibration across the entire spectrum of observed flow conditions. These distributions enable evaluation of whether the model adequately represents the variability and magnitude of observed flows. Model performance is further quantified using the model evaluation statistics, Nash-Sutcliffe Efficiency (NSE) and Percent Bias (PBIAS). NSE is a normalised, dimensionless statistical metric used to quantitatively assess the predictive skill of hydrological or environmental models and PBIAS is a dimensionless, relative error metric that

quantifies the average tendency of a model to overestimate or underestimate the observed values. An NSE value of 1 indicates a perfect agreement between modelled and observed values, with values approaching 1 reflecting increasingly reliable model performance and a low value for PBIAS indicates good agreement. The performance evaluation criteria applied in this study were based on the framework outlined by Moriasi et al. (2015) Table 3-1.

Table 3-1 Statistical Analysis Classification

Statistical Analysis Classifications				
Statistic	**Very Good**	**Good**	**Satisfactory**	**Not Satisfactory**
NSE	0.8	0.7	0.5	<0.5
PBIAS	+-5	+-10	+-15	>+-15

3.2.2 Glashaboy River

A hydrology model has been constructed for the River Glashaboy to derive river flows for the MIKE11 model. The model has been calibrated against gauged flows at the Meadowbrook (Ref 19032) hydrometric gauge. Model results have been compared using statistical and timeseries analytical methods to determine the suitability of the model for undertaking the water quality assessment.

The results of the statistical performance analysis, provided in Table 3-2, show that the model achieves Very Good for both the NSE and PBIAS. A comparison of percentile distribution plot is presented in Figure 3-2, showing good agreement with the observed data across all flow percentiles. Figure 3-3 and Figure 3-4 provide comparison plots between the modelled flows and observed flows, indicating a good agreement with the timing of peak flow events and the level of magnitude of these events. While there were slight differences between the two data sets —most notably a high peak in March 2013, the overall level of agreement is good and shows that the hydrology model produces a good representation of the flow regime in the River Glashaboy.

Table 3-2 Statistical Performance Analysis

Statistical Measure	Value	Classification
NSE	0.82	Very Good
PBIAS	7.90	Very Good

Figure 3-2 Flow Distribution Comparison of Observed and Modelled Flow

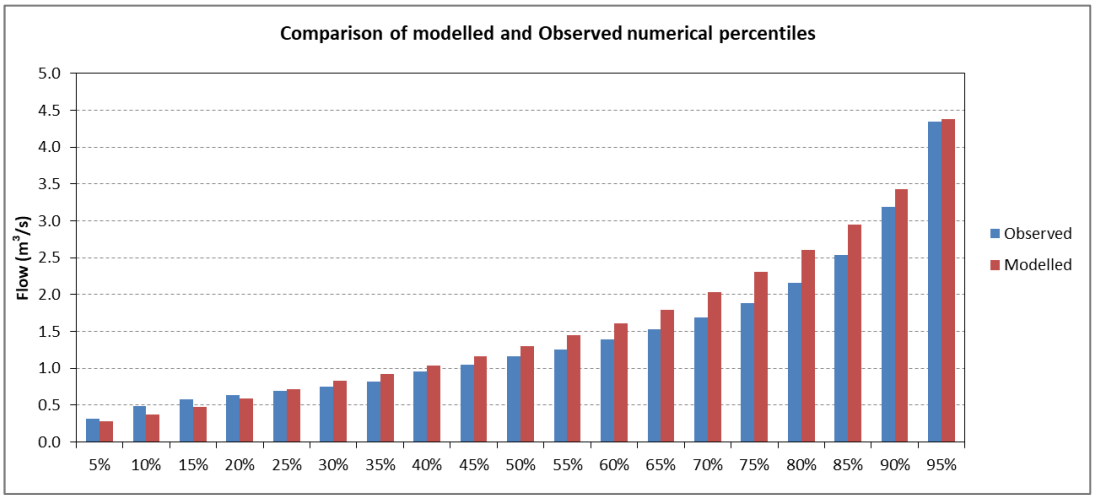


Figure 3-3 Time Series Comparison of Modelled and Observed Flow -2011

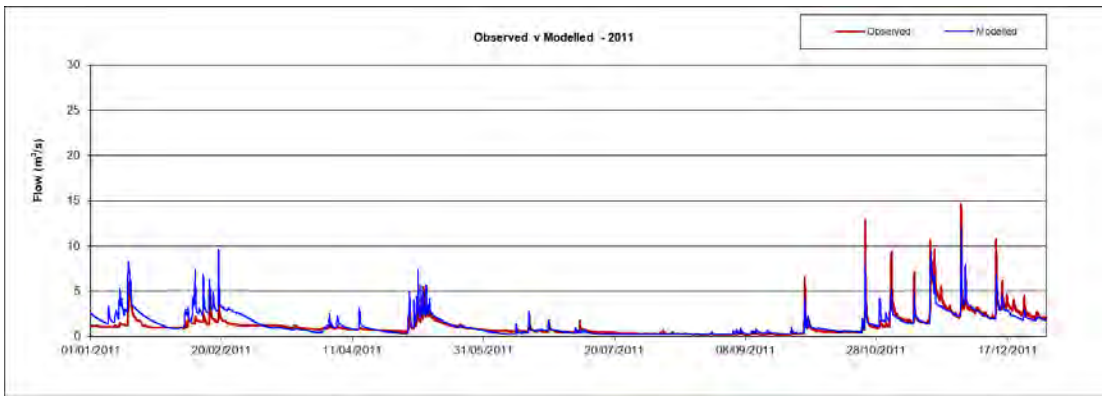
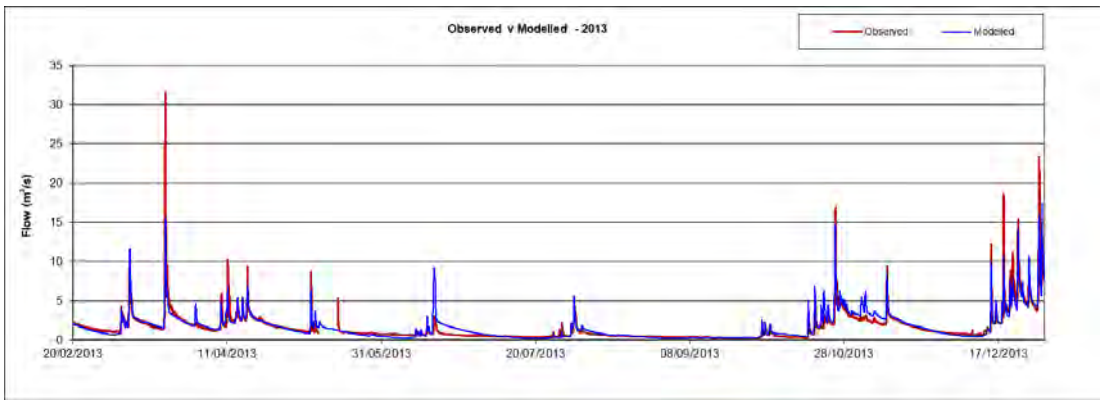


Figure 3-4 Time Series Comparison of Modelled and Observed Flow-2013



3.2.3 Owenboy River

A hydrology model has been constructed for the River Owenboy to derive river flows for the MIKE11 model. The model has been calibrated against gauged flows at Ballea hydrometric gauge. Model results have been comped using statistical and timeseries analytical methods to determine the suitability of the model for undertaking the water quality assessment.

The results of the statistical performance analysis, provided in Table 3-3, show that the model achieves Satisfactory for the NSE and Very Good for PBIAS. A comparison of percentile distribution plot is presented in Figure 3-5, underpredictions in the lower and higher percentiles. Attempting to improve the mid-percentile fit would compromise the accuracy at the other ends of the distribution. As such, the overall fit is considered satisfactory. Figure 3-6 and Figure 3-7 provide comparison plots between the modelled flows and observed flows, indicating a good agreement with the timing of peak flow events and the level of magnitude of these events. While there were slight differences between the two data sets the overall level of agreement is good and shows that the hydrology model produces a good representation of the flow regime in the River Owenboy.

Table 3-3 Statistical Performance Analysis

Statistical Measure	Value	Classification
NSE	0.58	Satisfactory
PBIAS	4.6	Very Good

Figure 3-5 Flow Distribution Comparison of Observed and Modelled Flow

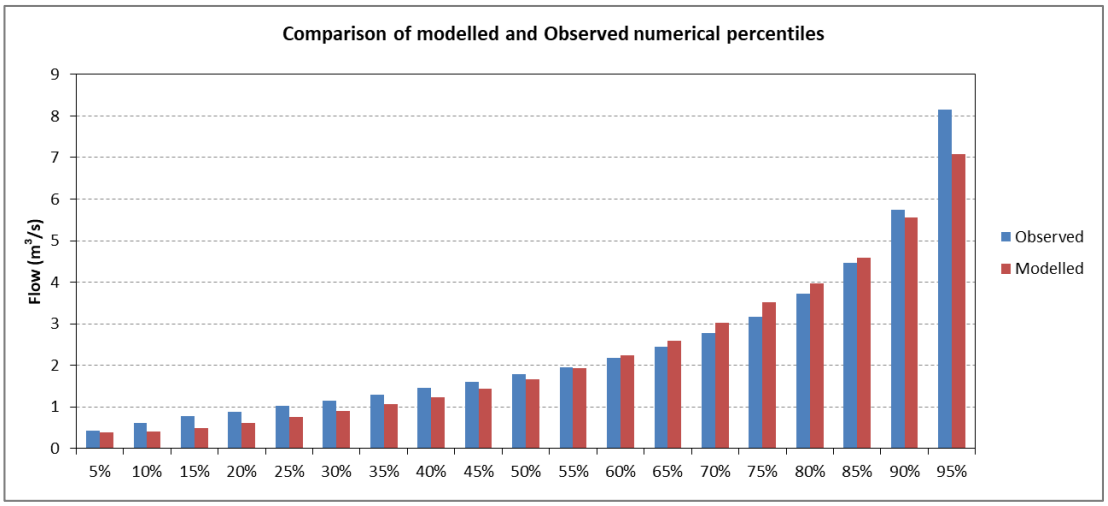


Figure 3-6 Time Series Comparison of Modelled and Observed Flow -2009

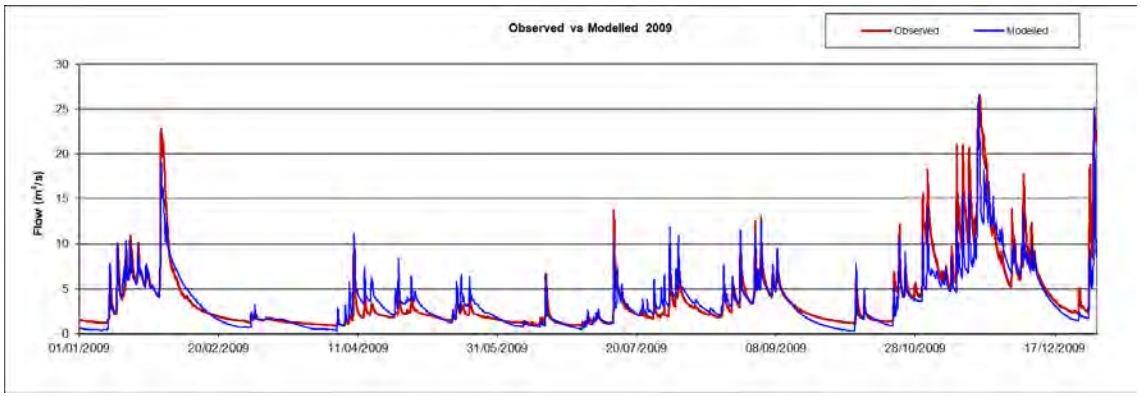
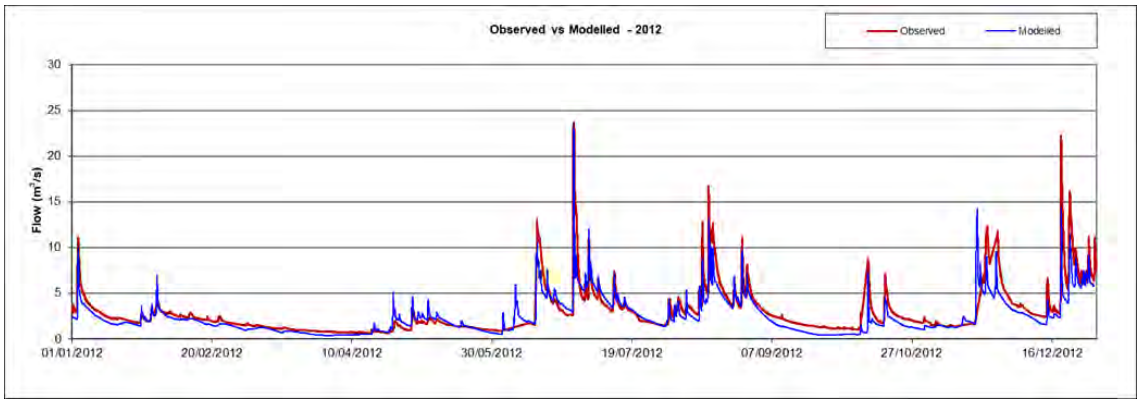


Figure 3-7 Time Series Comparison of Modelled and Observed Flow -2012



3.2.4 Owenaccura River

A hydrology model has been constructed for the River Owencurra to derive river flows for the MIKE11 model. The model has been calibrated against gauged flows at the Ballyedmond (Ref 19020) hydrometric gauge. Model results have been compared using statistical and timeseries analytical methods to determine the suitability of the model for undertaking the water quality assessment.

The results of the statistical performance analysis, provided in Table 3-4, show that the model achieves Good for the NSE and Very Good for PBIAS. A comparison of percentile distribution plot is presented Figure 3-8, showing a good agreement although the model slightly overpredicts in the mid-percentile range and underpredicts in the lower percentile range. Figure 3-9 and Figure 3-10 provide comparison plots between the modelled flows and observed flows, indicating a good agreement with the timing of peak flow events and the level of magnitude of these events. While there were slight differences between the two data sets with some high peak events observed. However, the overall level of agreement is good and shows that the hydrology model produces a good representation of the flow regime in the River Owenacurra.

Table 3-4 Statistical Performance Analysis

Statistical Measure	Value	Classification
NSE	0.77	Good
PBIAS	0.32	Very Good

Figure 3-8 Flow Distribution Comparison of Observed and Modelled Flow

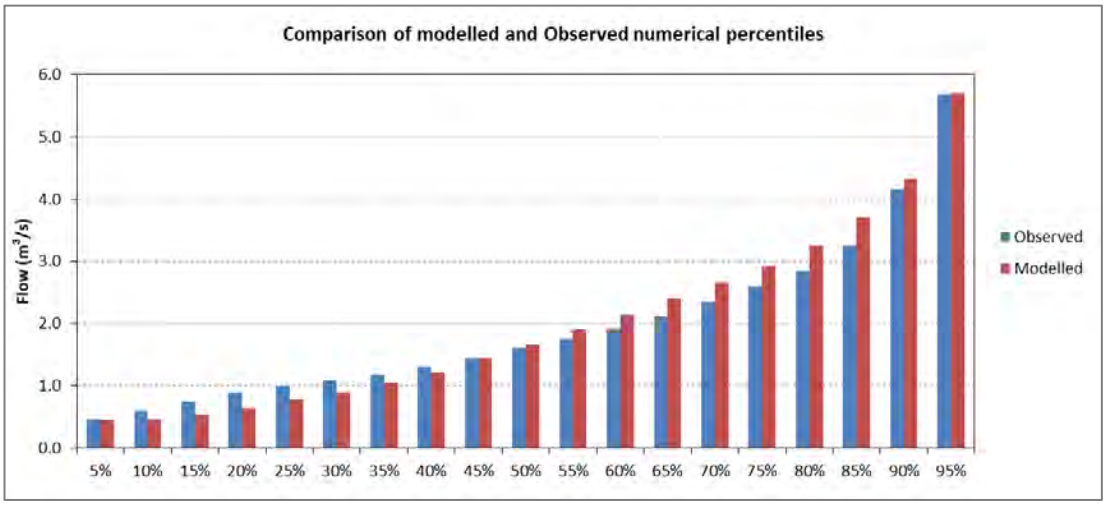


Figure 3-9 Time Series Comparison of Modelled and Observed Flow Model-2013

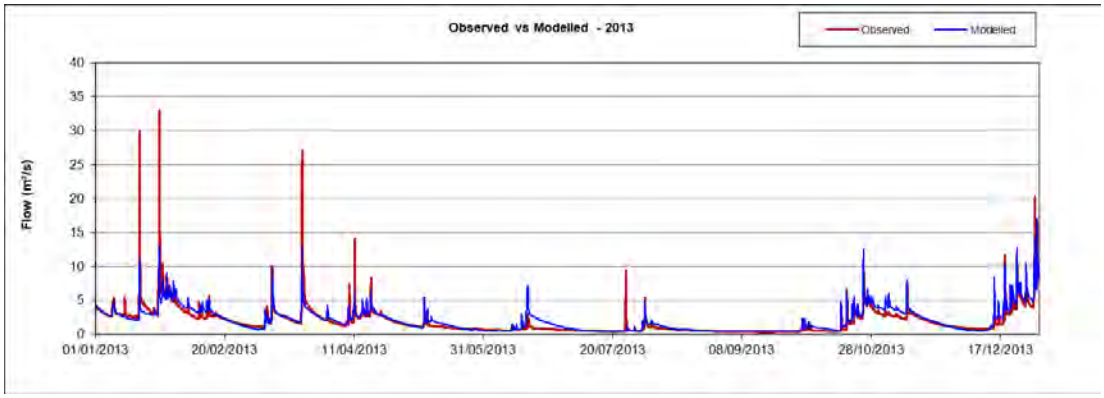
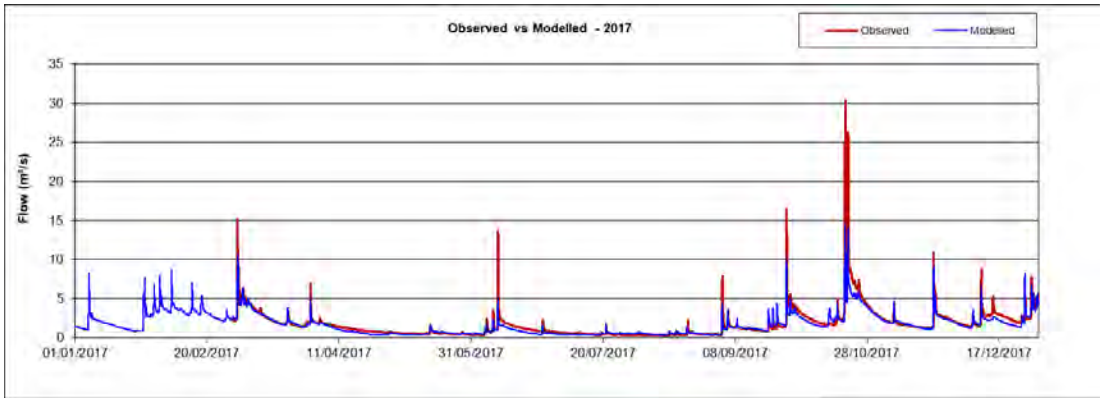


Figure 3-10 Time Series Comparison of Modelled and Observed Flow -2017



3.2.5 River Lee

As river gauging data were limited within the Lee catchment both in terms of locations and durations, gauged flows at Blackpool Retail Park on the Bride (Cork) was used as a surrogate dataset to create river inputs (scaling by mean flows) for the Lee model (see model calibration and validation report P2443_R6257_Rev1 for details). Therefore, a surrogate hydrology model has been constructed and calibrated against the gauged flows at Blackpool Retail Park. Model results have been compared using statistical and timeseries analytical methods to determine the suitability of the model for undertaking the water quality assessment.

The results of the statistical performance analysis, provided in Table 3-5, show that the model achieves Very Good for both the NSE and PBIAS. The comparison of percentile distribution plot is presented in Figure 3-11, showing good agreement although the model underpredicts in the higher-percentiles. Figure 3-12 and Figure 3-13 provide comparison plots between the modelled flows and observed flows, indicating a good agreement with the timing of peak flow events and the level of magnitude of these events. While there were slight differences between the two data sets the overall level of agreement is good and shows that the hydrology model produces a good representation of the flow regime for the surrogate site used for the River Lee model inputs.

Table 3-5 Statistical Performance Analysis

Statistical Measure	Value	Classification
NSE	0.89	Very Good
PBIAS	0.37	Very Good

Figure 3-11 Flow Distribution Comparison of Observed and Modelled Flow

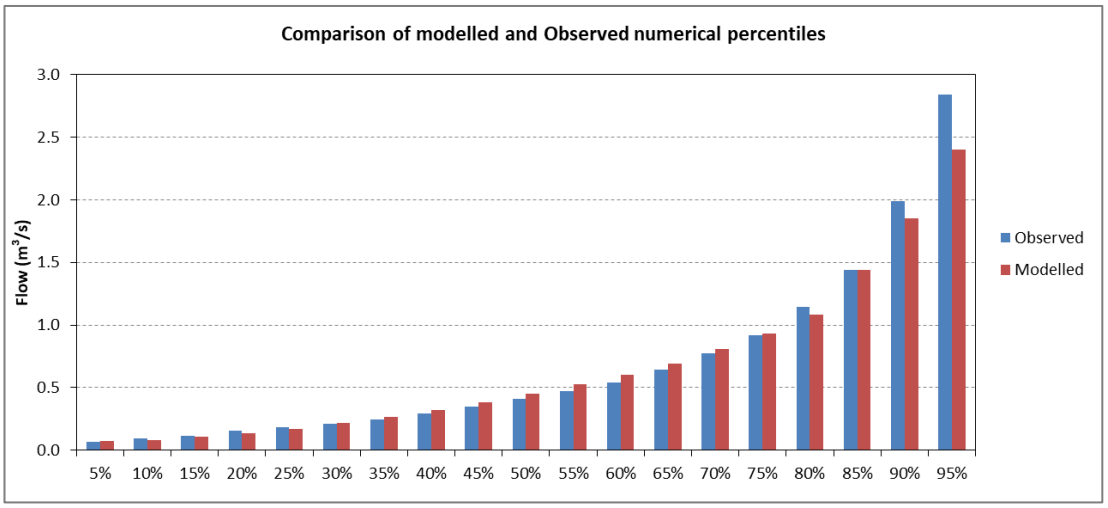


Figure 3-12 Schematic Representation of the Hydrology Model-2014

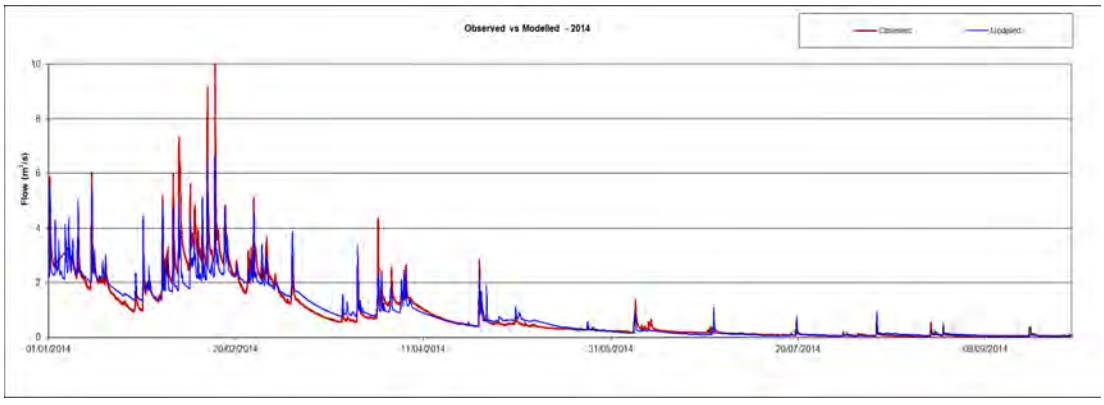
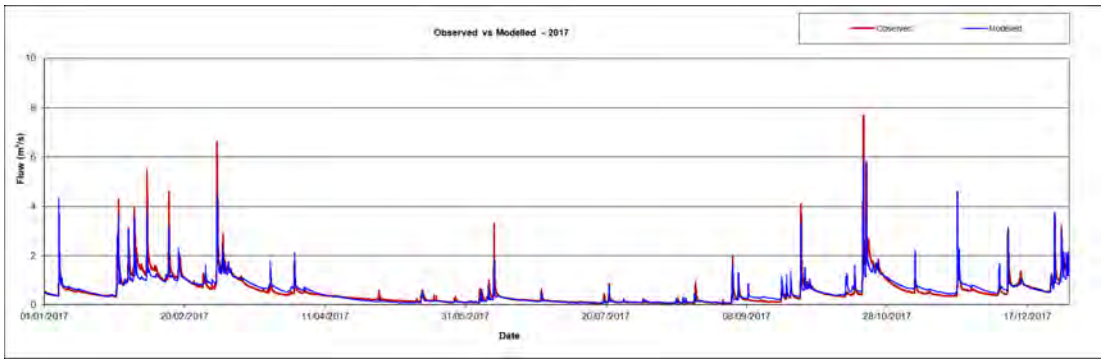


Figure 3-13 Schematic Representation of the Hydrology Model-2017



3.3 Climate Change Impact Assessment

The MIKE11 models were initially run with the maximum allowable ELVs determined for the Current (Baseline) condition, for the three planning horizons, from which the maximum allowable ELVs for planning horizons of 2030, 2055, and 2080 were calculated, following the approach detailed in Section 2.5.1. Finally, the MIKE11 models were run with the calculated maximum allowable ELVs to demonstrate there will be low risk of causing a deterioration in water quality status when the WwTPs were operated at the maximum ELVs determined for each of the planning horizons.

The models have been run for both the current river water quality conditions (non-NC) and NC condition which is used to assess the impact of WwTP if the upstream water quality is exceed the threshold of the objective status or within the upper 25% of in-band WAC of the objective status.

3.3.1 Glashaboy River

The river flows included in the model were derived from the calibrated hydrology model driven by the stochastic rainfall data for 2030, 2055 and 2080, and the WwTP flows for these three horizons are given in Table 3-6.

Table 3-7, Table 3-8 and Table 3-9 provides the maximum allowable ELVs calculated from the initial model runs, for 2030, 2055 and 2080 horizons.

Table 3-6 Flow Inputs Applied in the River Glashaboy Modelling Scenarios

Receiving Watercourse	WwTPS	Flows		
		2030	2055	2080
Glashaboy River	Carrignavar	0.0032	0.0039	0.0044
	Coole East	0.0018	0.0021	0.0024
	Ros Ard WwTP	0.0054	0.0063	0.0072
Butlerstown River	Knockraha - Chapelfield WwTP	0.0024	0.0027	0.0030
	Knockraha - Village Centre WWTP			

Table 3-7 Final ELVs Determined for WwTPs in the Glashaboy Model for BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Carrignavar	No	Good	Yes	25	13.7	11.2	10
Coole East	No	Good	Yes	125	86.8	72.5	64
Ros Ards	No	Good	Yes	25	25	64	21.2
Knockraha Chapelfield and Knockraha Village	Yes	High	Yes	125	23.6	20.6	18.6

Table 3-8 Final ELVs Determined for WwTPs in the Glashaboy Model for Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Carrignavar	No	Good	Yes	2	0.78	0.64	0.57
Coole East	No	Good	Yes	20	86.8	72.5	64
Ros Ards	No	Good	Yes	20	5.37	4.48	3.96
Knockraha Chapelfield and Knockraha Village	Yes	High	Yes	5	0.98	0.85	0.78

Table 3-9 Final ELVs Determined for WwTPs in the Glashaboy Model for

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Carrignavar	No	Good	Yes	1.5	0.41	0.34	0.30
Coole East	No	Good	Yes	3	2.46	2.03	1.84
Ros Ards	No	Good	Yes	3	0.74	0.64	0.55
Knockraha Chapelfield and Knockraha Village	No	Good	Yes	1.5	0.41	0.34	0.30

Figure 3-14 to Figure 3-31 present the model results for both non-NC and NC conditions with the maximum ELVs determined, for 2030, 2055 and 2080. These figures illustrate modelled water quality along a 12,000 m reach of the Glashaboy River, extending from the upstream boundary, and highlight the locations of the Carrignavar WwTP, Coole East WwTP, and Ros Ards WwTP, located approximately at 400 m, 4,000 m, and 11,000 m, respectively. Similarly, Figure 3-32 to Figure 3-49 show the model results along a 7,000 m reach of the Butlerstown branch, indicating the locations of Knockraha

Chapelfield WwTP and Knockraha Village WwTP, situated approximately 800 m from the upstream boundary. In addition, two tributaries that influence the Glashaboy and Butlerstown watercourses are shown in the plots, as they contribute to the overall water quality dynamics of the system.

Table 3-10 and Table 3-11 provides a summary of the model results, indicating water quality in the river when the WwTPs were operated with the maximum ELVs determined.

Table 3-10 Summary of Glashaboy Results

Scenarios	Parameters
	BOD
2030 (Figure 3-14 and Figure 3-15	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-15). The 95th percentile and mean concentrations show Carrignavar WwTP has noticeable impact on the water quality. The 95th percentile BOD concentration shows that BOD rises downstream of Carrignavar WwTP to 1.2 mg/l and this is below EQS High status threshold. Similarly, the mean concentration shows BOD rises to 0.58 mg/l and this is below the threshold for High status. Coole East and Ros Ards WwTP has minimal impacts on water quality for both 95th percentile and mean concentrations.
2055 (Figure 3-20 and Figure 3-21)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-21). All WwTPs increase the 95%ile concentration to approximately to 1.3 mg/l and the mean concentration to 0.6 mg/l, which are below the threshold of High status.
2080 (Figure 3-26 and Figure 3-27)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-27). All WwTPs increase the 95%ile concentration to approximately to 1.3 mg/l and the mean concentration to 0.6 mg/l, which are below the threshold of High status.
	Ammonia
2030 (Figure 3-16 and Figure 3-17)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-17). The 95th percentile and mean concentrations show Carrignavar WwTP has noticeable impact on the water quality. The 95th percentile ammonia concentration shows that ammonia rises downstream of Carrignavar WwTP to 0.06 mg/l and this is below EQS High status threshold. Similarly, the mean concentration shows ammonia rises to 0.025 mg/l and this is below the threshold for High status. The 95th percentile and mean concentrations show Ros Ards WwTP has small impact on the water quality. The 95th percentile ammonia concentration shows that ammonia rises downstream of Ros Ards WwTP from 0.004 mg/l to 0.017 mg/l and this is below EQS High status threshold. Similarly, the mean concentration shows ammonia rises from 0.002 mg/l to 0.007 mg/l, and this is below the threshold for High status. Coole East WwTP has negligible impacts on water quality for both 95th percentile and mean concentrations.
2055 (Figure 3-22 and Figure 3-23)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-23). All WwTPs increase the 95%ile concentration to approximately to 0.06 mg/l and the mean concentration to below 0.03 mg/l, which are below the threshold of High status.

Scenarios	Parameters
2080 (Figure 3-28 and Figure 3-29)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-29). All WwTPs increase the 95%ile concentration to approximately to 0.06 mg/l and the mean concentration to below 0.03 mg/l, which are below the threshold of High status.
	MRP
2030 (Figure 3-18 and Figure 3-19)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-19). The 95th percentile and mean concentrations show Carrignavar WwTP has noticeable impact on the water quality. The 95th percentile MRP concentration shows that MRP rises downstream of Carrignavar WwTP to 0.034 mg/l and this is below EQS High status threshold. Similarly, the mean concentration shows rises to 0.015 mg/l and this is below High Status. Coole East and WwTP has no impact on MRP mean concentration and small impact on 95th percentile concentration. Downstream Ros Ards WwTP, the 95th percentile MRP concentration shows MRP rises to 0.017 mg/l and has negligible impact concentration.
2055 (Figure 3-24 and Figure 3-25)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-25). All WwTPs increase the 95%ile concentration close to the High threshold of 0.045 mg/l and the mean concentration to 0.006 mg/l which is well below the threshold of High status.
2080 (Figure 3-30 and Figure 3-31)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition (Figure 3-31). All WwTPs increase the 95%ile concentration close to the High threshold of 0.045 mg/l and the mean concentration to 0.006 mg/l which is well below the threshold of High status.

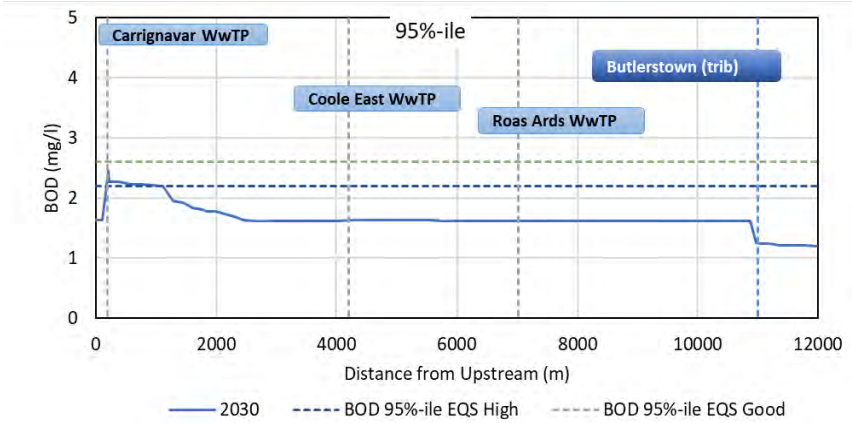
Table 3-11 Summary of Butlerstown Results

Scenarios	Parameters
	BOD
2030 (Figure 3-32 and Figure 3-33)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-33) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile BOD concentration shows that BOD rises downstream of Knockraha WwTPs to 0.71 mg/l and this is 32% of in-band WAC. Similarly, the mean concentration shows BOD rises to 0.41 mg/l, and this is 32% of in-band WAC.

Scenarios	Parameters
2055 (Figure 3-38 and Figure 3-39)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-39) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile BOD concentration shows that BOD rises downstream of Knockraha WwTPs to 0.8 mg/l and this is 36% of in-band WAC. Similarly, the mean concentration shows BOD rises to 0.45 mg/l, and this is 35% of in-band WAC.
2080 (Figure 3-44 and Figure 3-45)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-45) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile BOD concentration shows that BOD rises downstream of Knockraha WwTPs to 0.8 mg/l and this is 36% of in-band WAC. Similarly, the mean concentration shows BOD rises to 0.45 mg/l, and this is 35% of in-band WAC.
	Ammonia
2030 (Figure 3-34 and Figure 3-35)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-34). For Knockraha WwTPs, the 95th percentile ammonia concentration increases to 0.034 mg/l, and this is 38% of in-band WAC. Similarly, mean ammonia concentration increases to 0.022 mg/l, and this is 55% of in-band WAC.
2055 (Figure 3-40 and Figure 3-41)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-40). For Knockraha WwTPs, the 95th percentile ammonia concentration increases to 0.038 mg/l, and this is 42% of in-band WAC. Similarly, mean ammonia concentration increases to 0.024 mg/l, and this is 60% of in-band WAC.
2080 (Figure 3-46 and Figure 3-47)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-46). For Knockraha WwTPs, the 95th percentile ammonia concentration increases to 0.038 mg/l, and this is of 42% of in-band WAC. Similarly, mean ammonia concentration increases to 0.024 mg/l, and this is 60% of in-band WAC.
	MRP
2030 (Figure 3-36 and Figure 3-37)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-37) is applied to calculate ELVs for MRP, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile MRP concentration shows that rises downstream of Knockraha WwTP to 0.014 mg/l and this is 31% of in-band WAC. Similarly, the mean concentration shows rises to 0.008 mg/l, and this is 32% of in-band WAC.
2055 (Figure 3-42 and Figure 3-43)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-43) is applied

Scenarios	Parameters
	to calculate ELVs for MRP as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile MRP concentration shows that MRP rises downstream of Knockraha WwTP to 0.016 mg/l and this is 36% of in-band WAC. Similarly, the mean concentration shows MRP rises to 0.009 mg/l, and this is 36% of in-band WAC.
2080 (Figure 3-48 and Figure 3-49)	For Knockraha WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-49) is applied to calculate ELVs for MRP, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile and mean concentrations show Knockraha WwTPs has noticeable impact on the water quality. The 95th percentile MRP concentration shows that MRP rises downstream of Knockraha WwTP to 0.016 mg/l and this is 36% of in-band WAC. Similarly, the mean concentration shows MRP rises to 0.009 mg/l, and this is 36% of in-band WAC

Figure 3-14 BOD Results for 2030 Scenario – Glashaboy



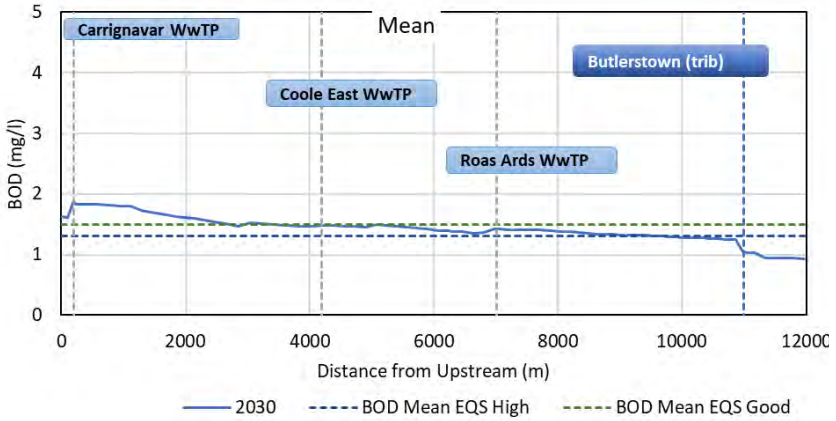
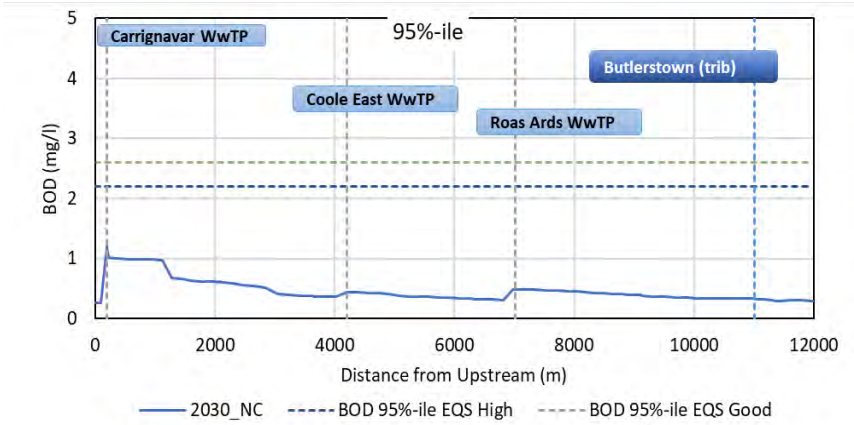


Figure 3-15 BOD Results for 2030 NC Scenario – Glashaboy



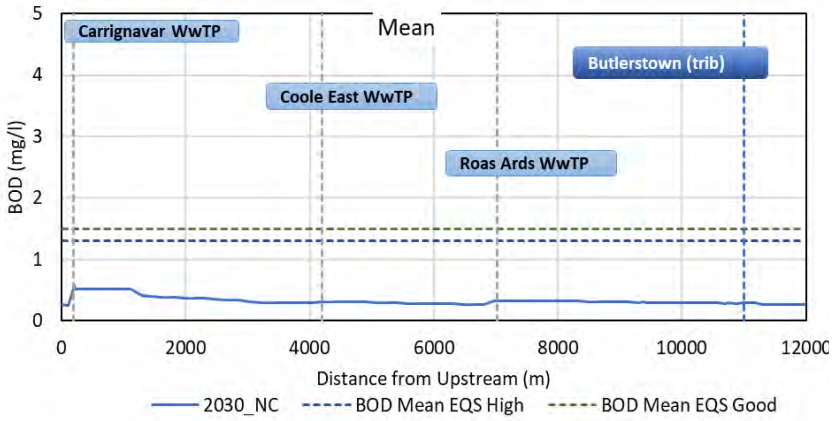
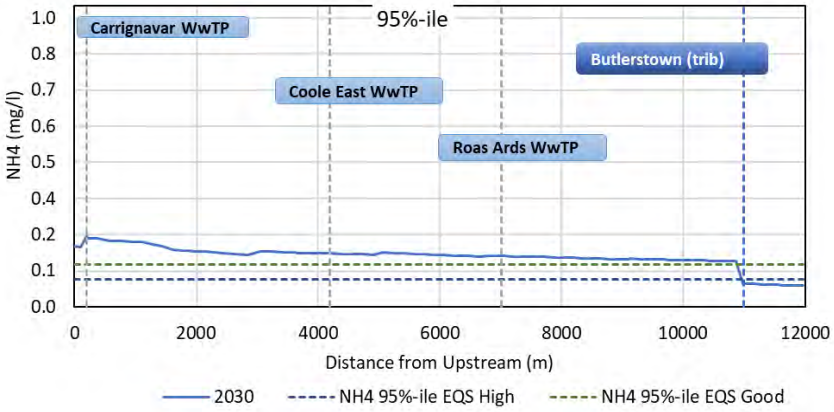


Figure 3-16 Ammonia Results for 2030 Scenario – Glashaboy



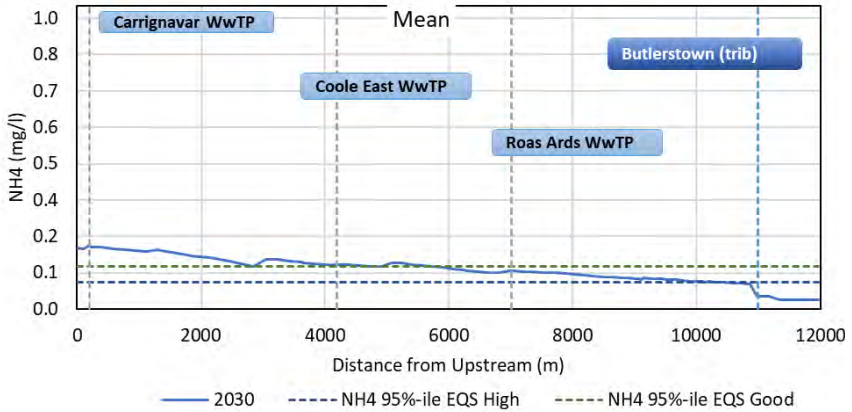
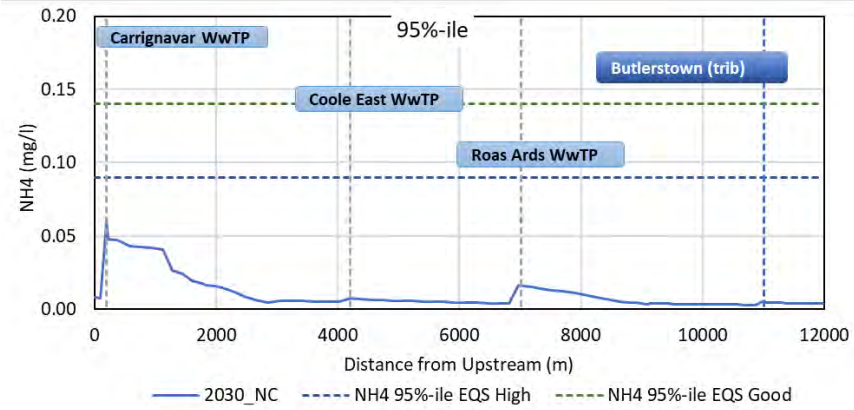


Figure 3-17 Ammonia Results for 2030 NC Scenario – Glashaboy



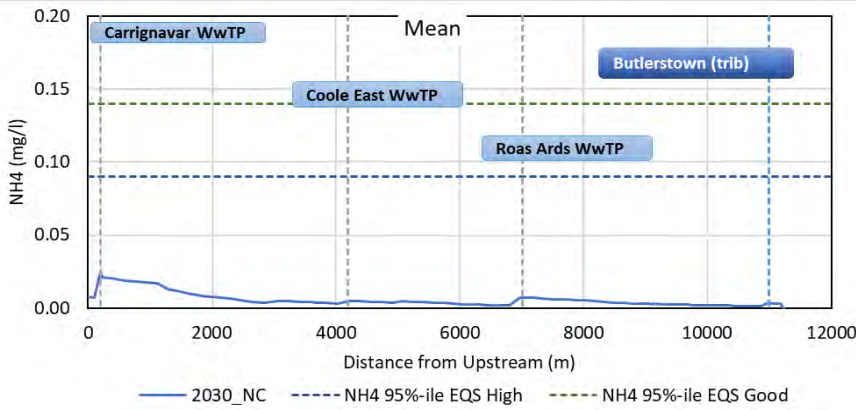
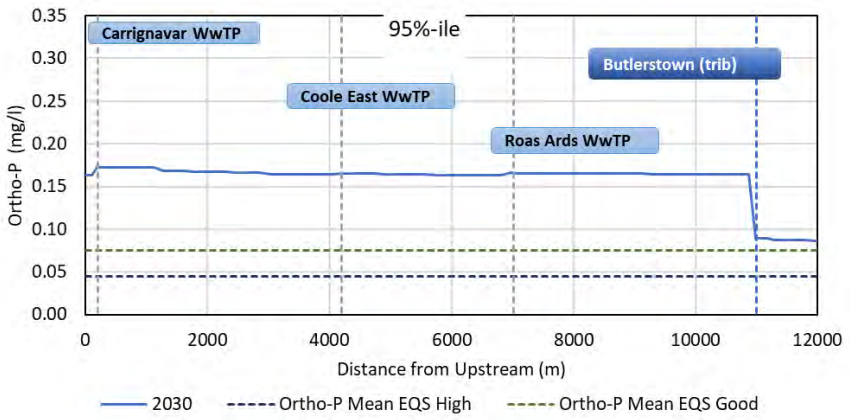


Figure 3-18 MRP Results for 2030 Scenario – Glashaboy



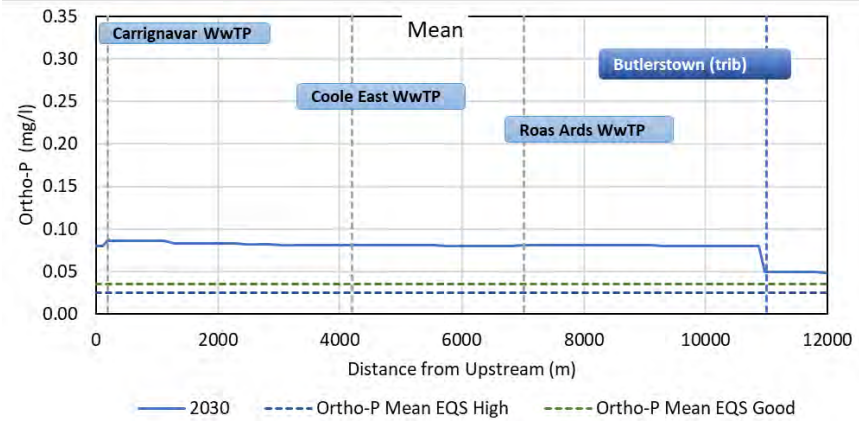
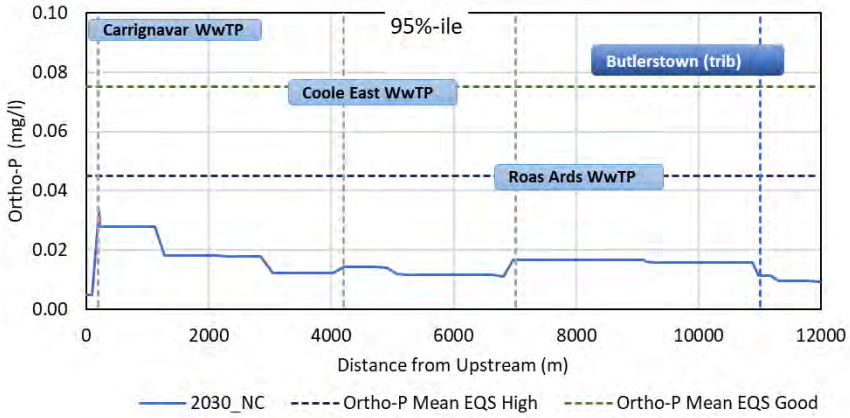


Figure 3-19 MRP Results for 2030 NC scenario – Glashaboy



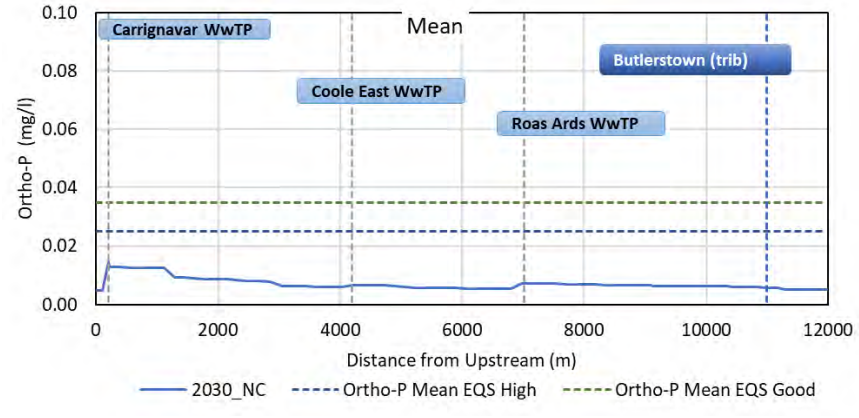
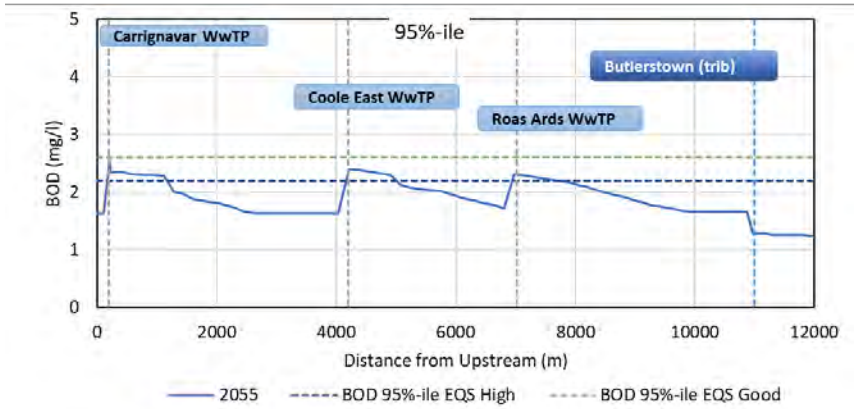


Figure 3-20 BOD Results for 2055 Scenario – Glashaboy



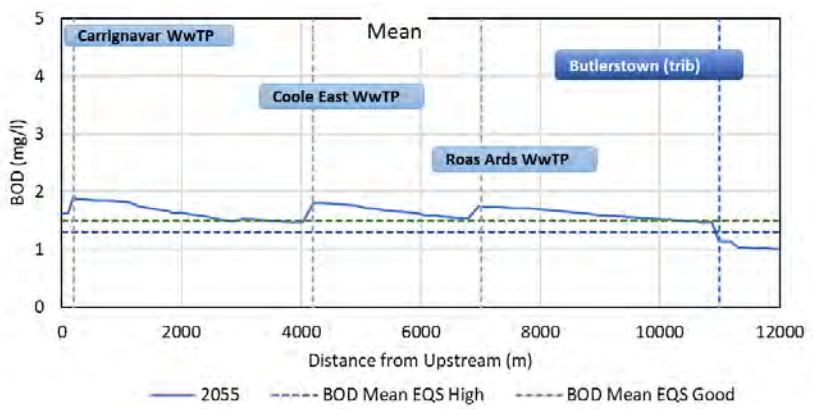
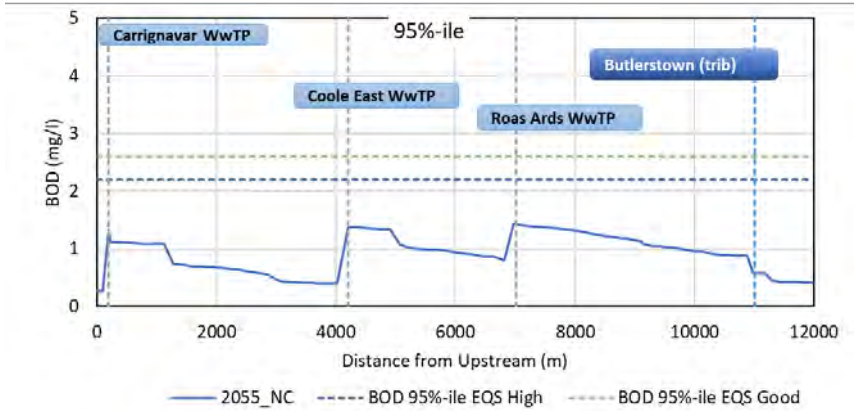


Figure 3-21 BOD Results for 2055 NC Scenario – Glashaboy



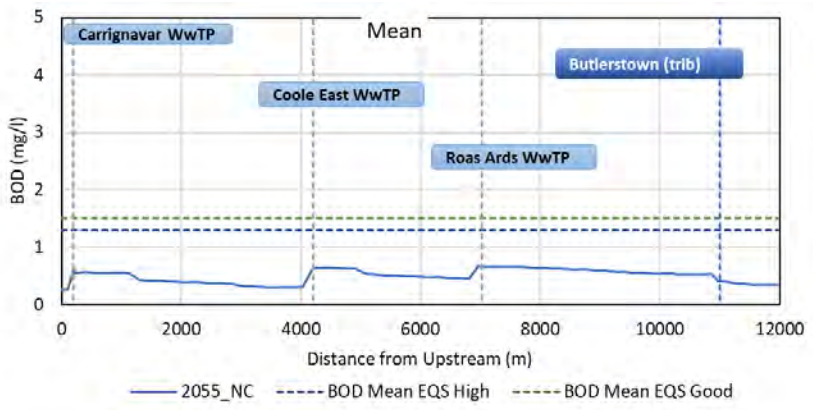
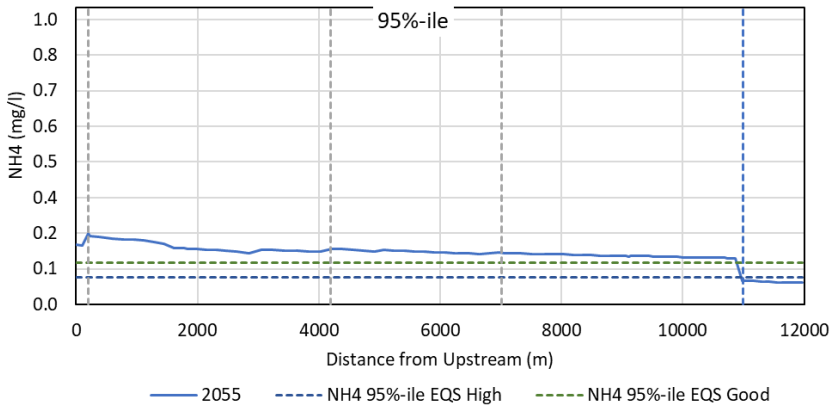


Figure 3-22 Ammonia Results for 2055 Scenario – Glashaboy



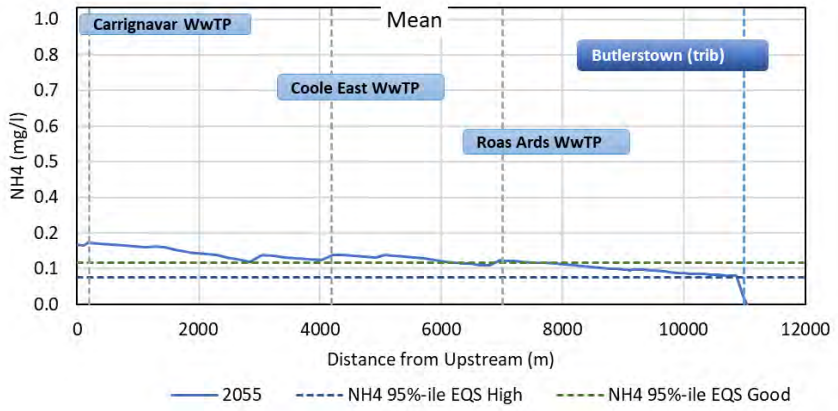
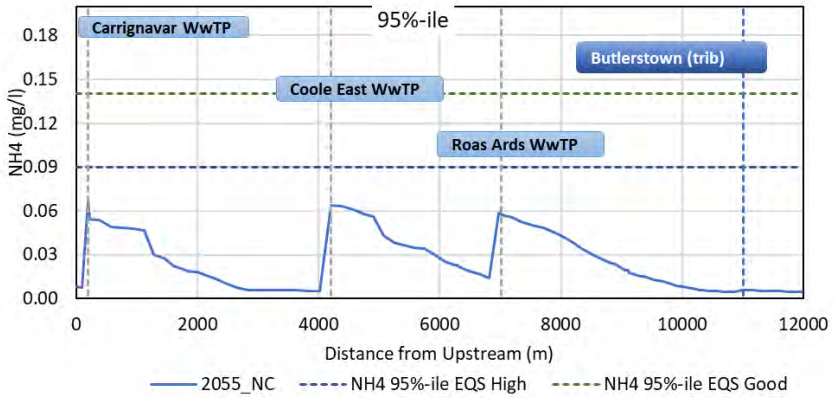


Figure 3-23 Ammonia Results for 2055 NC Scenario – Glashaboy



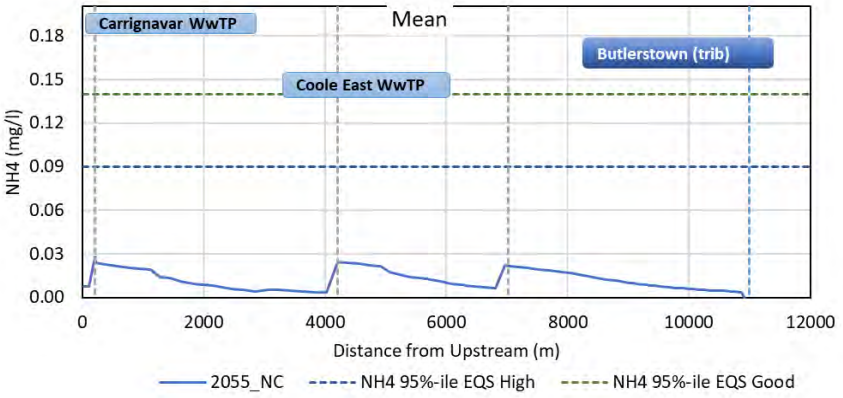


Figure 3-24 MRP Results for 2055 Scenario – Glashaboy

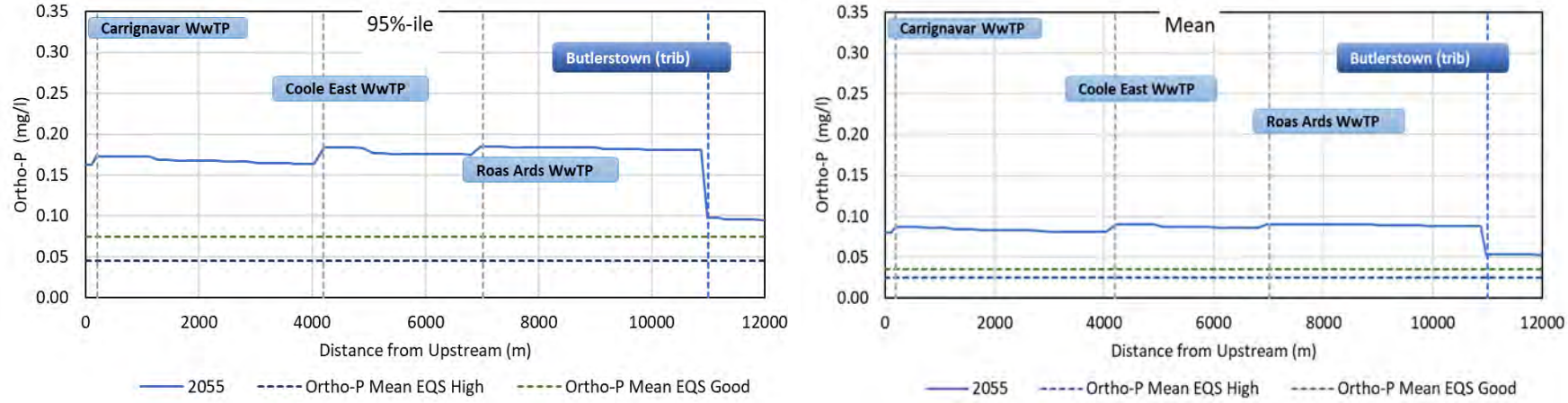


Figure 3-25 MRP Results for 2055 NC Scenario – Glashaboy

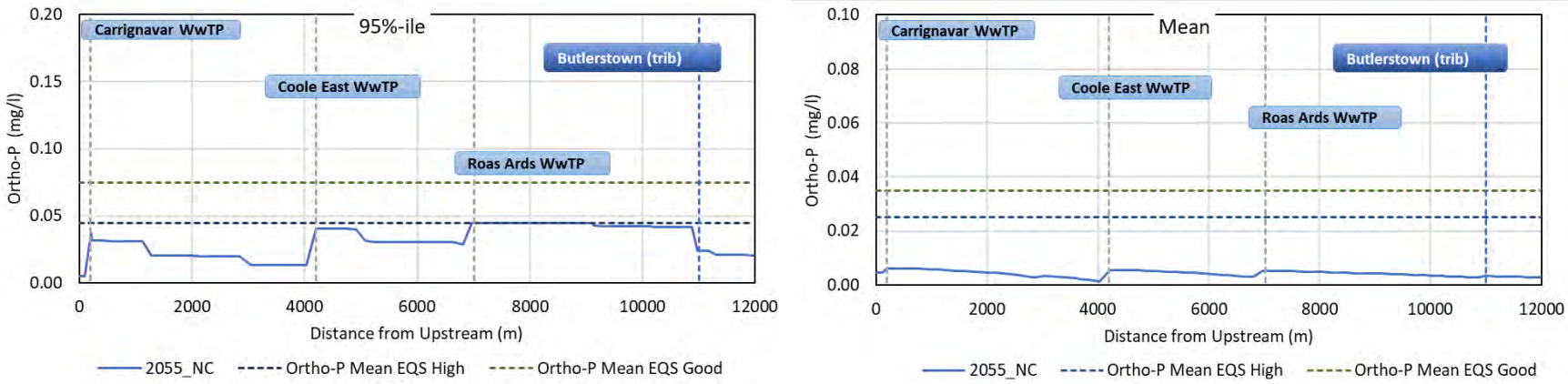
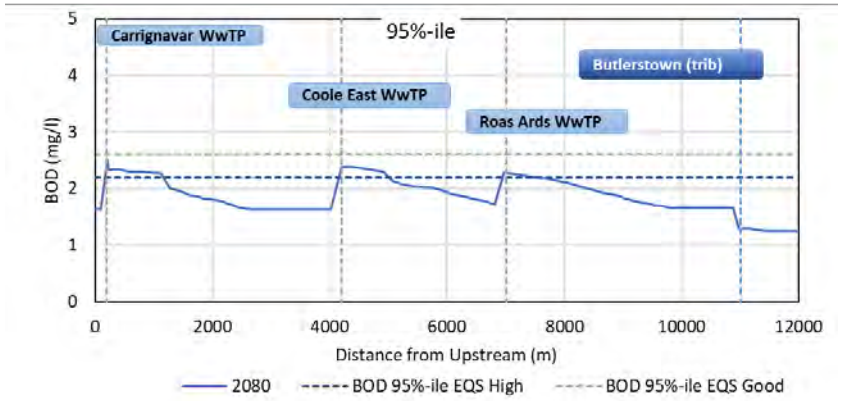


Figure 3-26 BOD Results for 2080 Scenario – Glashaboy



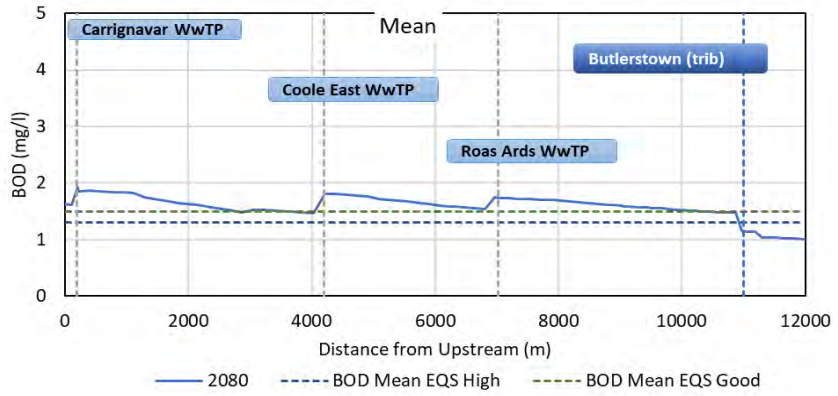
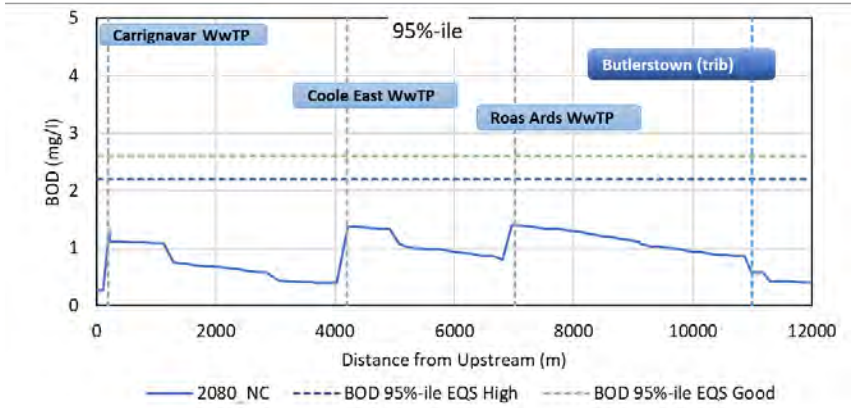


Figure 3-27 BOD Results for 2080 NC Scenario – Glashaboy



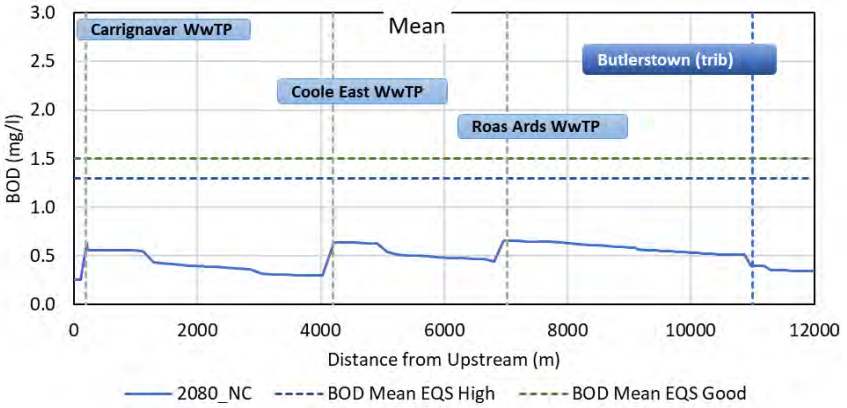
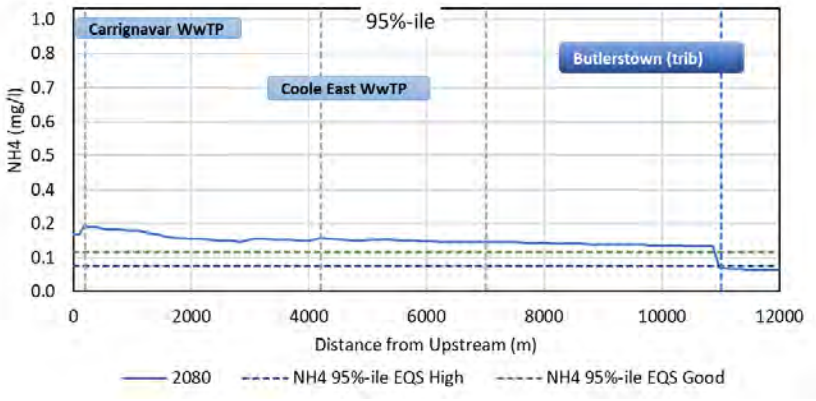


Figure 3-28 Ammonia Results for 2080 Scenario – Glashaboy



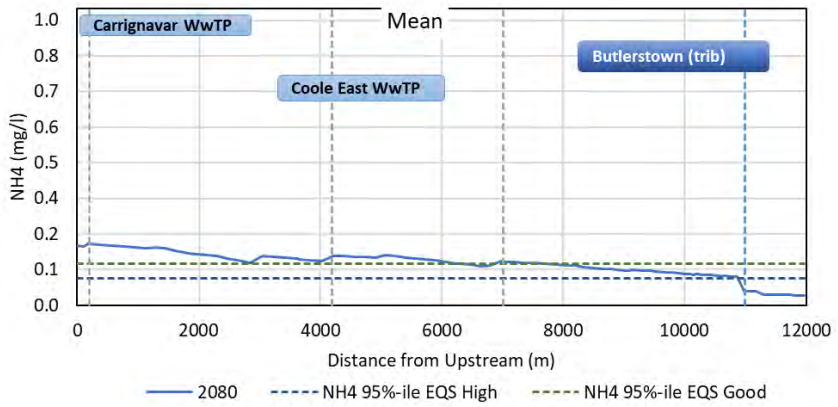
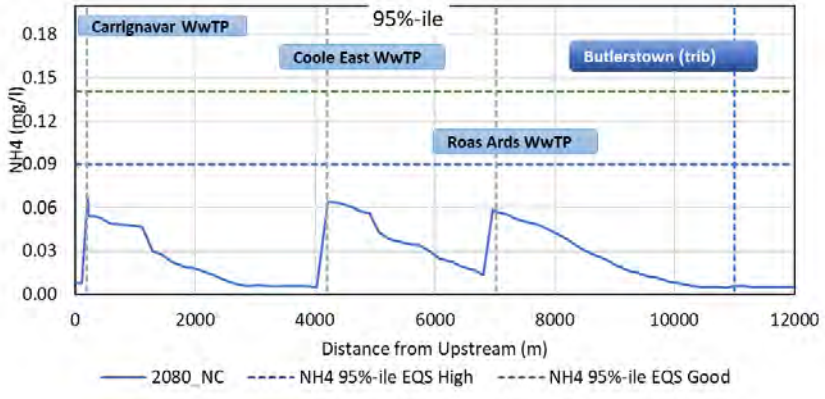


Figure 3-29 Ammonia Results for 2080 NC Scenario – Glashaboy



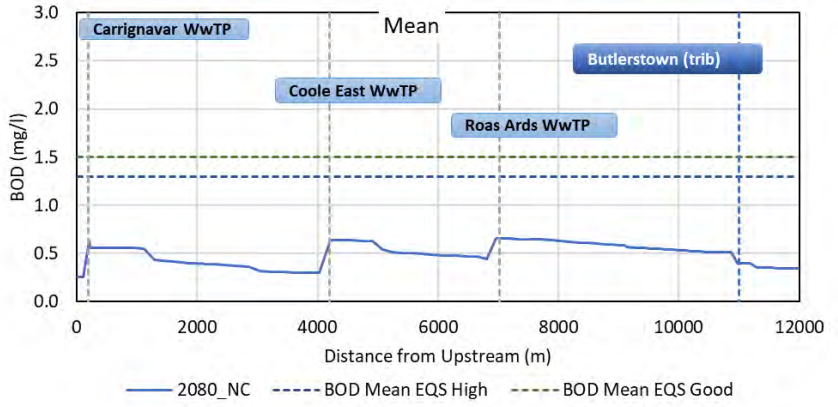
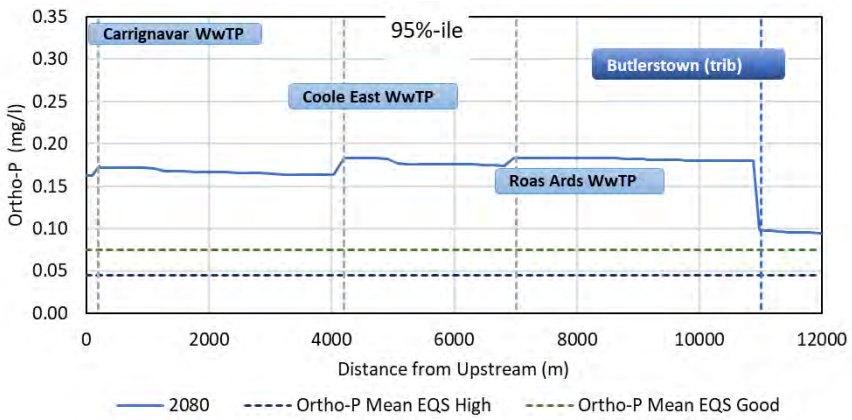


Figure 3-30 MRP Results for 2080 Scenario – Glashaboy



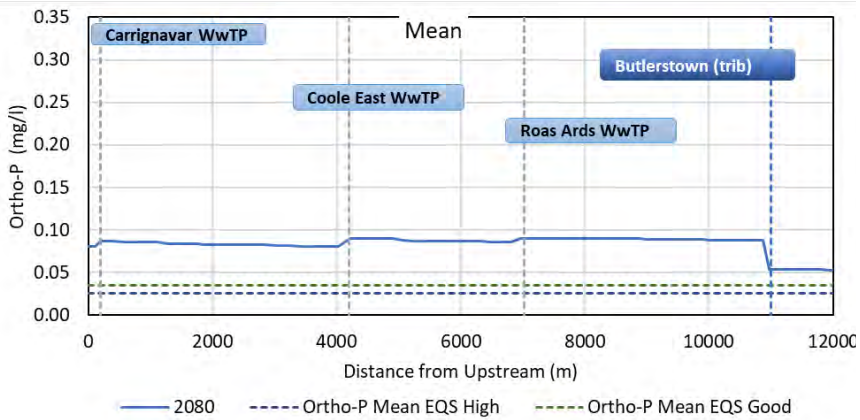
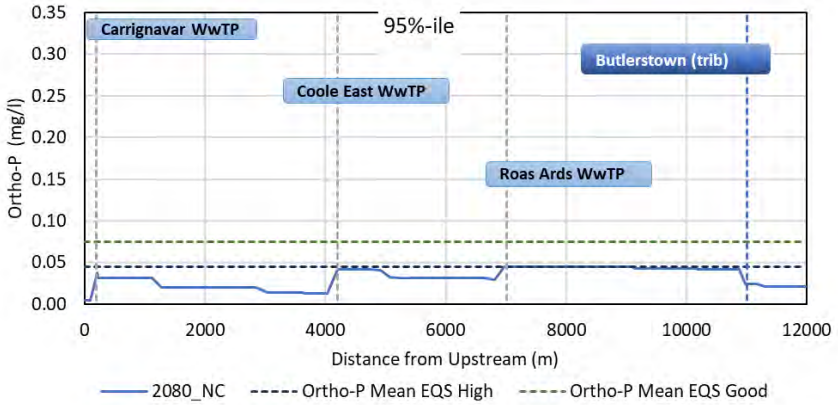


Figure 3-31 MRP Results for 2080 NC Scenario – Glashaboy



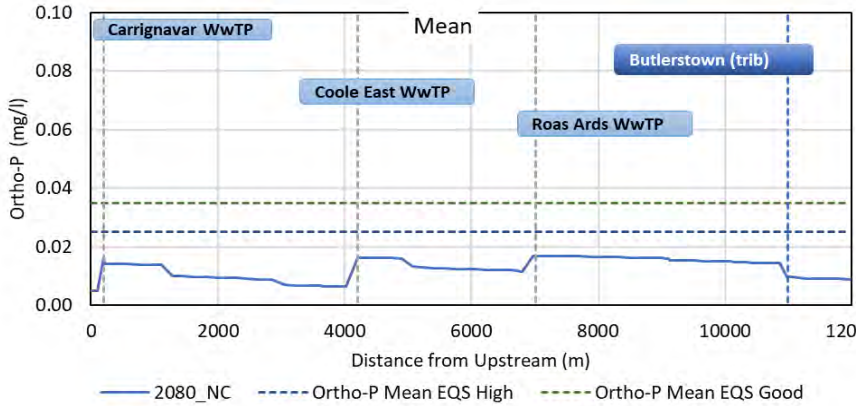
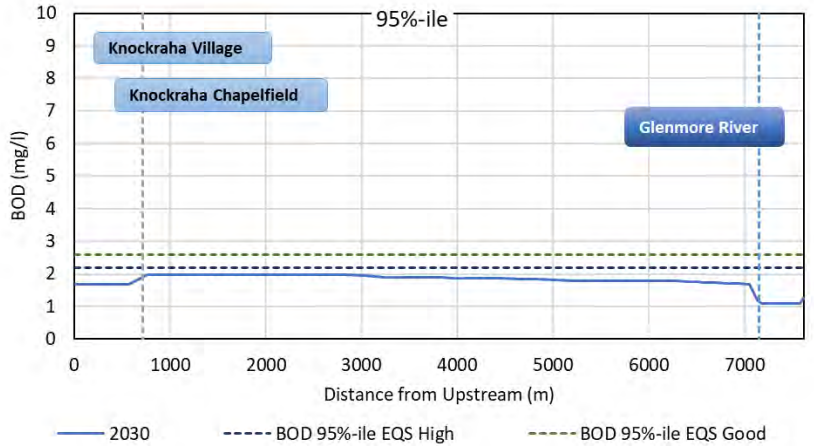


Figure 3-32 BOD Results for 2030 Scenario – Butlerstown



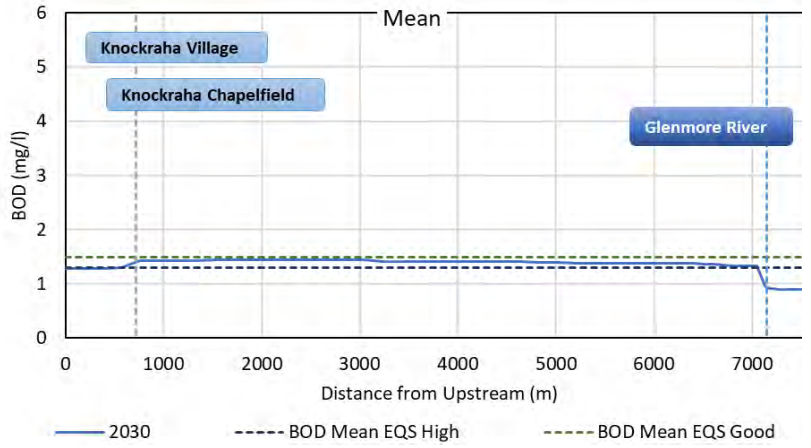
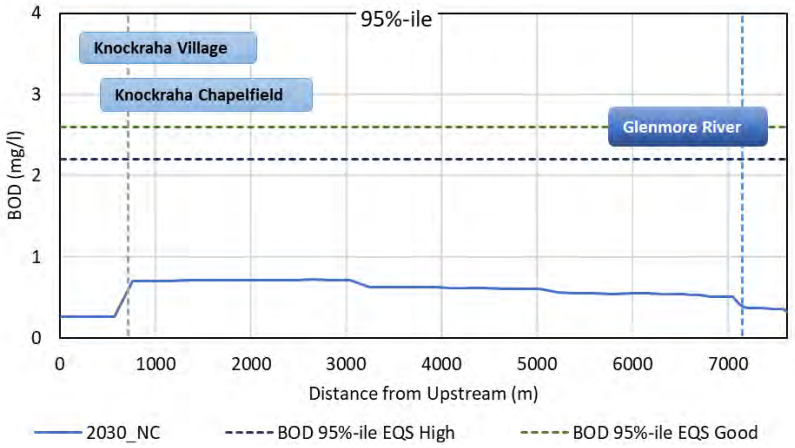


Figure 3-33 BOD Results for 2030 NC Scenario – Butlerstown



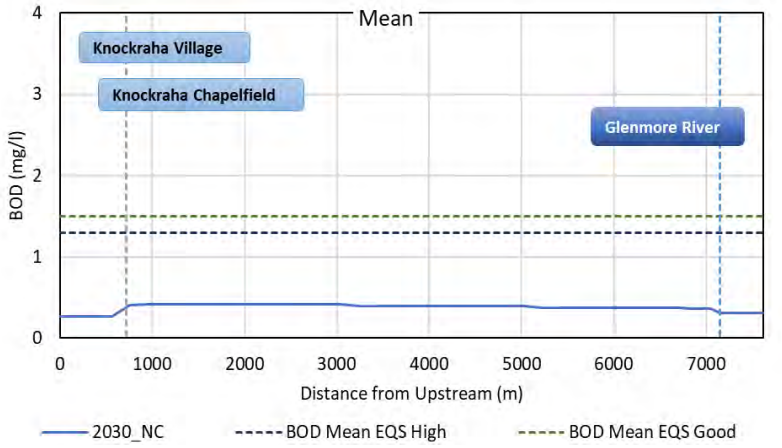
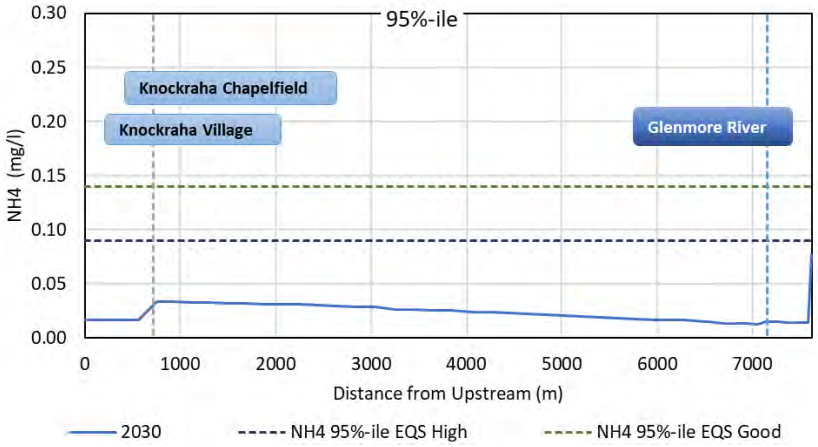


Figure 3-34 Ammonia Results for 2030 Scenario – Butlerstown



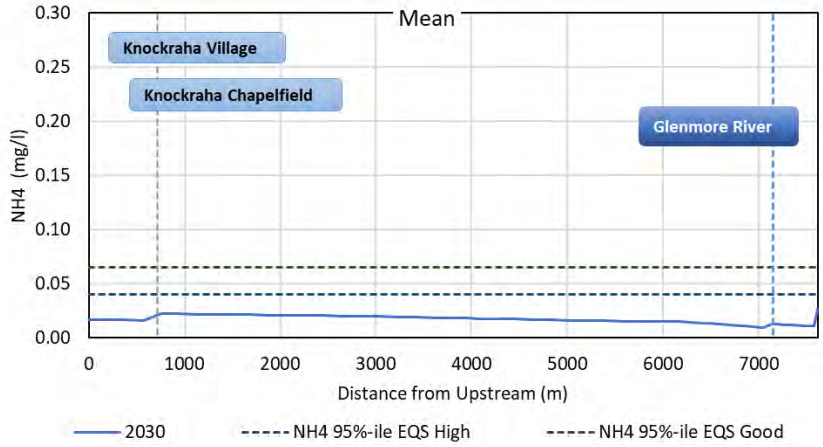
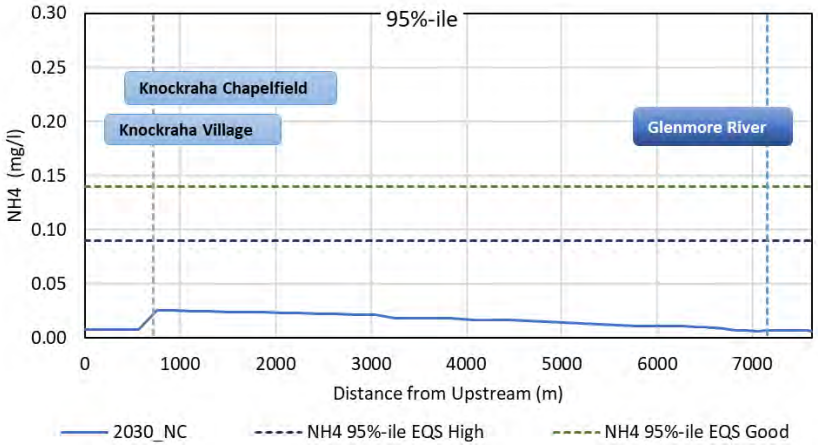


Figure 3-35 Ammonia Results for 2030 NC Scenario – Butlerstown



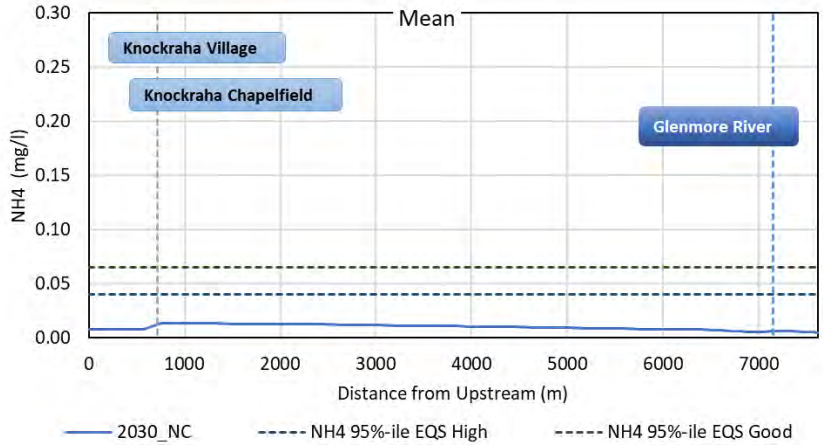
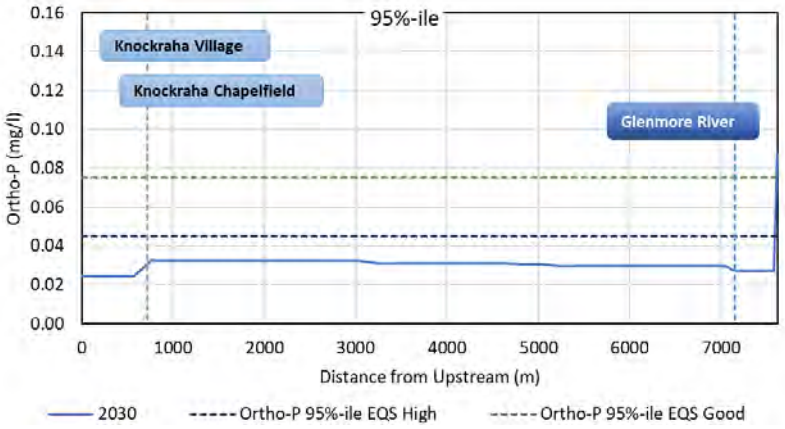


Figure 3-36 MRP Results for 2030 Scenario – Butlerstown



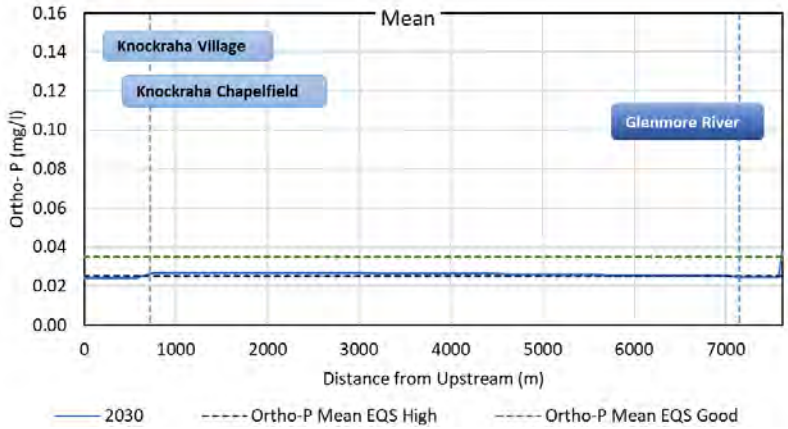
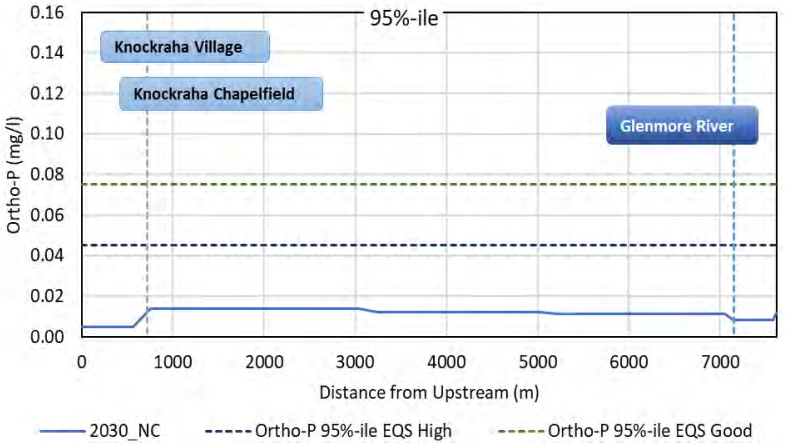


Figure 3-37 MRP Results for 2030 NC Clean Scenario – Butlerstown



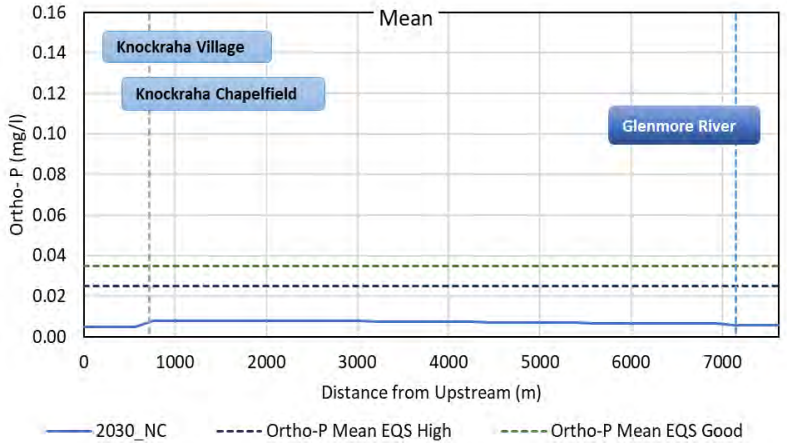
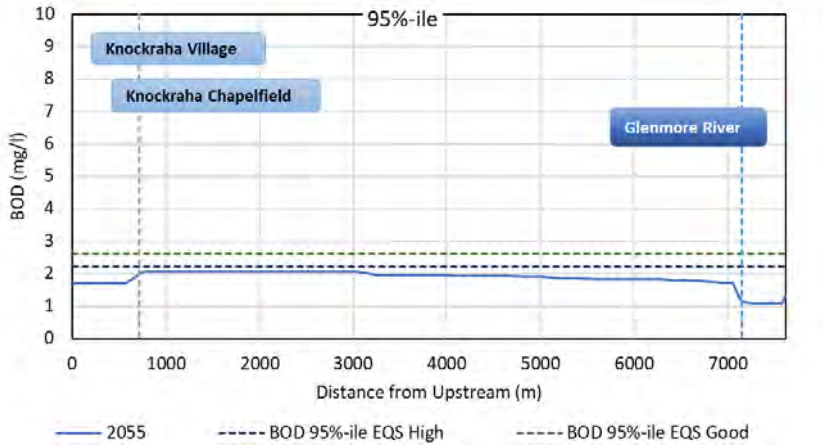


Figure 3-38 BOD Results for 2055 Scenario – Butlerstown



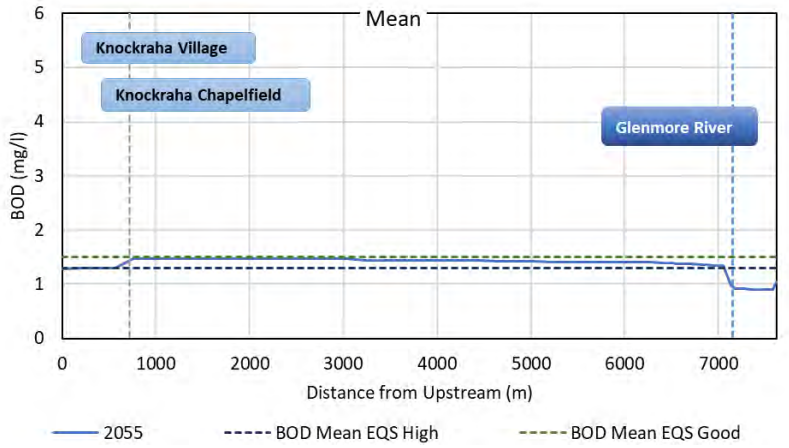
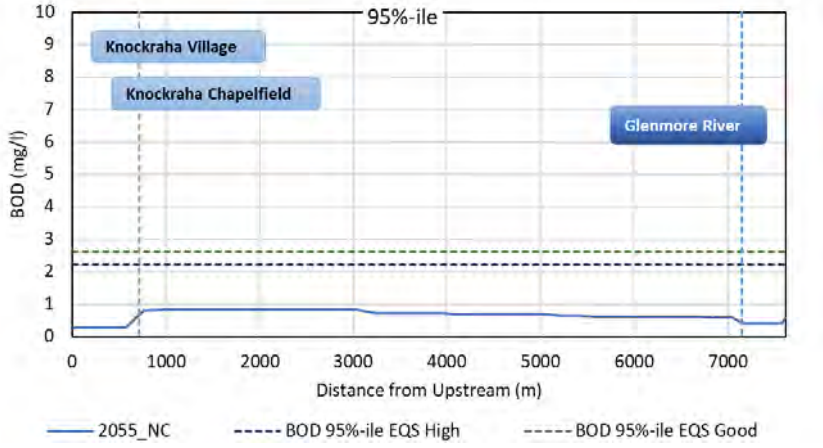


Figure 3-39 BOD Results for 2055 NC Scenario – Butlerstown



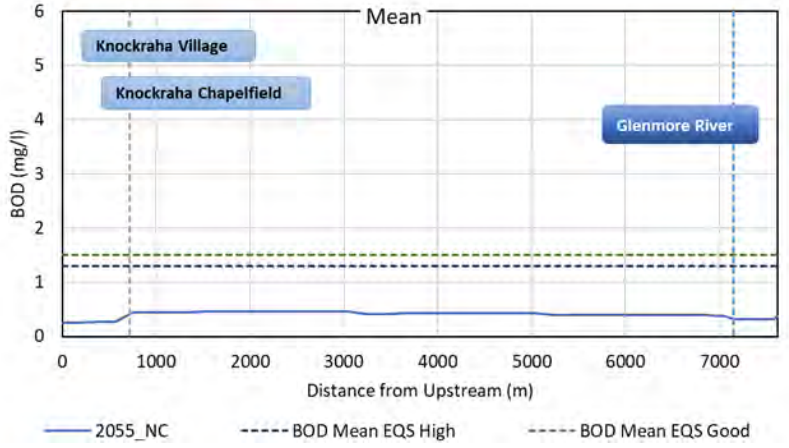


Figure 3-40 Ammonia Results for 2055 Scenario – Butlerstown

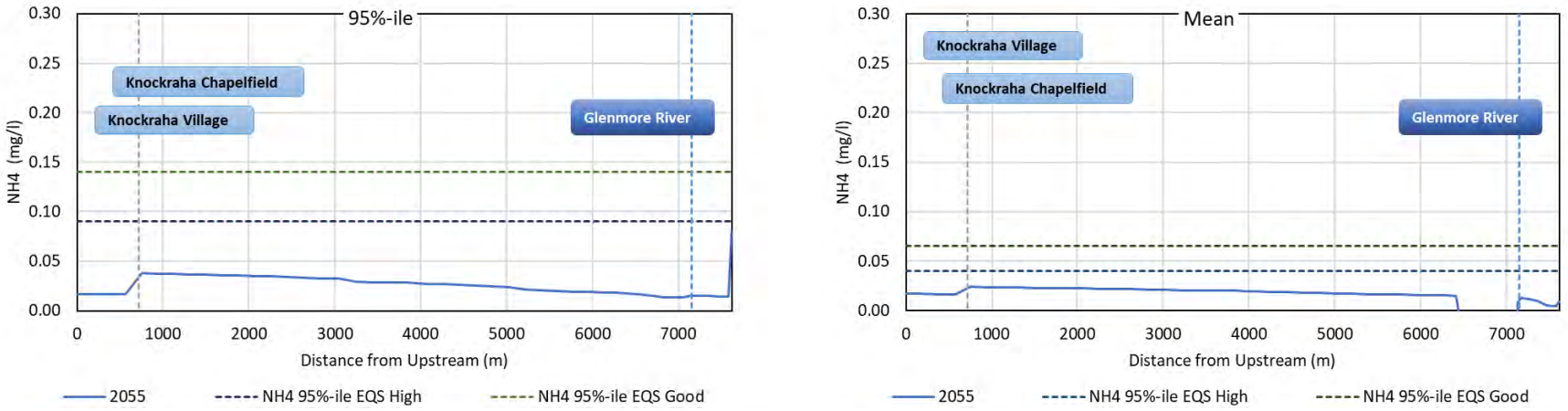


Figure 3-41 Ammonia Results for 2055 NC Scenario – Butlerstown

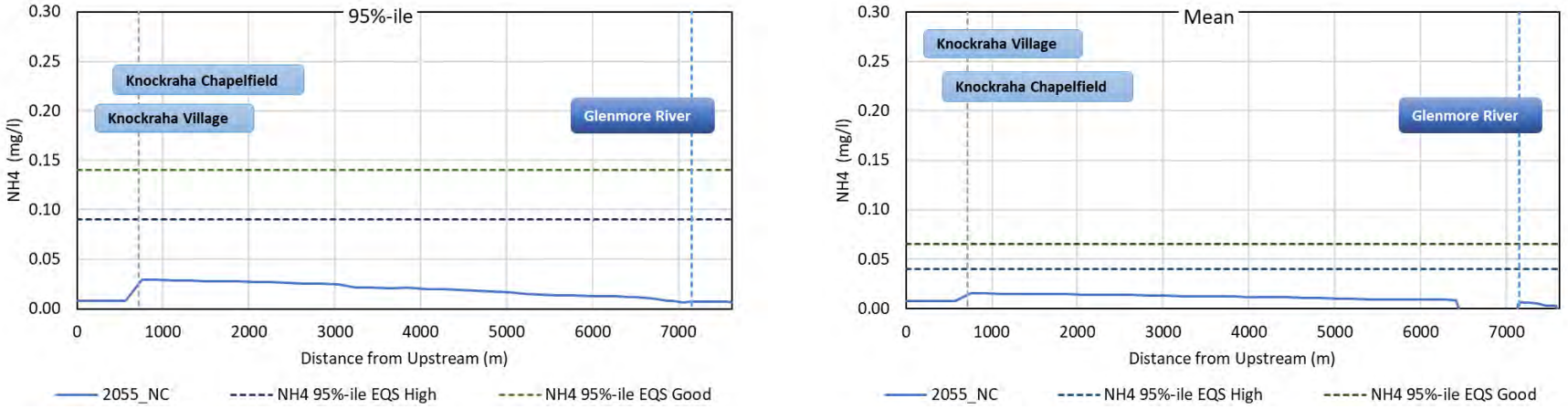
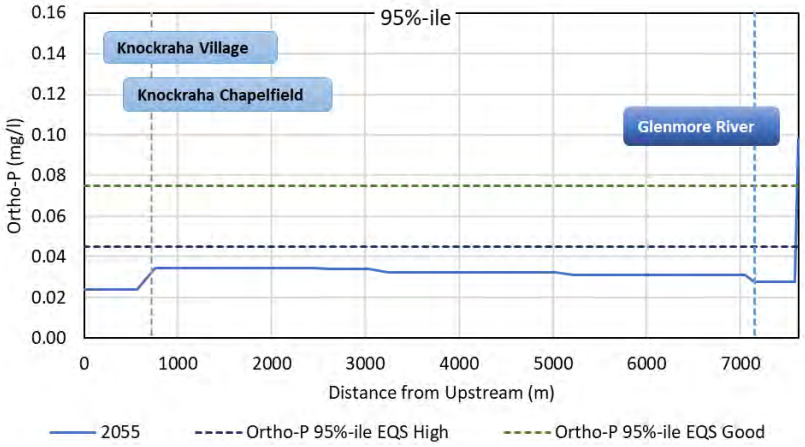


Figure 3-42 MRP Results for 2055 Scenario – Butlerstown



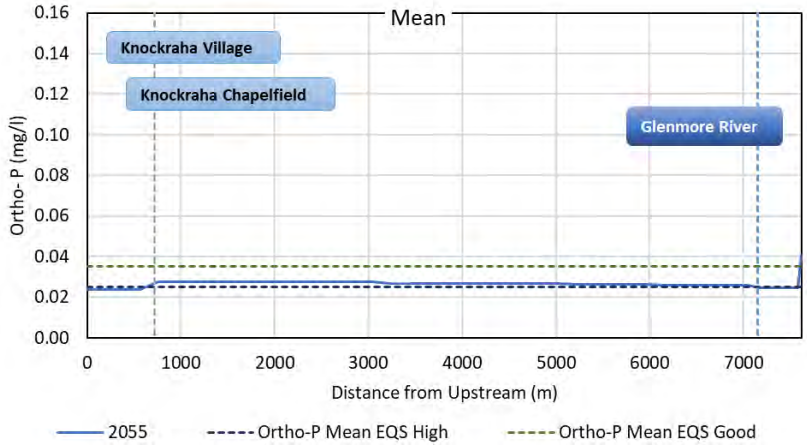
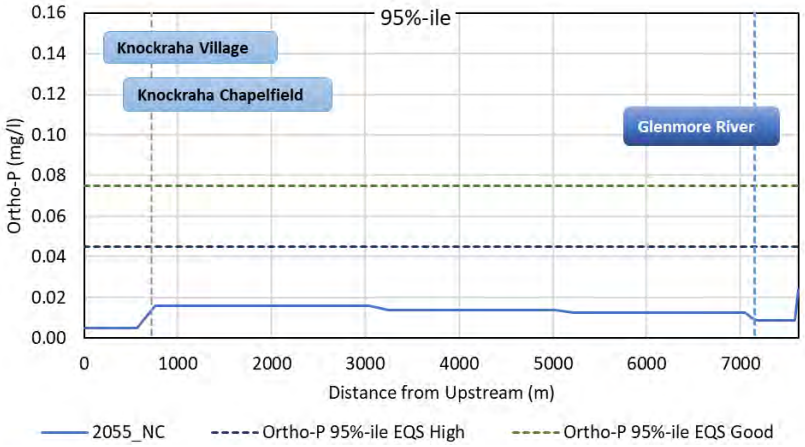


Figure 3-43 MRP Results for 2055 NC Scenario – Butlerstown



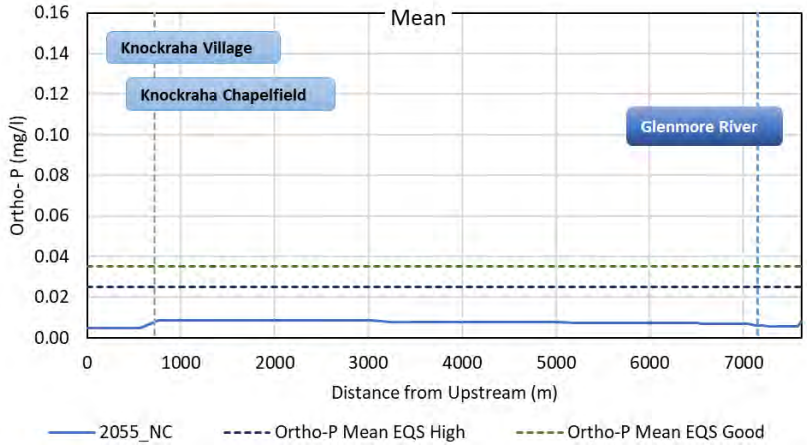
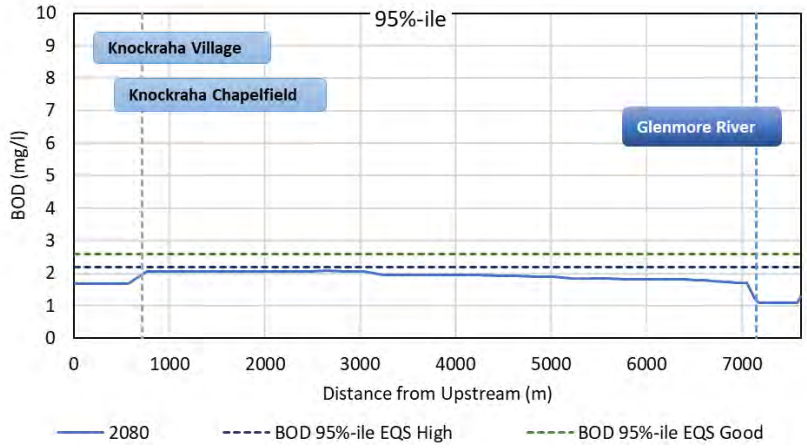


Figure 3-44 BOD Results for 2080 Scenario – Butlerstown



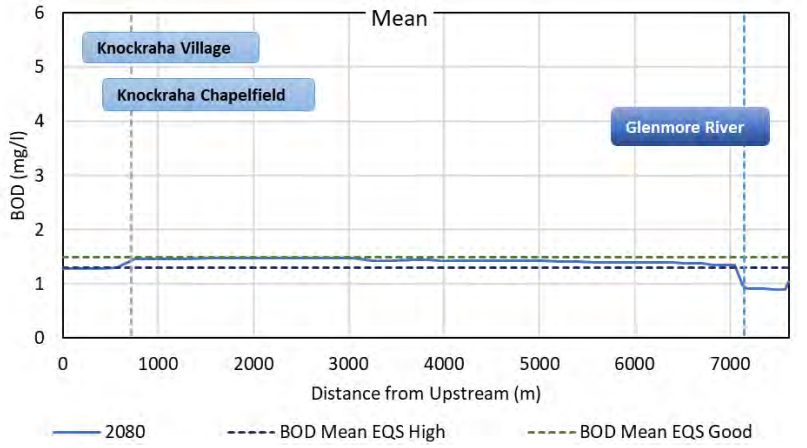
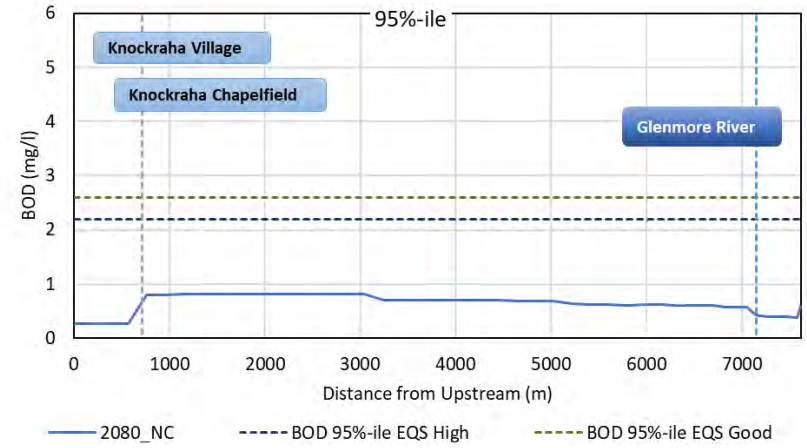


Figure 3-45 BOD Results for 2080 NC Scenario – Butlerstown



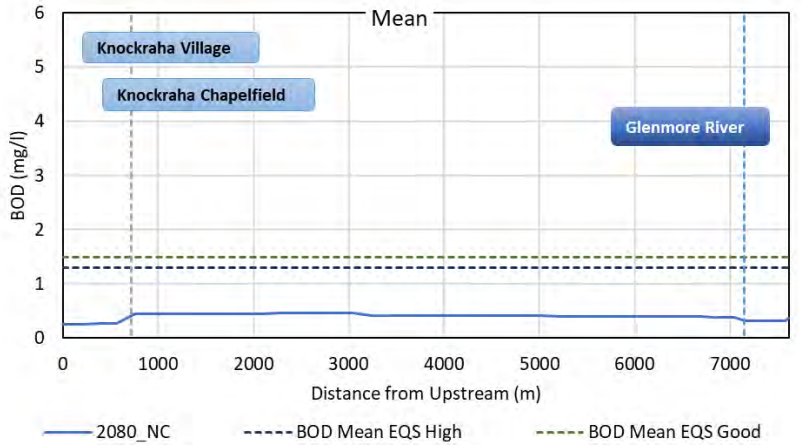


Figure 3-46 Ammonia Results for 2080 Scenario – Butlerstown

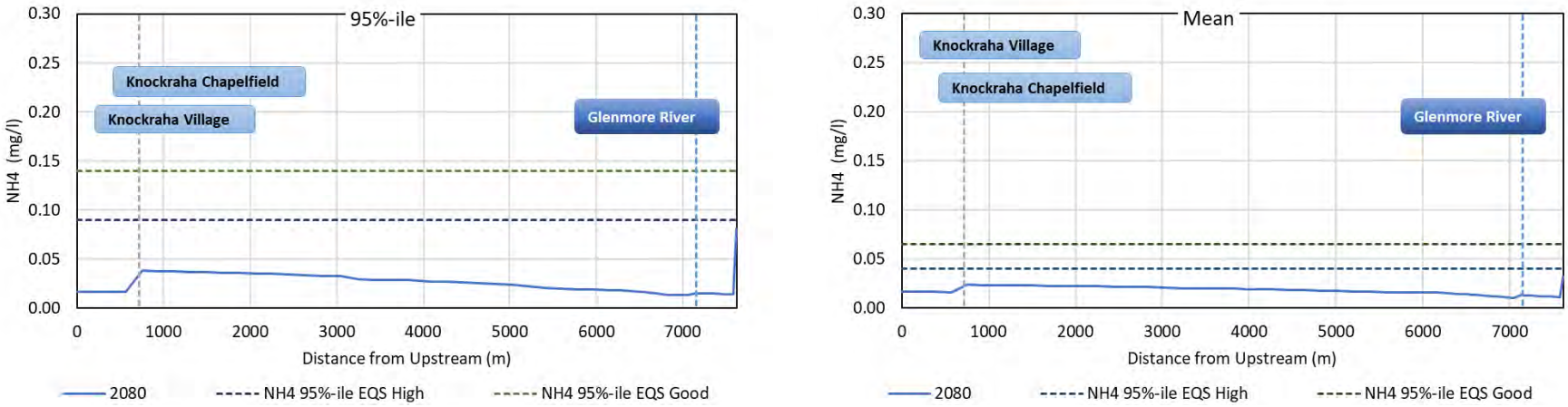


Figure 3-47 Ammonia Results for 2080 NC Scenario – Butlerstown

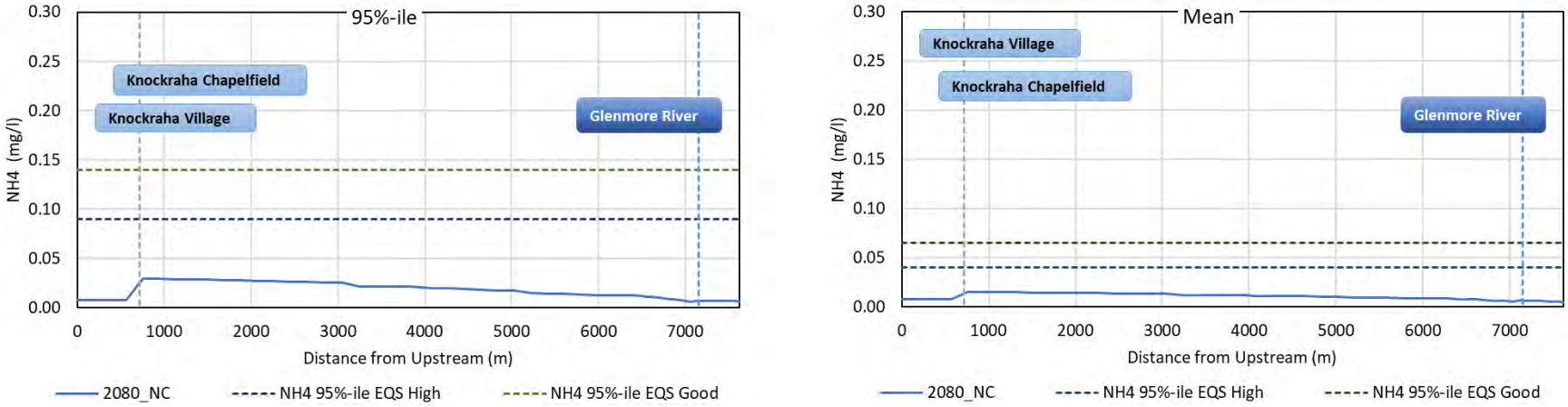
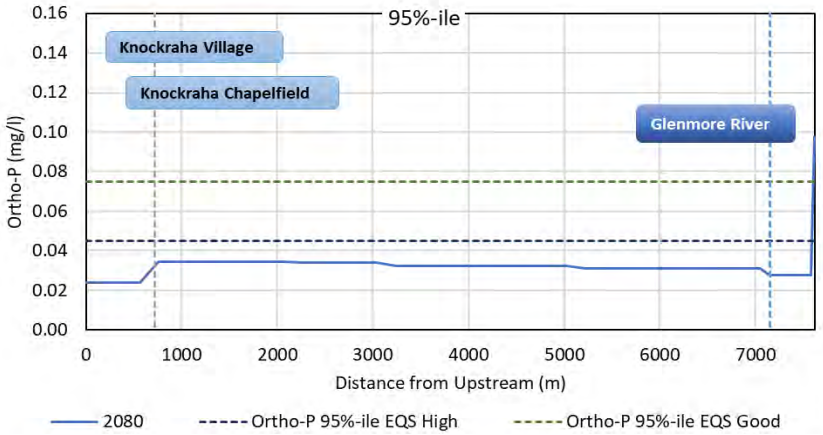


Figure 3-48 MRP Results for 2080 Scenario – Butlerstown



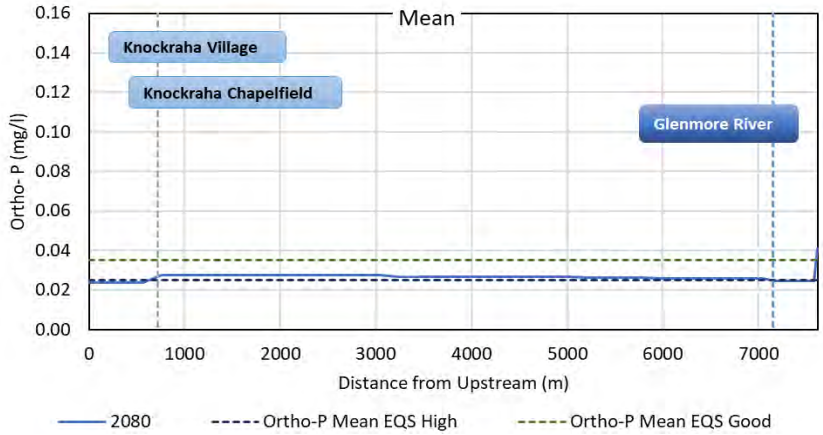
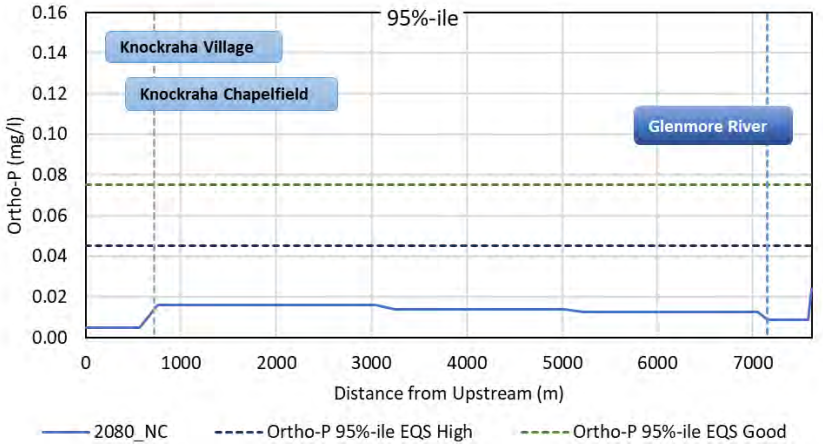
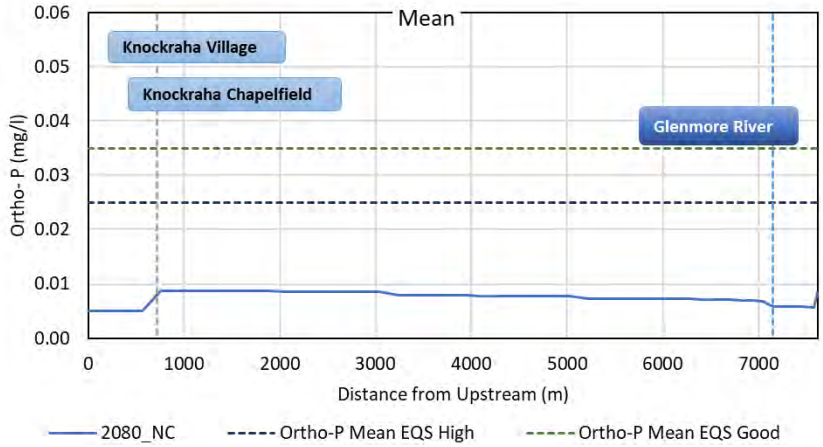


Figure 3-49 MRP Results for 2080 NC Scenario – Butlerstown





3.3.2 Owenboy River

The river flows included in the model are derived from the calibrated hydrology model driven by the stochastic rainfall data for 2030, 2055 and 2080, and the WwTP flows for these three horizons are given in Table 3-12.

Table 3-15, Table 3-14 and Table 3-15 provides the maximum allowable ELVs calculated from the initial model runs, for 2030, 2055 and 2080 horizons.

Table 3-12 Flow Inputs Applied in the River Owenboy Modelling Scenarios

Receiving Watercourse	WwTPS	Flows		
		2030	2055	2080
Owenboy	Ballygarvan	0.0030	0.0014	0.0015
	Halfway	0.0012	0.0035	0.0039

Table 3-13 Final ELVs Determined for WwTPs in the Owenboy Model for BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Halfway	No	High	No	5	5	5	5
Ballygarvan	No	High	No	25	25	25	25

Table 3-14 Final ELVs Determined for WwTPs in the Owenboy Model for Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Halfway	No	High	No	2	2	2	2
Ballygarvan	No	High	No	5	4.10	3.55	3.14

Table 3-15 Final ELVs Determined for WwTPs in the Owenboy Model for

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Halfway	No	Good	Yes	1	1	1	1
Ballygarvan	No	Good	Yes	3	3	3	2.74

The results for the three future scenarios—2030, 2055, and 2080, encompassing the parameters BOD, ammonia, and for River Owenboy, are presented in Figure 3-50 to Figure 3-67 . These figures illustrate modelled conditions along a 20,000 m reach of the Owenboy River, extending from the upstream boundary, and highlight the locations of the Ballygarvan WwTP and Halfway WwTP, located approximately at 5000 m and 14000 m respectively.

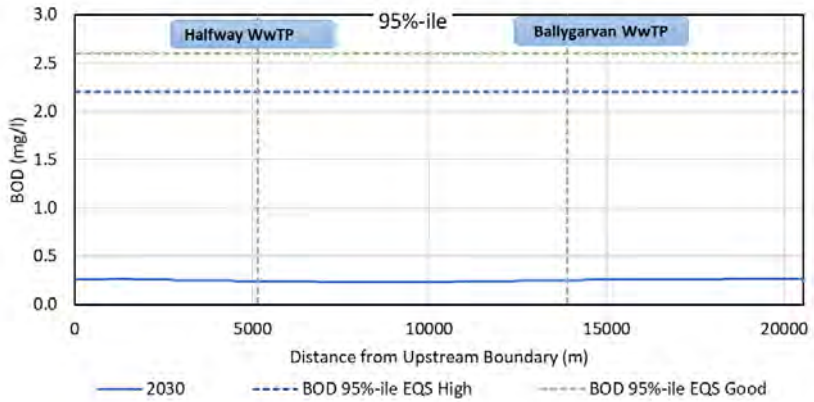
Table 3-16 provides a summary of the model results, indicating water quality in the river when the WwTPs are operated with the maximum ELVs determined.

Table 3-16 Summary of Owenboy Results

Scenarios	Parameters
	BOD
2030 (Figure 3-50 and Figure 3-51)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-50). The EQS for the target status High is achieved for BOD 95th percentile and mean concentrations for both Halfway WwTP and Ballygarvan WwTP. Both the WwTPs have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
2055 (Figure 3-56 and Figure 3-57)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-56). The EQS for the target status High is achieved for BOD 95th percentile mean concentrations for both Halfway WwTP and Ballygarvan WwTP. Both the WwTPs have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
2080 (Figure 3-62 and Figure 3-63)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-62). The EQS for the target status High is achieved for BOD 95th percentile mean concentrations for both Halfway WwTP and Ballygarvan WwTP. Both the WwTPs have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
	Ammonia
2030 (Figure 3-52 and Figure 3-53)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-52). The EQS for the target status High is achieved for ammonia 95th percentile mean concentrations for both Halfway WwTP and Ballygarvan WwTP. At downstream of Halfway WwTP, the ammonia 95th percentile concentration is 0.057 mg/l and is 63% of in-band WAC. Similarly mean ammonia concentration is 0.031 mg/l and is 73% of in-band WAC. At downstream of Ballygarvan WwTP, the ammonia 95th percentile concentration is 0.041 mg/l and is 46% of in-band WAC. Similarly mean ammonia concentration is 0.022 mg/l and is 55% of in-band WAC.
2055 (Figure 3-58 and Figure 3-59)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-58). The EQS for the target status High is achieved for ammonia 95th percentile mean concentrations for both Halfway WwTP and Ballygarvan WwTP. At downstream of Halfway WwTP, the ammonia 95th percentile concentration is 0.058 mg/l

Scenarios	Parameters
	and is 64% of in-band WAC. Similarly mean ammonia concentration is 0.032 mg/l and is 80% of in-band WAC. At downstream of Ballygarvan WwTP, the ammonia 95th percentile concentration is 0.043 mg/l and is 48% of in-band WAC. Similarly mean ammonia concentration is 0.027 mg/l and is 68% of in-band WAC.
2080 (Figure 3-64 and Figure 3-65)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-64). The EQS for the target status High is achieved for ammonia 95th percentile mean concentrations for both Halfway WwTP and Ballygarvan WwTP. At downstream of Halfway WwTP, the ammonia 95th percentile concentration is 0.059 mg/l and is 66% of in-band WAC. Similarly mean ammonia concentration is 0.033 mg/l and is 83% of in-band WAC. At downstream of Ballygarvan WwTP, the ammonia 95th percentile concentration is 0.044 mg/l and is 49% of in-band WAC. Similarly mean ammonia concentration is 0.028 mg/l and is 70% of in-band WAC.
	MRP
2030 (Figure 3-54 and Figure 3-55)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Ballygarvan WwTP and Halfway WwTP are determined using the NC condition (Figure 3-55). The impacts of Halfway WwTP and Ballygarvan WwTP are low, with the concentrations at the downstream of the WwTPs being well below the thresholds of High status.
2055 (Figure 3-60 and Figure 3-61)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Ballygarvan WwTP and Halfway WwTP are determined using the NC condition (Figure 3-61). The impacts of Halfway WwTP and Ballygarvan WwTP are low, with the concentrations at the downstream of the WwTPs being well below the thresholds of High status.
2080 (Figure 3-66 and Figure 3-67)	As the EQS for the target status of Good is already exceeded at the upstream river, the maximum ELVs for Ballygarvan WwTP and Halfway WwTP are determined using the NC condition (Figure 3-67). The impacts of Halfway WwTP and Ballygarvan WwTP are low, with the concentrations at the downstream of the WwTPs being well below the thresholds of High status.

Figure 3-50 BOD Results for 2030 Scenario – Owenboy



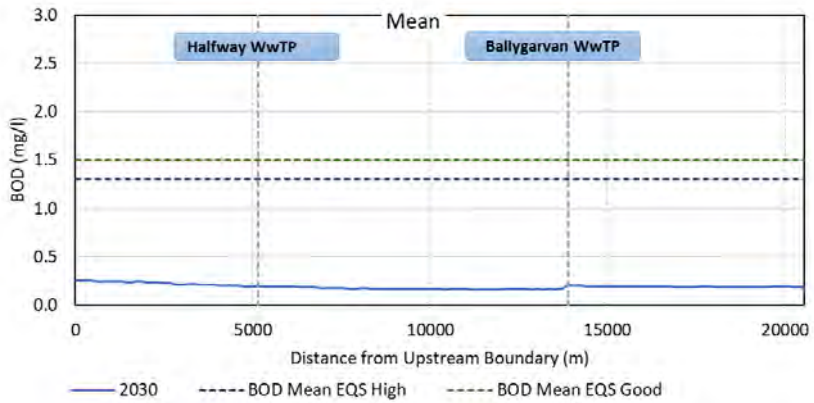
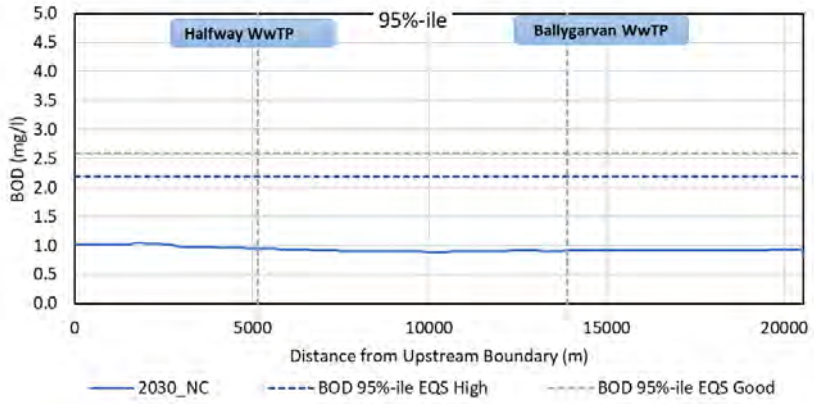


Figure 3-51 BOD Results for 2030 NC Scenario – Owenboy



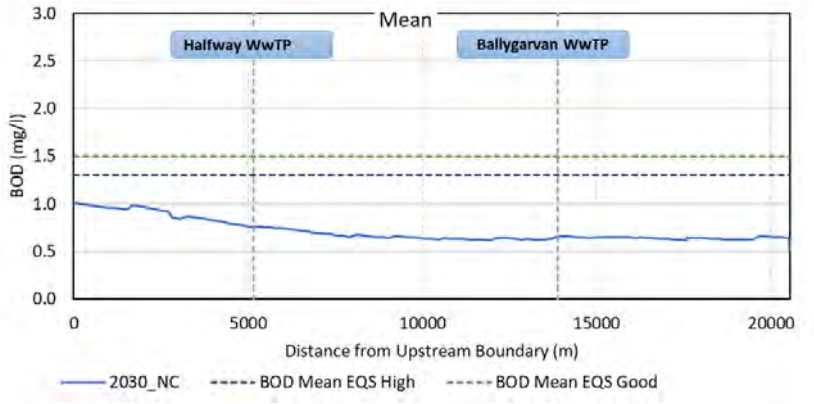
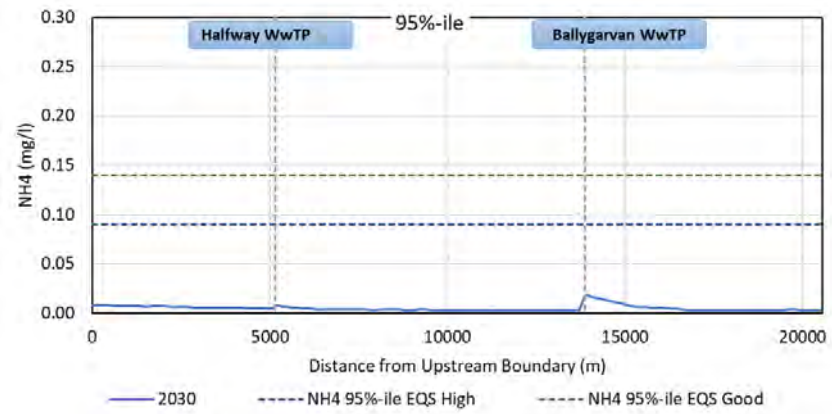


Figure 3-52 Ammonia Results for 2030 Scenario – Owenboy



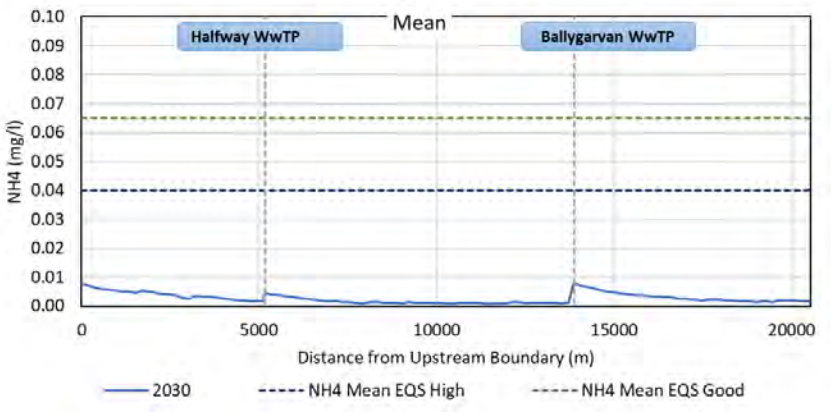
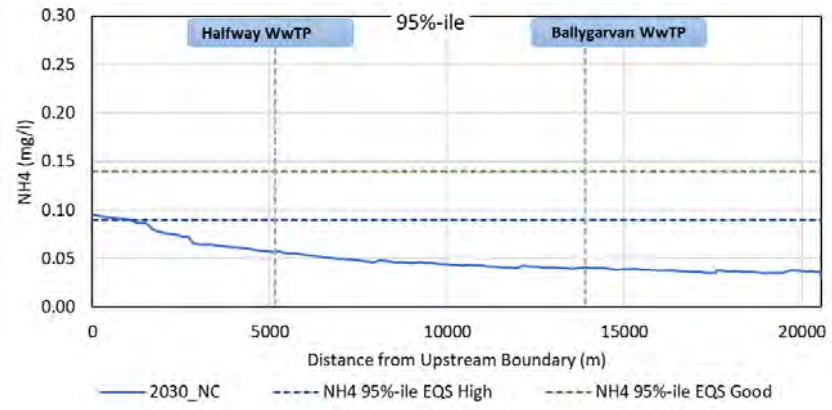


Figure 3-53 Ammonia Results for 2030 NC Scenario – Owenboy



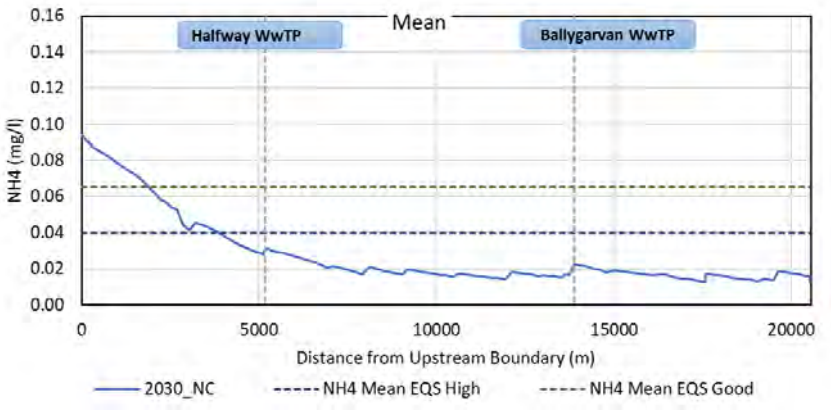
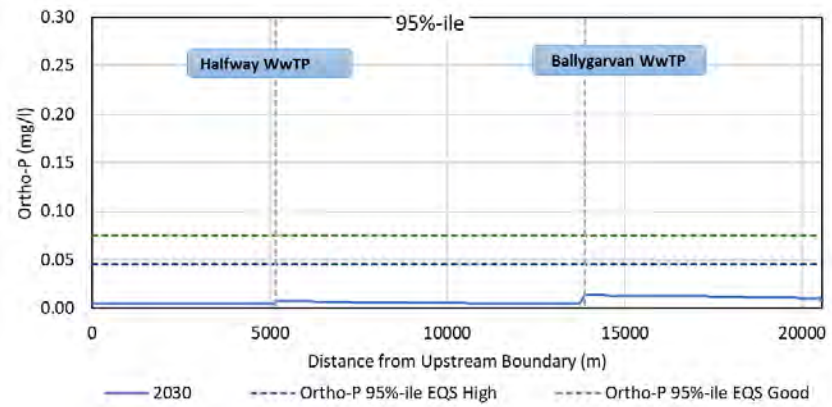


Figure 3-54 MRP Results for 2030 Scenario – Owenboy



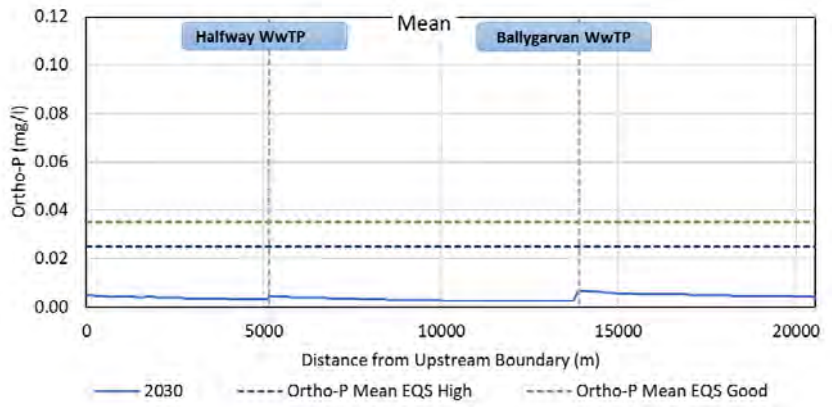
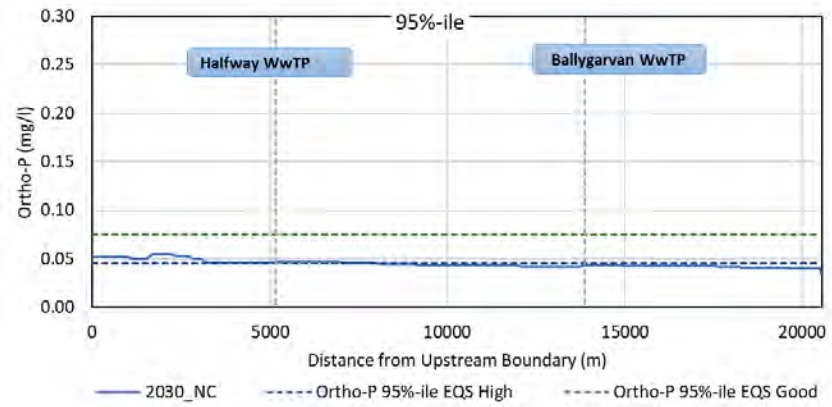


Figure 3-55 MRP Results for 2030 NC Scenario – Owenboy



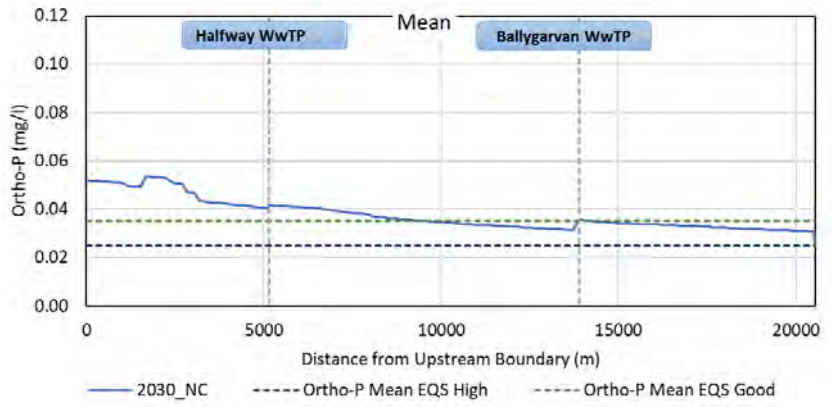
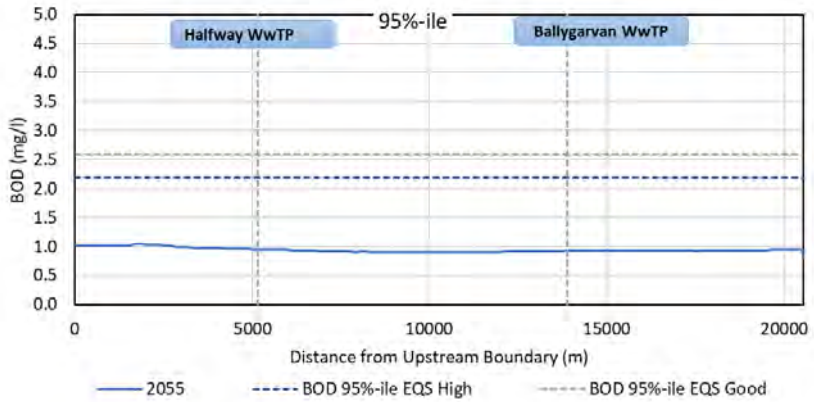


Figure 3-56 BOD Results for 2055 Scenario – Owenboy



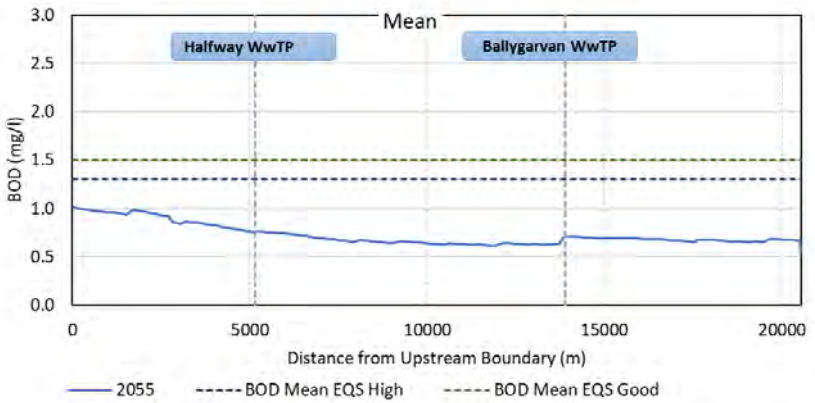
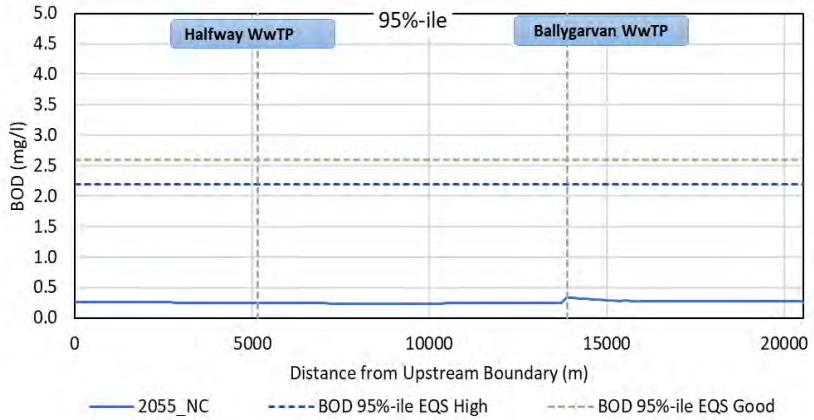


Figure 3-57 BOD Results for 2055 NC Scenario – Owenboy



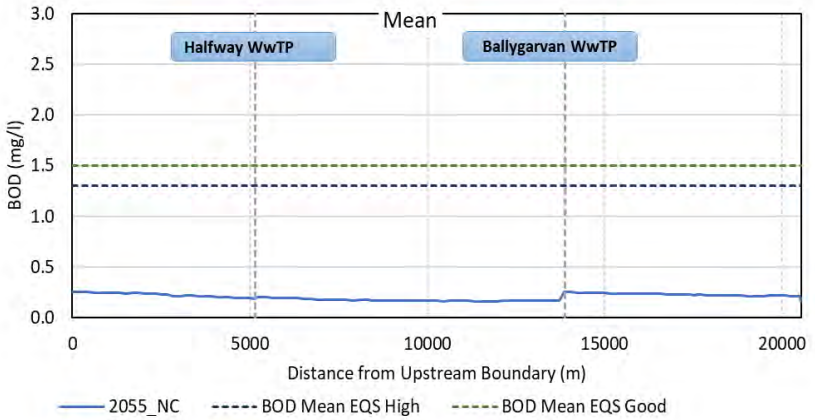
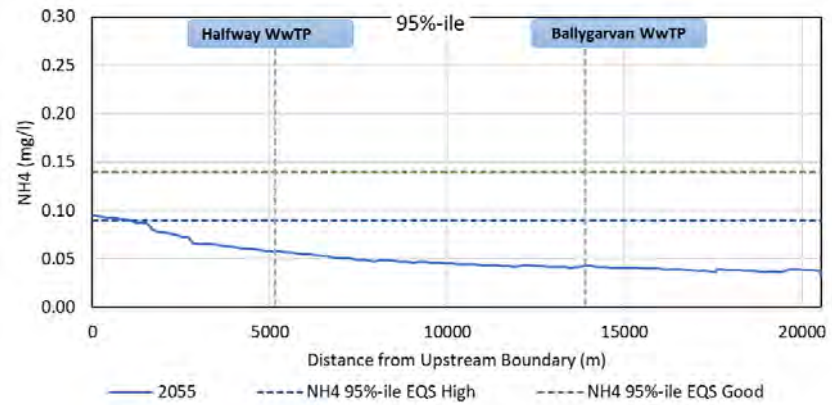


Figure 3-58 Ammonia Results for 2055 Scenario – Owenboy



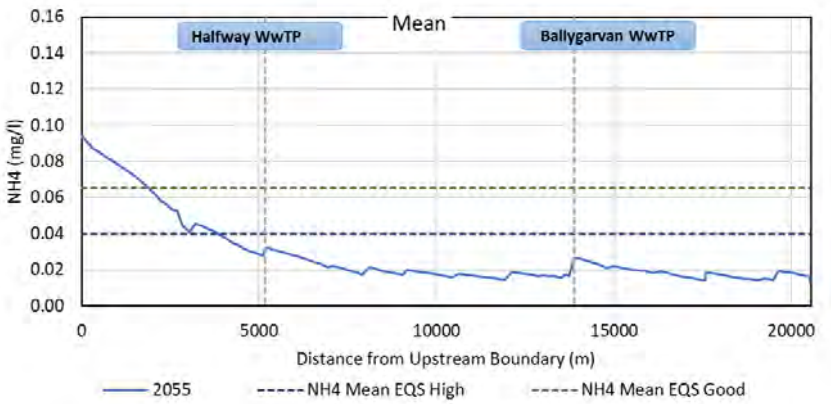
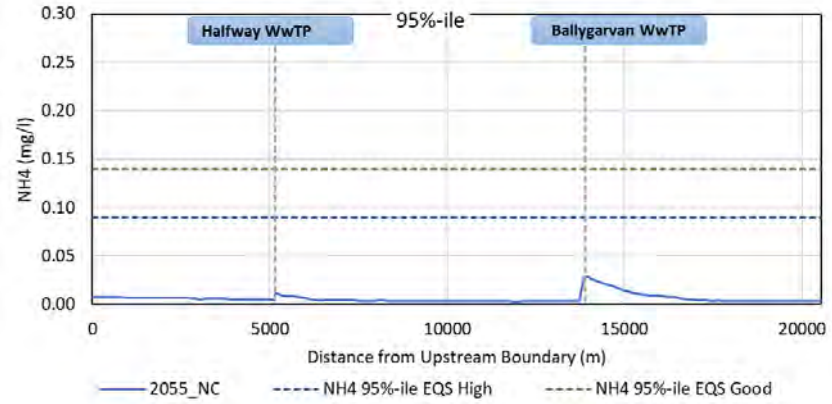


Figure 3-59 Ammonia Results for 2055 NC Scenario – Owenboy



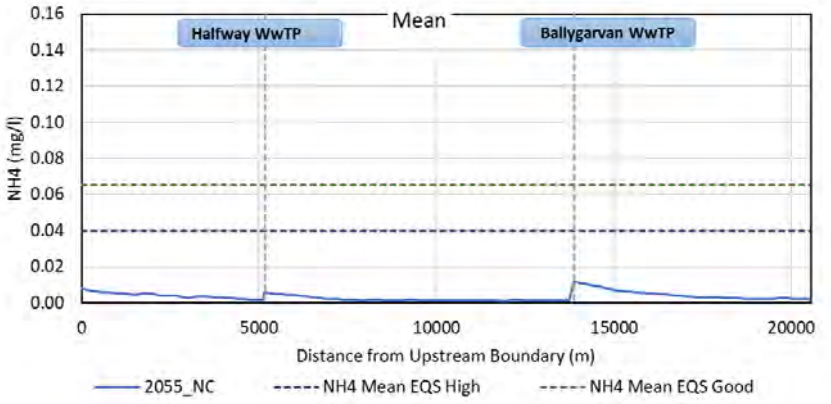
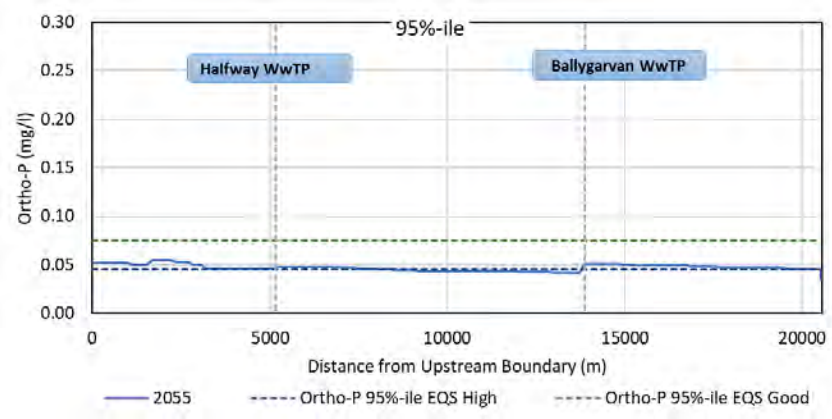


Figure 3-60 MRP Results for 2055 Scenario – Owenboy



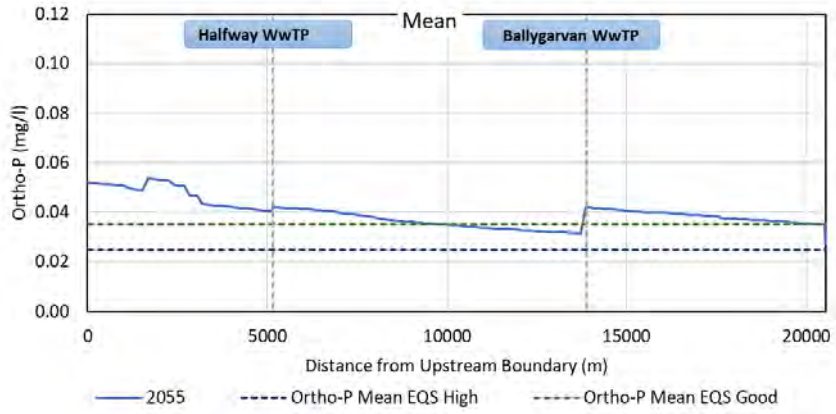
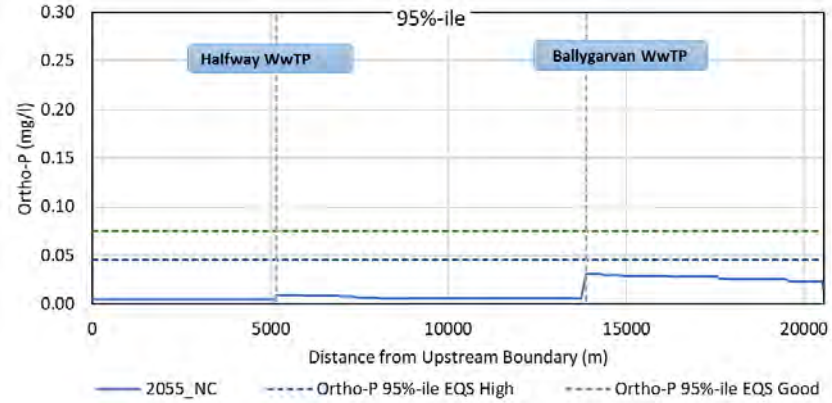


Figure 3-61 MRP Results for 2055 NC Scenario – Owenboy



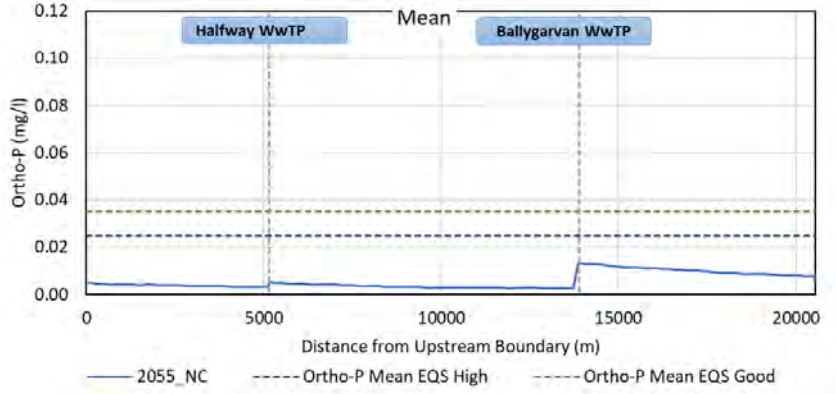
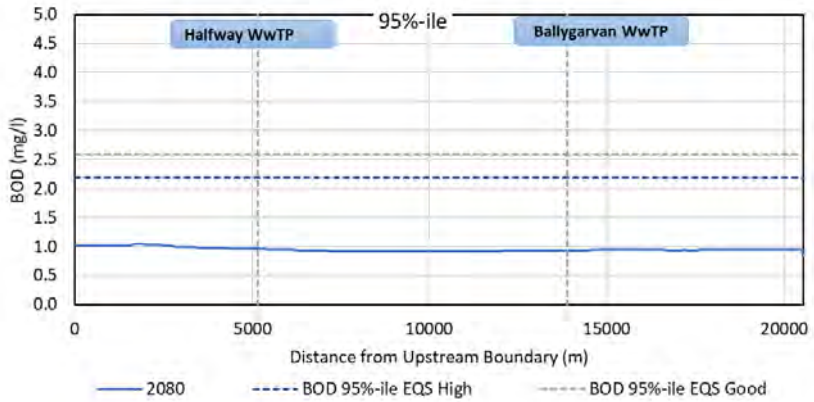


Figure 3-62 BOD Results for 2080 Scenario – Owenboy



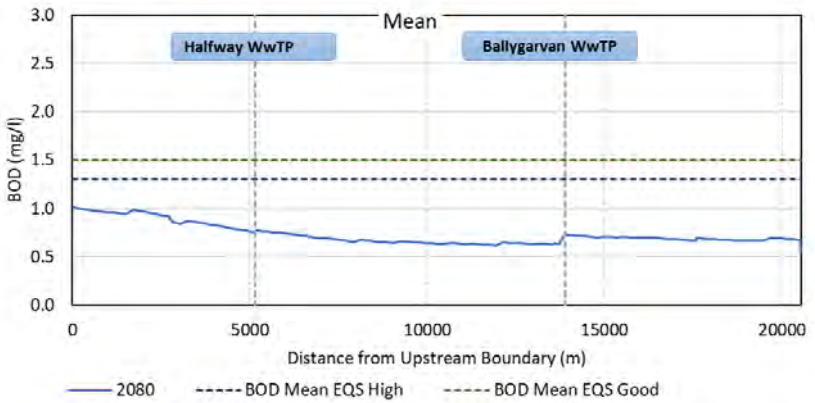
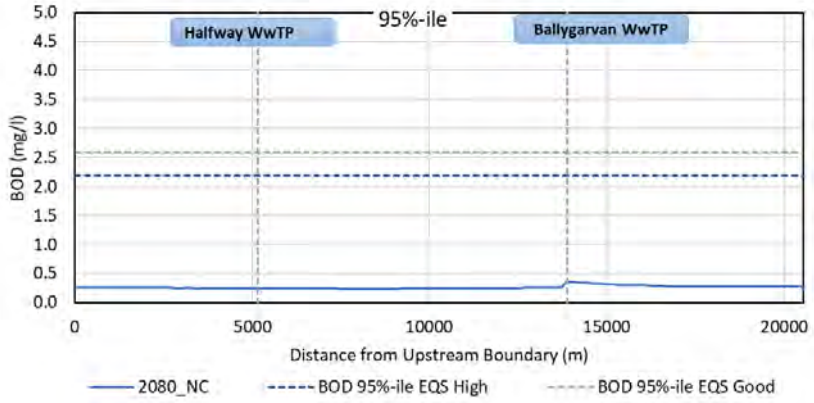


Figure 3-63 BOD Results for 2080 NC Scenario – Owenboy



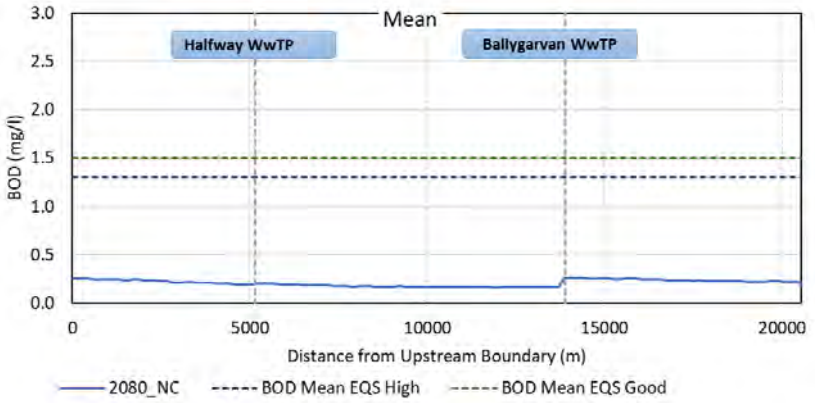
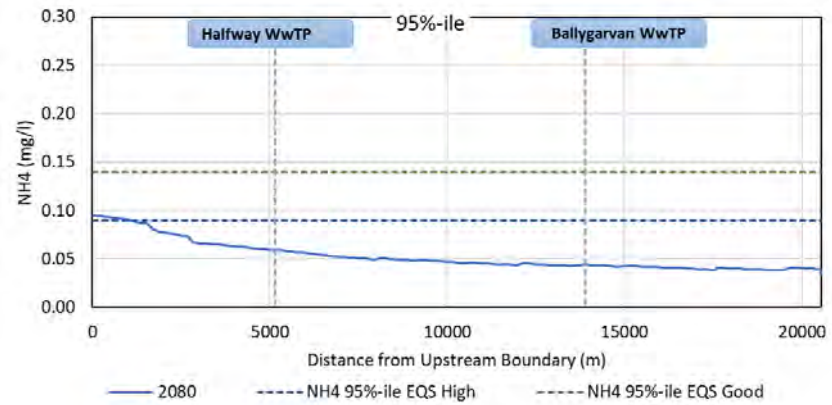


Figure 3-64 Ammonia Results for 2080 Scenario – Owenboy



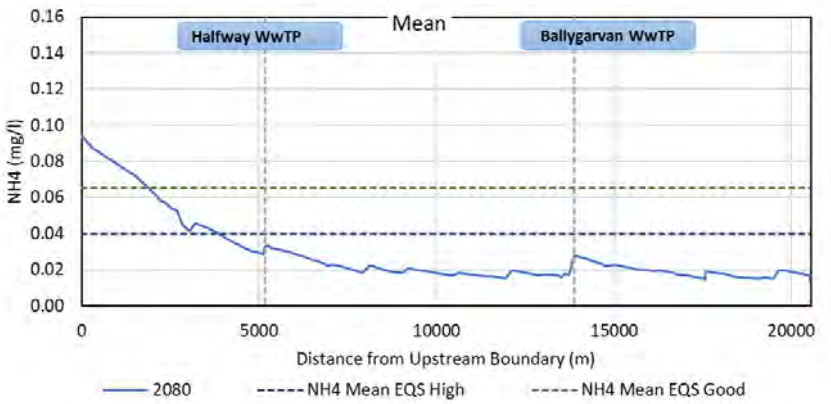
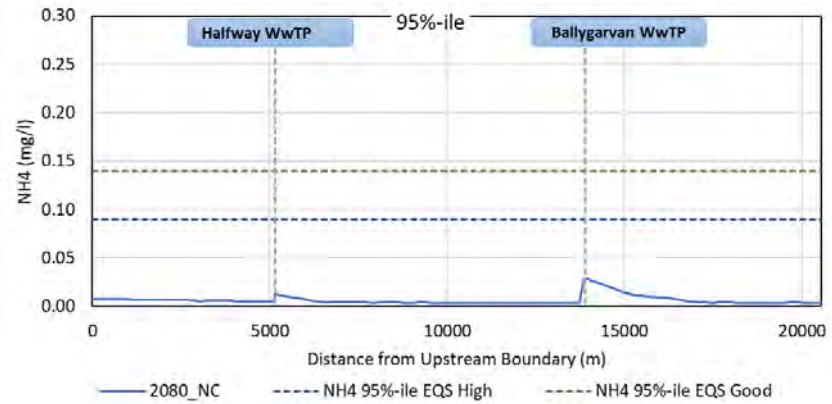


Figure 3-65 Ammonia Results for 2080 NC Scenario – Owenboy



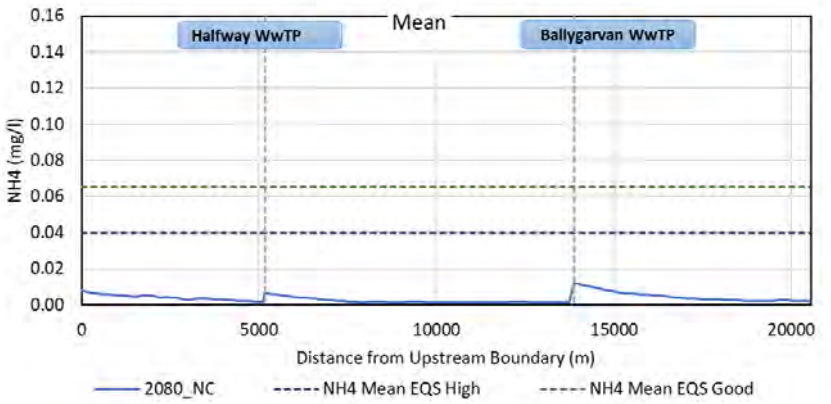
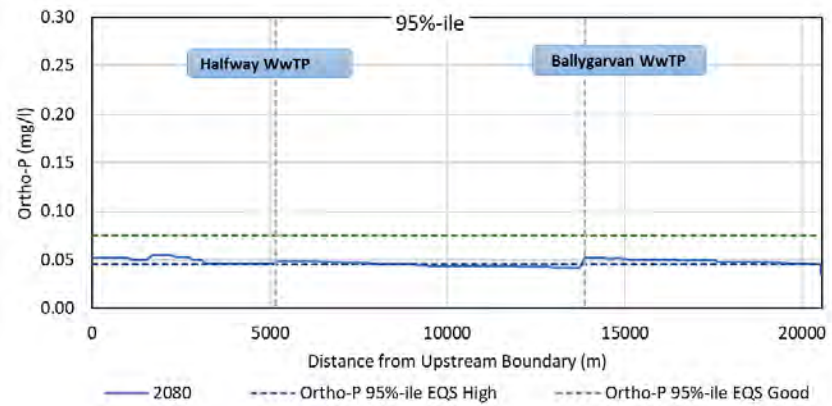


Figure 3-66 MRP Results for 2080 Scenario – Owenboy



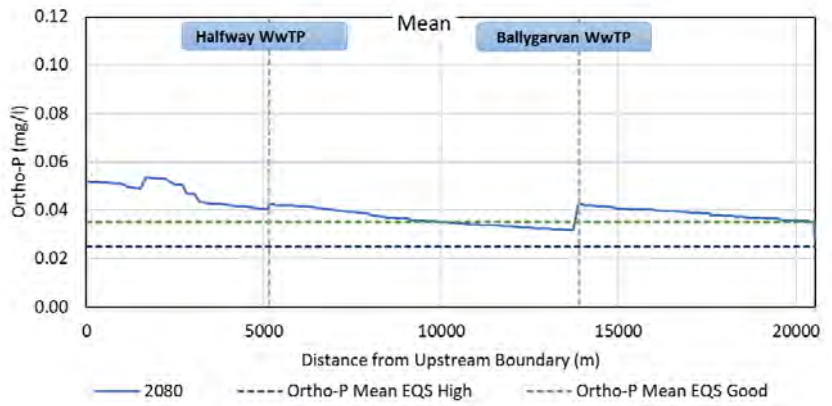
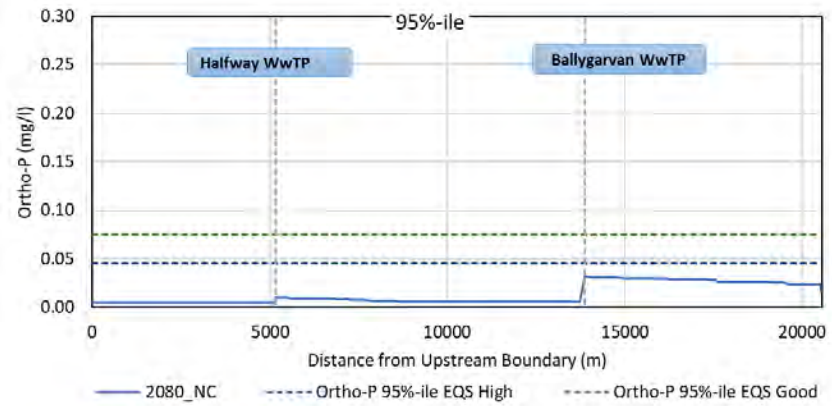
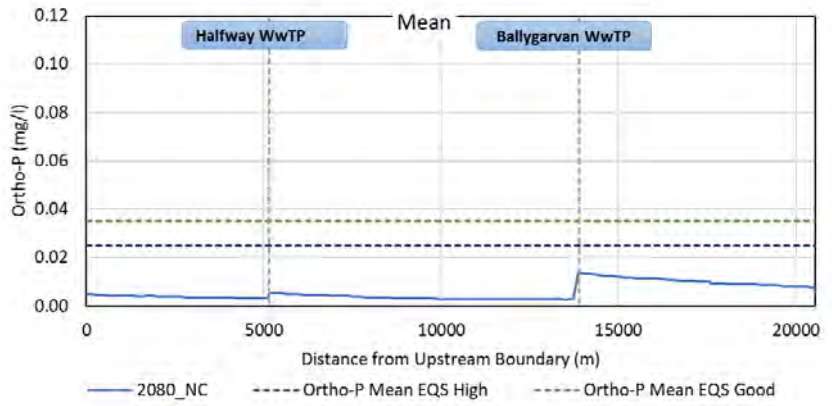


Figure 3-67 MRP Results for 2080 NC scenario – Owenboy





3.3.3 Owencurra River

The river flows included in the model are derived from the calibrated hydrology model driven by the stochastic rainfall data for 2030, 2055 and 2080, and the WwTP flows for these three horizons are given in Table 3-17.

Table 3-18, Table 3-19 and Table 3-20 provides the maximum allowable ELVs calculated from the initial model runs, for 2030, 2055 and 2080 horizons.

Table 3-17 Flow Inputs Applied in the River Owencurra Modelling Scenarios

Receiving Watercourse	WwTPS	Flows		
		2030	2055	2080
Owencurra River	Ballincurrig	0.0018	0.0022	0.0025
	Lisgoold North	0.0009	0.0011	0.0012
	Lisgoold South	0.0009	0.0011	0.0012
Dungourney River	Dungourney	0.0012	0.0014	0.0015

Table 3-18 Final ELVs Determined for WwTPs in the Owencurra Model for BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Ballincurrig	Yes	High	No	125	32.4	26.7	23.9
Lisgoold North	Yes	High	No	5	5	5	5
Lisgoold South	Yes	High	No	200	123.2	101.1	90.1
Dungourney	No	High	No	145	64.6	55.0	48.7

Table 3-19 Final ELVs Determined for WwTPs in the Owencurra Model for Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Ballincurrig	Yes	High	No	20	1.39	1.15	1.02
Lisgoold North	Yes	High	No	5	5	4.62	4.10
Lisgoold South	Yes	High	No	30	3.91	3.20	2.86
Dungourney	No	High	No	20	1.63	1.39	1.23

Table 3-20 Final ELVs Determined for WwTPs in the Owencurra Model for

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Ballincurrig	Yes	High	Yes	5	0.70	0.58	0.51
Lisgoold North	Yes	High	Yes	0.5	0.5	0.5	0.5
Lisgoold South	Yes	High	Yes	3	2.77	2.32	1.98
Dungourney	No	Good	No	3	0.59	0.50	0.44

The results for the three assessed years—2030, 2055, and 2080—incorporating both future and NC scenario outputs for the River Owencurra, are presented in Figure 3-68 to Figure 3-85. These figures show conditions along a 14,000 m river reach extending from the upstream boundary and highlights the locations of the Ballincurrig WwTP, Lisgold North WwTP, and Lisgold South WwTP, situated at approximately 5,000 m, 4,000 m, and 8,000 m, respectively.

Similarly, Figure 3-86 to Figure 3-103 results present the results for the same set of scenarios—Current, 2055, and 2080—for the River Dungourney. These figures depict a 10,000 m river reach from the upstream boundary and identify the location of the Dungourney WwTP, situated approximately 390 m downstream from the upstream boundary.

Table 3-21 and Table 3-22 provides a summary of the model results, indicating water quality in the river when the WwTPs are operated with the maximum ELVs determined.

Table 3-21 Summary of Owencurra Results

Scenarios	Parameters
	BOD
2030 (Figure 3-68 and Figure 3-69)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-68). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold South WwTP shows a small increase in BOD concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.9 mg/l and is 41% of in-band WAC. Similarly mean concentration is 0.79 mg/l and is 61% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.74 mg/l and is 34% of in-band WAC. Similarly mean concentration is 0.73 mg/l and is 56% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 0.95 mg/l and is 43% of in-band WAC. Similarly mean concentration is 0.83 mg/l and is 64% of in-band WAC.
2055 (Figure 3-74 and Figure 3-75)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-74). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold

Scenarios	Parameters
	South WwTP shows a small increase in BOD concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.99 mg/l and is 45% of in-band WAC. Similarly mean concentration is 0.83 mg/l and is 64% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.76 mg/l and is 35% of in-band WAC. Similarly mean concentration is 0.75 mg/l and is 58% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 1.13 mg/l and is 51% of in-band WAC. Similarly mean concentration is 0.91 mg/l and is 70% of in-band WAC.
2080 Figure 3-80 and Figure 3-81)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-80). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold South WwTP shows a small increase in BOD concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.99 mg/l and is 45% of in-band WAC. Similarly mean concentration is 0.83 mg/l and is 64% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.76 mg/l and is 35% of in-band WAC. Similarly mean concentration is 0.75 mg/l and is 58% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 1.13 mg/l and is 51% of in-band WAC. Similarly mean concentration is 0.91 mg/l and is 70% of in-band WAC.
	Ammonia
2030 (Figure 3-70 and Figure 3-71)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-70). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold South WwTP shows a small increase in ammonia concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.024 mg/l and is 27% of in-band WAC. Similarly mean concentration is 0.018 mg/l and is 45% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.025 mg/l and is 28% of in-band WAC. Similarly mean concentration is 0.019 mg/l and is 48% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 0.032 mg/l and is 36% of in-band WAC. Similarly mean concentration is 0.022 mg/l and is 55% of in-band WAC.

Scenarios	Parameters
2055 (Figure 3-76 and Figure 3-77)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-76). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold South WwTP shows a small increase in ammonia concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.028 mg/l and is 31% of in-band WAC. Similarly mean concentration is 0.019 mg/l and is 48% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.035 mg/l and is 39% of in-band WAC. Similarly mean concentration is 0.023 mg/l and is 58% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 0.046 mg/l and is 51% of in-band WAC. Similarly mean concentration is 0.028 mg/l and is 70% of in-band WAC.
2080 (Figure 3-82 and Figure 3-83)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs are determined based on current river condition (non-NC) condition (Figure 3-82). The 95th percentile and mean concentration for Ballincurrig WwTP and Lisgold South WwTP shows a small increase in ammonia concentration downstream of both WwTPs in the discharging waterbody. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration. At downstream of Ballincurrig WwTP, the 95th percentile concentration is 0.028 mg/l and is 31% of in-band WAC. Similarly mean concentration is 0.019 mg/l and is 48% of in-band WAC. At downstream of Lisgold North WwTP, the 95th percentile concentration is 0.035 mg/l and is 39% of in-band WAC. Similarly mean concentration is 0.023 mg/l and is 58% of in-band WAC. At downstream of Lisgold South WwTP, the 95th percentile concentration is 0.046 mg/l and is 51% of in-band WAC. Similarly mean concentration is 0.028 mg/l and is 70% of in-band WAC.
	MRP
2030 (Figure 3-72 and Figure 3-73)	For MRP, NC condition (Figure 3-73) is applied to calculate ELVs, as the EQS for High status is already exceeded at the upstream of the river. For Ballincurrig WwTP, the 95th percentile MRP concentration rise to 0.014 mg/l and is 31% of in-band WAC. Similarly, mean concentration shows an increase to 0.008 mg/l and is 32% of in-band WAC. For Lisgold South WwTP, the 95th percentile MRP concentration rise to 0.015 mg/l and is 33% of in-band WAC. Similarly, mean concentration shows an increase in MRP concentration to 0.009 mg/l and is 36% of in-band WAC. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration, and downstream concentrations are much lower than the threshold concentration for High status.

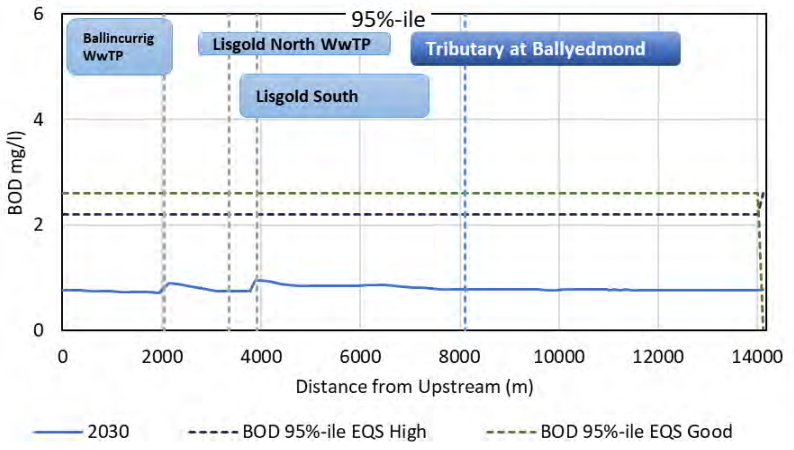
Scenarios	Parameters
2055 (Figure 3-78 and Figure 3-79)	For MRP, NC condition (Figure 3-79) is applied to calculate ELVs, as the EQS for High status is already exceeded at the upstream of the river. For Ballincollig WwTP, the 95th percentile MRP concentration rise to 0.016 mg/l and is within 36% of in-band WAC. Similarly, mean concentration shows an increase in MRP concentration to 0.009 mg/l and is 36% of in-band WAC. For Lisgold South WwTP, the 95th percentile MRP concentration rise to 0.019 mg/l and is within 42% in-band WAC. Similarly, mean concentration shows an increase in concentration to 0.01 mg/l and is within 40% in-band WAC. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration, and downstream concentrations are much lower than the threshold concentration for High status.
2080 (Figure 3-84 and Figure 3-85)	For Ballincurrig WwTP, Lisgold South WwTP and Lisgold North WwTP, NC condition (Figure 3-85) is applied to calculate ELVs for MRP, as the EQS for High status is already exceeded at the upstream of the WwTPs. For Ballincollig WwTP, the 95th percentile concentration rise to 0.02 mg/l and is within 34% in-band WAC. Similarly, mean concentration shows an increase in concentration to 0.01 mg/l and is within 34% in-band WAC. For Lisgold South WwTP, the 95th percentile concentration rise to 0.021 mg/l and is within 47% in-band WAC. Similarly, mean concentration shows an increase in concentration to 0.011 mg/l and is within 44% in-band WAC. Lisgold North WwTP has no impact on the water quality for both 95th percentile and mean concentration, and downstream concentrations are much lower than the threshold concentration for High status.

Table 3-22 Summary of Dungourney Results

Scenarios	Parameters
	BOD
2030 (Figure 3-86 and Figure 3-87)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-86). The 95th percentile BOD concentration increases to 1.03 mg/l and is within 47% in-band WAC. The mean concentration increases to 0.94 mg/l and is within 72% in-band WAC.
2055 (Figure 3-92 and Figure 3-93)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-92). The 95th percentile BOD concentration increases to 1.36 mg/l and is within 62% in-band WAC. The mean BOD concentration shows increase to 1.08 mg/l and is within 83% in-band WAC.
2080 (Figure 3-98 and Figure 3-99)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-98). The 95th percentile BOD concentration increases to 1.37 mg/l and is within 62% in-band WAC. The mean BOD concentration shows increase to 1.08 mg/l and is within 83% in-band WAC.

Scenarios	Parameters
	Ammonia
2030 (Figure 3-88 and Figure 3-89)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-88). The 95th percentile ammonia concentration increases slightly to 0.033 mg/l and is 37% of in-band WAC. The mean ammonia concentration shows increase slightly to 0.031 mg/l and is 78% of in-band WAC.
2055 (Figure 3-94 and Figure 3-95)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-94). The 95th percentile ammonia concentration increases to 0.041 mg/l and is within 46% in-band WAC. The mean ammonia concentration shows increase to 0.034 mg/l and is within 85% in-band WAC.
2080 (Figure 3-100 and Figure 3-101)	The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-100). The 95th percentile ammonia concentration increases to 0.042 mg/l and is within 47% in-band WAC. The mean ammonia concentration shows increase to 0.034 mg/l and is within 85% in-band WAC.
	MRP
2030 (Figure 3-90 and Figure 3-91)	The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-90). The 95th percentile MRP concentration increases to 0.033 mg/l and is below the threshold of High status. The mean MRP concentration shows increase to 0.031 mg/l and is 70% of in-band WAC.
2055 (Figure 3-96 and Figure 3-97)	The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-96) The 95th percentile concentration increases to 0.035 mg/l and is below the threshold of High status. The mean MRP concentration shows increase to 0.033 mg/l and is 80% of in-band WAC.
2080 (Figure 3-102 and Figure 3-103)	The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-102). The 95th percentile MRP concentration increases to 0.035 mg/l and is below the threshold of High status. The mean MRP concentration shows increase to 0.031 mg/l and is 80% of in-band WAC.

Figure 3-68 BOD Results for 2030 Scenario – Owencurra



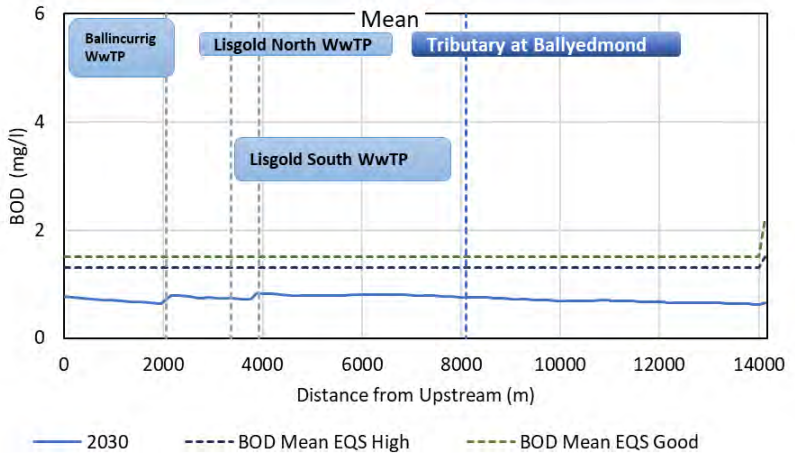
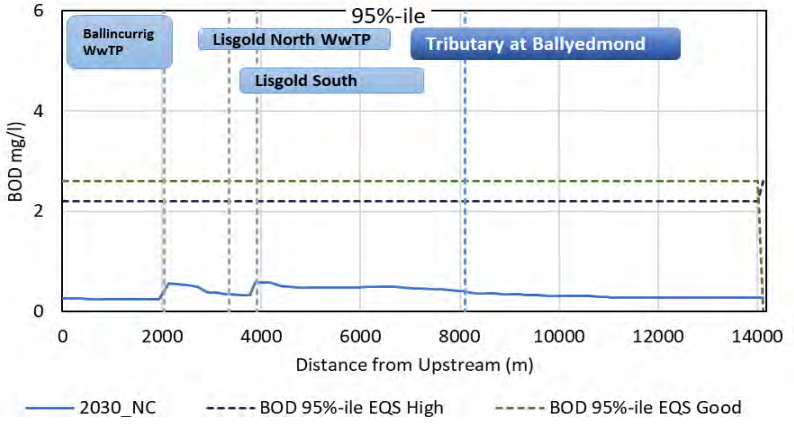


Figure 3-69 BOD Results for 2030 NC Scenario – Owencurra



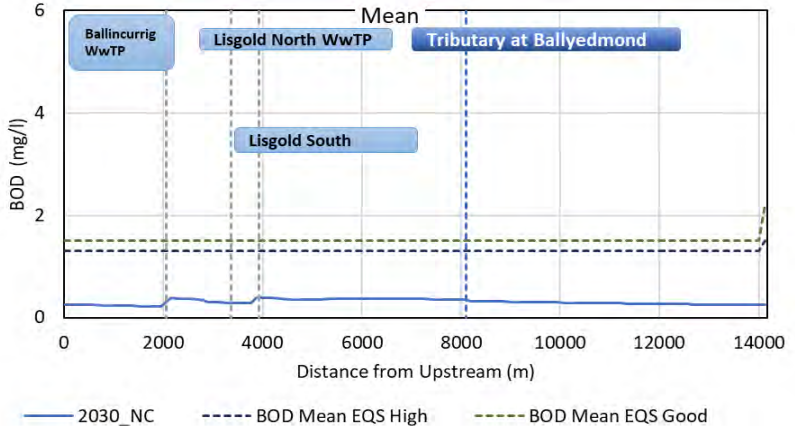
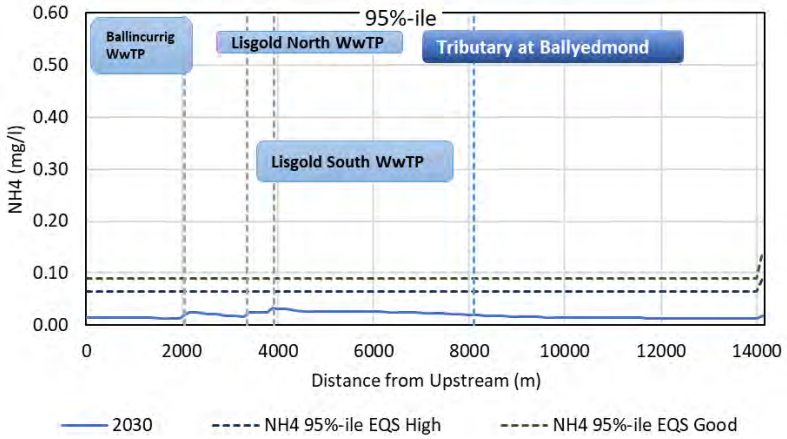


Figure 3-70 Ammonia Results for 2030 Scenario – Owencurra



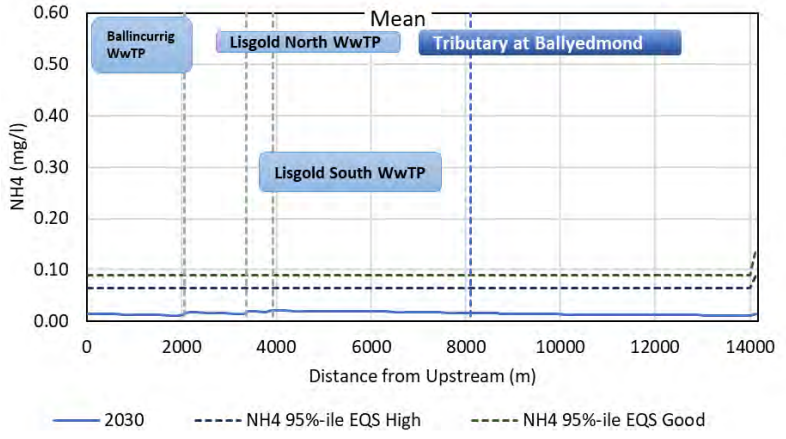
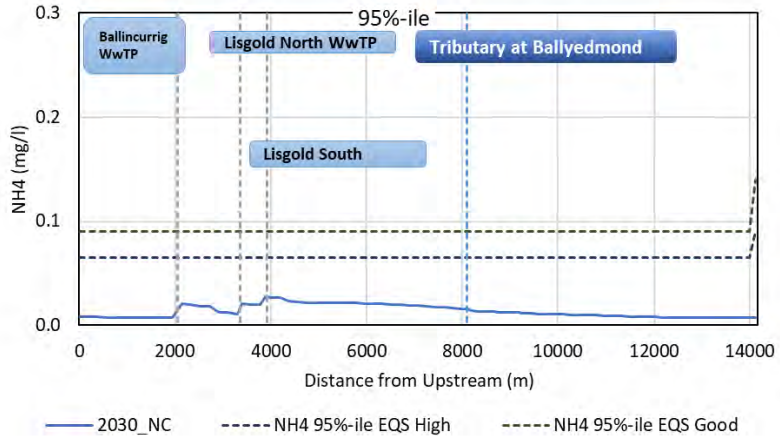


Figure 3-71 Ammonia Results for 2030 NC Scenario – Owencurra



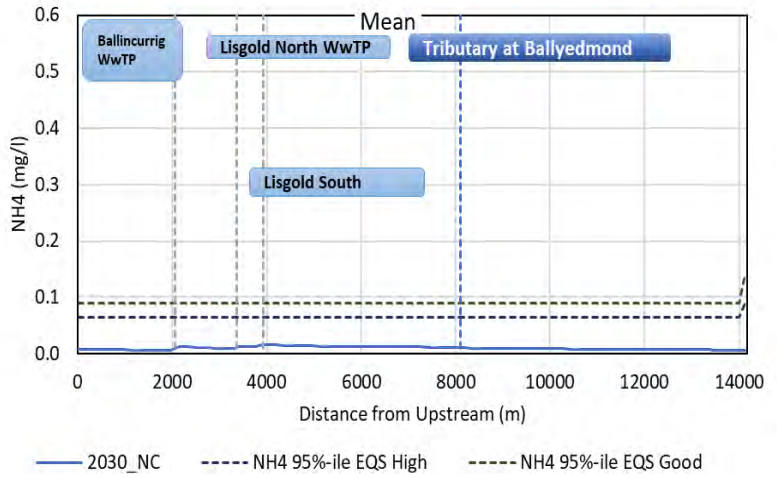
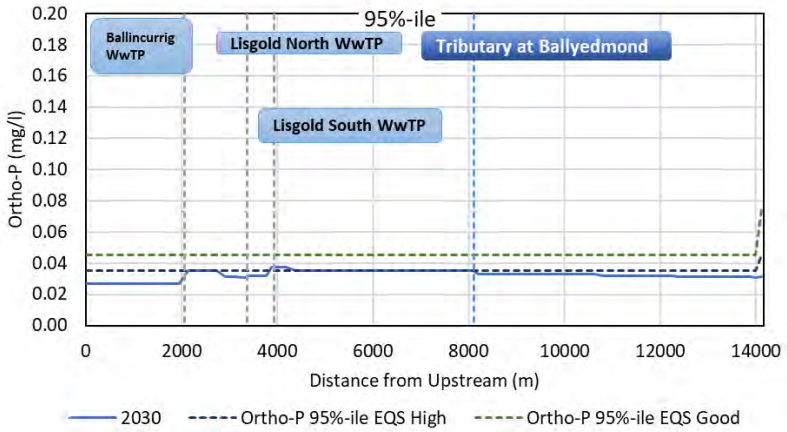


Figure 3-72 MRP Results for 2030 Scenario – Owencurra



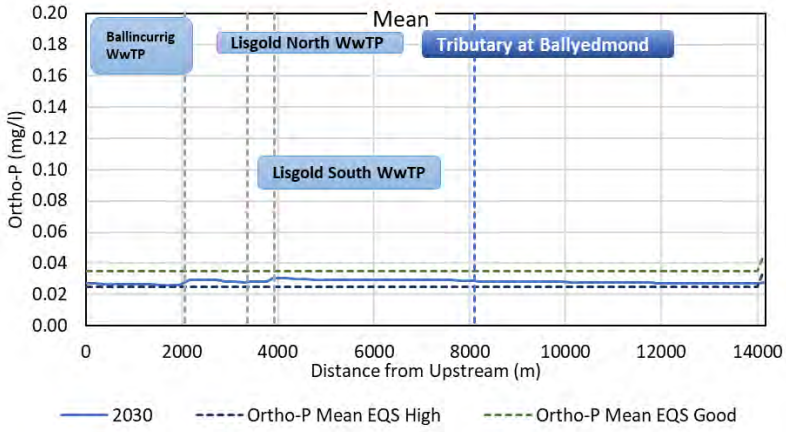
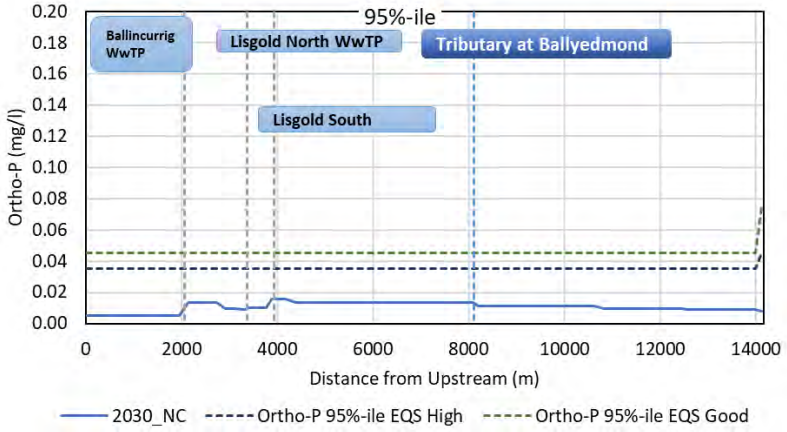


Figure 3-73 MRP Results 2030 for current NC Scenario – Owencurra



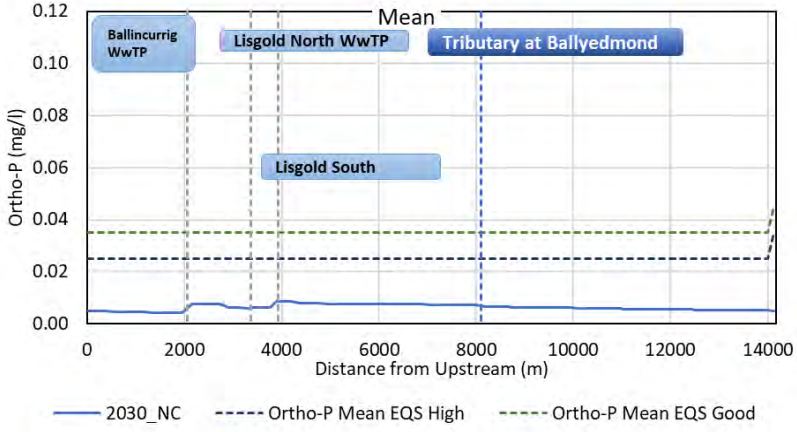
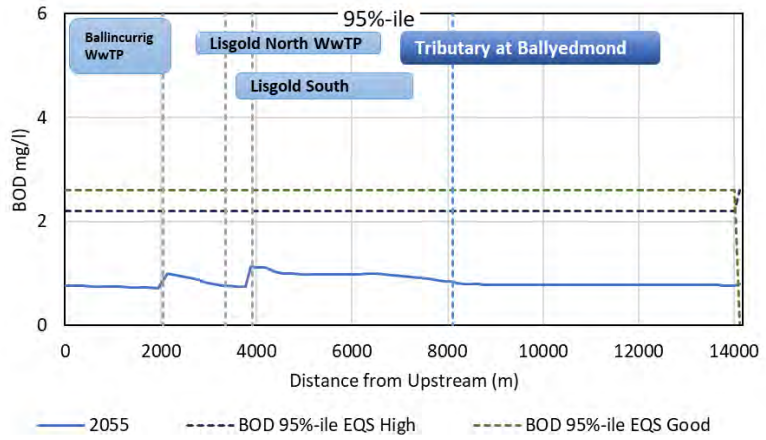


Figure 3-74 BOD Results for 2055 Scenario – Owencurra



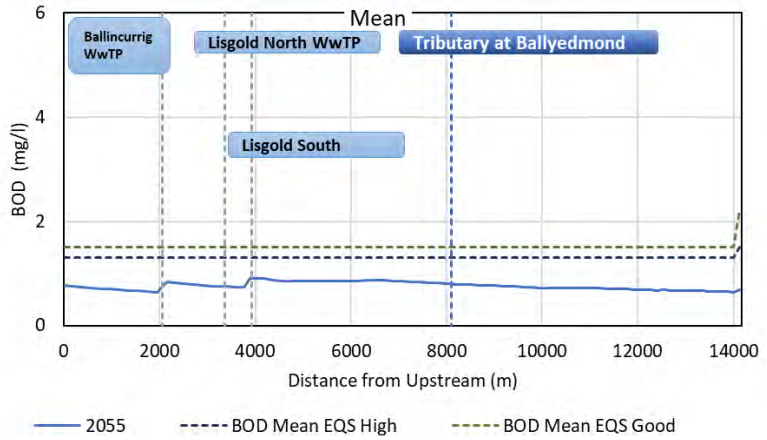
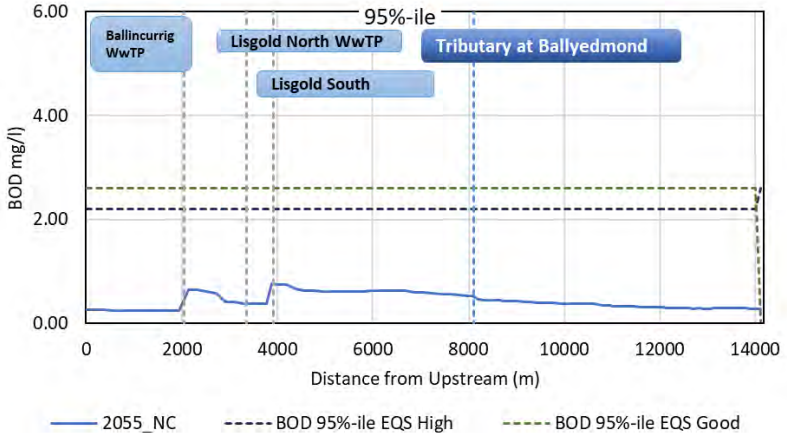


Figure 3-75 BOD Results for 2055 NC Scenario – Owencurra



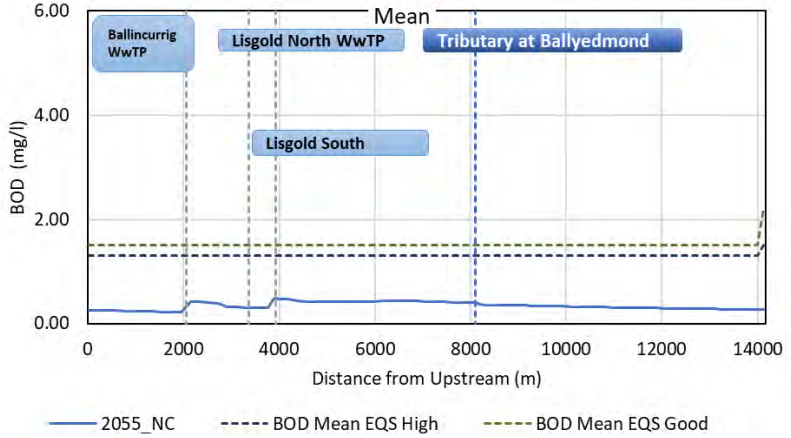
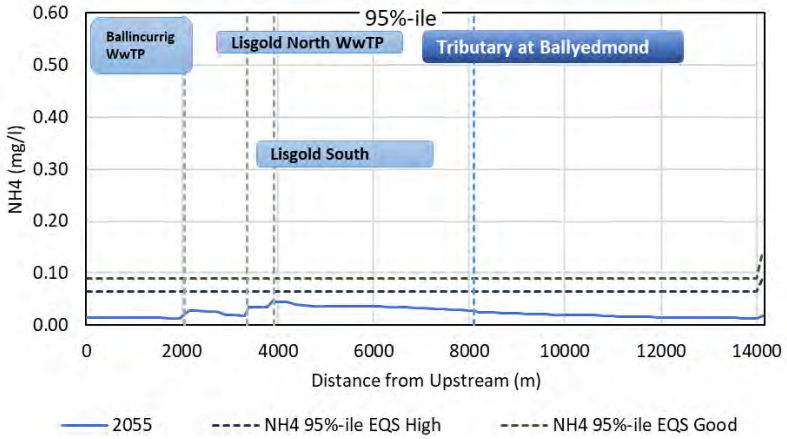


Figure 3-76 Ammonia Results for 2055 Scenario – Owencurra



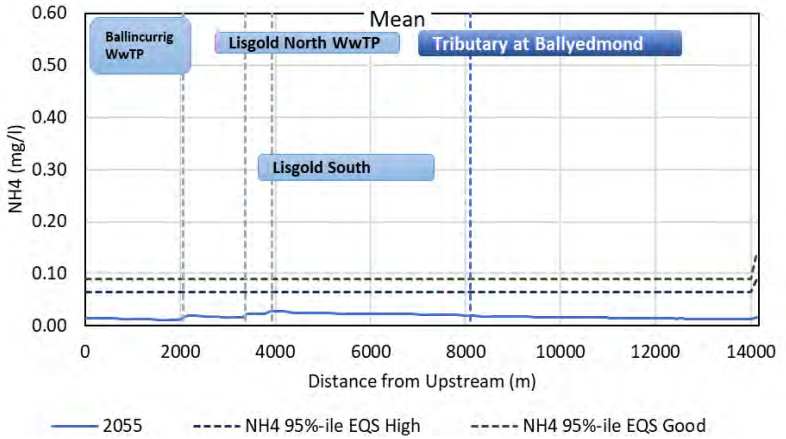
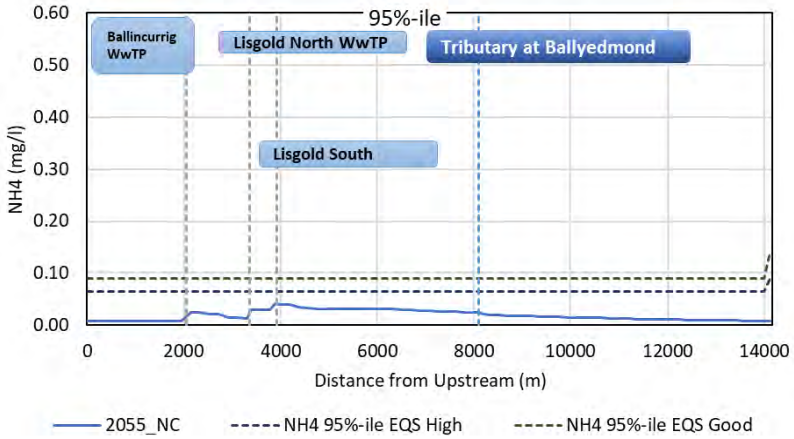


Figure 3-77 Ammonia Results for 2055 NC Scenario – Owencurra



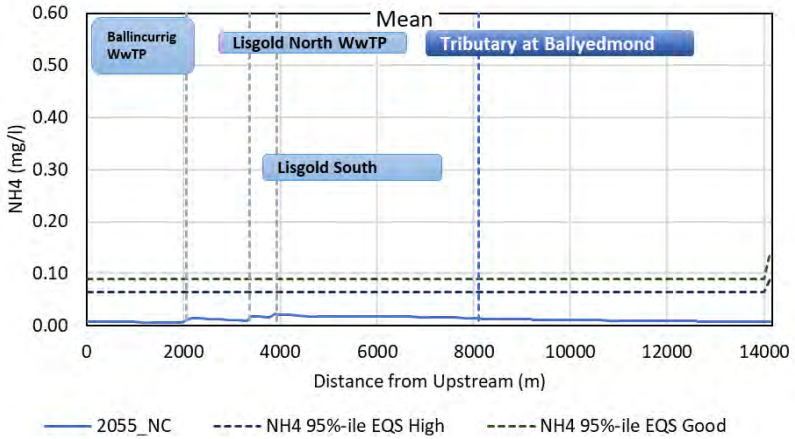
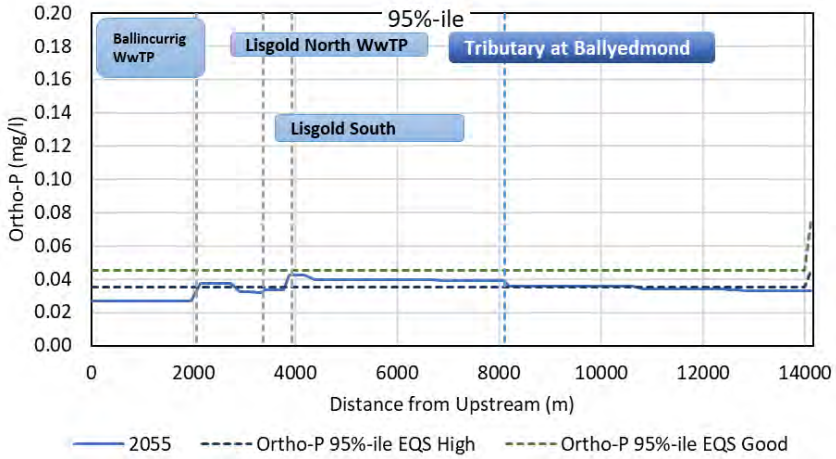


Figure 3-78 MRP Results for 2055 Scenario – Owencurra



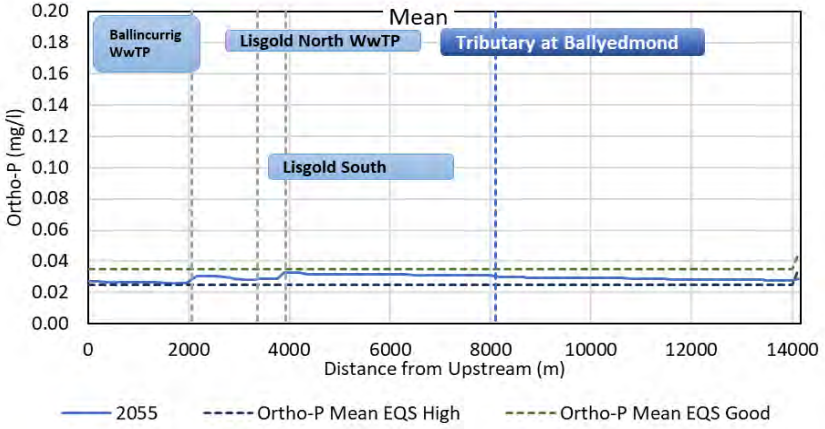
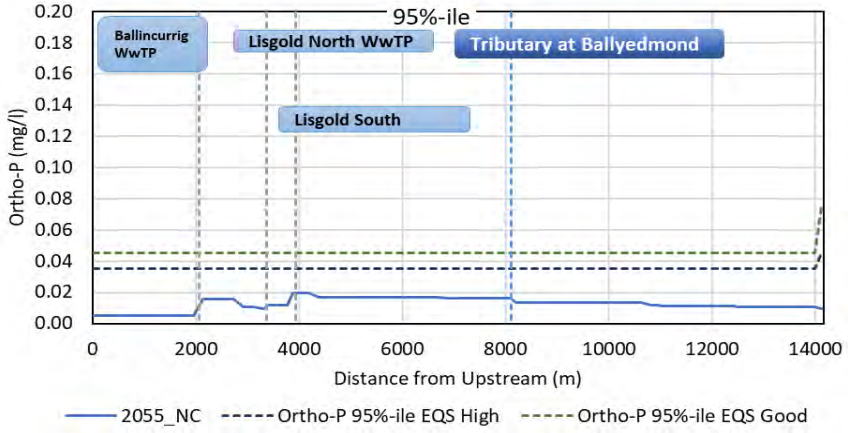


Figure 3-79 MRP Results for 2055 NC Scenario – Owencurra



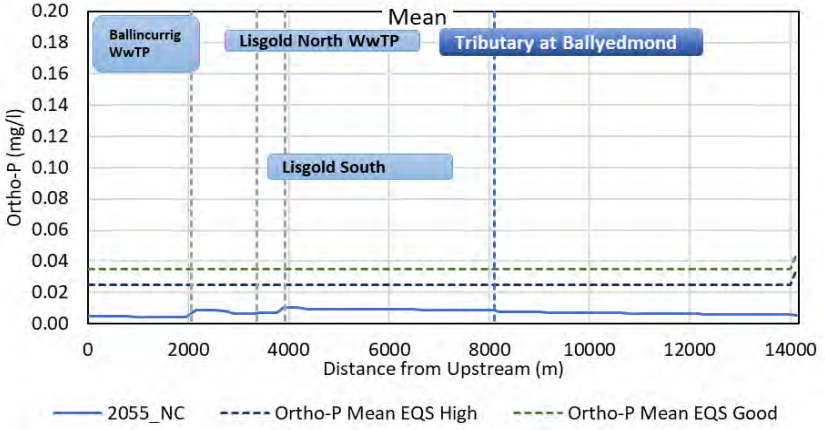
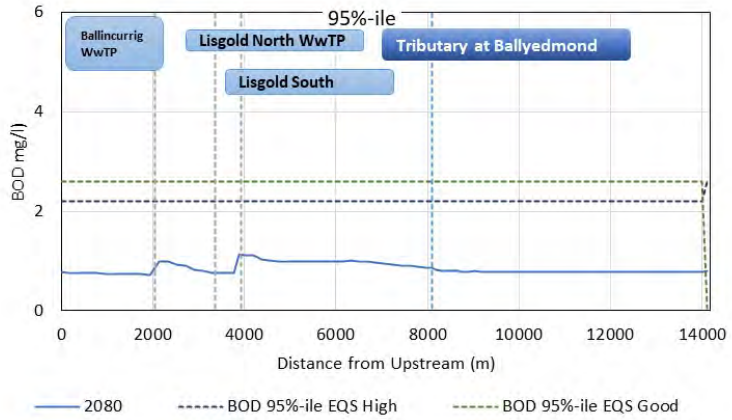


Figure 3-80 BOD Results for 2080 Scenario – Owencurra



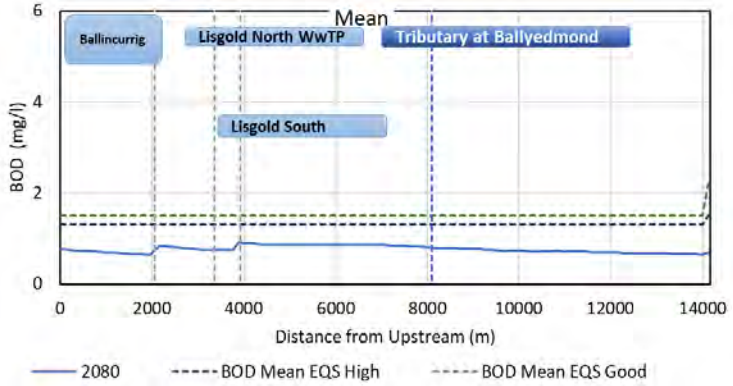
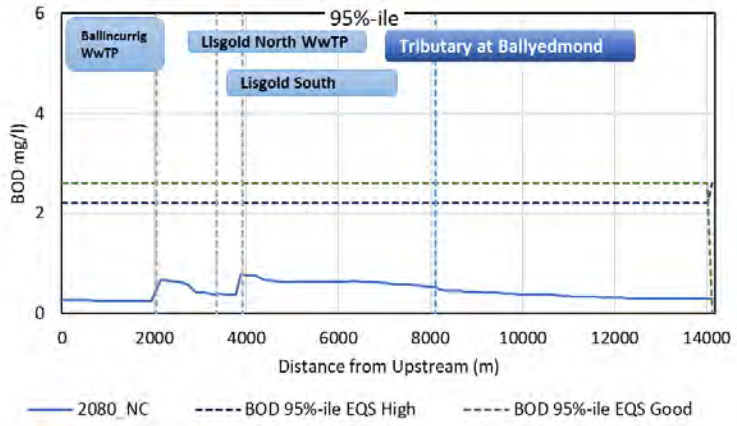


Figure 3-81 BOD Results for 2080 NC Scenario – Owencurra



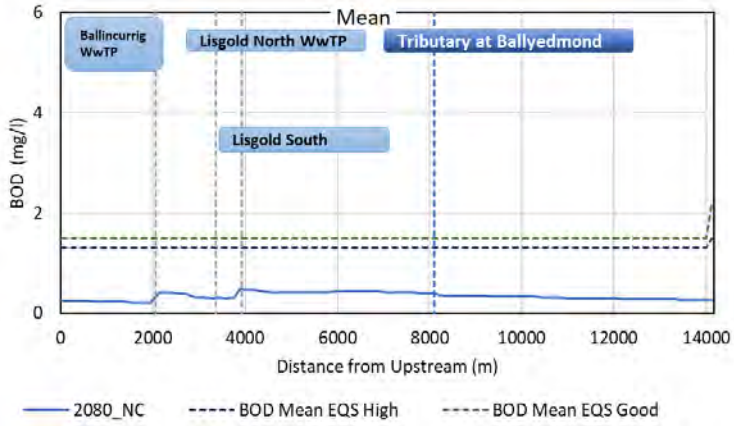
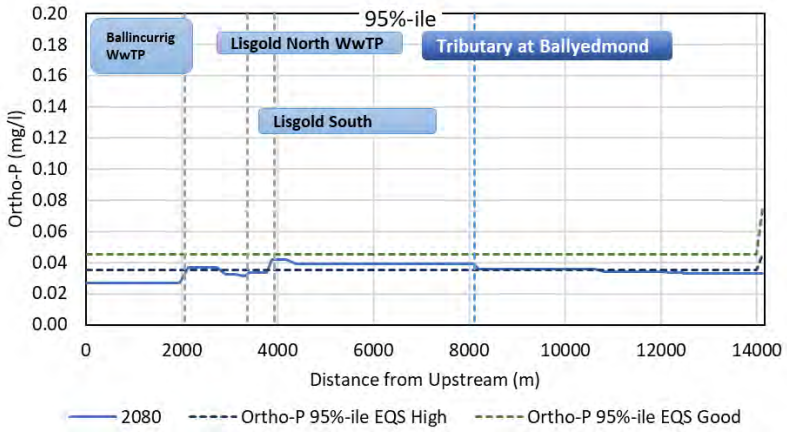


Figure 3-82 Ammonia Results for 2080 Scenario – Owencurra



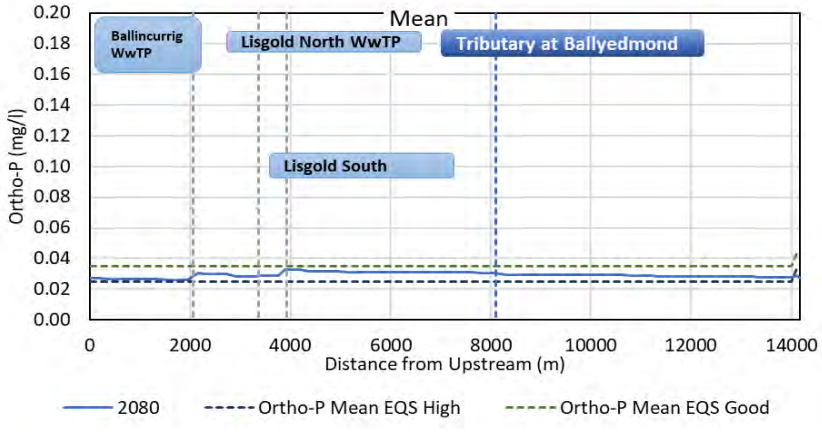
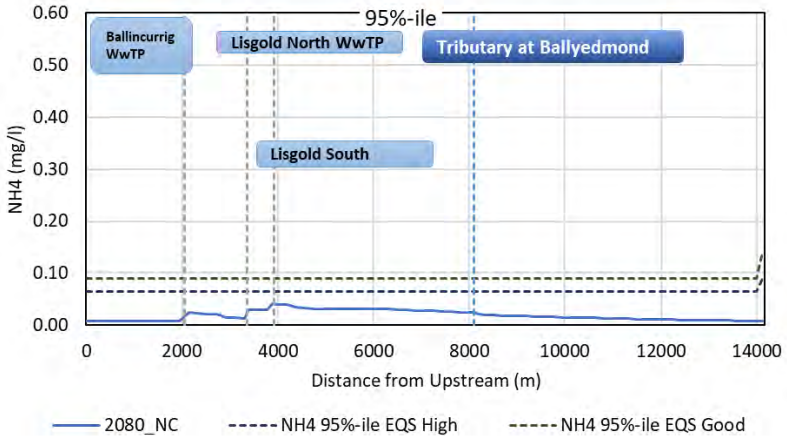


Figure 3-83 Ammonia Results for 2080 NC Scenario – Owencurra



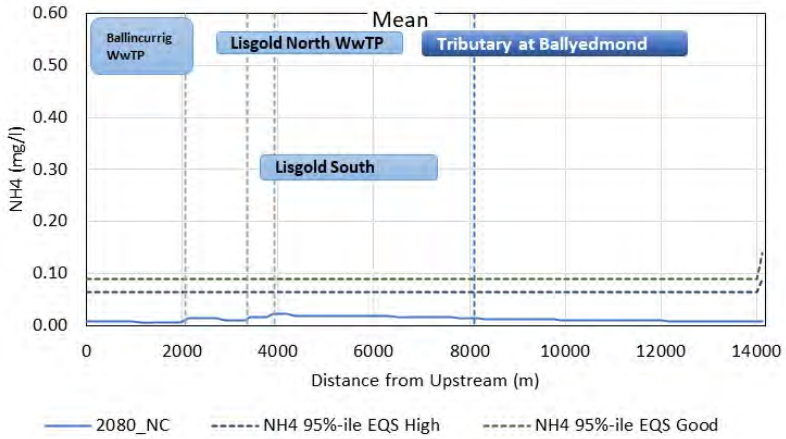
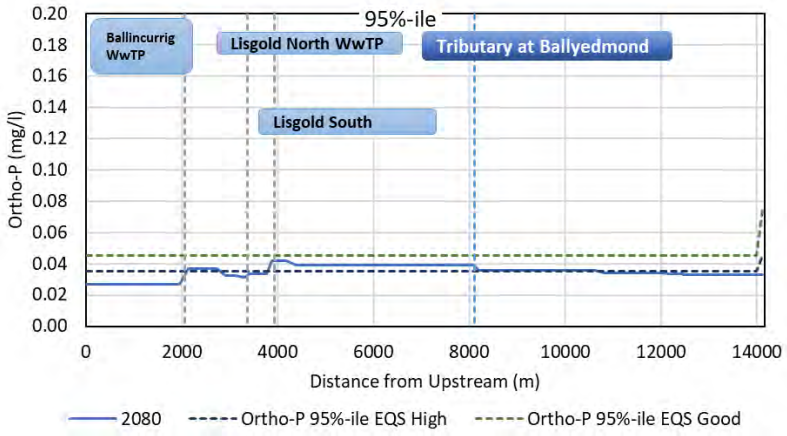


Figure 3-84 MRP Results for 2080 Scenario – Owencurra



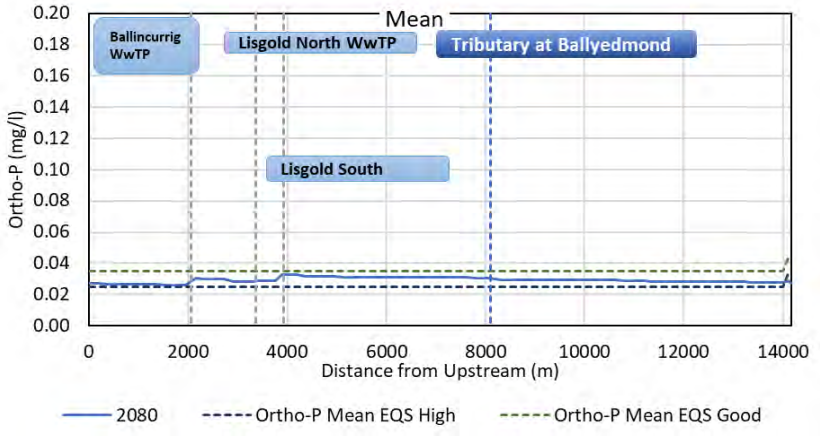
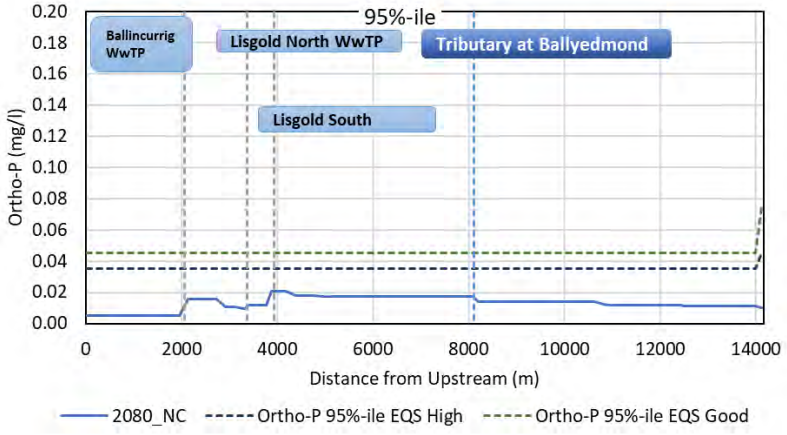


Figure 3-85 MRP Results for 2080 NC Scenario – Owencurra



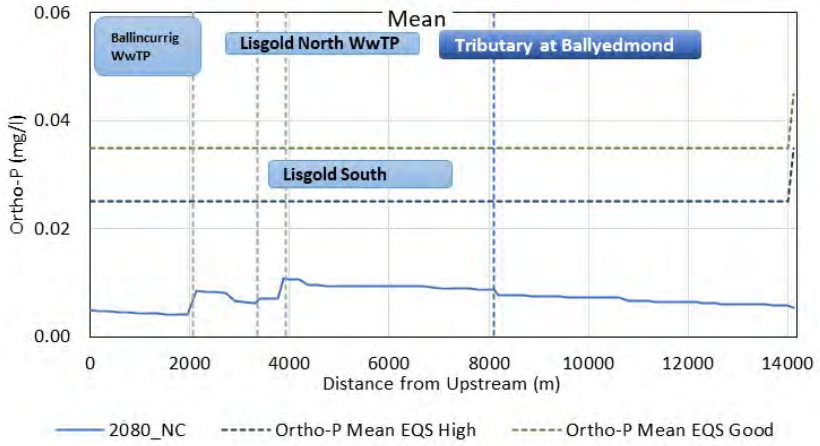
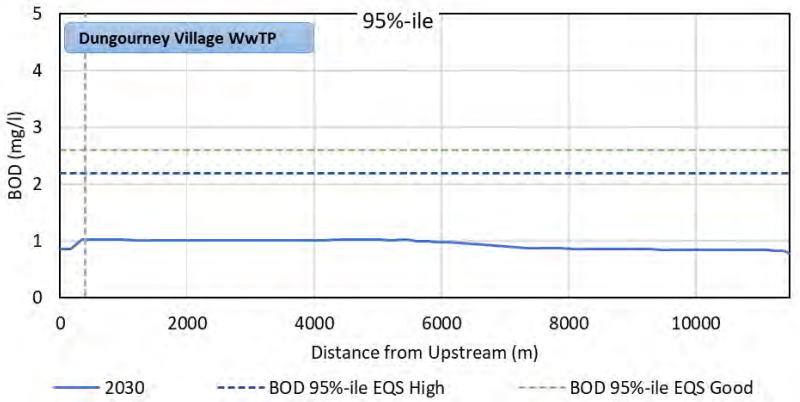


Figure 3-86 BOD Results for 2030 Scenario – Dungourney



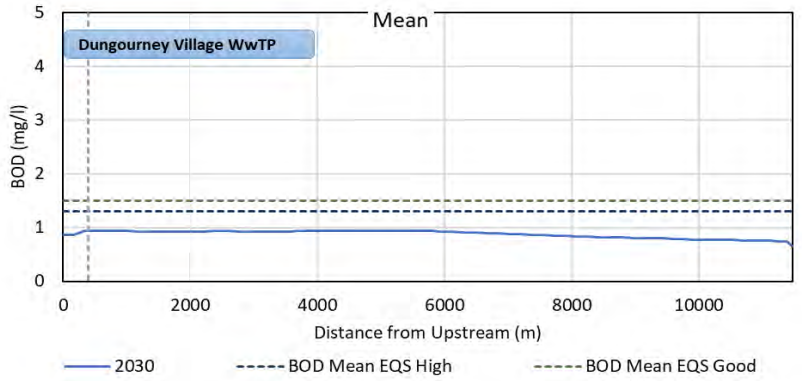
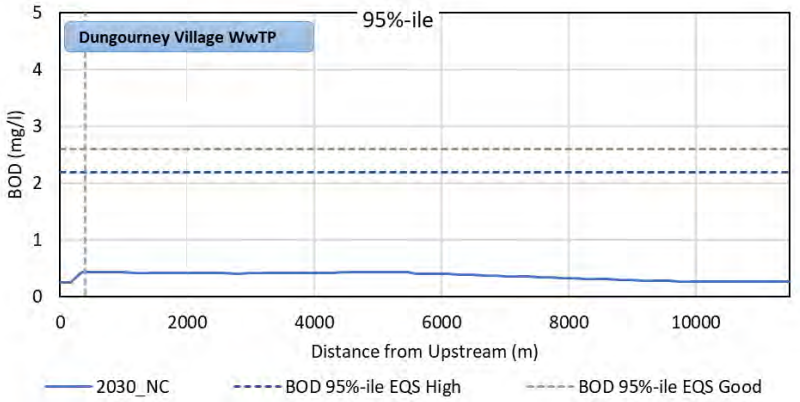


Figure 3-87 BOD Results for 2030 NC Scenario – Dungourney



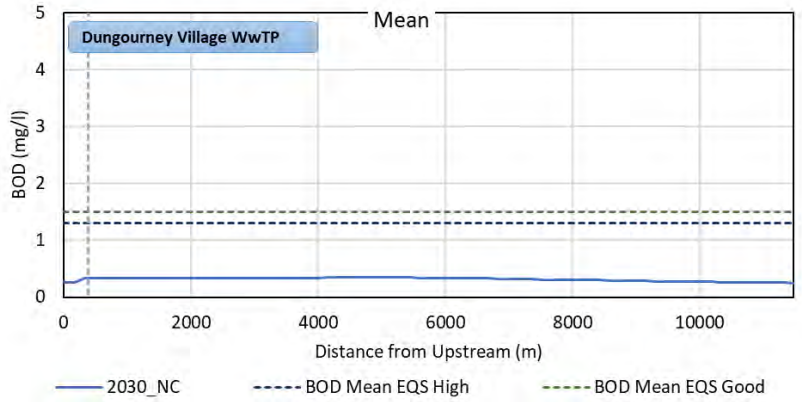
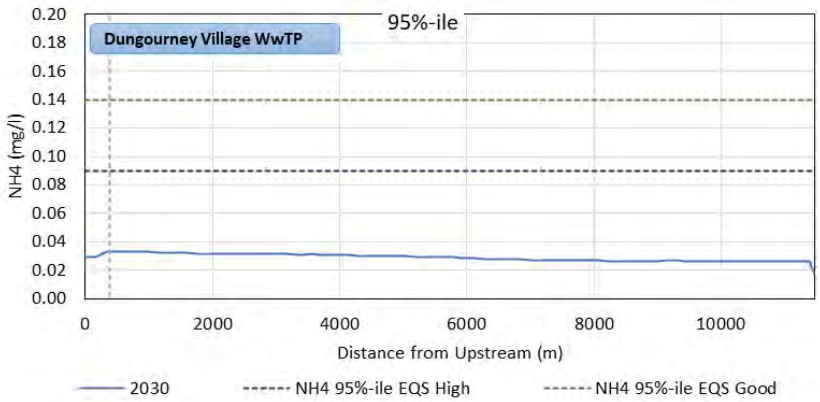


Figure 3-88 Ammonia Results for 2030 Scenario – Dungourney



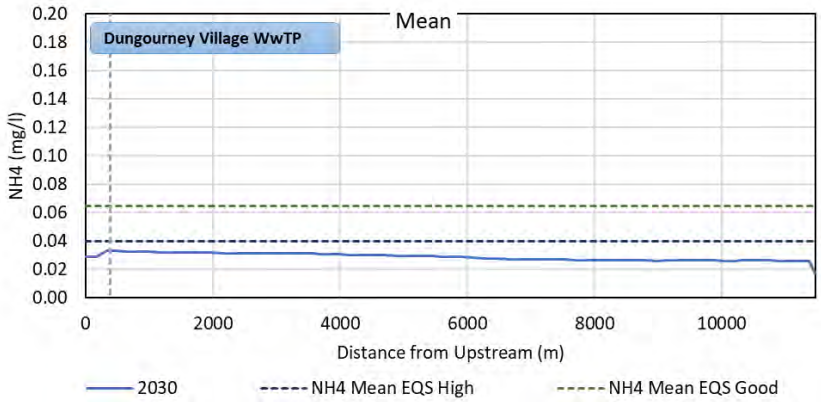
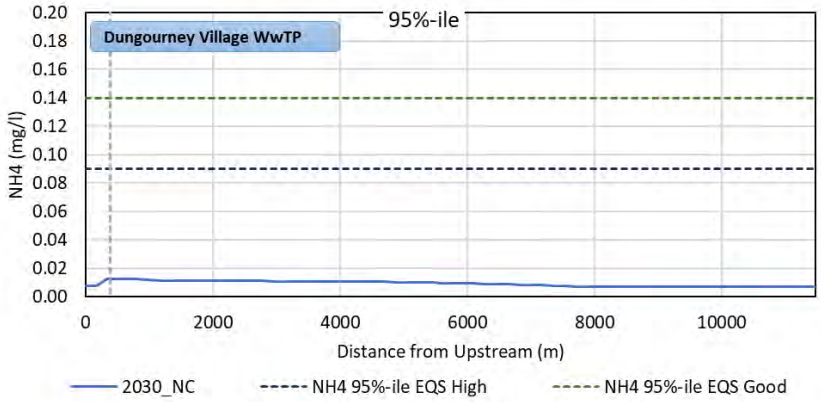


Figure 3-89 Ammonia Results for 2030 NC Scenario – Dungourney



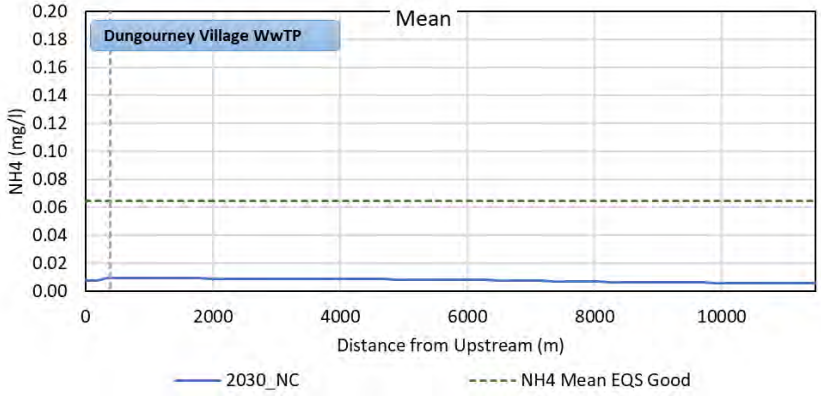
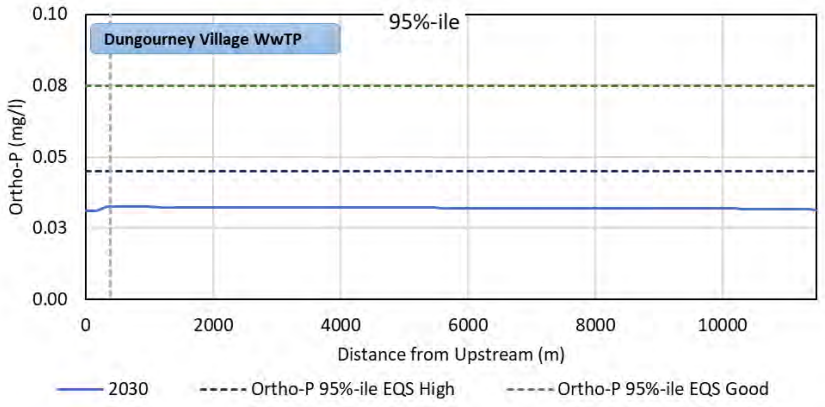


Figure 3-90 MRP Results for 2030 Scenario – Dungourney



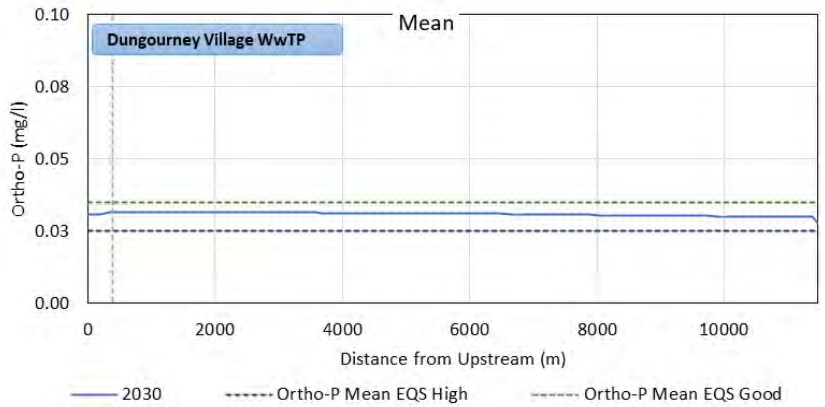
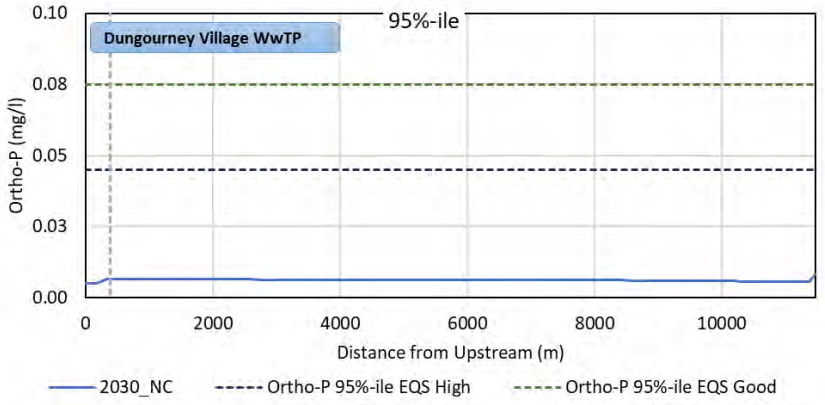


Figure 3-91 MRP Results for 2030 NC Scenario – Dungourney



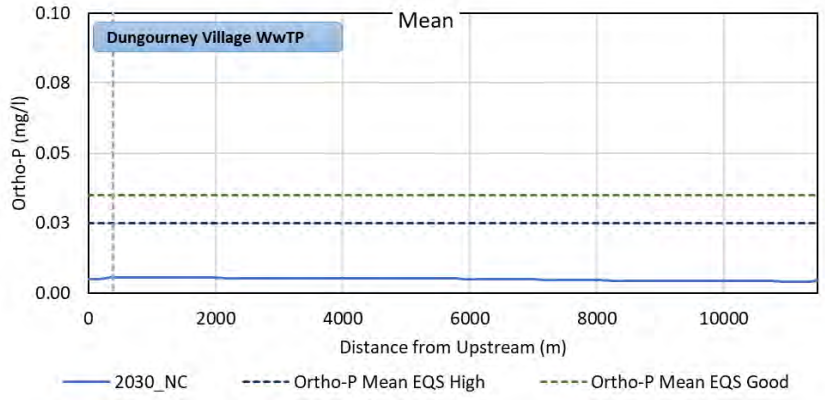
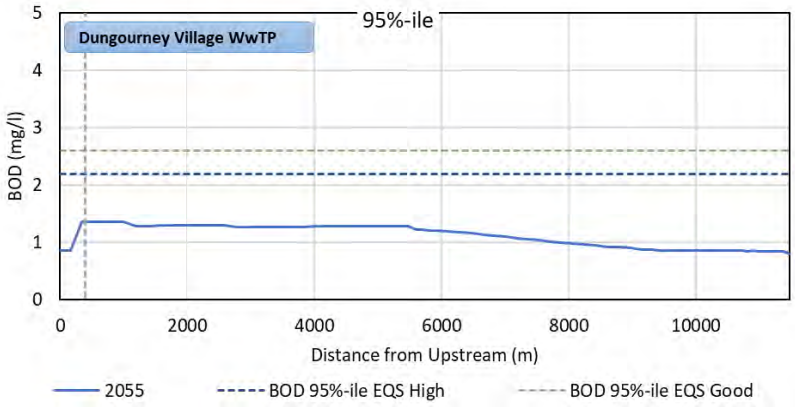


Figure 3-92 BOD Results for 2055 Scenario – Dungourney



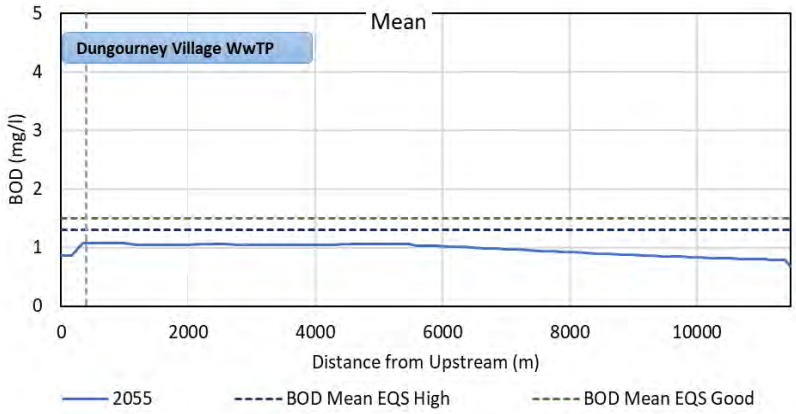
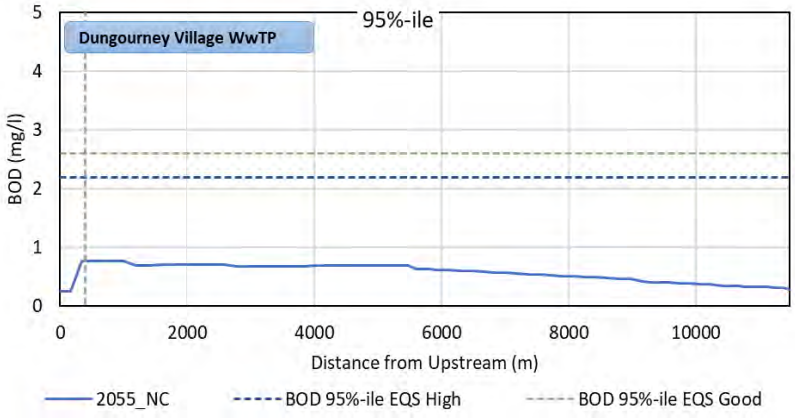


Figure 3-93 BOD Results for 2055 NC Scenario – Dungourney



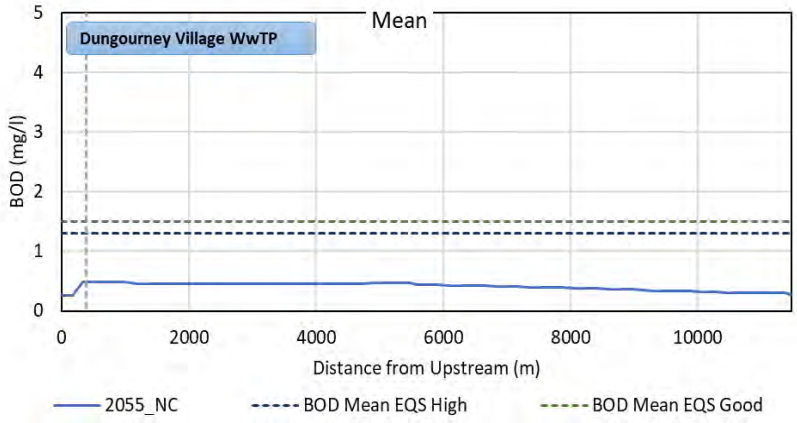
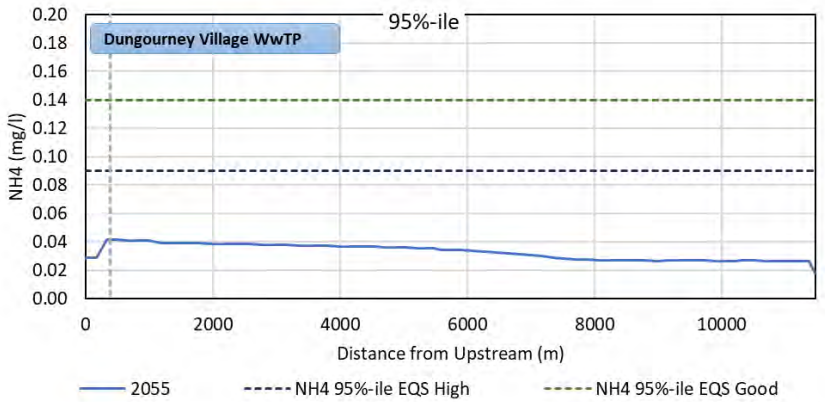


Figure 3-94 Ammonia Results for 2055 Scenario – Dungourney



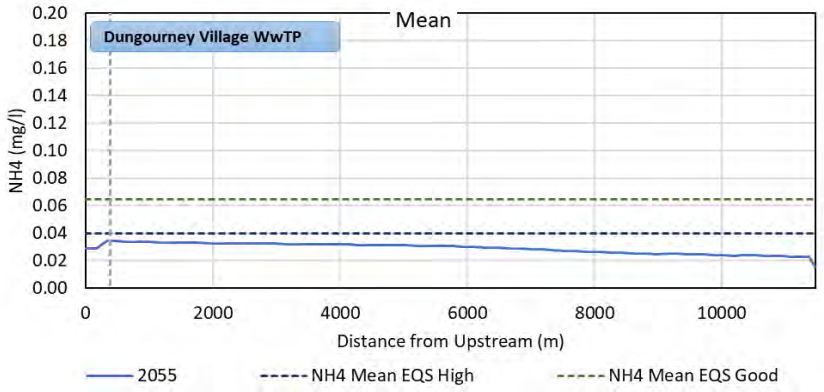
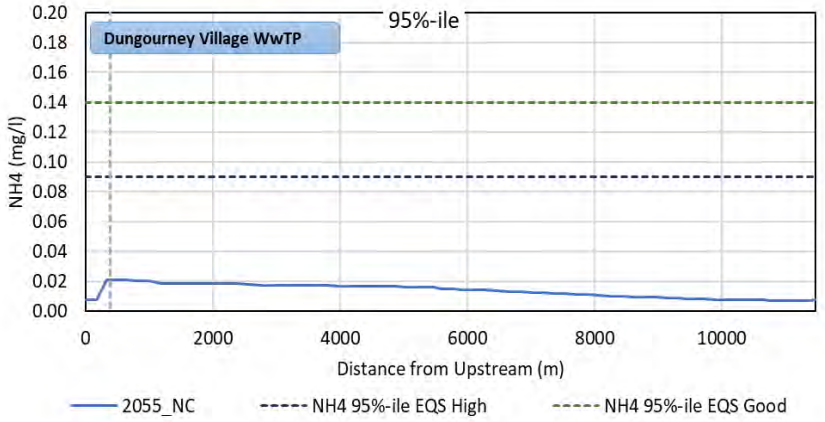


Figure 3-95 Ammonia Results for 2055 NC Scenario – Dungourney



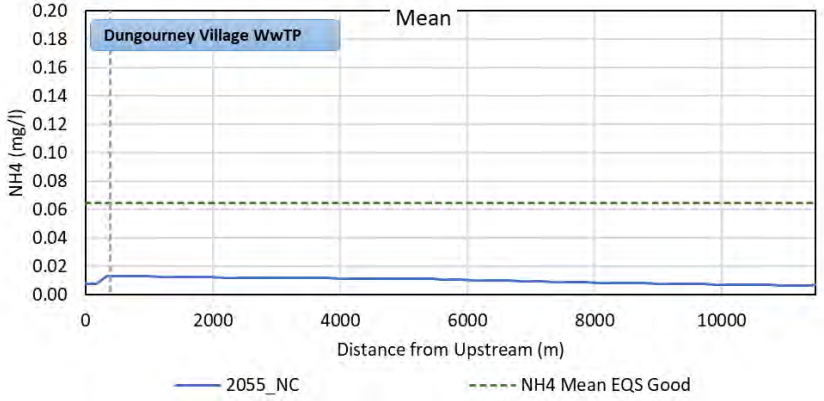
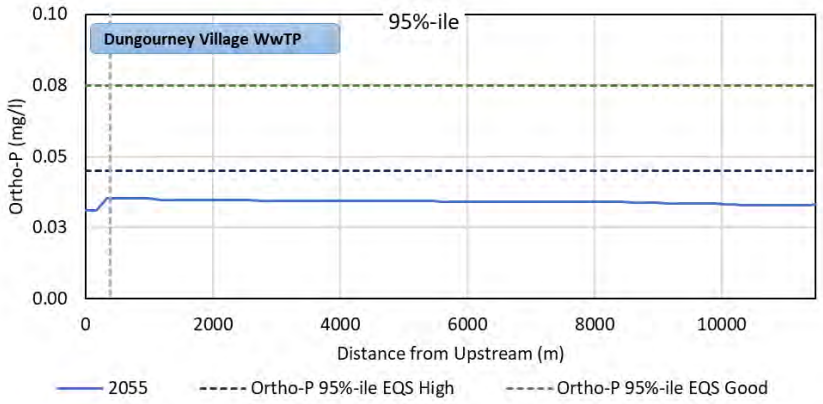


Figure 3-96 MRP Results for 2055 Scenario – Dungourney



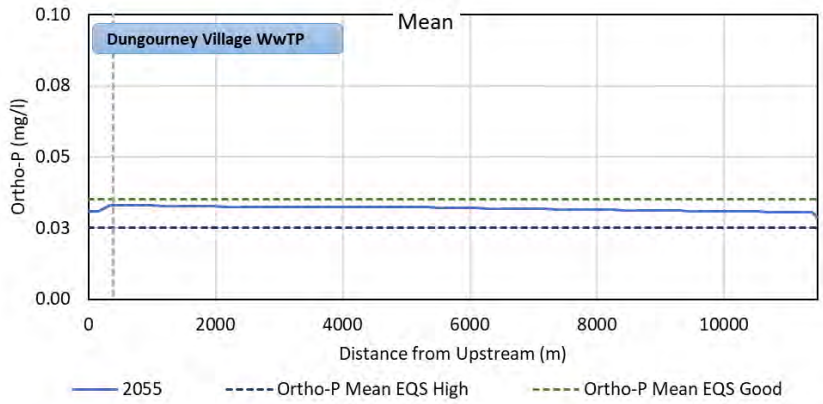
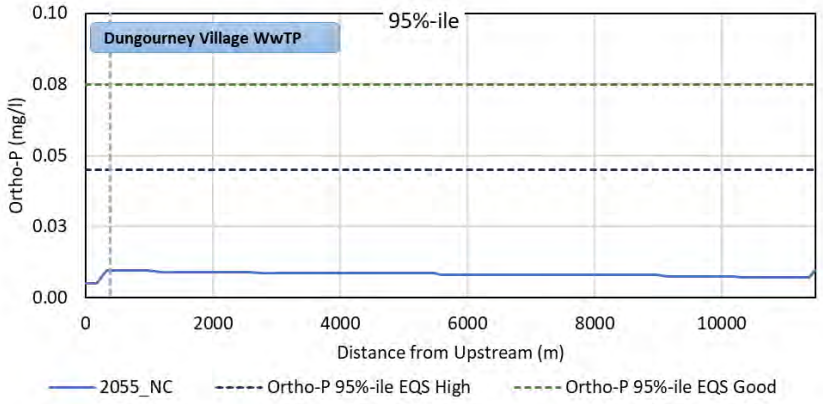


Figure 3-97 MRP Results for 2055 NC Scenario – Dungourney



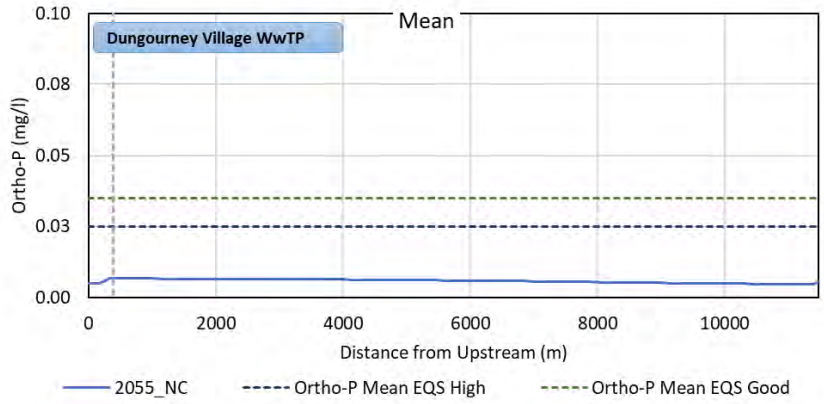
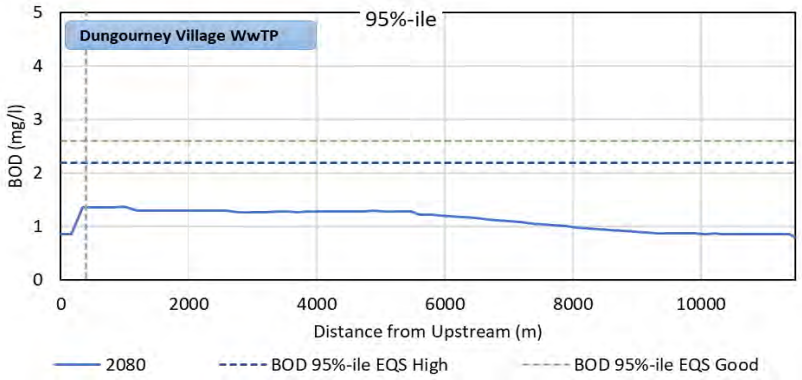


Figure 3-98 BOD Results for 2080 Scenario – Dungourney



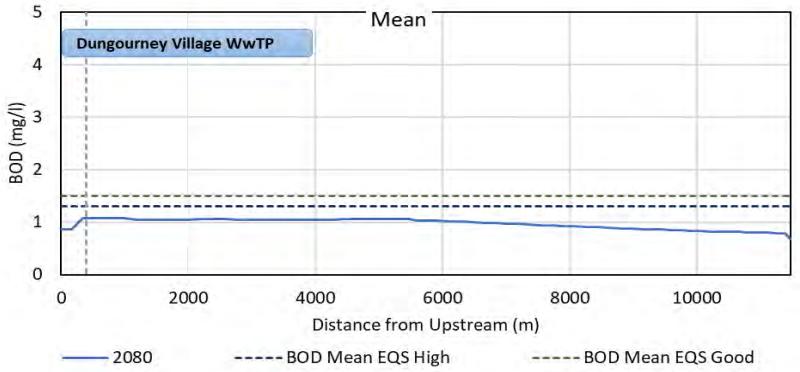
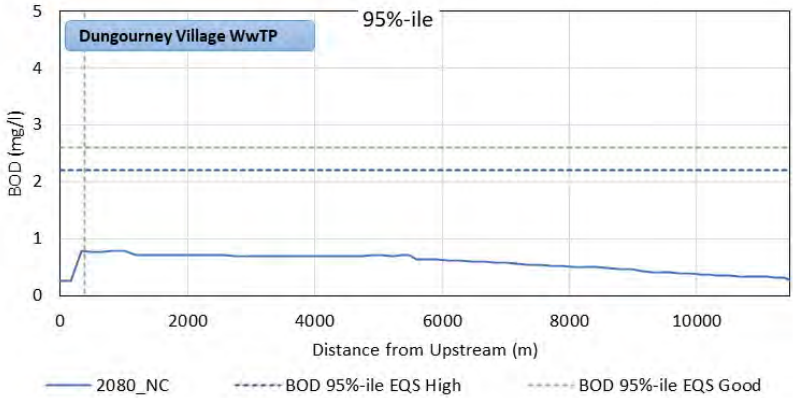


Figure 3-99 BOD Results for 2080 NC Scenario – Dungourney



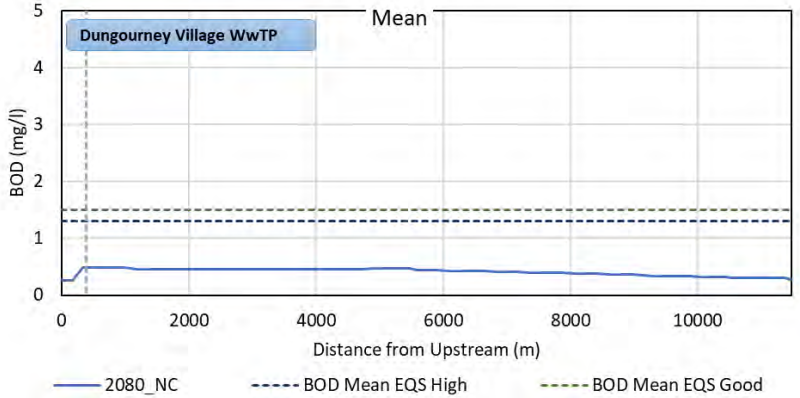
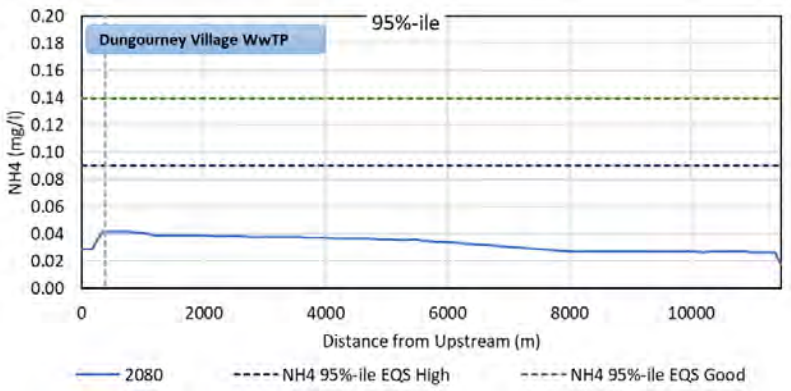


Figure 3-100 Ammonia Results for 2080 Scenario – Dungourney



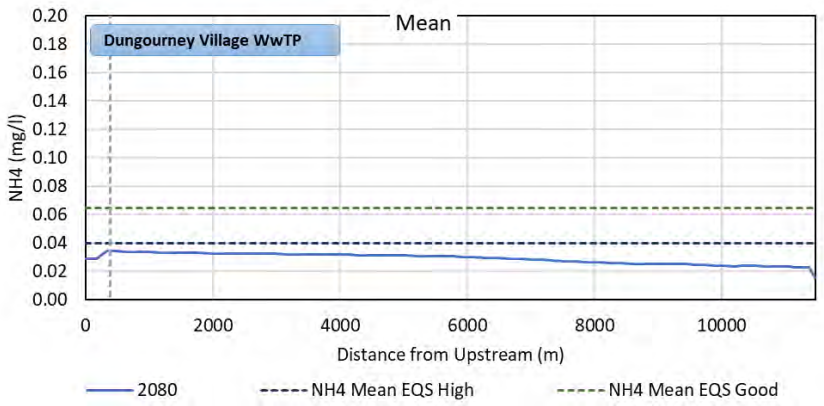
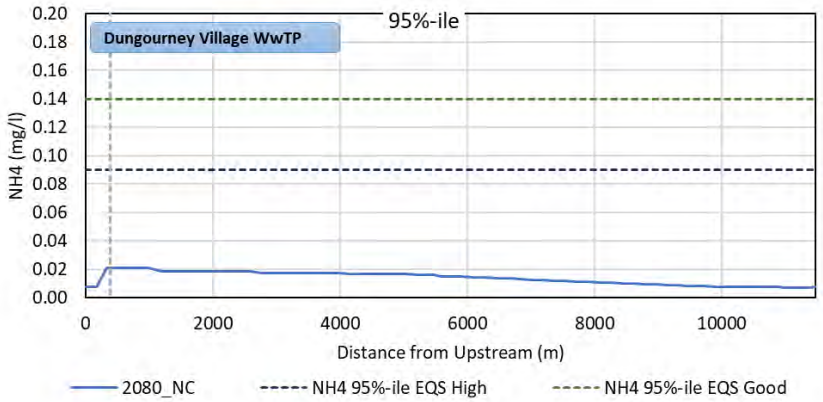


Figure 3-101 Ammonia Results for 2080 NC Scenario – Dungourney



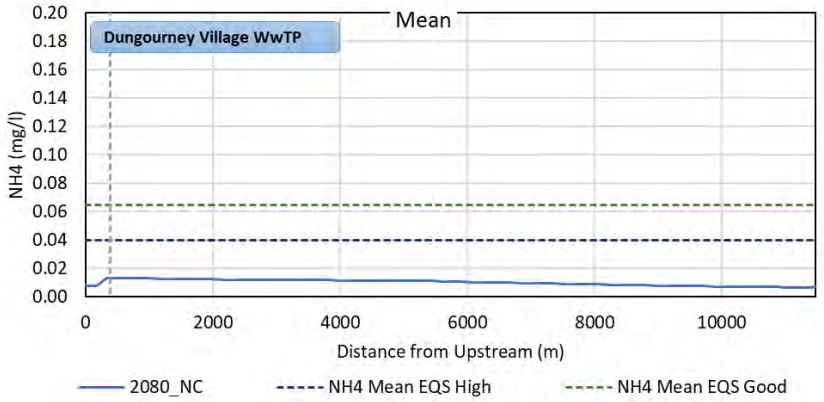
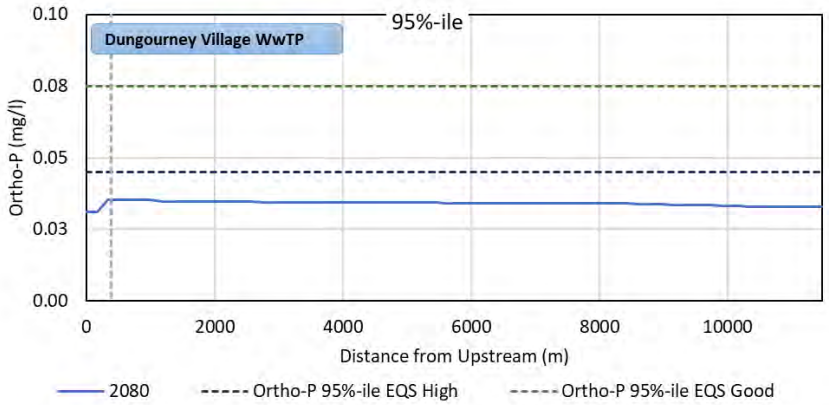


Figure 3-102 MRP Results for 2080 Scenario – Dungourney



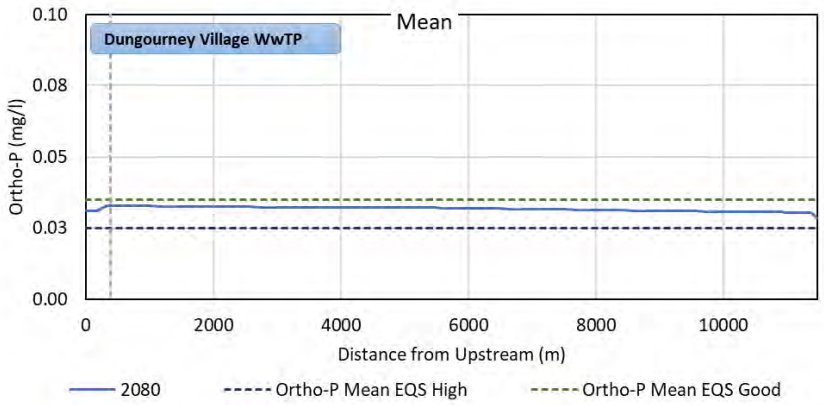
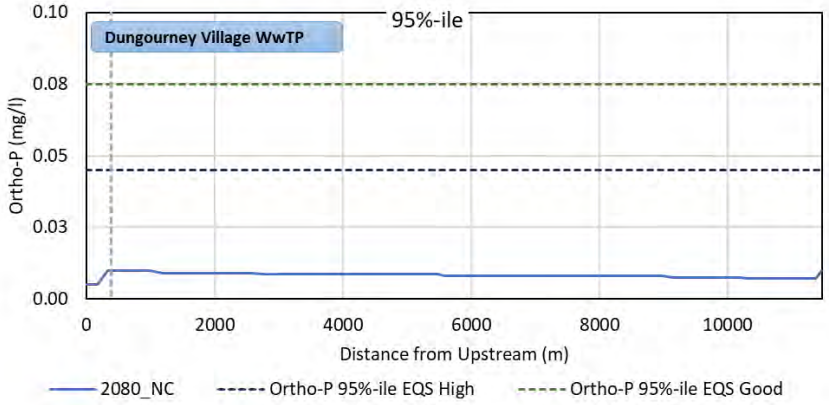
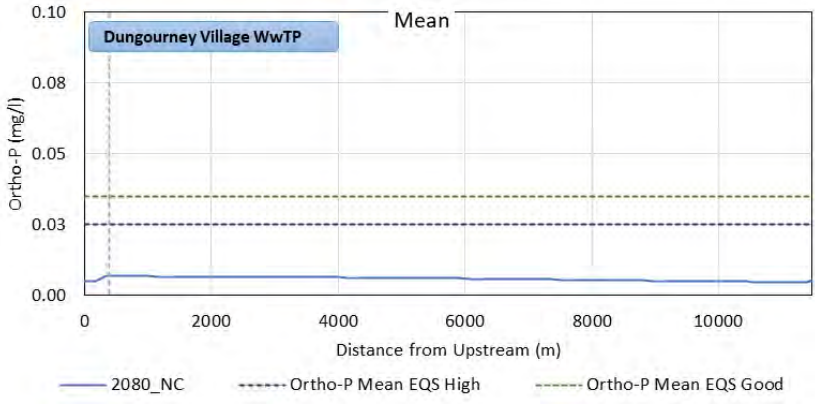


Figure 3-103 MRP Results for 2080 NC Scenario – Dungourney





3.3.4 River Lee

The river flows included in the model were derived from the calibrated hydrology model driven by the stochastic rainfall data for 2030, 2055 and 2080, and the WwTP flows for these three horizons are given in Table 3-23.

Table 3-24, Table 3-25 and Table 3-26provides the maximum allowable ELVs calculated from the initial model runs, for 2030, 2055 and 2080 horizons.

Table 3-23 Flow Inputs Applied in the River Lee Modelling Scenarios

Receiving Watercourse	WwTPS	Flows		
		2030	2055	2080
Blarney River	Whitechurch WwTP	0.0036	0.0041	0.0046
	Killeens WwTP	0.0038	0.0055	0.0062
Martin River	Grenagh WwTP	0.0045	0.0041	0.0046
Shournagh River	Courtbrack WwTP	0.0022	0.0025	0.0027
	Blarney WwTP	0.0598	0.0921	0.1028
Bride	Cloughdov WwTP	0.0038	0.0045	0.0051
	Kilumney WwTP	0.0105	0.0128	0.0144
Dripsey River	Rylane WwTP	0.0013	0.0015	0.0017
	Agabullogue WwTP	0.0010	0.0012	0.0014
	Dripsey WwTP	0.0020	0.0023	0.0026
River Lee	Coachford WwTP	0.0064	0.0075	0.0085
	Inniscarra WwTP	0.0011	0.0013	0.0015
	Ballincollig WwTP	0.1313	0.2020	0.2272

Table 3-24 Final ELVs Determined for WwTPs in the Lee Model for BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Whitechurch WwTP	Yes	High	Yes	25	3.3	2.8	2.6
Killeens WwTP	No	Good	Yes	25	4.2	2.8	2.6
Grenagh WwTP	No	Good	No	25	2.7	2.3	2.0
Courtbrack WwTP	Yes	High	Yes	25	25	25	25
Blarney WwTP	Yes	High	Yes	20	4.2	2.7	2.4
Cloughdov WwTP	Yes	High	Yes	10	10	10	10
Kilumney WwTP	No	Good	No	25	25	25	25
Rylane WwTP	Yes	High	No	25	11.1	9.4	8.4
Agabullogue WwTP	Yes	High	No	25	14.0	11.9	10.6
Dripsey WwTP	Yes	High	No	25	24.9	21.5	19.2

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Coachford WwTP	No	Good	No	21.63	21.63	21.63	21.63
Inniscarra WwTP	No	Good	No	25	25	25	25
Ballincollig WwTP	No	Good	No	25	20.2	13.2	11.6

Table 3-25 Final ELVs Determined for WwTPs in the Lee Model for Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Whitechurch WwTP	Yes	High	Yes	10	0.19	0.16	0.15
Killeens WwTP	No	Good	Yes	28.4	0.58	0.39	0.36
Grenagh WwTP	No	Good	No	3	0.60	0.51	0.46
Courtbrack WwTP	Yes	High	No	10	3.84	3.18	3.21
Blarney WwTP	Yes	High	No	1.5	0.23	0.15	0.13
Cloughdov WwTP	Yes	High	Yes	2	2.00	2.00	2.00
Kilumney WwTP	No	High	No	10	2.45	2.05	1.76
Rylane WwTP	Yes	High	No	10	0.77	0.66	0.58
Agabullogue WwTP	Yes	High	No	5	3.73	3.17	2.82
Dripsey WwTP	Yes	High	No	10	3.53	3.03	2.74
Coachford WwTP	No	Good	No	6.8	6.62	5.63	5.01
Inniscarra WwTP	No	High	No	10	10	10	10
Ballincollig WwTP	No	High	No	5	1.13	0.73	0.66

Table 3-26 Final ELVs Determined for WwTPs in the Lee Model for

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Whitechurch WwTP	Yes	High	Yes	5	0.07	0.06	0.06
Killeens WwTP	No	Good	Yes	1	0.26	0.18	0.16
Grenagh WwTP	No	Good	Yes	1.7	0.31	0.26	0.23
Courtbrack WwTP	Yes	High	Yes	2	1.63	1.34	1.37
Blarney WwTP	Yes	High	Yes	0.8	0.08	0.05	0.05
Cloughdov WwTP	Yes	High	Yes	0.8	0.8	0.75	0.65
Kilumney WwTP	No	Good	No	5	0.73	0.60	0.54
Rylane WwTP	Yes	High	Yes	2	0.39	0.33	0.29

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Agabullogue WwTP	Yes	High	Yes	1	0.82	0.71	0.61
Dripsey WwTP	Yes	High	Yes	5	1.60	1.38	1.24
Coachford WwTP	No	High	No	0.88	0.88	0.88	0.88
Inniscarra WwTP	No	High	No	5	5	5	5
Ballincollig WwTP	No	Good	No	2	0.62	0.40	0.36

The results for the three assessed years—2030, 2055, and 2080—incorporating both future and NC scenarios for the River Lee and its branches, are presented in Figure 3-104 to Figure 3-211.

The River Lee comprises six branches, with the corresponding results for the Blarney branch shown in Figure 3-104 to Figure 3-121. These figures reflect conditions over a 7000 m stretch from the upstream boundary and highlight the locations of key infrastructure, including the Whitechurch WwTP and Killeens WwTP, situated approximately 125 m and 2500 m downstream, respectively.

Figure 3-122 to Figure 3-139 similarly present the outcomes for the Martin River under the 2030, 2055, and 2080 scenarios. This river reach extends 10,000 m downstream from the upstream boundary, with the Grenagh WwTP located approximately 50 m from the starting point.

Figure 3-140 to Figure 3-157 also includes the results for the Shournagh River, covering a 12,000 m section from the upstream boundary. This reach features the Courtbrack WwTP and Blarney WwTP, positioned approximately 125 m and 7000 m downstream, respectively.

For the Dripsey River, Figure 3-158 to Figure 3-175 show scenario-based results along a 14,000 m reach. The Rylane WwTP, Aghabullogue WwTP, and Dripsey WwTP are located approximately 150 m, 4000 m, and 10,000 m downstream from the upstream boundary.

Similarly, the Bride River shown in Figure 3-176 to Figure 3-193 results span a 16,000 m reach, identifying the Cloughduv WwTP and Killumney WwTP at approximately 1900 m and 13,200 m downstream, respectively.

Lastly, the Lee River is represented over a 30,000 m stretch in Figure 3-194 to Figure 3-211 , detailing the locations of the Coachford WwTP, Inniscarra WwTP, and Ballincollig WwTP, situated approximately 6000 m, 16,300 m, and 23,000 m downstream, respectively. The plots also indicate the positions of the Dripsey, Bride, and Shournagh watercourses, as well as a dam located along this reach.

Table 3-27, Table 3-28, Table 3-29, Table 3-30, Table 3-31 and Table 3-32 provides a summary of the model results, indicating water quality in the river when the WwTPs are operated with the maximum ELVs determined.

Table 3-27 Summary of Blarney Results

Scenarios	Parameters
	BOD
2030 (Figure 3-104 and Figure 3-105	For Whitechurch WwTP, NC condition (Figure 3-105) is applied to calculate ELVs for BOD, as the EQS for the target High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for BOD, as the EQS for the target Good status is already exceeded at the upstream of the WwTP.

Scenarios	Parameters
	Both mean and 95th percentile BOD concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile BOD concentration rises sharply to 0.9 mg/l and this is 41% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.47 mg/l this is 36% of in-band WAC. The Killeens WwTP have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
2055 (Figure 3-110 and Figure 3-111)	For Whitechurch WwTP, NC condition (Figure 3-111) is applied to calculate ELVs for BOD, as the EQS for the target High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for BOD, as the EQS for the target Good status is already exceeded at the upstream of the WwTP. Both mean and 95th percentile BOD concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile BOD concentration rises sharply to 0.75 mg/l and this is 34% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.42 mg/l this is 32% of in-band WAC. The Killeens WwTP have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
2080 (Figure 3-116 and Figure 3-117)	For Whitechurch WwTP, NC condition (Figure 3-117) is applied to calculate ELVs for BOD, as the EQS for the target High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for BOD, as the EQS for the target Good status is already exceeded at the upstream of the WwTP. Both mean and 95th percentile BOD concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile BOD concentration rises sharply to 0.75 mg/l and this is 34% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.42 mg/l this is 32% of in-band WAC. The Killeens WwTP have negligible impact on the water quality for 95th percentile and mean BOD concentrations.
	Ammonia
2030 (Figure 3-106 and Figure 3-107)	For Whitechurch WwTP, NC condition (Figure 3-107) is applied to calculate ELVs for ammonia, as the EQS for High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for ammonia, as the EQS for Good status is already exceeded at the upstream of the WwTP. Both mean and 95th percentile ammonia concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile ammonia concentration rises sharply to 0.033 mg/l and this is 37% of in-band WAC. Similarly, mean ammonia concentration sharply rises to 0.016 mg/l this is 40% of in-band WAC. Both mean and 95th percentile ammonia concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are well below threshold concentration for High status.
2055 (Figure 3-112 and Figure 3-113)	For Whitechurch WwTP, NC condition (Figure 3-113) is applied to calculate ELVs for ammonia, as the EQS for High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to

Scenarios	Parameters
	calculate ELVs for ammonia, as the EQS for Good status is already exceeded at the upstream of the WwTP. The 95th percentile ammonia concentration increases to 0.026 mg/l downstream Whitechurch WwTP and this is 29% of in-band WAC. Similarly, mean ammonia concentration sharply rises to 0.014 mg/l this is 35% of in-band WAC. Both mean and 95th percentile ammonia concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are well below threshold concentration for High status.
2080 (Figure 3-118 and Figure 3-119)	For Whitechurch WwTP, NC condition (Figure 3-119) is applied to calculate ELVs for ammonia, as the EQS for High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for ammonia, as the EQS for Good status is already exceeded at the upstream of the WwTP. The 95th percentile ammonia concentration increases to 0.027 mg/l downstream Whitechurch WwTP and this is 30% of in-band WAC. Similarly, mean ammonia concentration sharply rises to 0.014 mg/l this is 35% of in-band WAC. Both mean and 95th percentile ammonia concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are well below threshold concentration for High status.
	MRP
2030 (Figure 3-108 and Figure 3-109)	For Whitechurch WwTP, NC condition (Figure 3-109) is applied to calculate ELVs for, MRP as the EQS for High status is already exceeded at the upstream of the river. Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for MRP, as the EQS for Good status is already exceeded at the upstream of the WwTP. Both mean and 95th percentile MRP concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile MRP concentration rises sharply to 0.018 mg/l and this is 40% of in-band WAC. Similarly, mean MRP concentration sharply rises to 0.009 mg/l this is 36% of in-band WAC. Both mean and 95th percentile MRP concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are below threshold concentration for High status.
2055 (Figure 3-114 and Figure 3-115	For Whitechurch WwTP, NC condition (Figure 3-115) is applied to calculate ELVs for MRP, as the EQS for High status is already exceeded at the upstream of the river. MRP Both mean and 95th percentile concentrations show a notable increase downstream of the Whitechurch WwTP. The 95th percentile concentration rises sharply to 0.015 mg/l and this is 33% of in-band WAC. Similarly, mean concentration sharply rises to 0.008 mg/l this is 32% of in-band WAC. Both mean and 95th percentile concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are below threshold concentration for High status.

Scenarios	Parameters
2080 Figure 3-120 and Figure 3-121)	MRP Similarly, Killeens WwTP, NC condition is applied to calculate ELVs for MRP, as the EQS for Good status is already exceeded at the upstream of the WwTP. Both mean and 95th percentile concentrations show a notable increase downstream of Whitechurch WwTP. The 95th percentile concentration rises sharply to 0.016 mg/l and this is 36% of in-band WAC. Similarly, mean concentration sharply rises to 0.008 mg/l this is 32% of in-band WAC. Both mean and 95th percentile concentrations show a notable increase downstream of the Killeens WwTP. However, the concentrations are below threshold concentration for High status.

Table 3-28 Summary of Martin Results

Scenarios	Parameters
	BOD
2030 (Figure 3-122 and Figure 3-123)	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-122). The impact of Grenagh WwTP on BOD in the river is low, with the 95th percentile concentration downstream of the WwTP being below High status threshold and mean concentration being 45% of in-band WAC.
2055 (Figure 3-128 and Figure 3-129)	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-128). The impact of Grenagh WwTP on BOD in the river is low, with the 95th percentile concentration downstream of the WwTP being below High status threshold and mean concentration being 60% of in-band WAC.
2080 (Figure 3-134 and Figure 3-135	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-134). The impact of Grenagh WwTP on BOD in the river is low, with the 95th percentile concentration downstream of the WwTP being below High status threshold and mean concentration being 60% of in-band WAC.
	Ammonia
2030 (Figure 3-124 and Figure 3-125)	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-124). The impact of Grenagh WwTP on BOD in the river is low, with the 95th percentile concentration downstream of the WwTP being below High status threshold and mean concentration being just below High status threshold.
2055 (Figure 3-130 and Figure 3-131)	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-130) For Grenagh WwTP,

Scenarios	Parameters
	ammonia 95th percentile increases to 0.091 mg/l and this is 2% of in-band WAC and ammonia mean concentration increases to 0.056 mg/l and this is 64% of in-band WAC.
2080 (Figure 3-136 and Figure 3-137)	For Grenagh WwTP, the target is Good status. The upstream river concentration is within the 75% in-band WAC of the target status of Good, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-136). For Grenagh WwTP, ammonia 95th percentile increases to 0.091 mg/l and this is 2% of in-band WAC and ammonia mean concentration increases to 0.056 mg/l and this is 64% of in-band WAC.
	MRP
2030 (Figure 3-126 and Figure 3-127)	For Grenagh WwTPs, the target is Good status. As the EQS for the target status of Good is already exceeded at the upstream river, NC condition (Figure 3-127) is applied to calculate ELVs for MRP. The Grenagh WwTP has no impact on MRP, with the 95th percentile and mean concentrations not exceeding the High threshold.
2055 (Figure 3-132 and Figure 3-133)	For Grenagh WwTPs, the target is High status as the WwTP discharge to a waterbody with a Good status objective. NC condition (Figure 3-133) is applied to calculate ELVs for MRP , as the target status Good is exceeded upstream river. For Grenagh WwTP, the 95th percentile increases to 0.038 mg/l and mean concentration increases to 0.016 mg/l. However, MRP concentration at downstream of the WwTP still meet the EQS for High status.
2080 (Figure 3-138 and Figure 3-139)	For Grenagh WwTPs, the target is High status as the WwTP discharge to a waterbody with a Good status objective. NC condition (Figure 3-139) is applied to calculate ELVs for MRP, as the target status Good exceeded upstream river. For Grenagh WwTP, the 95th percentile increases to 0.038 mg/l and mean concentration increases to 0.016 mg/l. However, MRP concentration at downstream of the WwTP still meet the EQS for High status.

Table 3-29 Summary of Shournagh Results

Scenarios	Parameters
	BOD
2030 (Figure 3-140 and Figure 3-141)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-141). The 95th percentile and mean BOD concentration for Courtbrack WwTP has small impact on water quality. The 95th percentile BOD concentration for Blarney WwTP rises sharply to 0.7 mg/l and this is 31% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.4 mg/l this is 31% of in-band WAC.
2055 (Figure 3-146 and Figure 3-147)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-147). The 95th percentile and mean BOD concentration for Courtbrack WwTP has small impact on water quality. The 95th percentile BOD concentration for

Scenarios	Parameters
	Blarney WwTP rises sharply to 0.79 mg/l and this is 36% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.44 mg/l this is 34% of in-band WAC.
2080 (Figure 3-152 and Figure 3-153)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-153). The 95th percentile and mean BOD concentration for Courtbrack WwTP has small impact on water quality. The 95th percentile BOD concentration for Blarney WwTP rises sharply to 0.79 mg/l and this is 36% of in-band WAC. Similarly, mean BOD concentration sharply rises to 0.44 mg/l this is 34% of in-band WAC.
	Ammonia
2030 (Figure 3-142 and Figure 3-143)	For Courtbrack and Blarney WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-142). The 95th percentile concentration downstream Courtbrack WwTP sharply rises to 0.045 mg/l and this is 50% of in-band WAC. Similarly, ammonia mean concentration rises to 0.027 mg/l and this is 68% of in-band WAC The 95th percentile concentration downstream Blarney WwTP rises to 0.021 mg/l and this is 23% of in-band WAC. Similarly, ammonia mean concentration rises to 0.014 mg/l and this is 35% of in-band WAC.
2055 (Figure 3-148 and Figure 3-149)	For Courtbrack and Blarney WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-148). The 95th percentile concentration downstream Courtbrack WwTP sharply rises to 0.05 mg/l and this is 56% of in-band WAC. Similarly, ammonia mean concentration rises to 0.029 mg/l and this is 73% of in-band WAC The 95th percentile concentration downstream Blarney WwTP rises to 0.025 mg/l and this is 28% of in-band WAC. Similarly, ammonia mean concentration rises to 0.016 mg/l and this is 40% of in-band WAC.
2080 (Figure 3-154 and Figure 3-155)	For Courtbrack and Blarney WwTPs, the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-154). The 95th percentile concentration downstream Courtbrack WwTP sharply rises to 0.05 mg/l and this is 56% of in-band WAC. Similarly, ammonia mean concentration rises to 0.029 mg/l and this is 73% of in-band WAC. The 95th percentile concentration downstream Blarney WwTP rises to 0.025 mg/l and this is 28% of in-band WAC. Similarly, ammonia mean concentration rises to 0.016 mg/l and this is 40% of in-band WAC.
	MRP
2030 (Figure 3-144 and Figure 3-145)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-145). The 95th

Scenarios	Parameters
	percentile concentration for Courtbrack and Blarney WwTP rises MRP to 0.017 mg/l and this is 38% of in-band WAC. Similarly, the mean MRP concentration rises to 0.009 mg/l this is 36% of in-band WAC. The 95th percentile concentration downstream Blarney WwTP rises to 0.015 mg/l and this is 33% of in-band WAC. Similarly, ammonia mean concentration rises to 0.007 mg/l and this is 28% of in-band WAC.
2055 (Figure 3-150 and Figure 3-151)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-151). The 95th percentile MRP concentration for Courtbrack and Blarney WwTP rises to 0.019 mg/l and this is 42% of in-band WAC. Similarly, the mean concentration rises to 0.009 mg/l this is 36% of in-band WAC. The 95th percentile concentration downstream Blarney WwTP rises to 0.017 mg/l and this is 38% of in-band WAC. Similarly, ammonia mean concentration rises to 0.008 mg/l and this is 32% of in-band WAC.
2080 (Figure 3-156 and Figure 3-157)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Blarney WwTP and Courtbrack WwTP were determined using the NC condition (Figure 3-157). The 95th percentile MRP concentration for Courtbrack and Blarney WwTP rises MRP to 0.019 mg/l and this is 42% of in-band WAC. Similarly, the mean concentration rises to 0.009 mg/l this is 36% of in-band WAC. The 95th percentile concentration downstream Blarney WwTP rises to 0.018 mg/l and this is 40% of in-band WAC. Similarly, ammonia mean concentration rises to 0.008 mg/l and this is 32% of in-band WAC.

Table 3-30 Summary of Dripsey Results

Scenarios	Parameters
	BOD
2030 (Figure 3-158 and Figure 3-159)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTPs discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-158) (Figure 3-158). The 95th percentile downstream of all the three WwTPs shows small increases. For, Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP, the 95th percentile BOD concentration increases to 1.64 mg/l downstream of each WwTP, and this is 75% of in-band WAC. The mean BOD concentration increases to 1.02 mg/l downstream of each WwTP and this is 79% of in-band WAC.
2055 (Figure 3-164 and Figure 3-165)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-164). The BOD 95th percentile increases to 1.84 mg/l downstream of Rylane WwTP and this is 84% of in-band WAC. The mean BOD concentration increases to 1.09 mg/l and this is 84% of in-band WAC.

Scenarios	Parameters
	Similarly, for Aghabullogue WwTP, the 95th percentile BOD concentration increases to 1.83 mg/l and this is within 83% in-band WAC. The mean BOD concentration increases to 1.09 mg/l and this is 84% of in-band WAC. For, Dripsey WwTP, the 95th percentile ammonia concentration increases to 1.74 mg/l and this is 79% of in-band WAC. The mean BOD concentration increases to 1.06 mg/l and this is 82% of in-band WAC.
2080 (Figure 3-170 and Figure 3-171)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-170) The BOD 95th percentile increases to 1.84 mg/l downstream of Rylane WwTP and this is 84% of in-band WAC. The mean BOD concentration increases to 1.09 mg/l and this is 84% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile BOD concentration increases to 1.83 mg/l and this is 83% of in-band WAC. The mean BOD concentration increases to 1.09 mg/l and this is 84% of in-band WAC. For, Dripsey WwTP, the 95th percentile ammonia concentration increases to 1.74 mg/l and this is 79% of in-band WAC. The mean BOD concentration increases to 1.06 mg/l and this is 82% of in-band WAC.
	Ammonia
2030 (Figure 3-160 and Figure 3-161)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-160). The ammonia 95th percentile increases to 0.031 mg/l downstream of Rylane WwTP and this is 34% of in-band WAC. The mean ammonia concentration increases to 0.027 mg/l and this is 68% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile ammonia concentration increases to 0.018 mg/l and this is 20% of in-band WAC. The mean ammonia concentration increases to 0.014 mg/l and this is 35% of in-band WAC. For, Dripsey WwTP, the 95th percentile ammonia concentration increases to 0.024 mg/l and this is 27% of in-band WAC. The mean ammonia concentration increases to 0.02 mg/l and this is 50% of in-band WAC.
2055 (Figure 3-158 and Figure 3-159)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-158Figure 3-184) The ammonia 95th percentile increases to 0.048 mg/l downstream of Rylane WwTP and this is 53% of in-band WAC. The mean ammonia concentration increases to 0.032 mg/l and this is 80% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile ammonia concentration increases to 0.048mg/l and this is 53% of in-band WAC. The mean ammonia concentration increases to 0.024 mg/l and this is 60% of in-band WAC.

Scenarios	Parameters
	For, Dripsey WwTP, the 95th percentile ammonia concentration increases to 0.032 mg/l and this is 36% of in-band WAC. The mean ammonia concentration increases to 0.022 mg/l and this is 55% of in-band WAC.
2080 (Figure 3-172 and Figure 3-173)	For Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP the target is High status as the WwTP discharge to a waterbody with a High status objective. The upstream river concentration is within the 75% in-band WAC of the target status of High, therefore the ELVs were determined based on current river condition (non-NC) condition (Figure 3-170). The ammonia 95th percentile increases to 0.048 mg/l downstream of Rylane WwTP and this is 53% of in-band WAC. The mean ammonia concentration increases to 0.032 mg/l and this is 80% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile ammonia concentration increases to 0.048 mg/l and this is 53% of in-band WAC. The mean ammonia concentration increases to 0.024 mg/l and this is 60% of in-band WAC. For, Dripsey WwTP, the 95th percentile ammonia concentration increases to 0.032 mg/l and this is 36% of in-band WAC. The mean ammonia concentration increases to 0.022 mg/l and this is 55% of in-band WAC.
	MRP
2030 (Figure 3-162 and Figure 3-163)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Rylane, Aghabullogue and Dripsey WwTP were determined using the NC condition (Figure 3-163). The 95th percentile increases to 0.01 mg/l downstream of Rylane WwTP and this is 22% of in-band WAC. The mean concentration increases to 0.006 mg/l and this is 24% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile concentration increases to 0.011 mg/l and this is 24% of in-band WAC. The mean concentration increases to 0.005 mg/l and this is 20% of in-band WAC. For, Dripsey WwTP, the 95th percentile concentration increases to 0.013 mg/l and this is 29% of in-band WAC. The mean concentration increases to 0.007 mg/l and this is 28% of in-band WAC.
2055 (Figure 3-168 and Figure 3-169)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Rylane, Aghabullogue and Dripsey WwTP were determined using the NC condition (Figure 3-169) The 95th percentile increases to 0.019 mg/l downstream of Rylane WwTP and this is 42% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC. Similarly, for Aghabullogue WwTP, the 95th percentile concentration increases to 0.023 mg/l and this is 51% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC. For, Dripsey WwTP, the 95th percentile concentration increases to 0.019 mg/l and this is 42% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC.Dripsey
2080 (Figure 3-174 and Figure 3-175)	As the EQS for the target status of High is already exceeded at the upstream river, the maximum ELVs for Rylane, Aghabullogue and Dripsey WwTP were determined using the NC condition (Figure 3-175) The 95th percentile increases to 0.019 mg/l downstream of Rylane WwTP and this is 42% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC.

Scenarios	Parameters
	Similarly, for Aghabullogue WwTP, the 95th percentile concentration increases to 0.023 mg/l and this is 51% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC. For, Dripsey WwTP, the 95th percentile concentration increases to 0.02 mg/l and this is 44% of in-band WAC. The mean concentration increases to 0.009 mg/l and this is 36% of in-band WAC.

Table 3-31 Summary of Bride Results

Scenarios	Parameters
	BOD
2030 (Figure 3-177 and Figure 3-176)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-177) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The WwTP has negligible impact on BOD in the river. For Killumney WwTP, the target is Good status and NC condition is not required as the 95th percentile and mean concentration are below EQS of High status. The 95th percentile BOD concentration shows a small increase to 1.7 mg/l and the mean BOD concentration increases to 1.2 mg/l, which are below EQS of High status.
2055 (Figure 3-182 and Figure 3-183)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-183) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile BOD concentration rises to 0.4 mg/l and this is 20% of in-band WAC. The mean BOD concentration rises to 0.3 mg/l and this is 24% of in-band WAC. For Killumney WwTP, the target is Good status and NC condition is not required as the 95th percentile and mean concentrations are below EQS of High status. The 95th percentile BOD concentration shows a small increase to 2.09 mg/l which is below the High status threshold. The mean BOD concentration increases to 1.33 mg/l this is 15% of in-band WAC.
2080 (Figure 3-188 and Figure 3-189)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-189) is applied to calculate ELVs for BOD, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile BOD concentration rises to 0.4 mg/l and this is 20% of in-band WAC. The mean BOD concentration rises to 0.3 mg/l and this is 24% of in-band WAC. For Killumney WwTP, the target is Good status and NC condition is not required as the 95th percentile and mean concentrations are below EQS of High status. The 95th percentile BOD concentration shows a small increase to 2.18 mg/l which is below the High status threshold. The mean BOD concentration increases to 1.36 mg/l this is this is 30% of in-band WAC.
	Ammonia
2030 (Figure 3-178 and Figure 3-179)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-179) is applied to calculate ELVs for ammonia, as the upstream water quality

Scenarios	Parameters
	conditions are within the upper 25% in-band WAC of High status. The WwTP has negligible impact on ammonia concentration in the river. For Killumney WwTP, the target is Good status and NC condition is not required as the 95th percentile and mean concentrations are below EQS of High status. The 95th percentile concentration increases to 0.055 mg/l and the mean concentration increases to 0.025 mg/l, which are below EQS of High status.
2055 (Figure 3-184 and Figure 3-185)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-185) is applied to calculate ELVs for ammonia, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile ammonia concentration rises to 0.029 mg/l and this is 32% of in-band WAC. The mean ammonia concentration rises to 0.013 mg/l and this is 33% of in-band WAC. For Killumney WwTP, NC condition is not required. The 95th percentile concentration increases to 0.059 mg/l and the mean concentration increases to 0.034 mg/l, which are below EQS of High status.
2080 (Figure 3-190 and Figure 3-191)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-191) is applied to calculate ELVs for ammonia, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile ammonia concentration rises to 0.033 mg/l and this is 32% of in-band WAC. The mean ammonia concentration rises to 0.014 mg/l and this is 33% of in-band WAC. For Killumney WwTP, NC condition is not required. The 95th percentile concentration increases to 0.06 mg/l and the mean concentration increases to 0.034 mg/l, which are below EQS of High status.
	MRP
2030 (Figure 3-180 and Figure 3-181)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-181) is applied to calculate ELVs for MRP, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile concentration rises to 0.008 mg/l and this is 18% of in-band WAC. The mean concentration rises to 0.005 mg/l and this is 20% of in-band WAC. For Killumney WwTP, NC condition is not required. The 95th percentile concentration increases to 0.041 mg/l which is below the High status threshold, and the mean concentration increases to 0.029 mg/l which is 40% of in-band WAC.
2055 (Figure 3-186 and Figure 3-187)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-187) is applied to calculate ELVs for MRP, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile MRP concentration rises to 0.016 mg/l and is this is 36% of in-band WAC. The mean MRP concentration rises to 0.008 mg/l and is this is 32% of in-band WAC. For Killumney WwTP, NC condition is not required. The 95th percentile concentration increases to 0.045 mg/l which is on the High status

Scenarios	Parameters
	threshold, and the mean concentration increases to 0.033 mg/l which is 80% of in-band WAC.
2080 (Figure 3-192 and Figure 3-193)	For Cloughduv WwTP, the target is High status as the WwTP discharge to a waterbody with a High status objective. NC condition (Figure 3-193) is applied to calculate ELVs for MRP, as the upstream water quality conditions are within the upper 25% in-band WAC of High status. The 95th percentile MRP concentration rises to 0.016 mg/l and is this is 36% of in-band WAC. The mean MRP concentration rises to 0.008 mg/l and is this is 32% of in-band WAC. For Killumney WwTP, NC condition is not required. The 95th percentile concentration increases to 0.045 mg/l which is on the High status threshold, and the mean concentration increases to 0.033 mg/l which is 80% of in-band WAC.

Table 3-32 Summary of Lee Results

Scenarios	Parameters
	BOD
2030 (Figure 3-194 and Figure 3-195)	For Coachford WwTP, Inniscarra WwTP and Ballincollig WwTP the target is Good status. NC condition is not required as the 95th percentile and mean concentrations of upstream river are below EQS of High status. Both Coachford WwTP and Inniscarra WwTP have no impact on the water quality for both 95th percentile and mean BOD concentrations. Ballincollig WwTP, the 95th percentile concentration increases to 1.94 mg/l and the mean concentration increases to 1.29 mg/l, which are below the High status thresholds.
2055 (Figure 3-200 and Figure 3-201)	For Coachford WwTP, Inniscarra WwTP and Ballincollig WwTP the target is Good status. NC condition is not required as the 95th percentile and mean concentrations of upstream river are below EQS of High status. Both the Coachford WwTP and Inniscarra WwTP has small impact on the water quality for both 95th percentile and mean BOD concentrations. Ballincollig WwTP, the 95th percentile concentration increases to 1.92 mg/l and the mean concentration increases to 1.28 mg/l, which are below the High status thresholds.
2080 (Figure 3-206 and Figure 3-207)	For Coachford WwTP, Inniscarra WwTP and Ballincollig WwTP the target is Good status. NC condition is not required as the 95th percentile and mean concentrations of upstream river are below EQS of High status. Both the Coachford WwTP and Inniscarra WwTP has small impact on the water quality for both 95th percentile and mean BOD concentrations. Ballincollig WwTP, the 95th percentile concentration increases to 1.92 mg/l and the mean concentration increases to 1.28 mg/l, which are below the High status thresholds.
	Ammonia
2030 (Figure 3-196 and Figure 3-197)	For Coachford WwTP the target is Good status, and for Inniscarra and Ballincollig WwTPs the target is High status due to low concentration at upstream of the WwTPs. All of three WwTPs have minimal impact on water quality.

Scenarios	Parameters
2055 (Figure 3-202 and Figure 3-203)	For Coachford WwTP the target is Good status, and for Inniscarra and Ballincollig WwTPs the target is High status due to low concentration at upstream of the WwTPs. All of three WwTPs have minimal impact on water quality.
2080 (Figure 3-208 and Figure 3-209)	For Coachford WwTP the target is Good status, and for Inniscarra and Ballincollig WwTPs the target is High status due to low concentration at upstream of the WwTPs. All of three WwTPs have minimal impact on water quality.
	MRP
2030 (Figure 3-198 and Figure 3-199)	For Coachford WwTP and Inniscarra WwTP the target is High status due to low concentration at upstream of the WwTPs, and for Ballincollig WwTPs the target is Good status. The 95th percentile and, mean concentration for Coachford WwTP has no impact on the water quality. For Inniscarra WwTP, the 95th percentile and mean MRP concentration has minimal impact on the water quality. For Ballincollig WwTP, the 95th percentile shows a sharp increase to 0.033 mg/l which is below the High status threshold. The mean MRP concentration increases to 0.027 mg/l and this is 20% of in-band WAC.
2055 (Figure 3-204 and Figure 3-205)	For Coachford WwTP and Inniscarra WwTP the target is High status due to low concentration at upstream of the WwTPs, and for Ballincollig WwTPs the target is Good status. The 95th percentile and, mean concentration for Coachford WwTP has no impact on the water quality. For Inniscarra WwTP, the 95th percentile and mean MRP concentration has minimal impact on the water quality. For Ballincollig WwTP, the 95th percentile shows a sharp increase to 0.034 mg/l which is below the High status threshold. The mean MRP concentration increases to 0.028 mg/l and this is 30% of in-band WAC.
2080 (Figure 3-210 and Figure 3-211)	For Coachford WwTP and Inniscarra WwTP the target is High status due to low concentration at upstream of the WwTPs, and for Ballincollig WwTPs the target is Good status. The 95th percentile and, mean concentration for Coachford WwTP has no impact on the water quality. For Inniscarra WwTP, the 95th percentile and mean MRP concentration has minimal impact on the water quality. For Ballincollig WwTP, the 95th percentile shows a sharp increase to 0.035 mg/l which is below the High status threshold. The mean MRP concentration increases to 0.028 mg/l and this is 30% of in-band WAC.

Figure 3-104 BOD Results for 2030 Scenario – Blarney

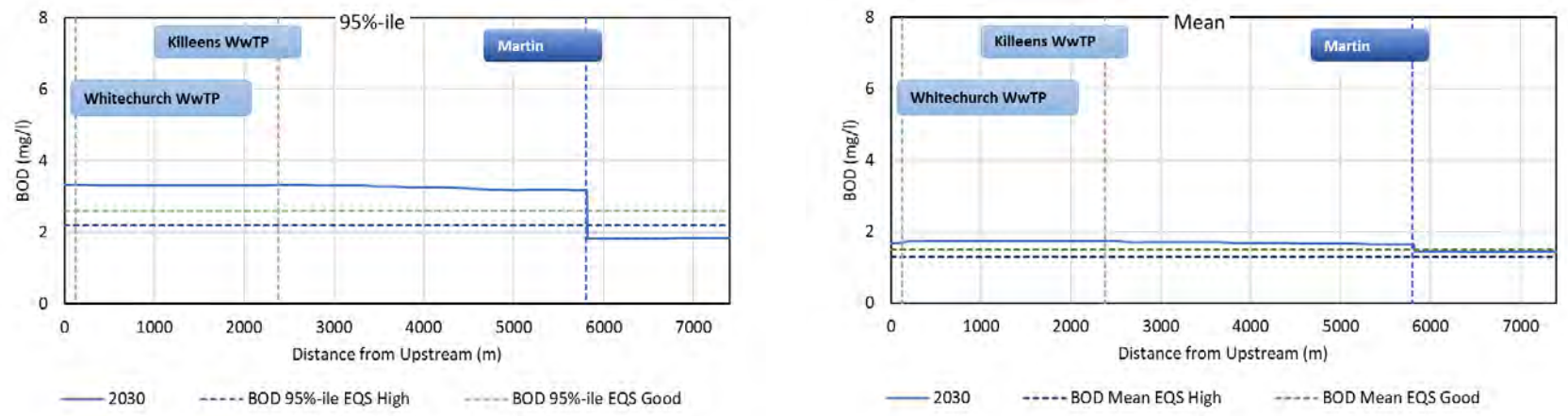


Figure 3-105 BOD Results for 2030 NC Scenario – Blarney

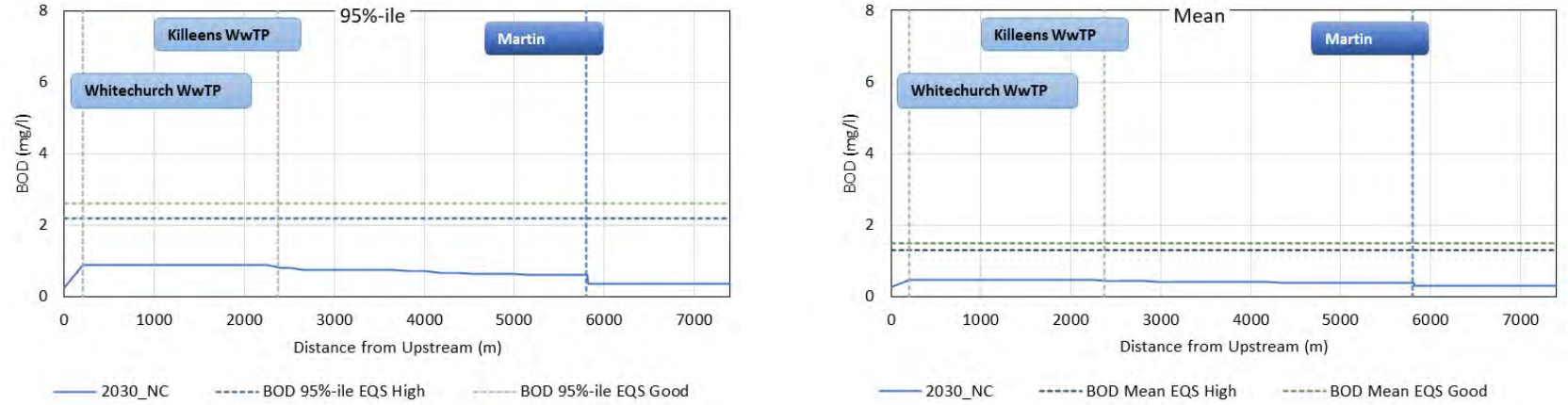
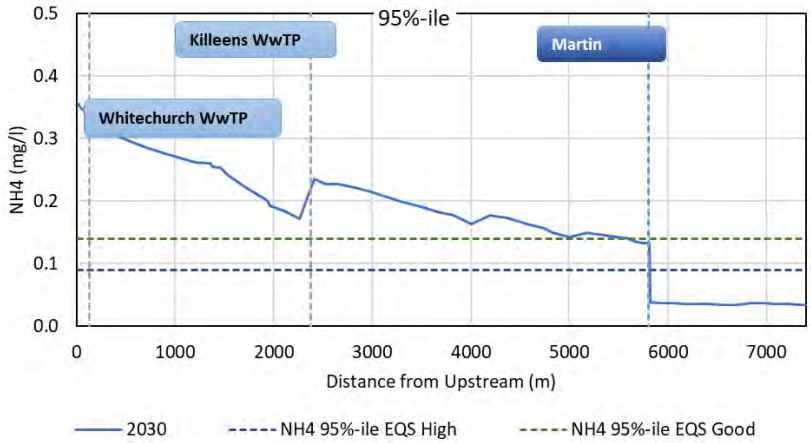


Figure 3-106 Ammonia Results for 2030 Scenario – Blarney



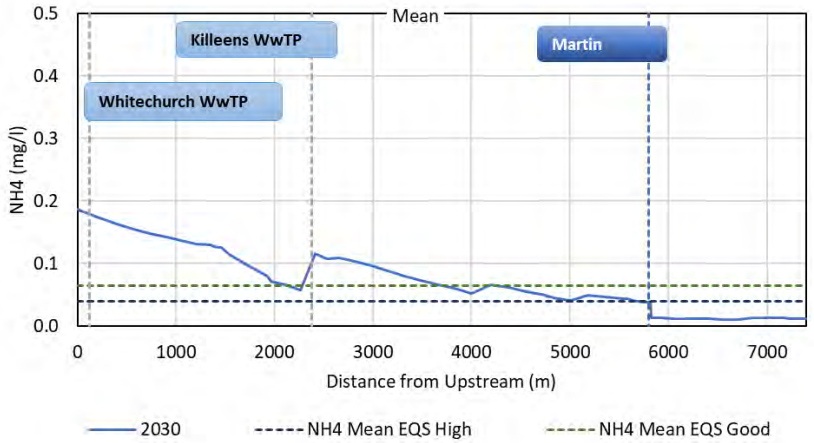
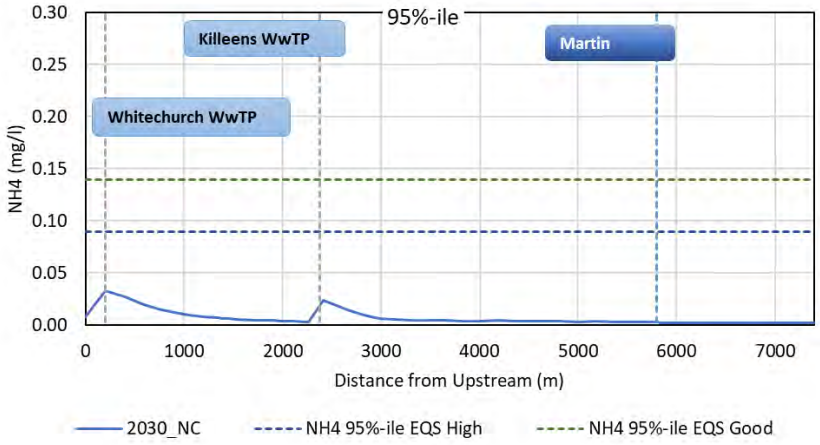


Figure 3-107 Ammonia Results for 2030 NC Scenario – Blarney



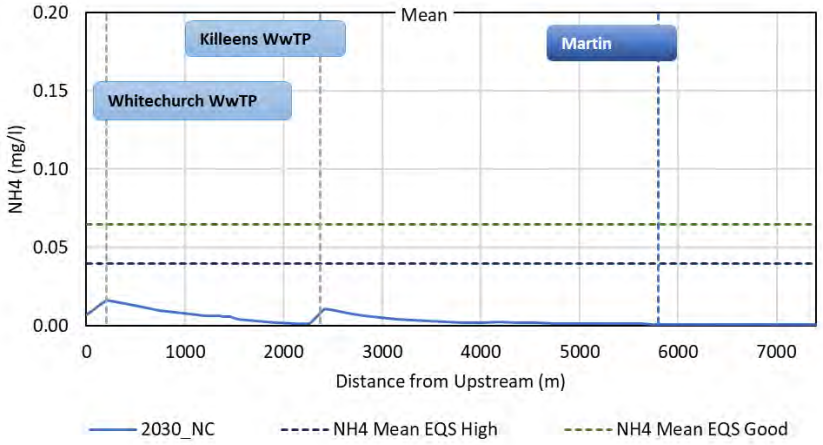
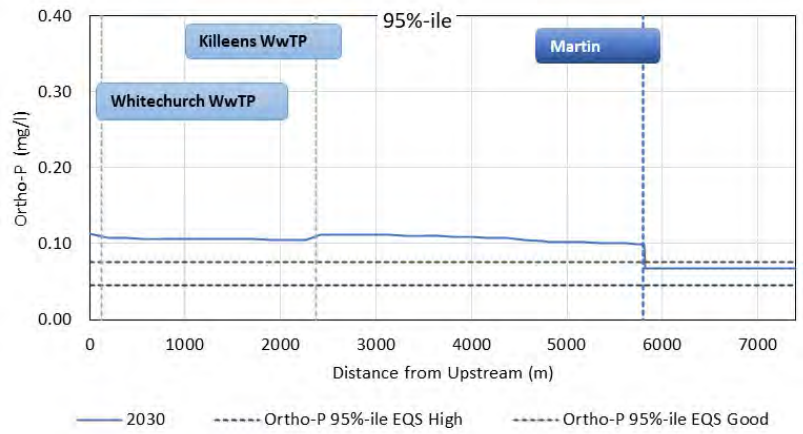


Figure 3-108 MRP Results for 2030 Scenario – Blarney



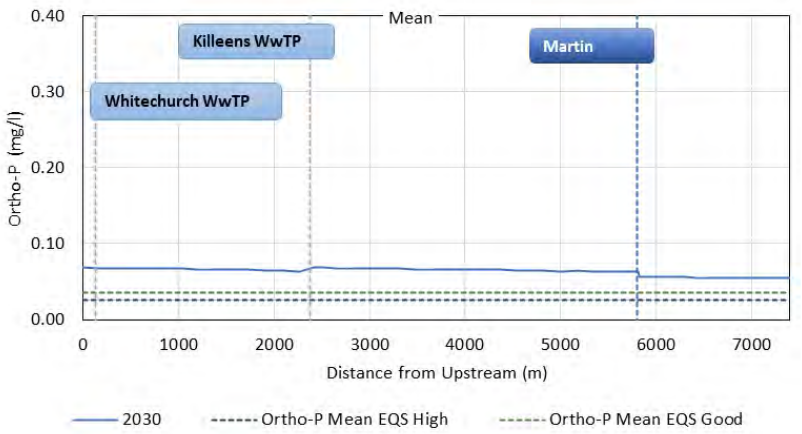
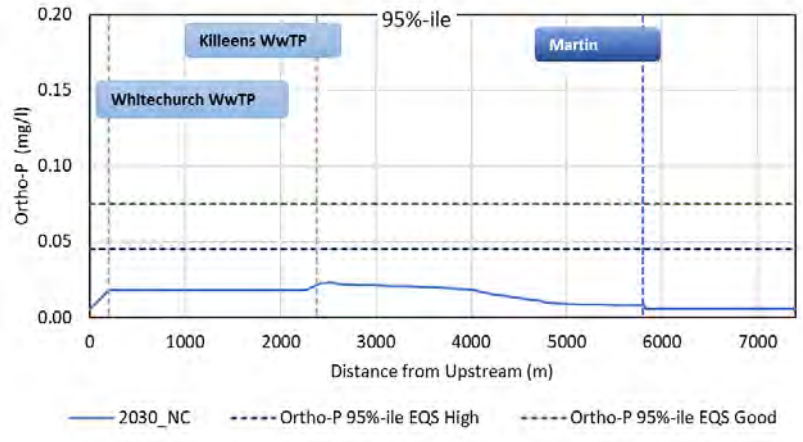


Figure 3-109 MRP Results for 2030 NC Scenario – Blarney



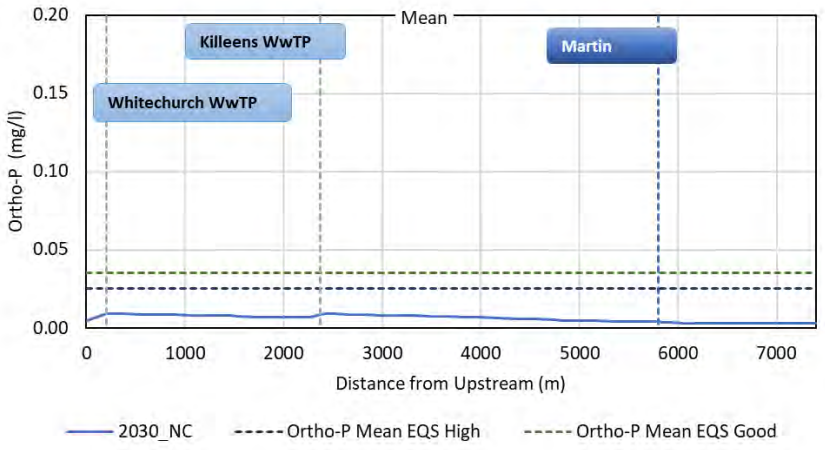
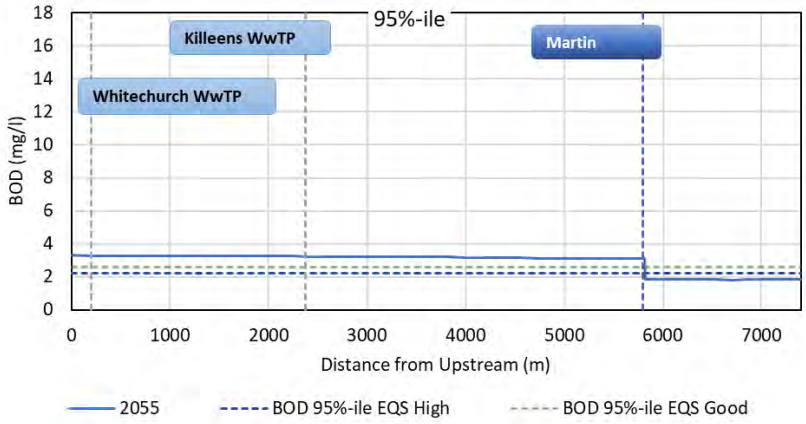


Figure 3-110 BOD Results for 2055 Scenario – Blarney



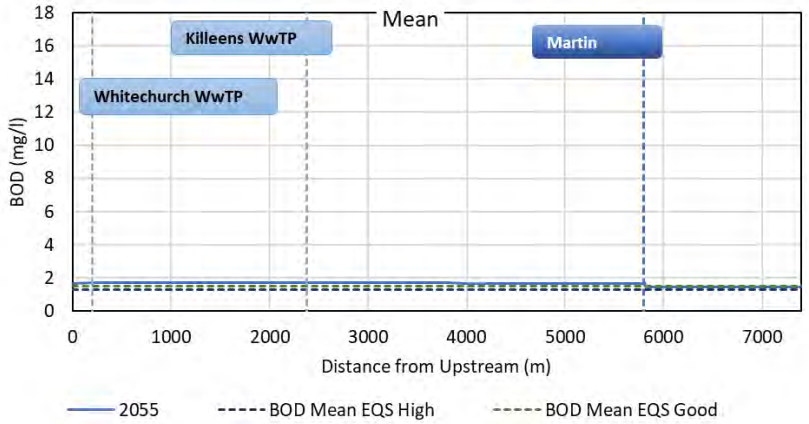
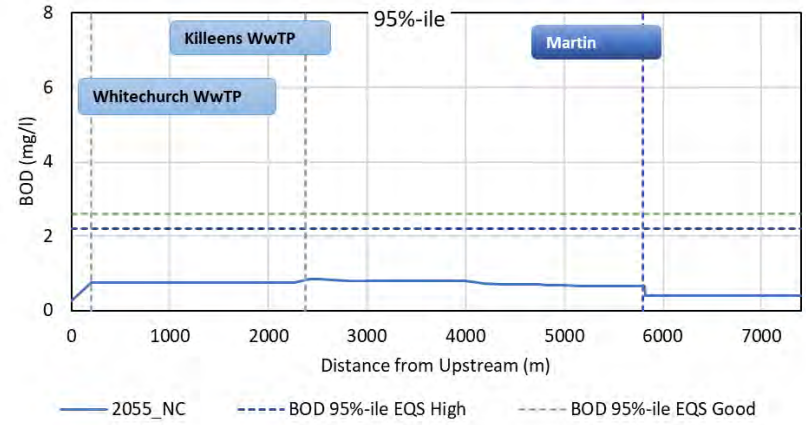


Figure 3-111 BOD Results for 2055 NC Scenario – Blarney



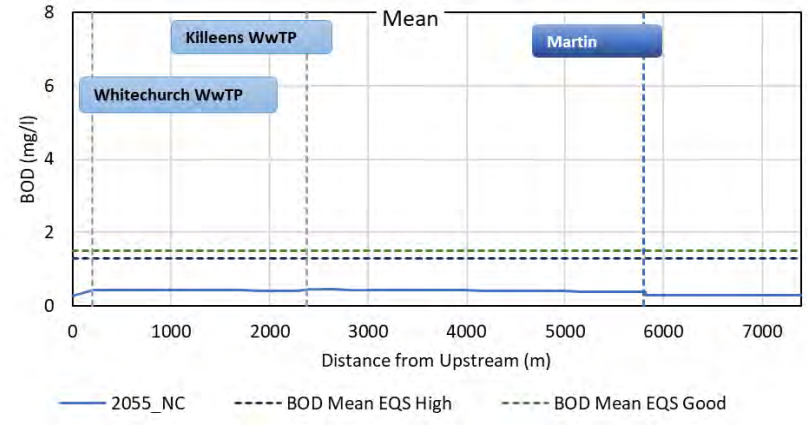
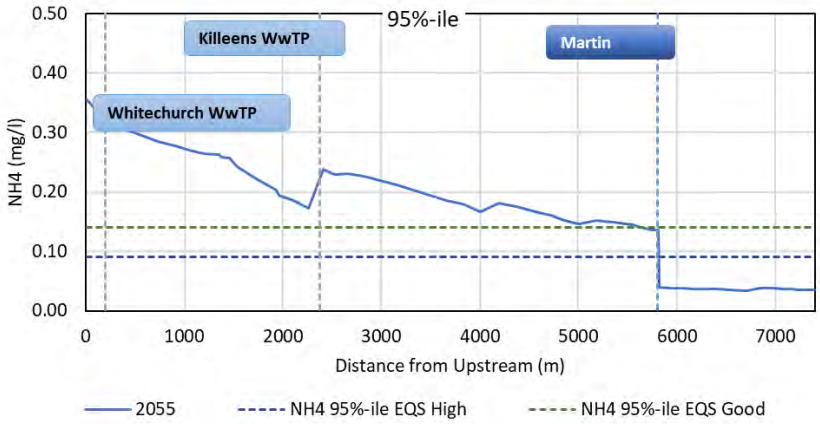


Figure 3-112 Ammonia Results for 2055 Scenario – Blarney



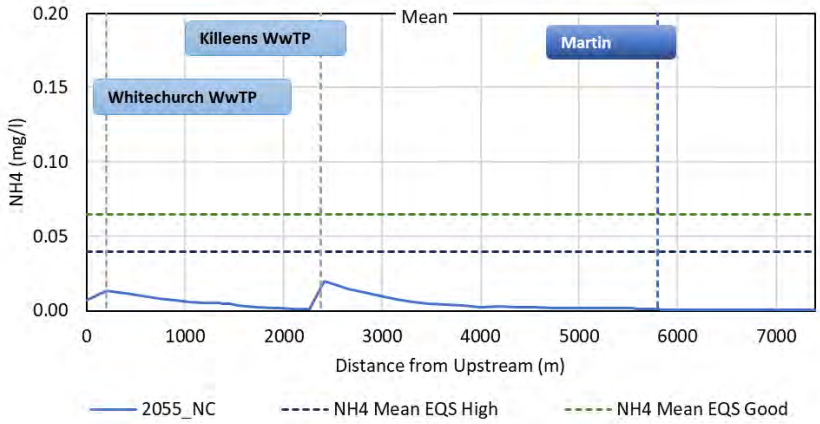
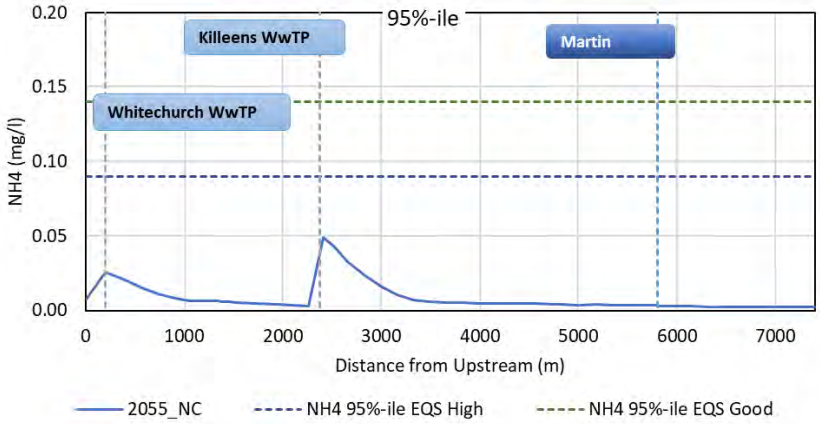


Figure 3-113 Ammonia Results for 2055 NC Scenario – Blarney



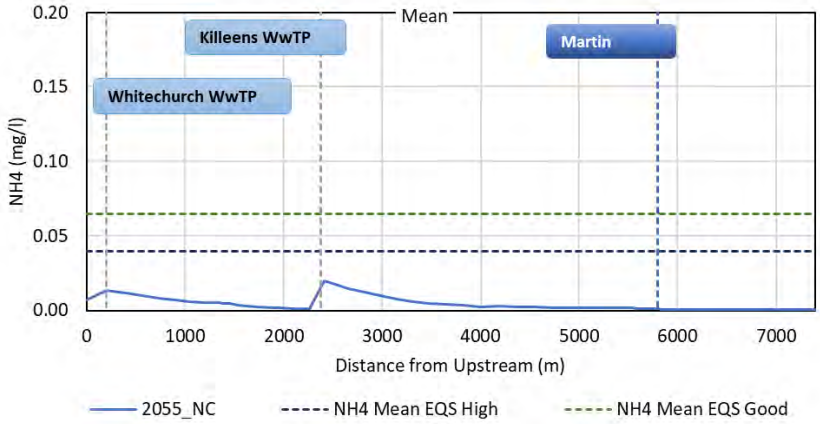
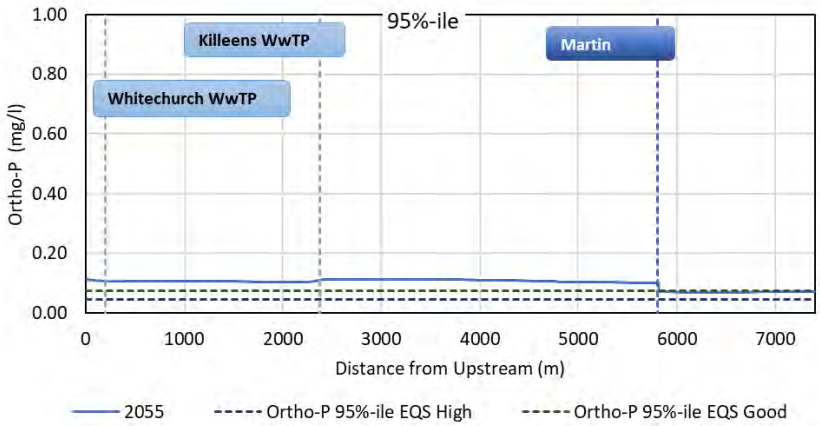


Figure 3-114 MRP Results for 2055 Scenario – Blarney



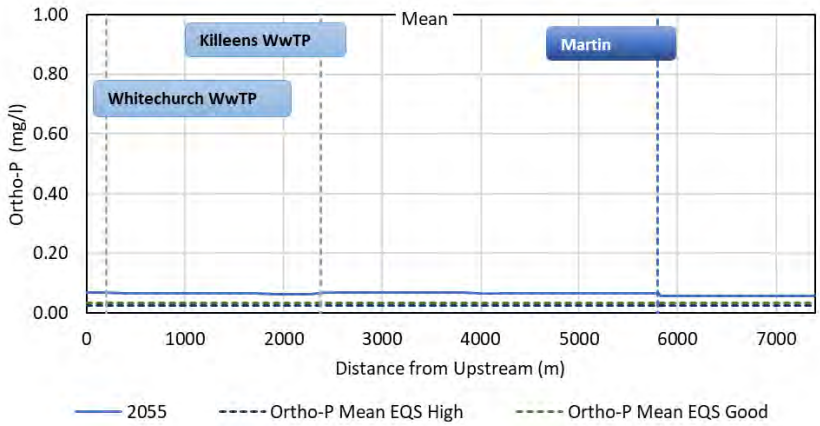
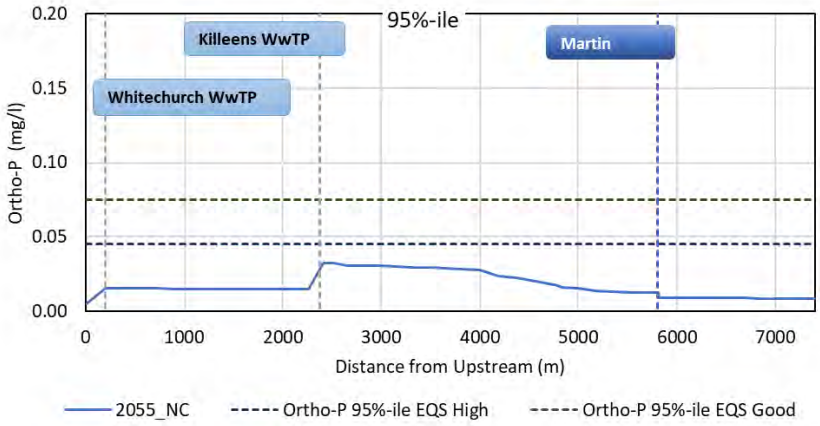


Figure 3-115 MRP Results for 2055 NC Scenario – Blarney



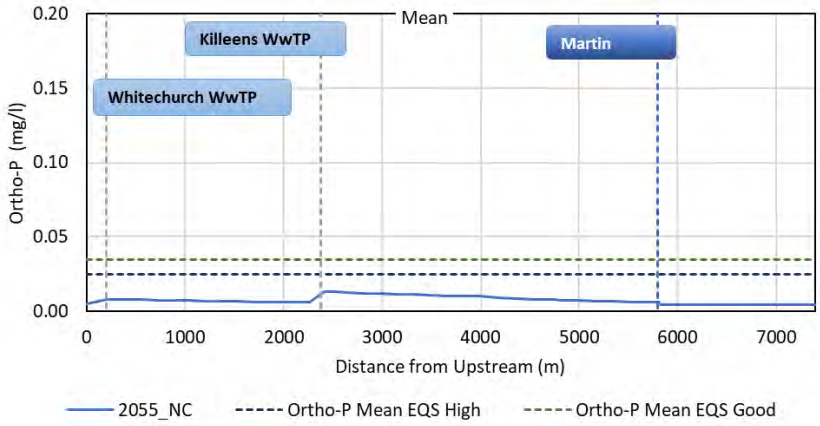


Figure 3-116 BOD Results for 2080 Scenario – Blarney

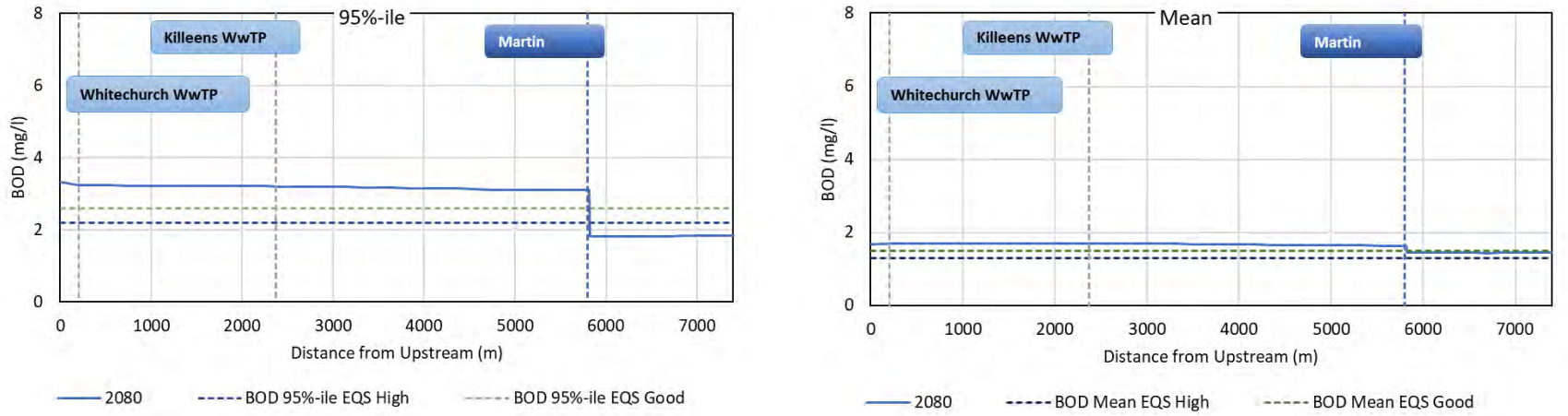


Figure 3-117 BOD Results for 2080 NC Scenario – Blarney

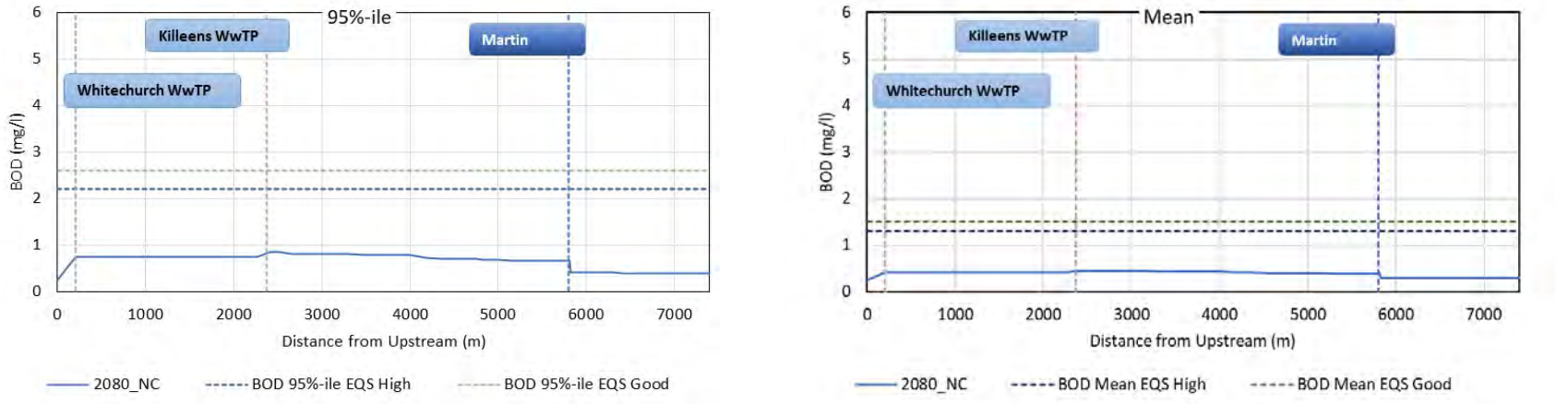
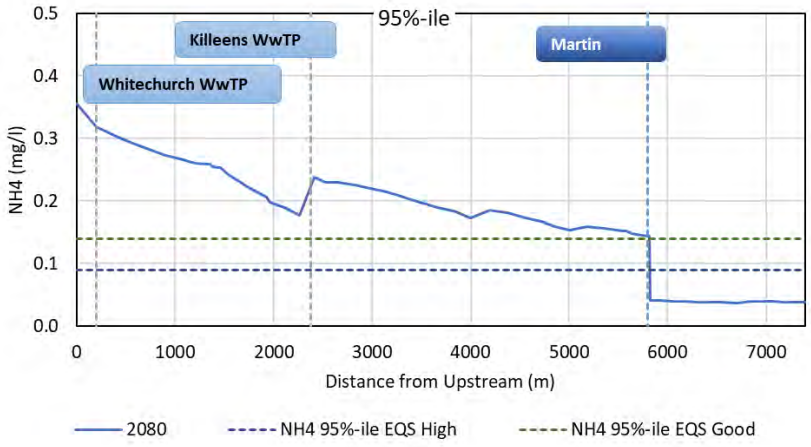


Figure 3-118 Ammonia Results for 2080 Scenario – Blarney



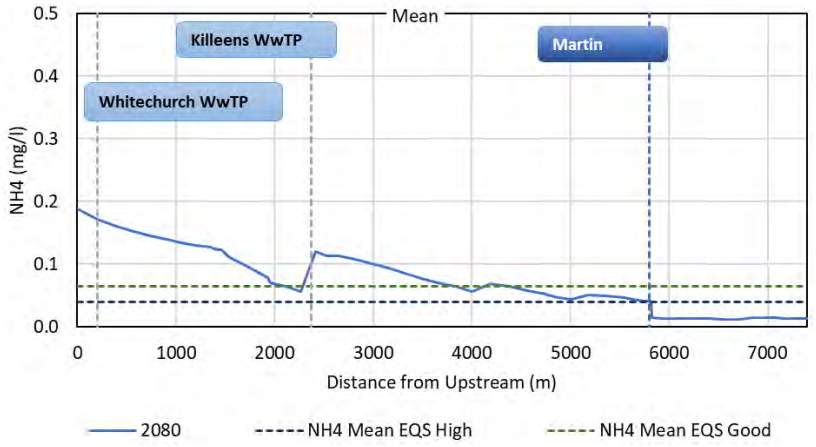
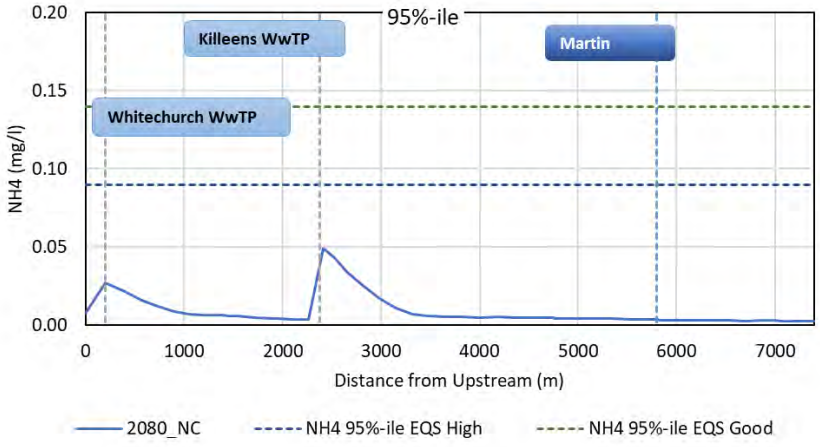


Figure 3-119 Ammonia Results for 2080 NC Scenario – Blarney



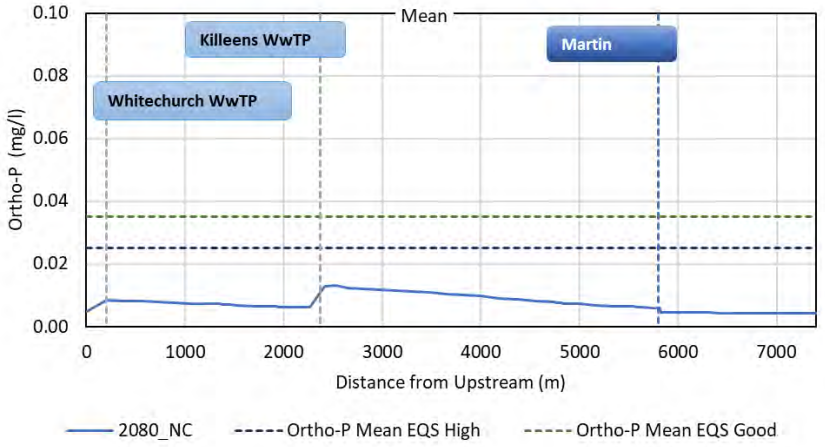


Figure 3-120 MRP Results for 2080 Scenario – Blarney

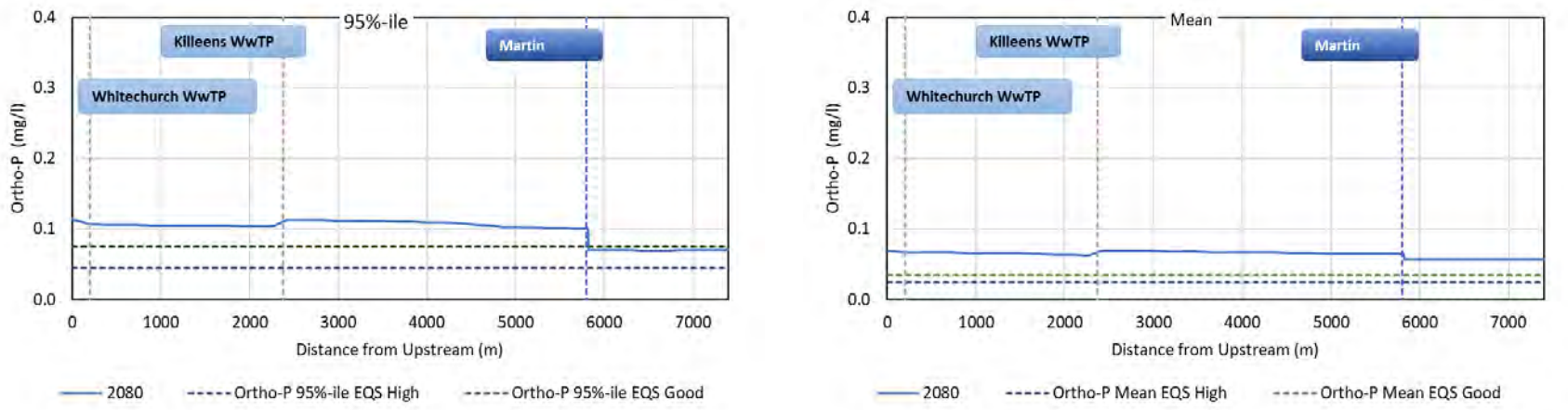


Figure 3-121 MRP Results for 2080 NC Scenario – Blarney

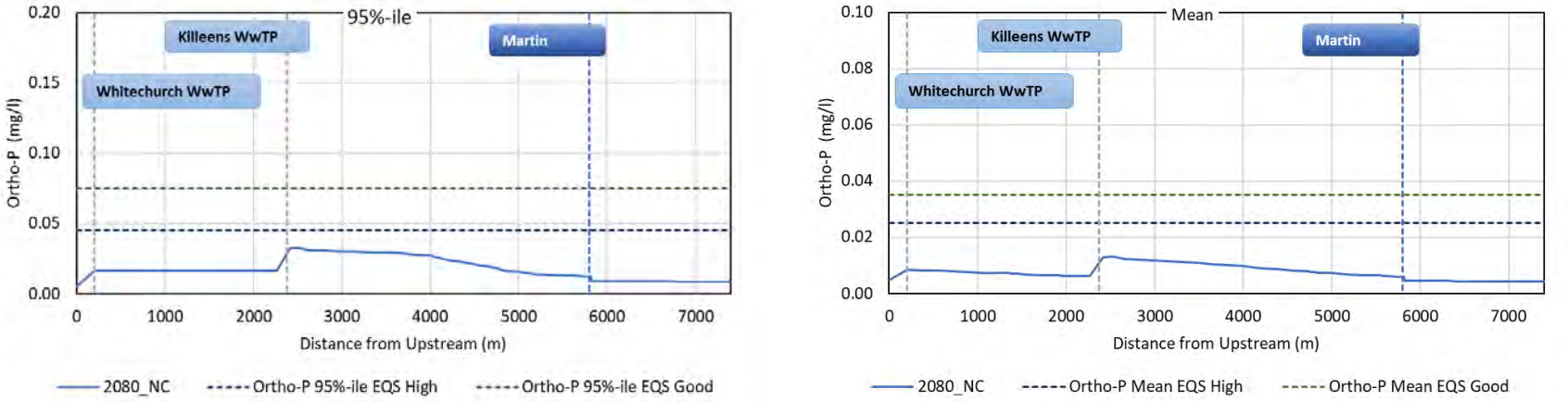
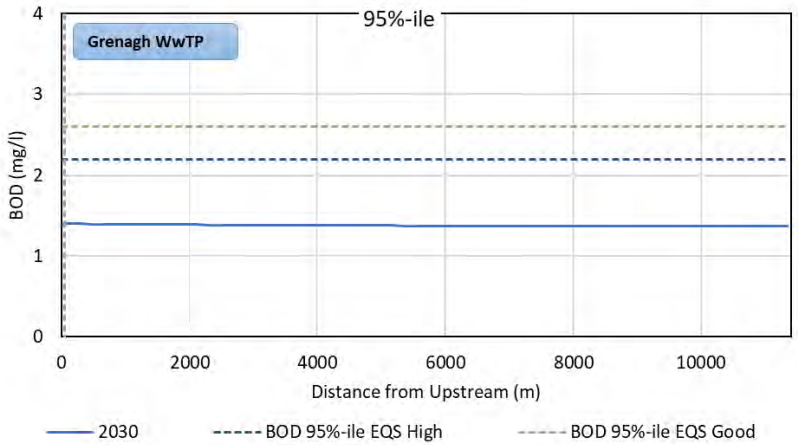


Figure 3-122 BOD Results for 2030 Scenario – Martin



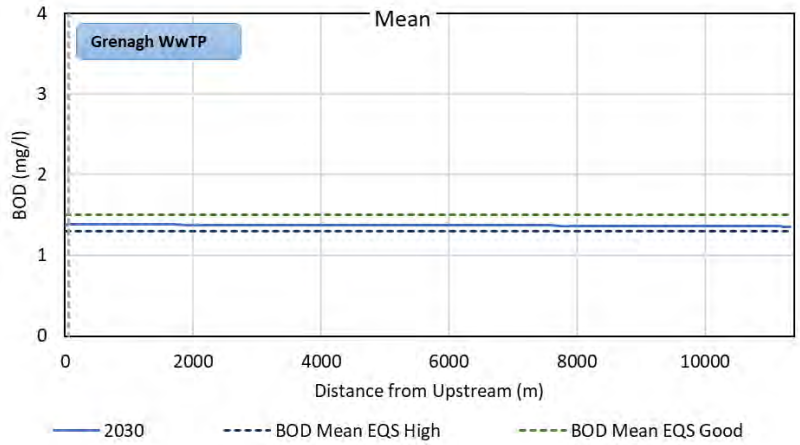
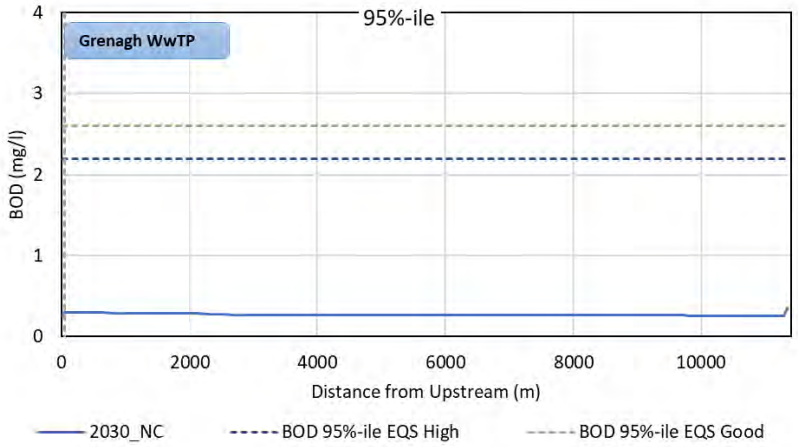


Figure 3-123 BOD Results for 2030 NC Scenario – Martin



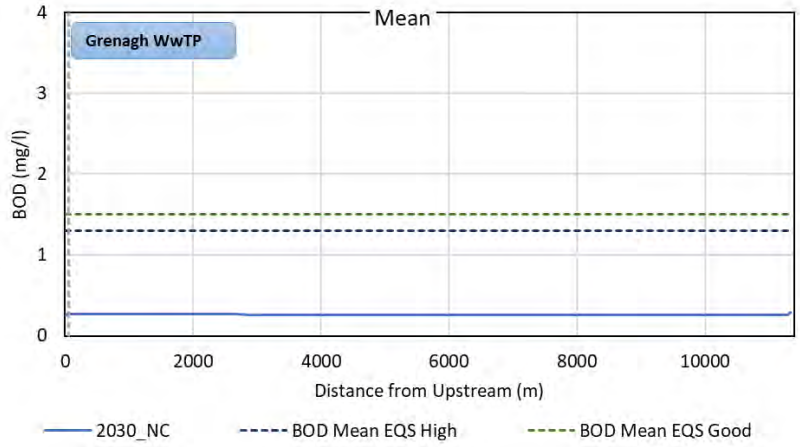
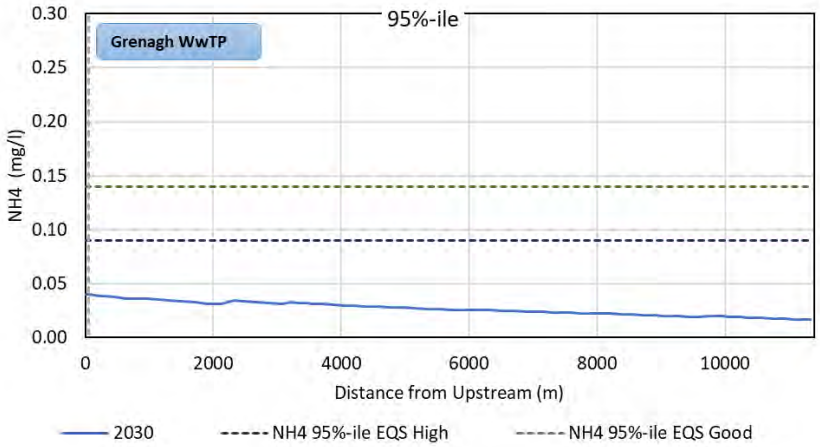


Figure 3-124 Ammonia Results for 2030 Scenario – Martin



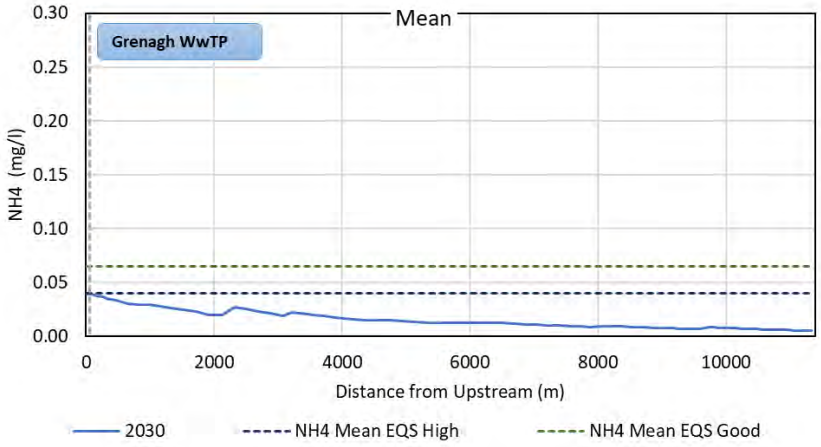
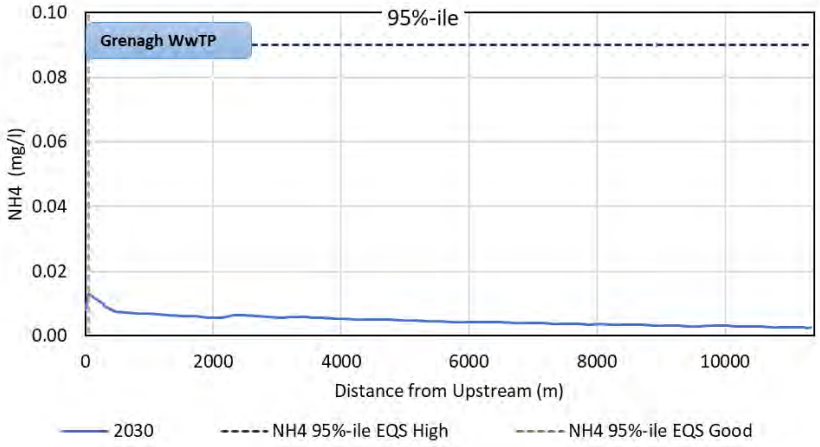


Figure 3-125 Ammonia Results for 2030 NC Scenario – Martin



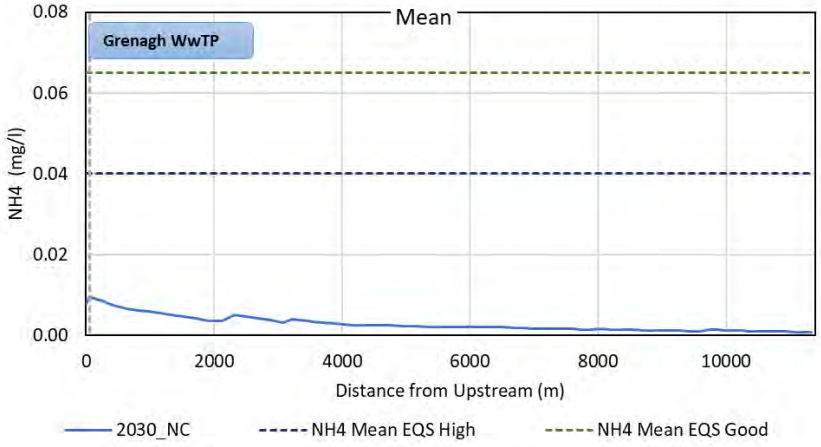
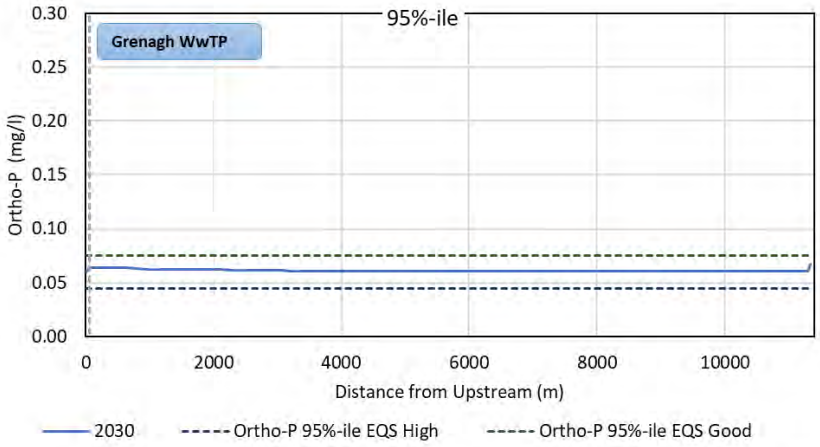


Figure 3-126 MRP Results for 2030 Scenario – Martin



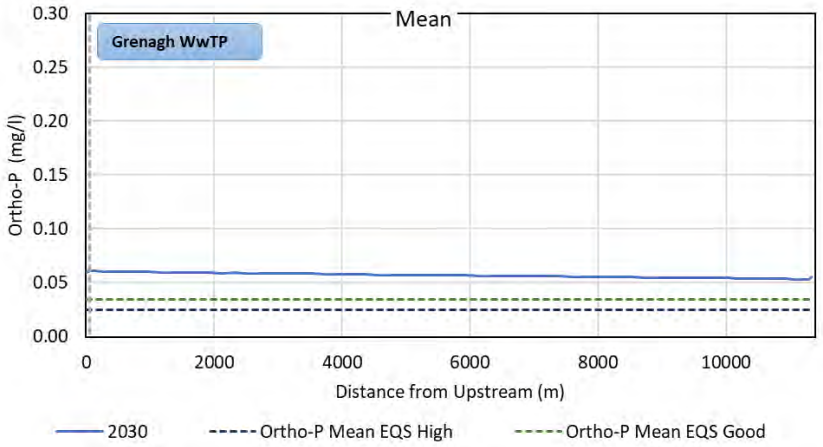
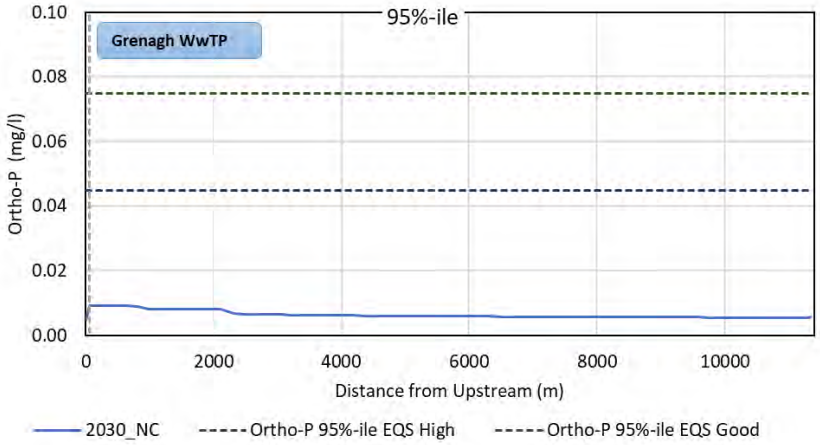


Figure 3-127 MRP Results for 2030 NC Scenario – Martin



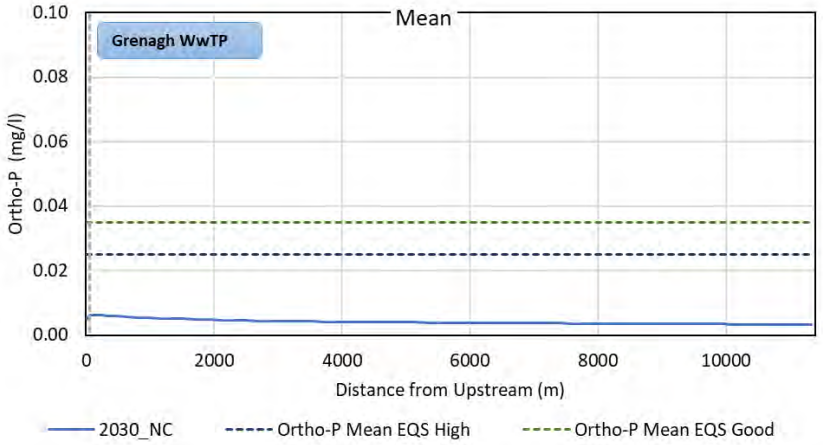
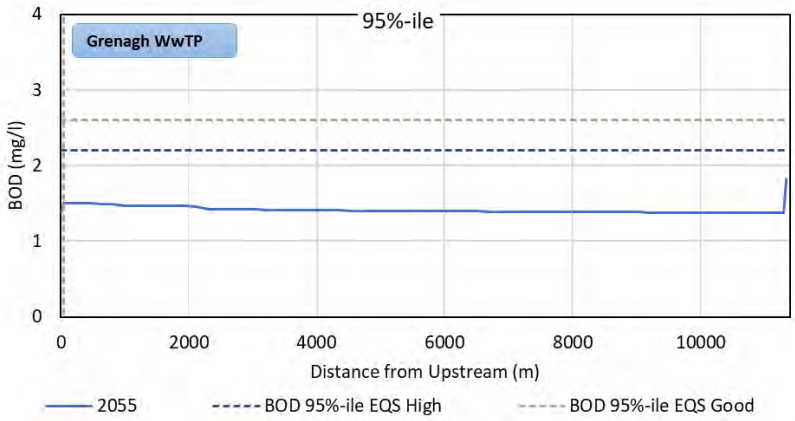


Figure 3-128 BOD Results for 2055 Scenario – Martin



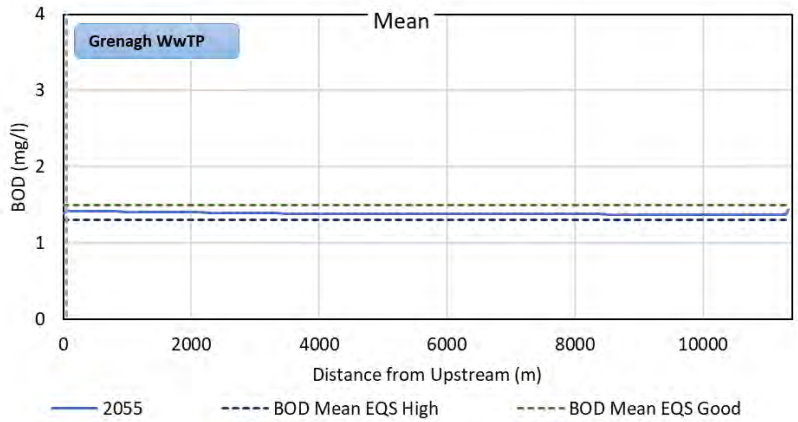
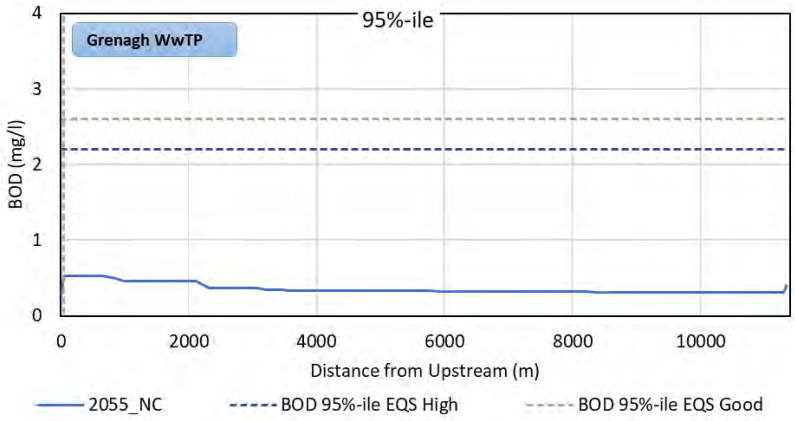


Figure 3-129 BOD Results for 2055 NC Scenario – Martin



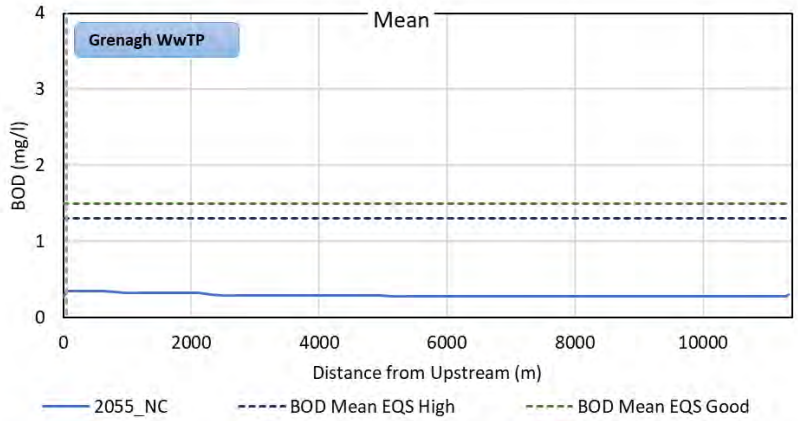
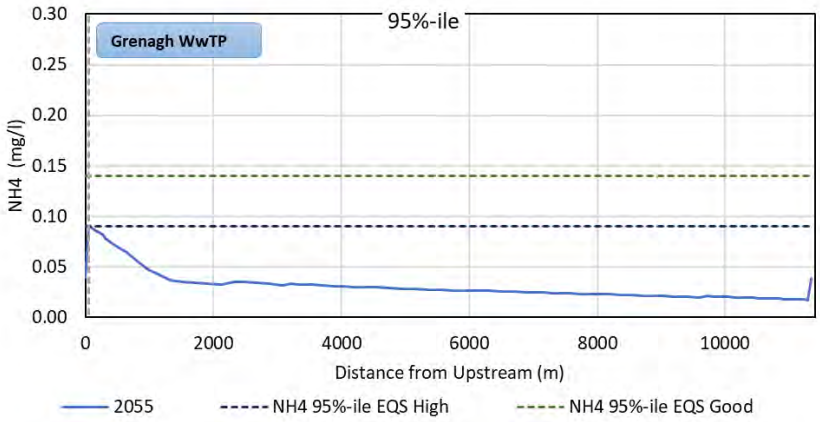


Figure 3-130 Ammonia Results for 2055 Scenario – Martin



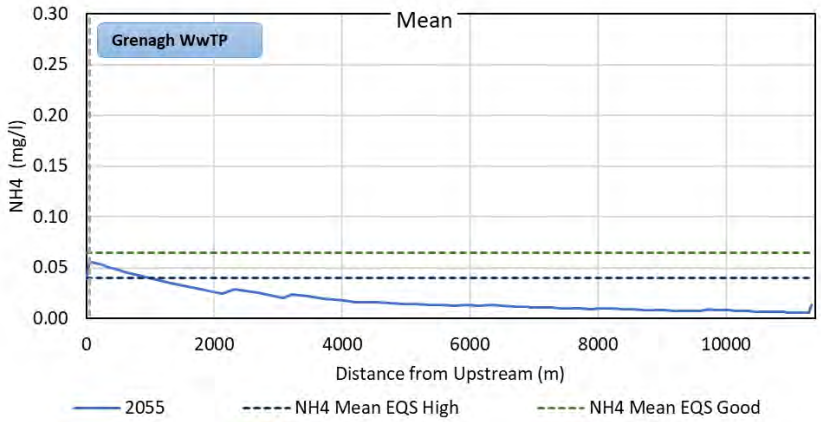
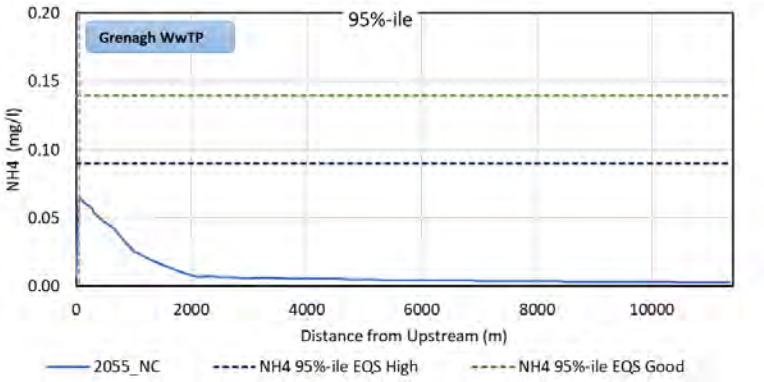


Figure 3-131 Ammonia Results for 2055 NC Scenario – Martin



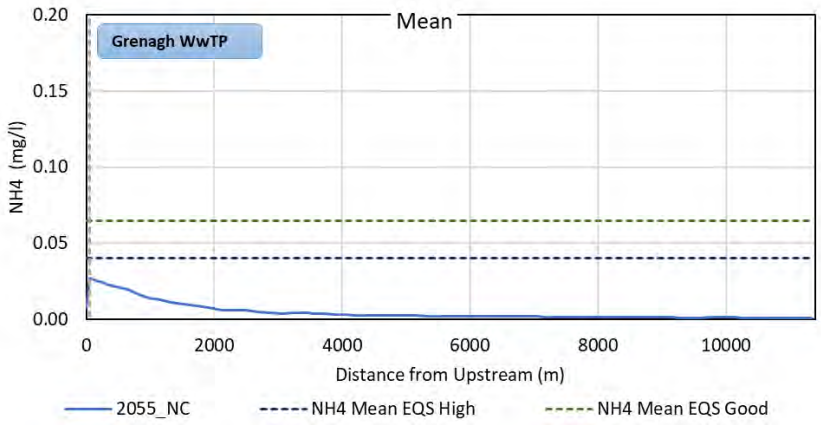
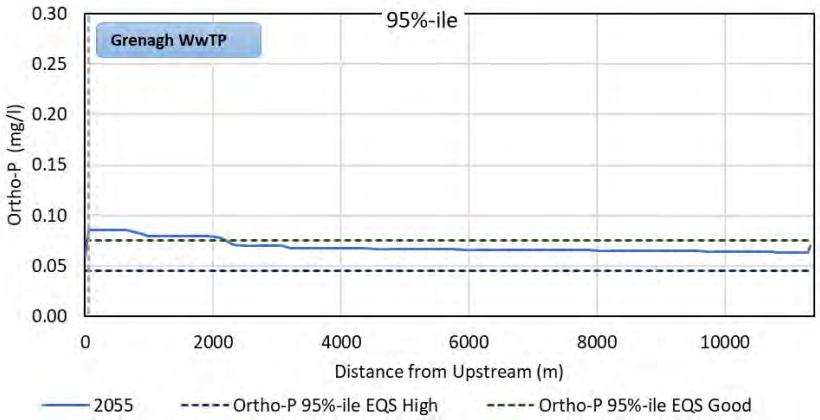


Figure 3-132 MRP Results for 2055 Scenario – Martin



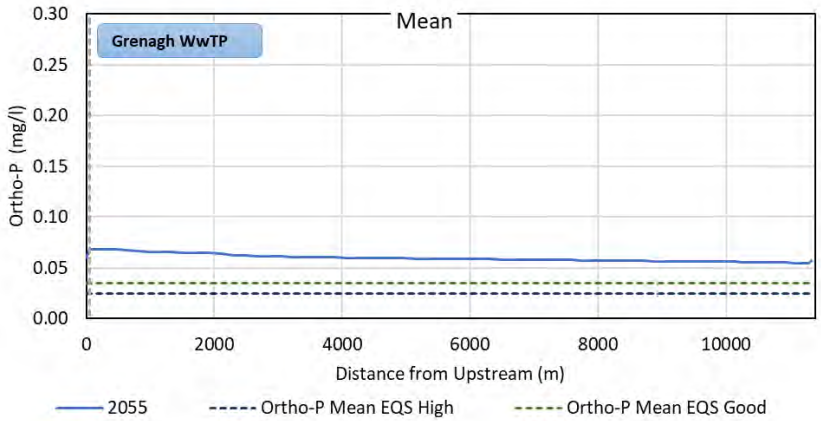
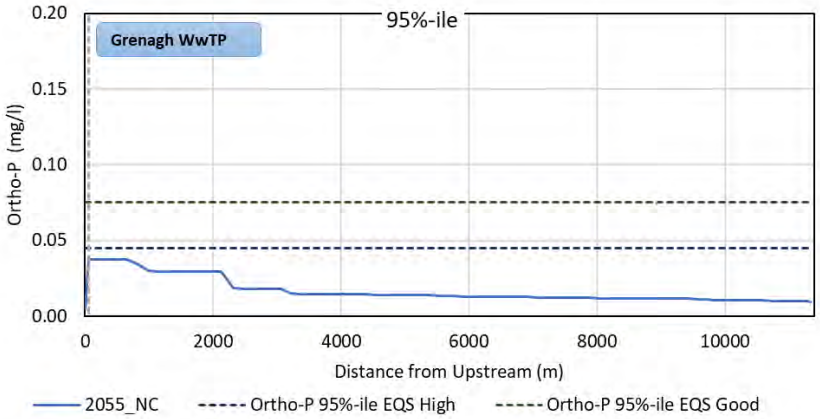


Figure 3-133 MRP Results for 2055 NC Scenario – Martin



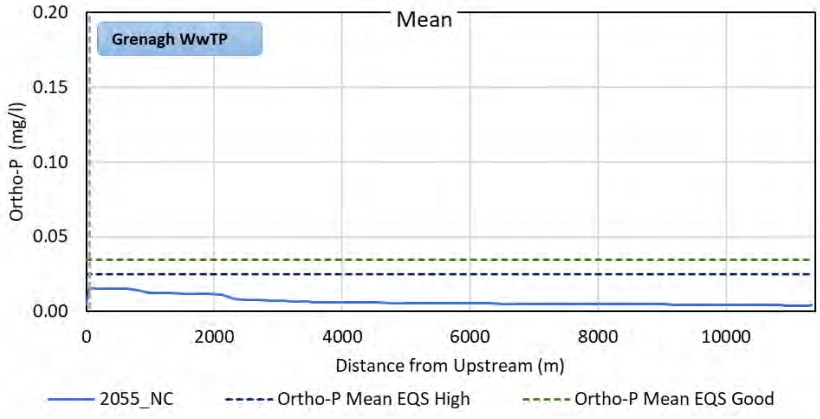
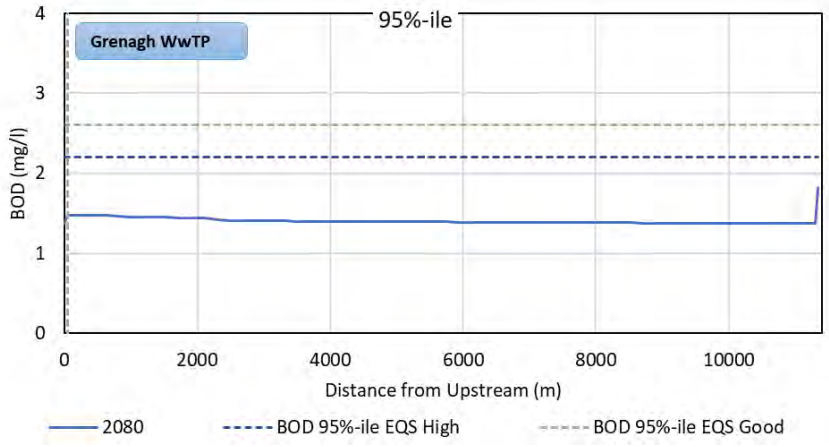


Figure 3-134 BOD Results for 2080 Scenario – Martin



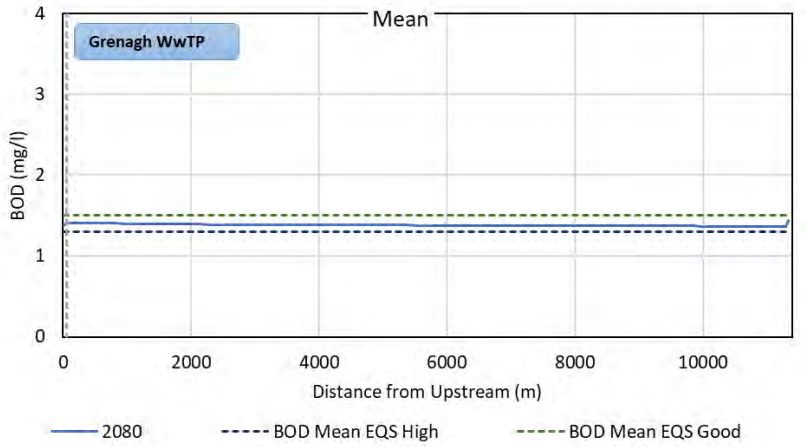
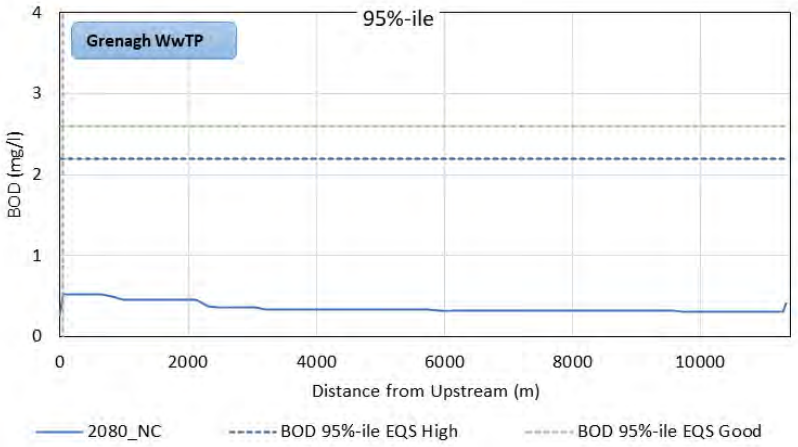


Figure 3-135 BOD Results for 2080 NC Scenario – Martin



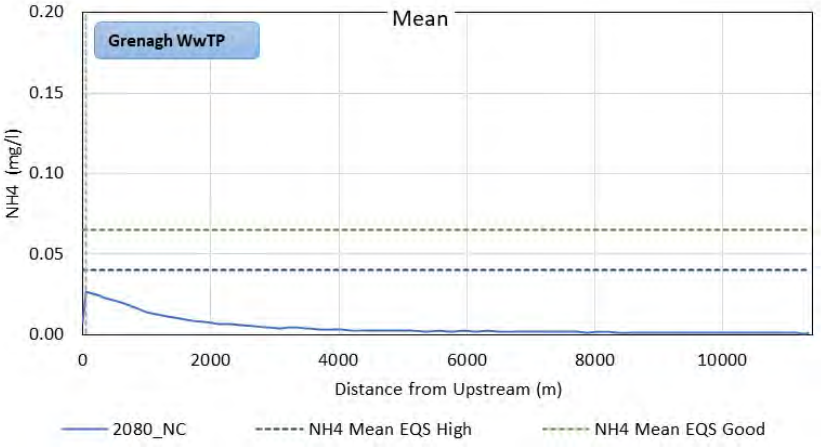
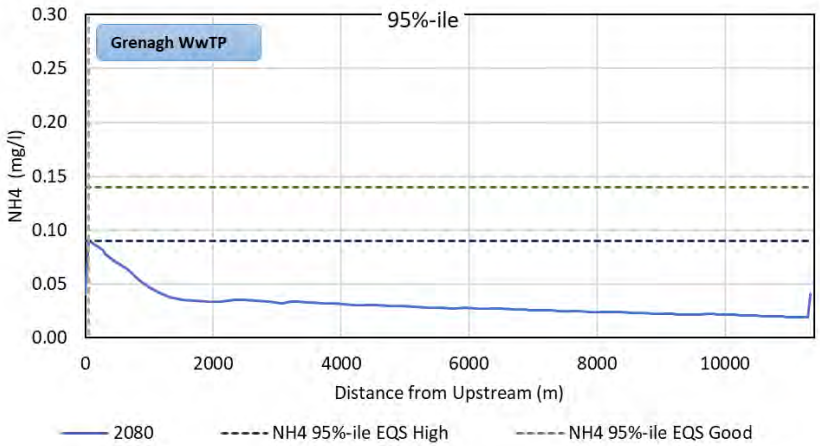


Figure 3-136 Ammonia Results for 2080 Scenario – Martin



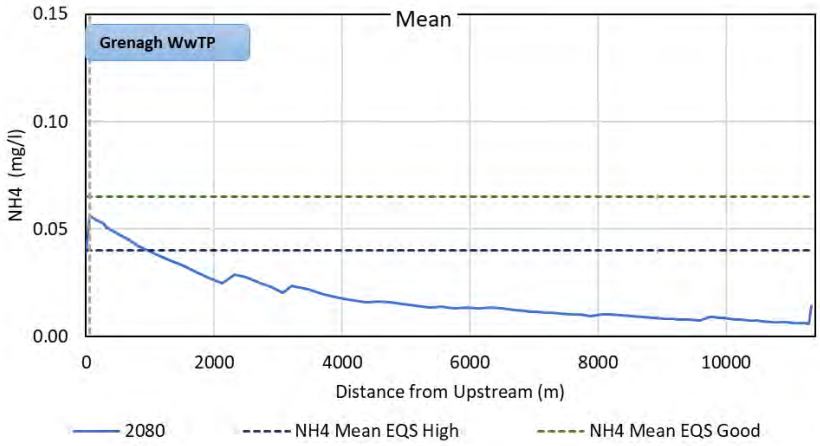
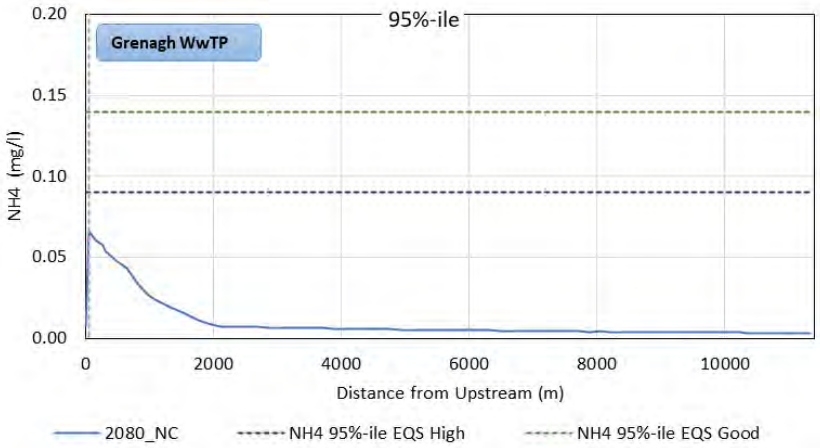


Figure 3-137 Ammonia Results for 2080 NC Scenario – Martin



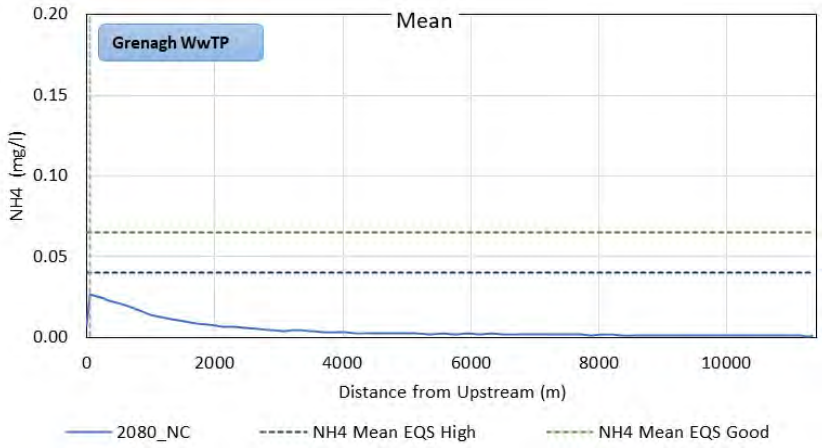
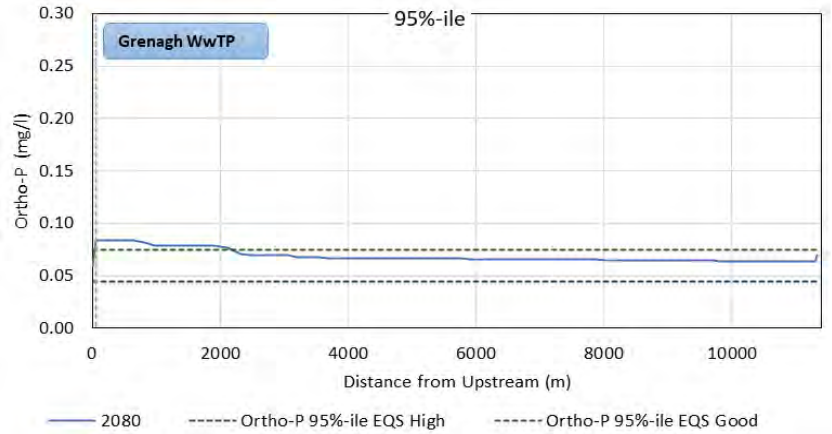


Figure 3-138 MRP Results for 2080 Scenario – Martin



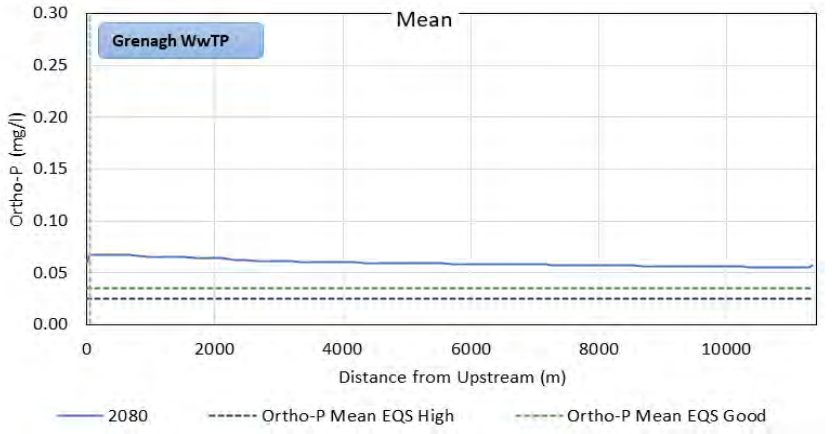
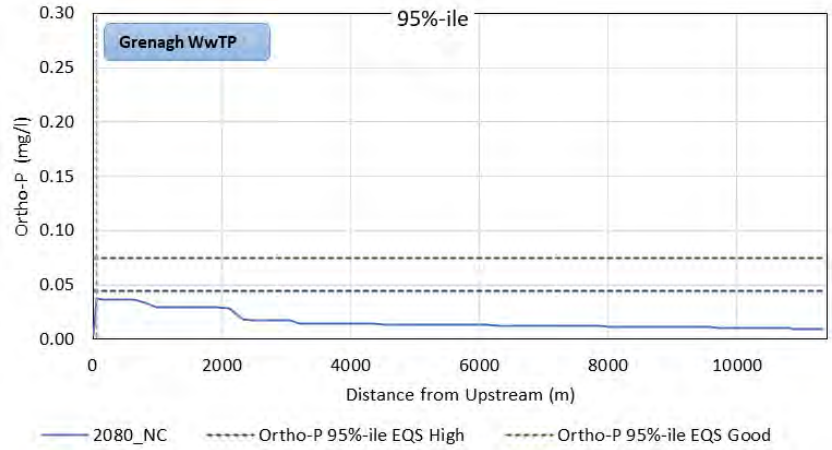


Figure 3-139 MRP Results for 2080 NC Scenario – Martin



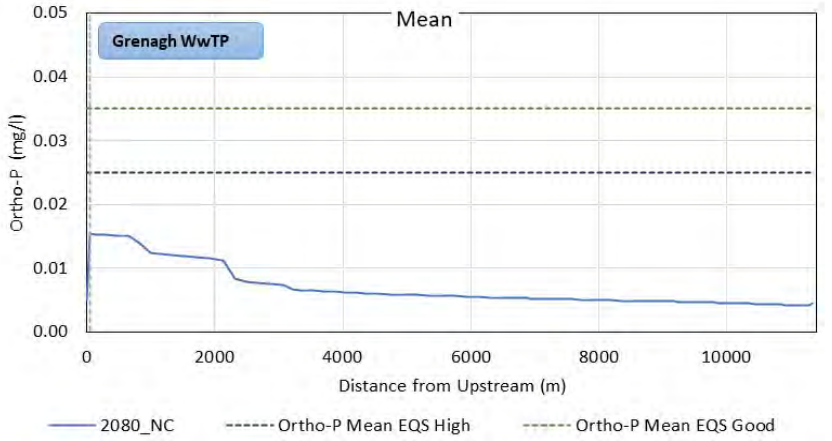
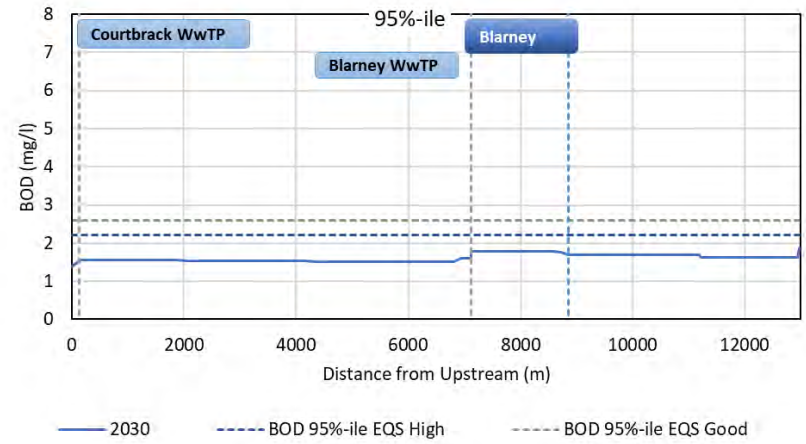


Figure 3-140 BOD Results for 2030 Scenario – Shournagh



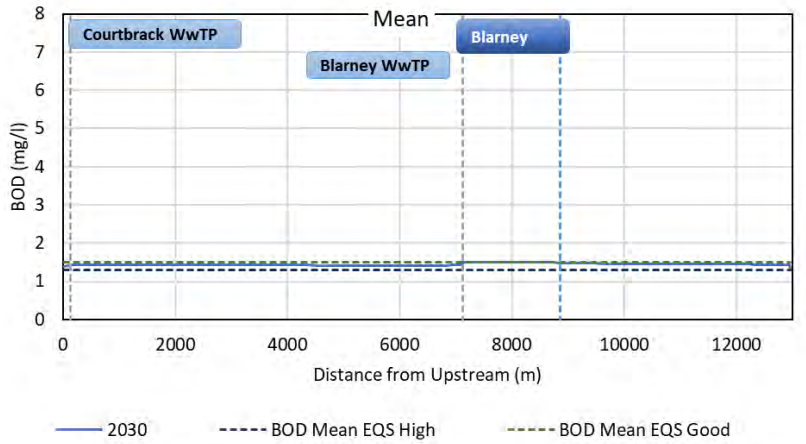
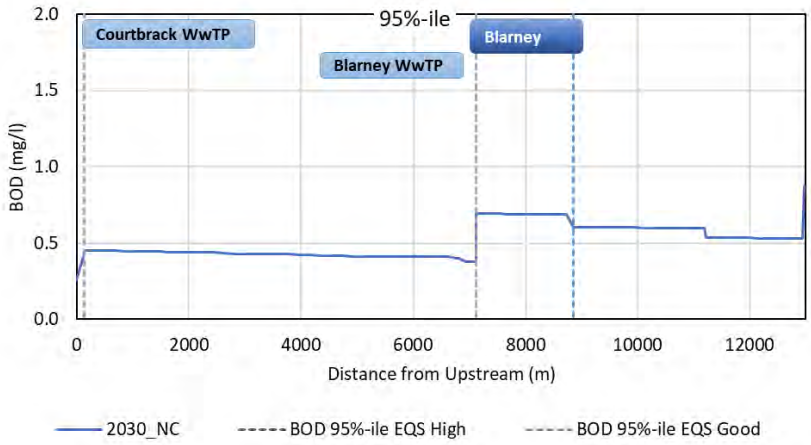


Figure 3-141 BOD Results for 2030 NC Scenario – Shournagh



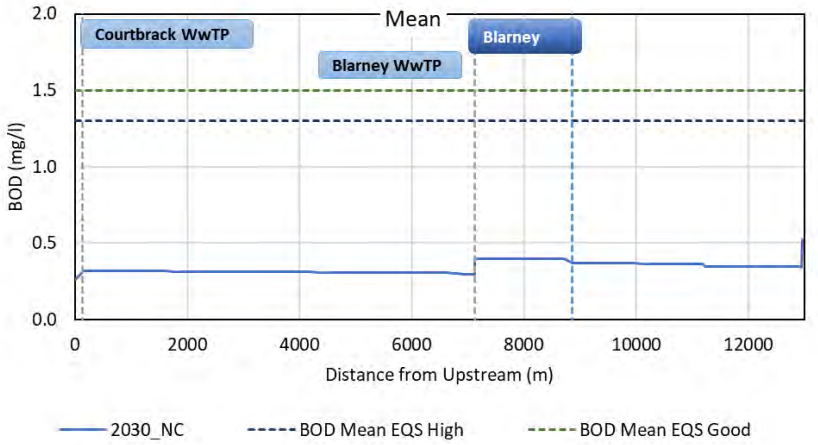
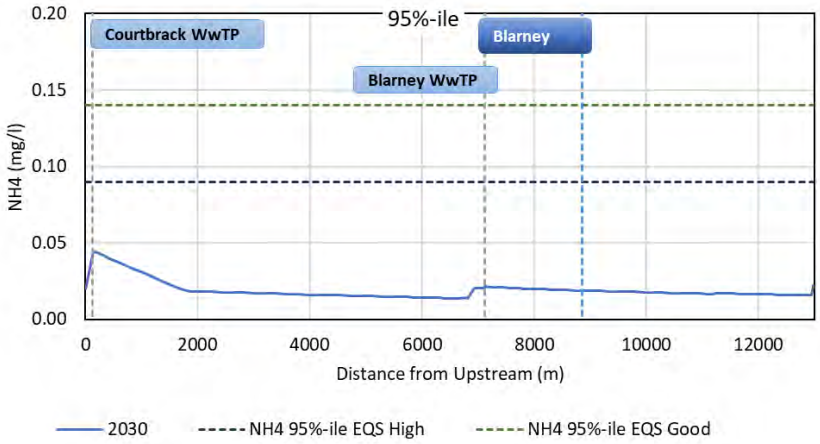


Figure 3-142 Ammonia Results for 2030 Scenario – Shournagh



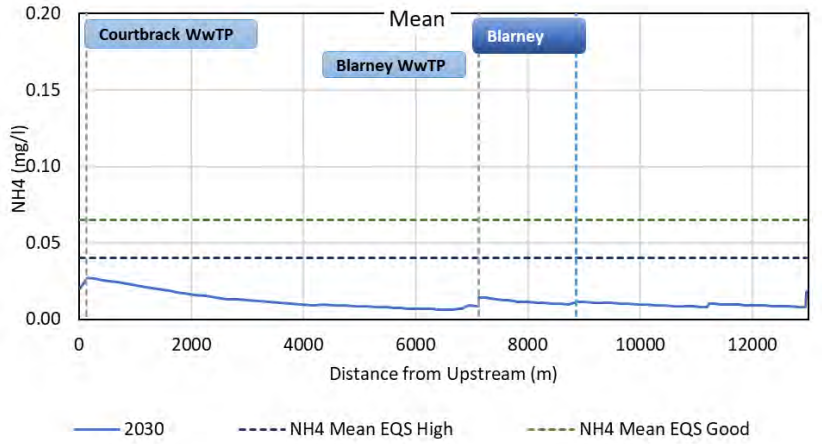
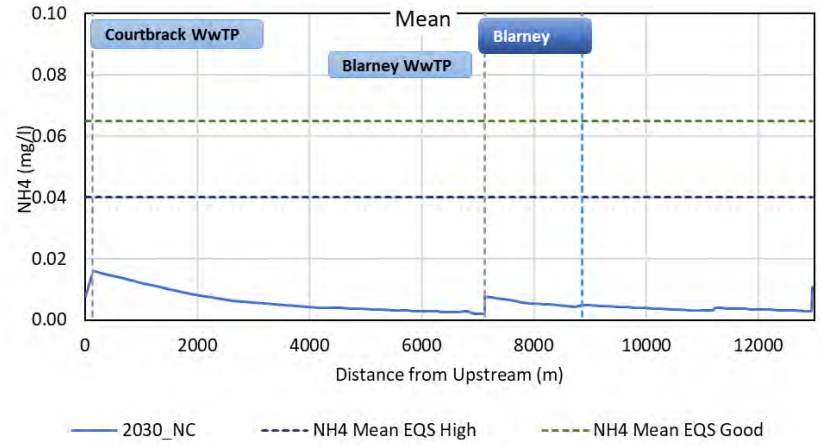


Figure 3-143 Ammonia Results for 2030 NC Scenario – Shournagh



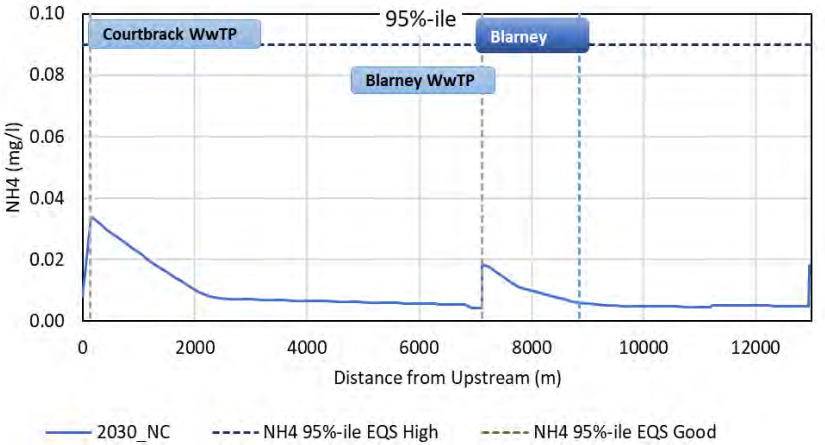
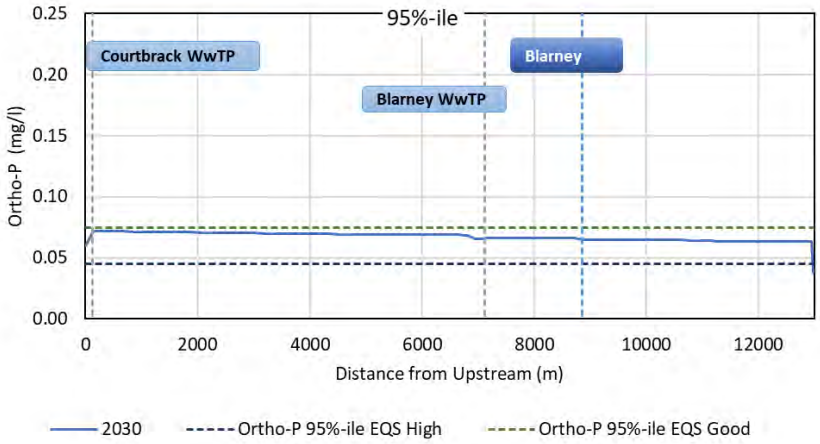


Figure 3-144 MRP Results for 2030 Scenario – Shournagh



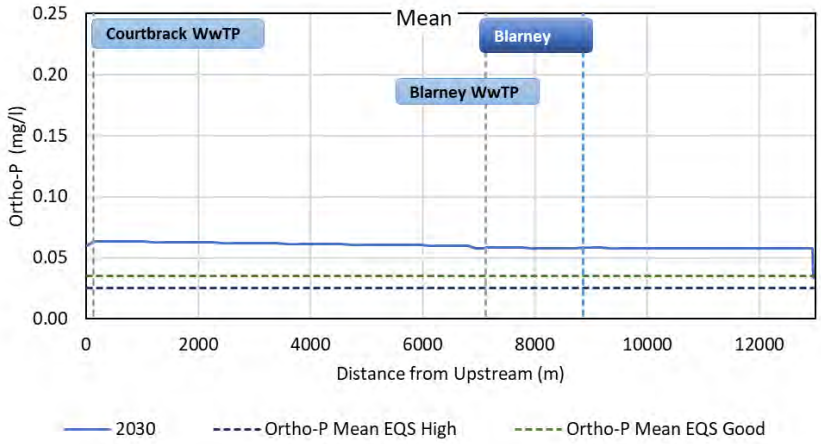
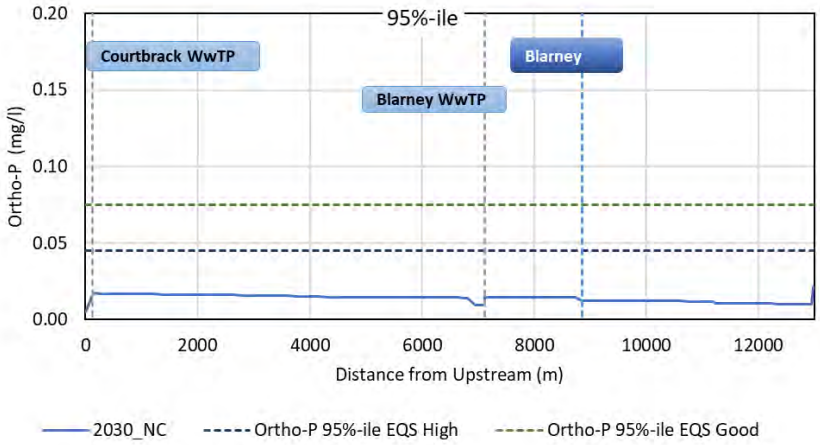


Figure 3-145 MRP Results for 2030 NC Scenario – Shournagh



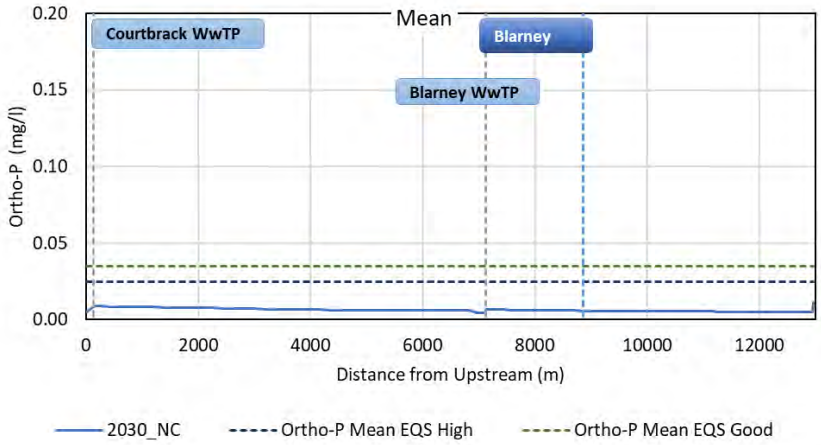
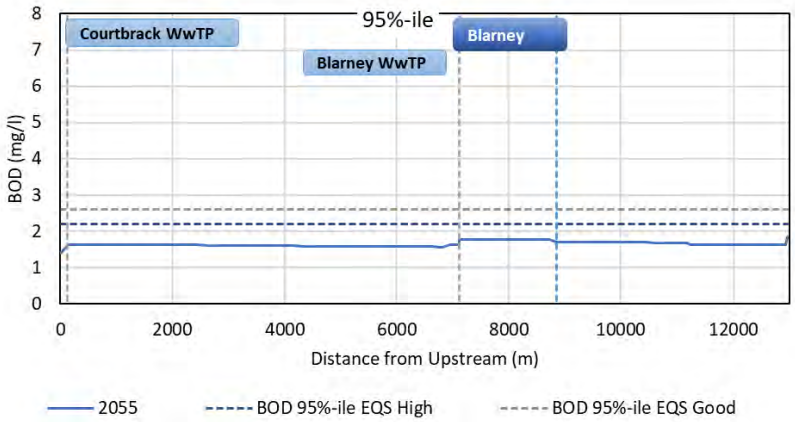


Figure 3-146 BOD Results for 2055 Scenario – Shournagh



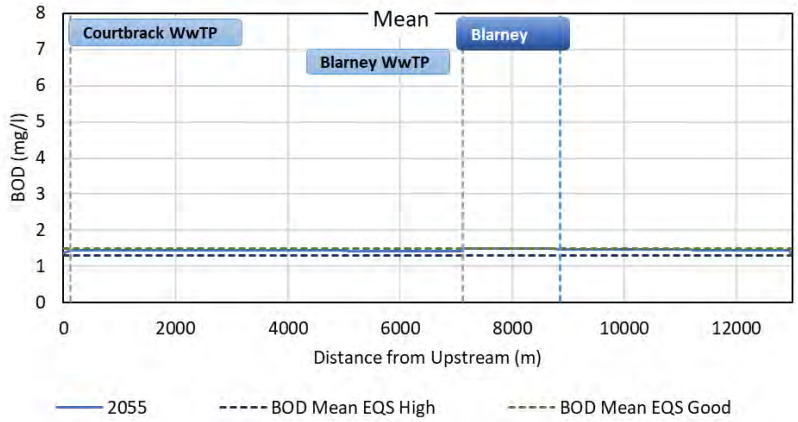
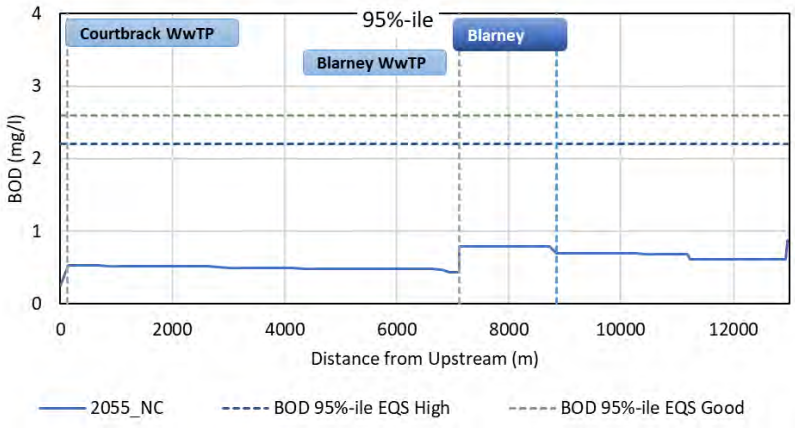


Figure 3-147 BOD Results for 2055 NC Scenario – Shournagh



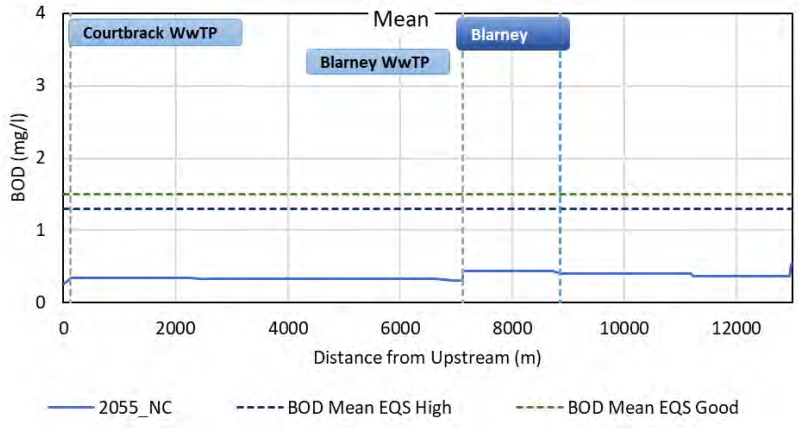
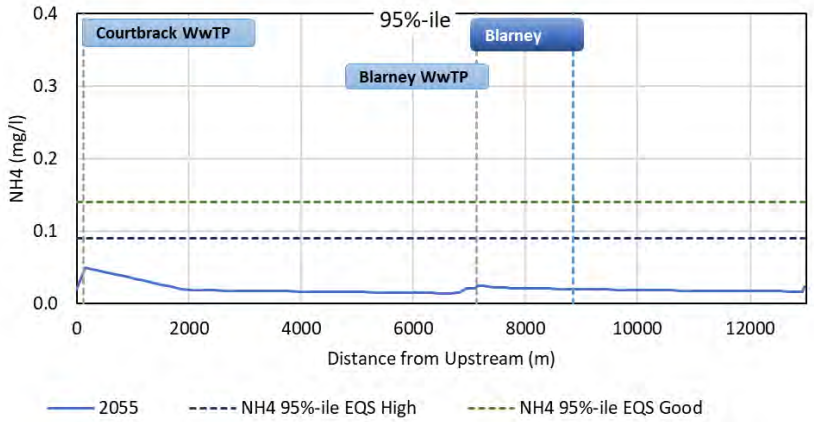


Figure 3-148 Ammonia Results for 2055 Scenario – Shournagh



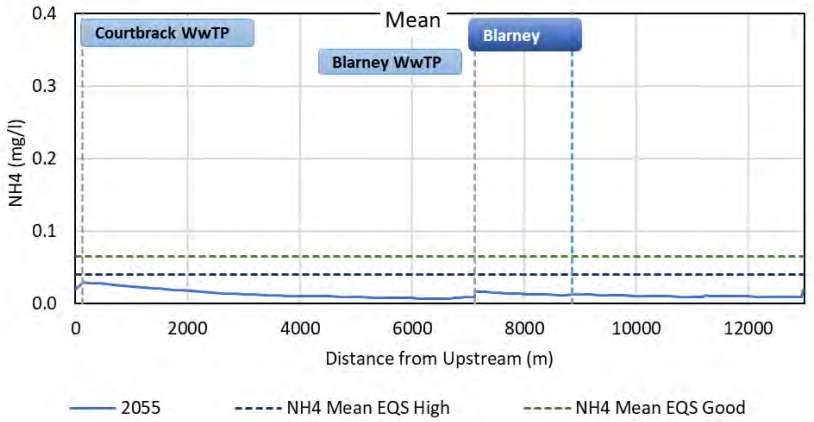
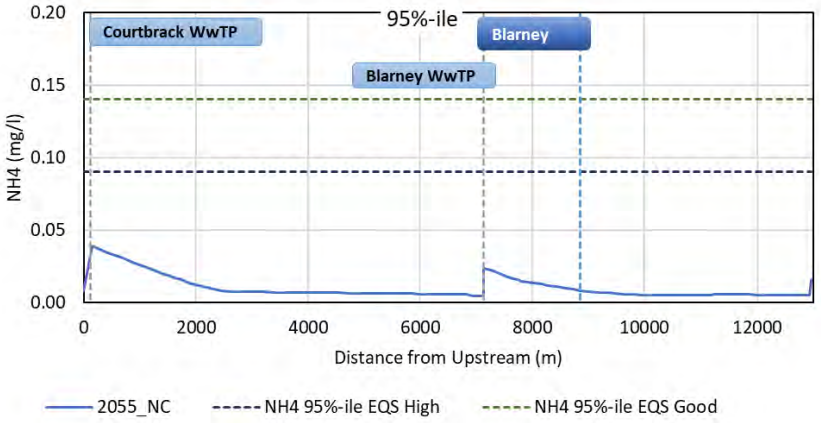


Figure 3-149 Ammonia Results for 2055 NC Scenario – Shournagh



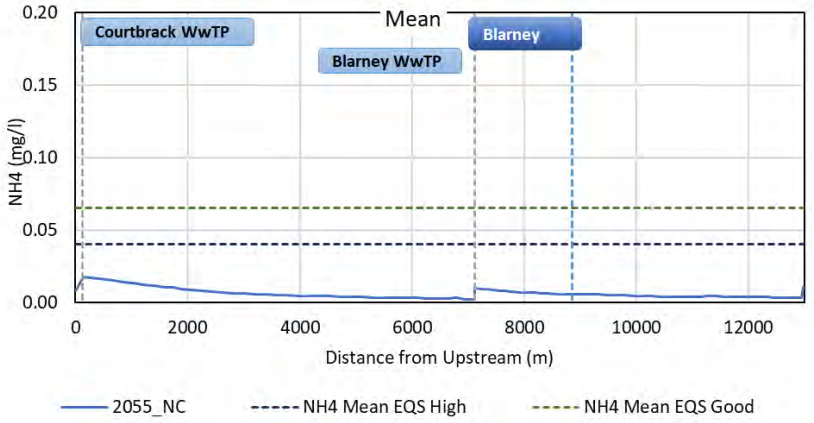
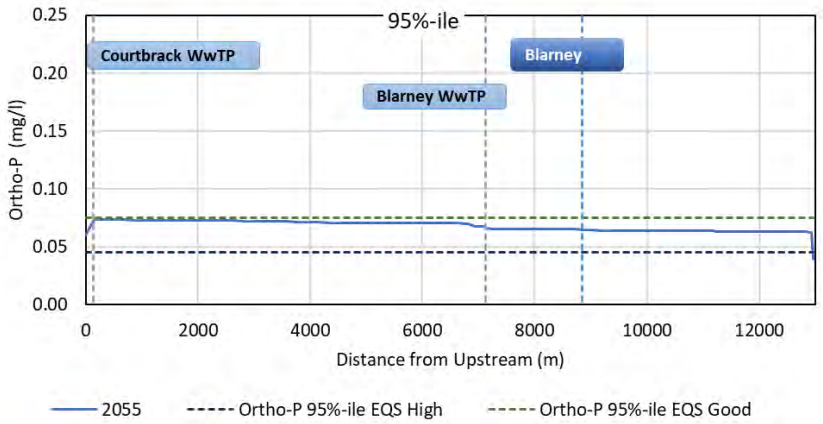


Figure 3-150 MRP Results for 2055 Scenario – Shournagh



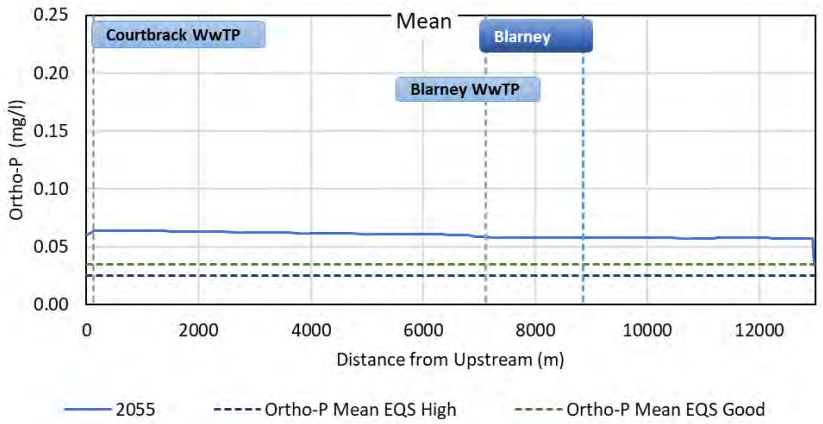
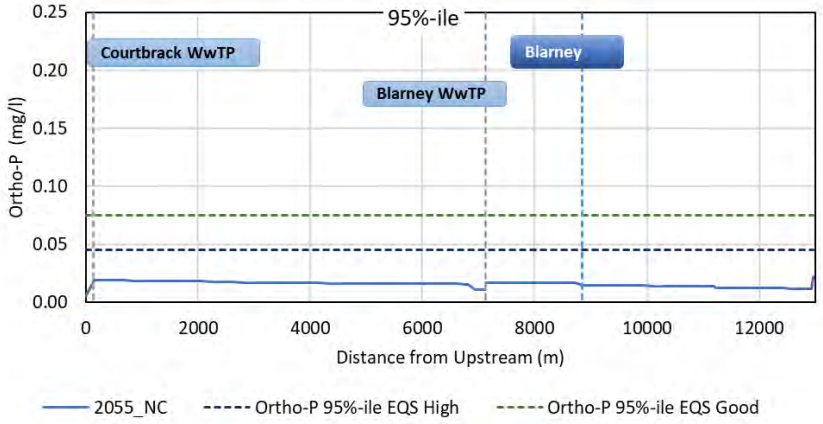


Figure 3-151 MRP Results for 2055 NC Scenario – Shournagh



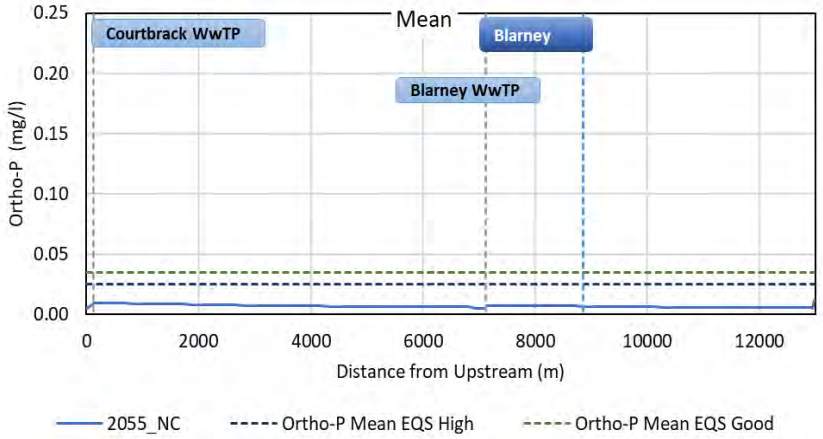
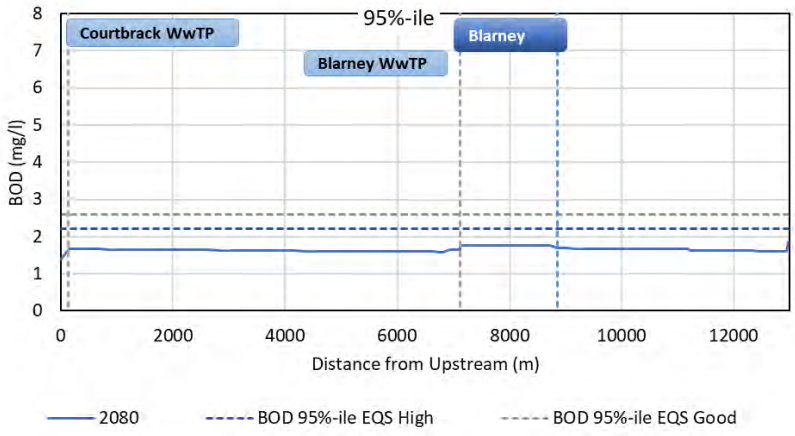


Figure 3-152 BOD Results for 2080 Scenario – Shournagh



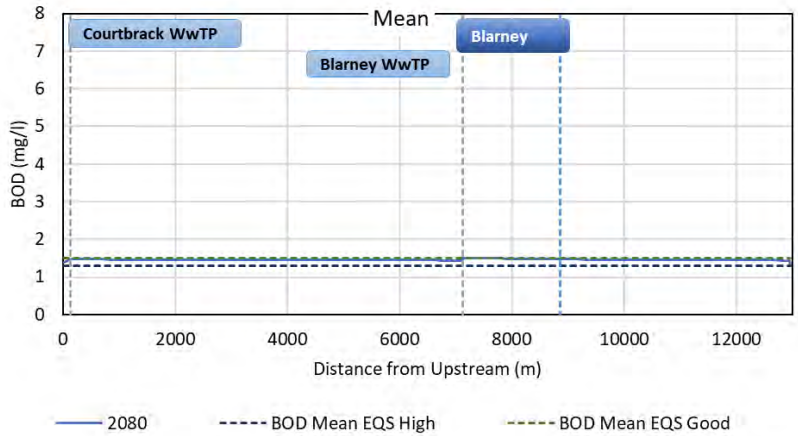
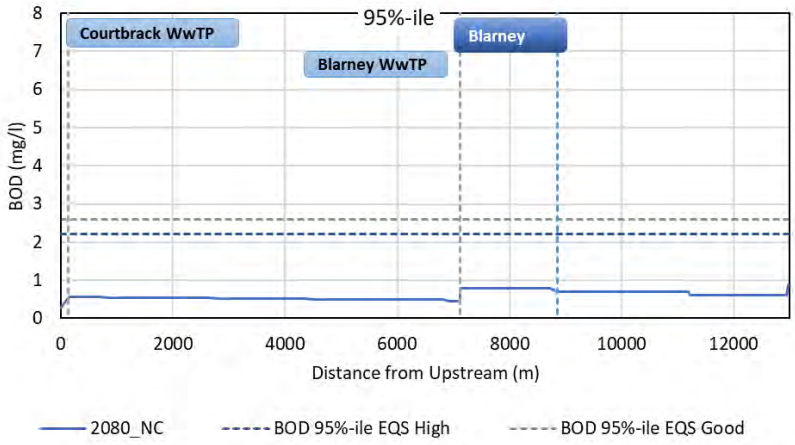


Figure 3-153 BOD Results for 2080 NC Scenario – Shournagh



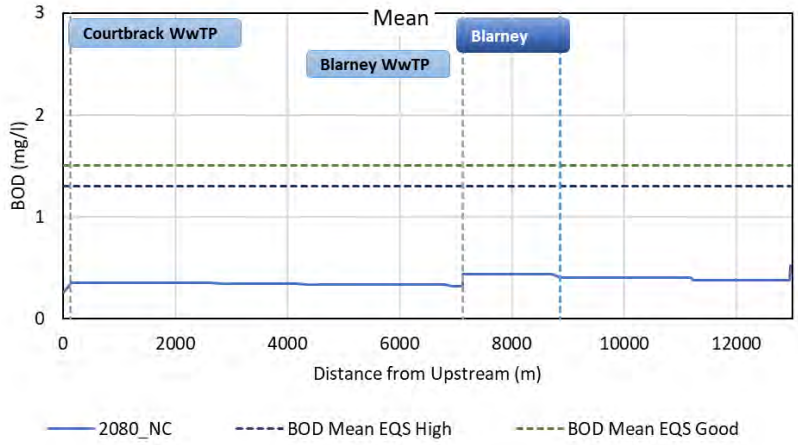
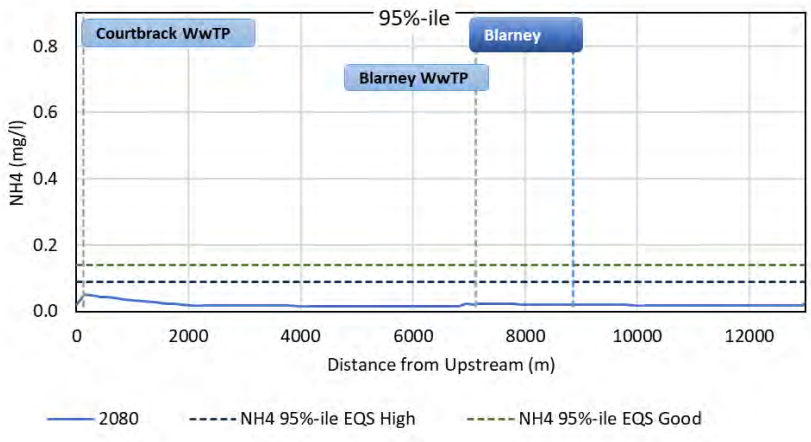


Figure 3-154 Ammonia Results for 2080 Scenario – Shournagh



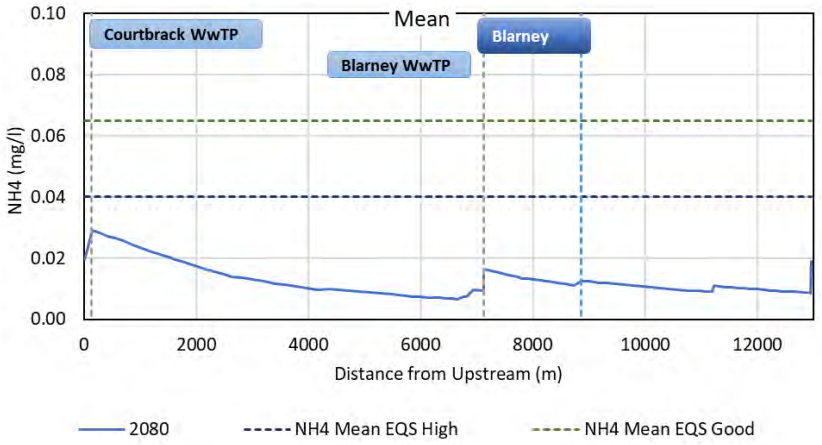
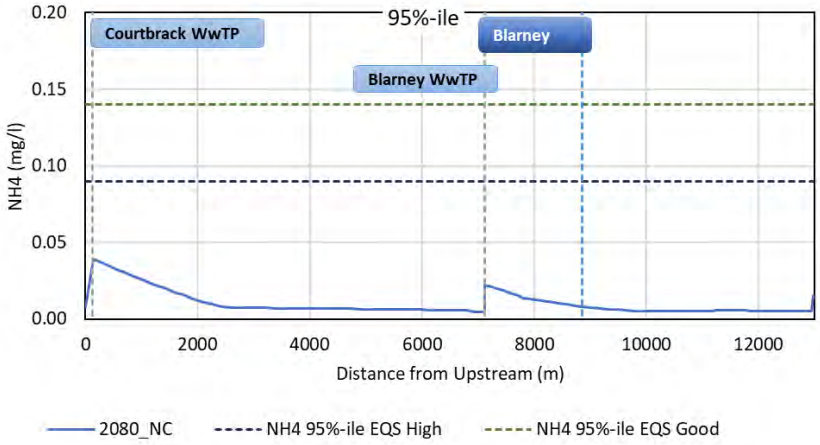


Figure 3-155 Ammonia Results for 2080 NC Scenario – Shournagh



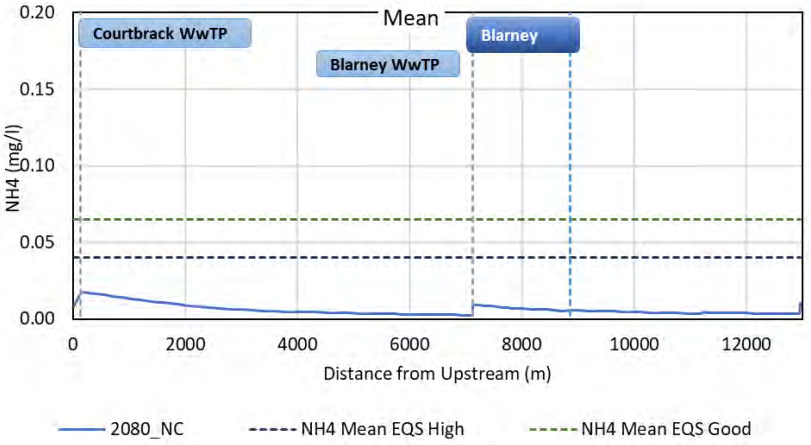


Figure 3-156 MRP Results for 2080 Scenario – Shournagh

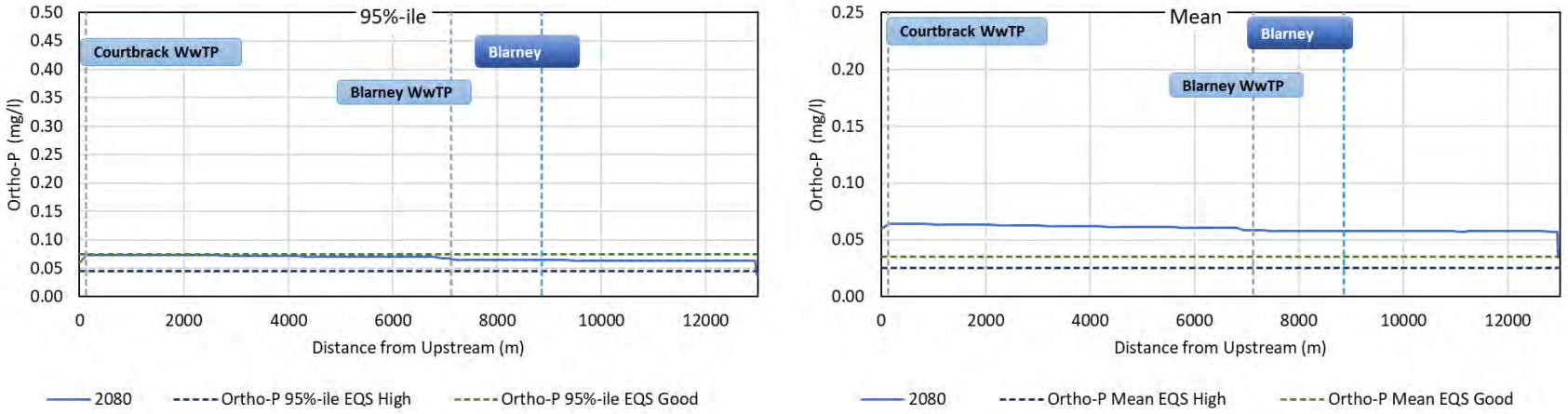


Figure 3-157 MRP Results for 2080 NC Scenario – Shournagh

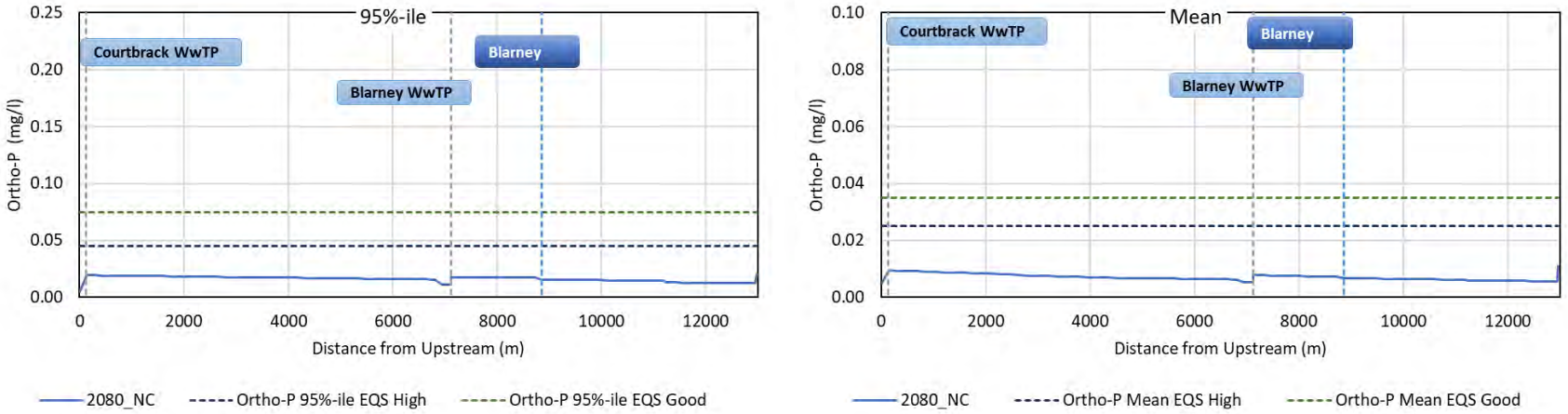
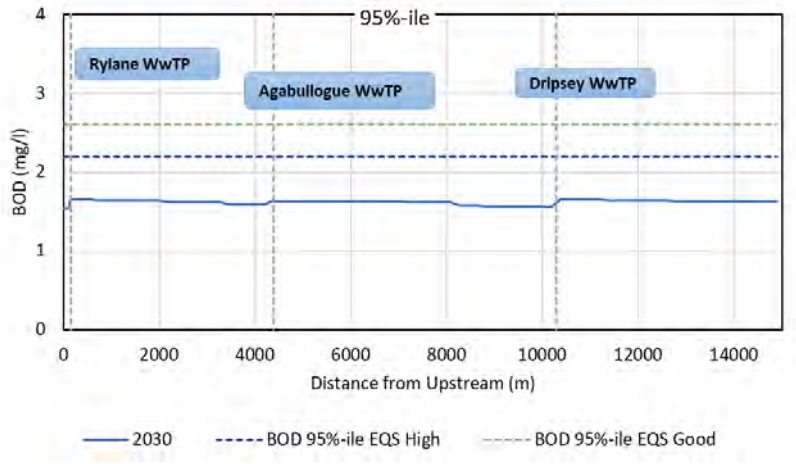


Figure 3-158 BOD Results for 2030 Scenario – Dripsey



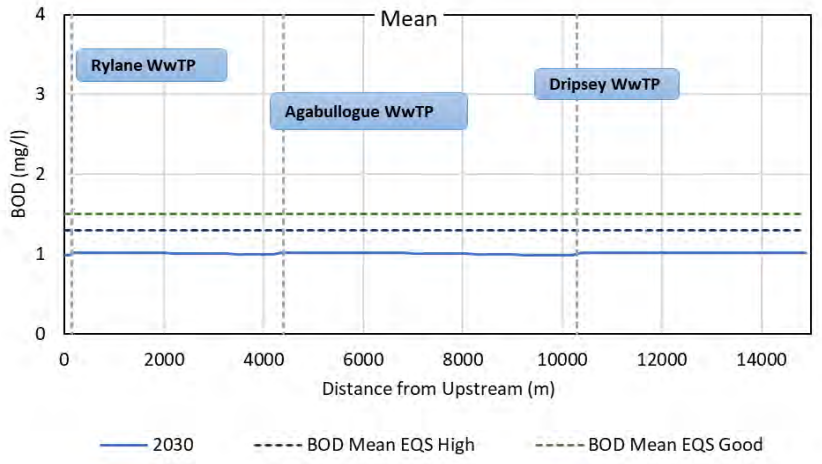
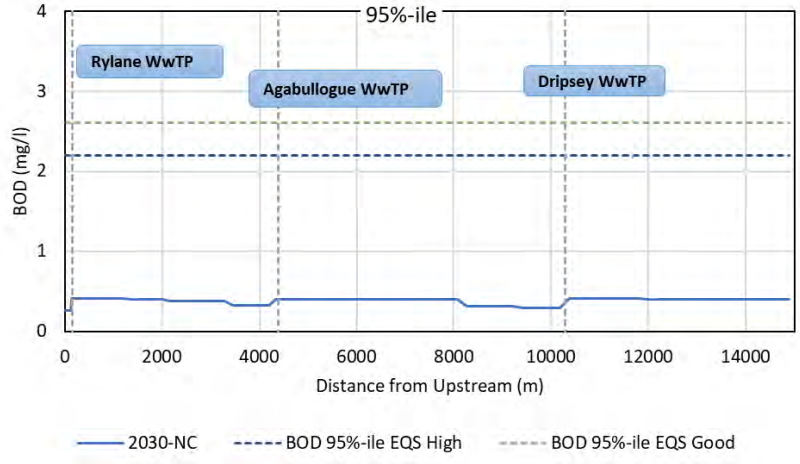


Figure 3-159 BOD Results for 2030 NC Scenario – Dripsey



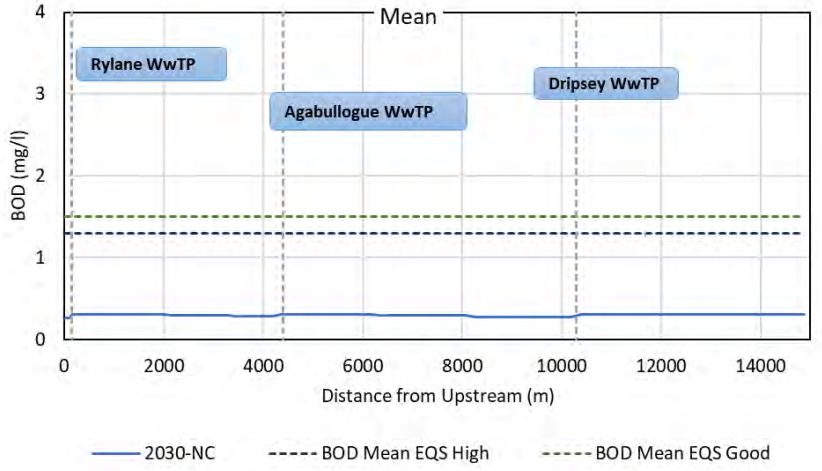


Figure 3-160 Ammonia Results for 2030 Scenario – Dripsey

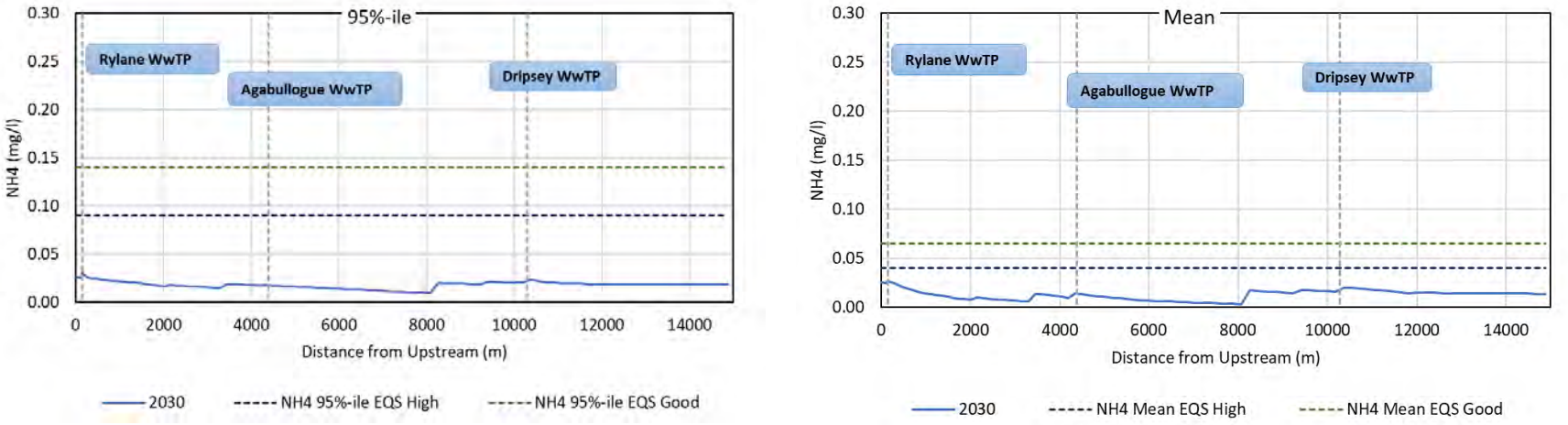


Figure 3-161 Ammonia Results for 2030 NC Scenario – Dripsey

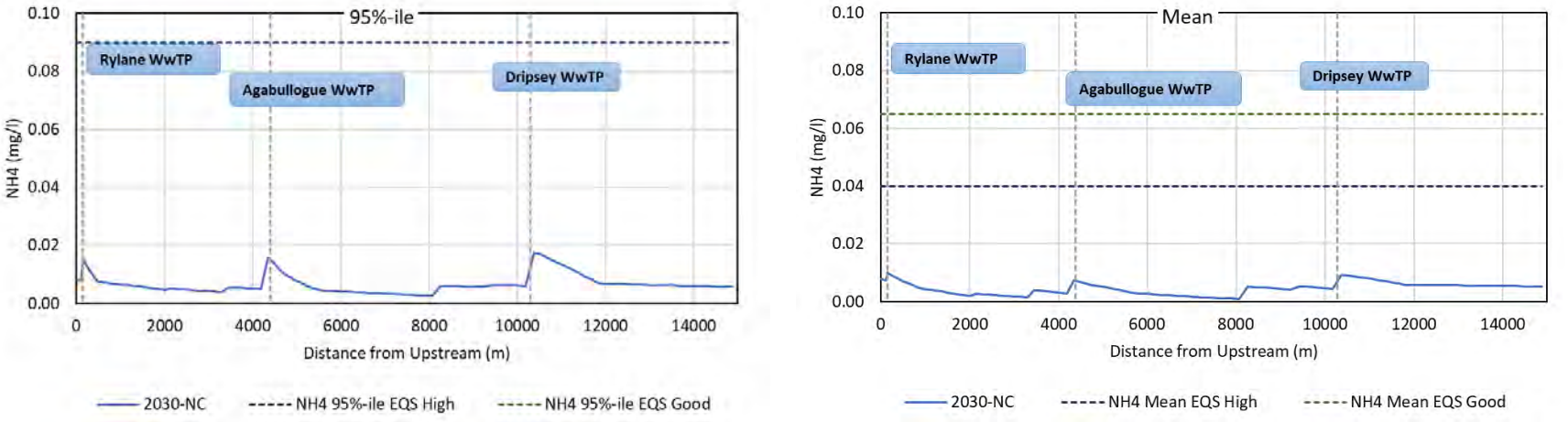
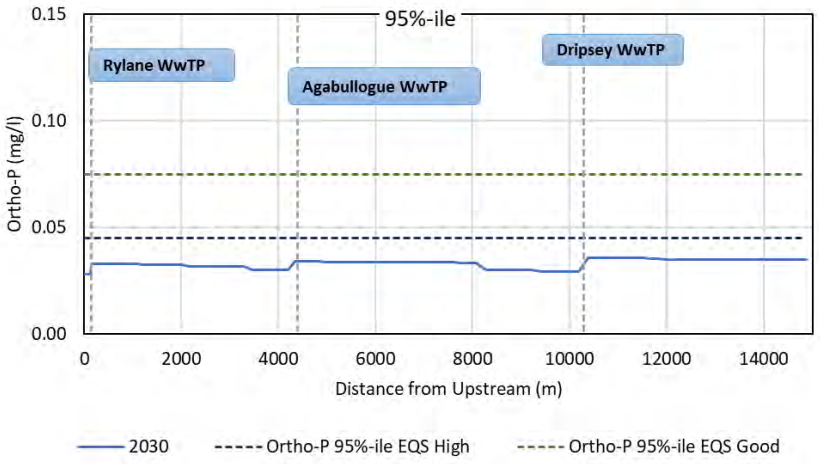


Figure 3-162 MRP Results for 2030 Scenario – Dripsey



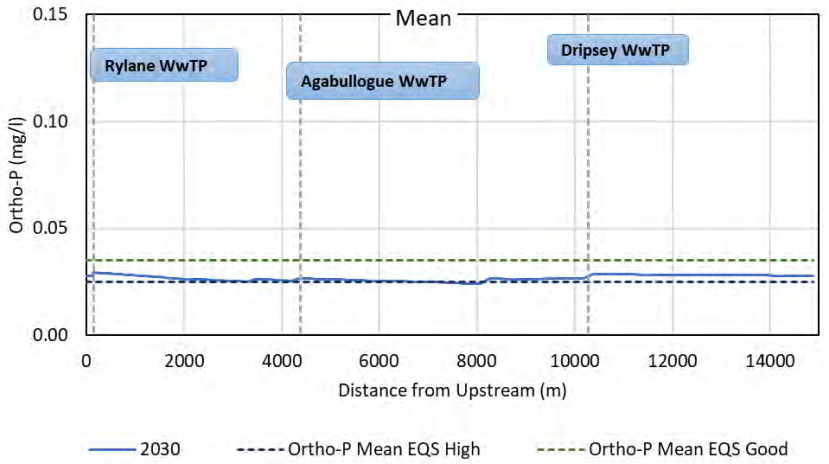
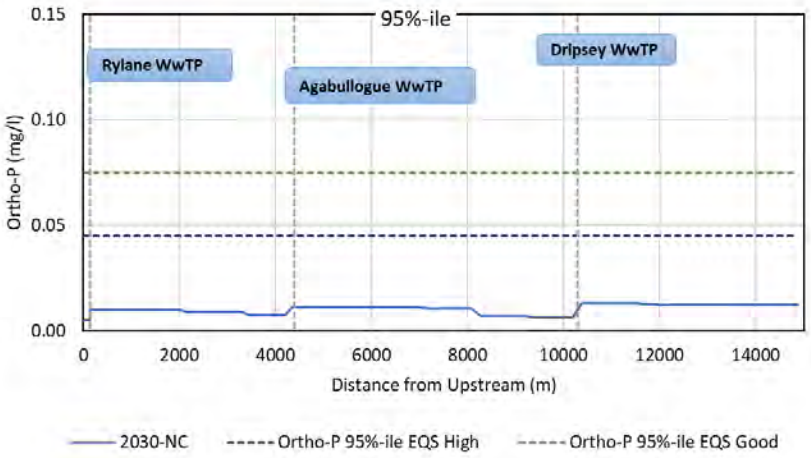


Figure 3-163 MRP Results for 2030 NC Scenario – Dripsey



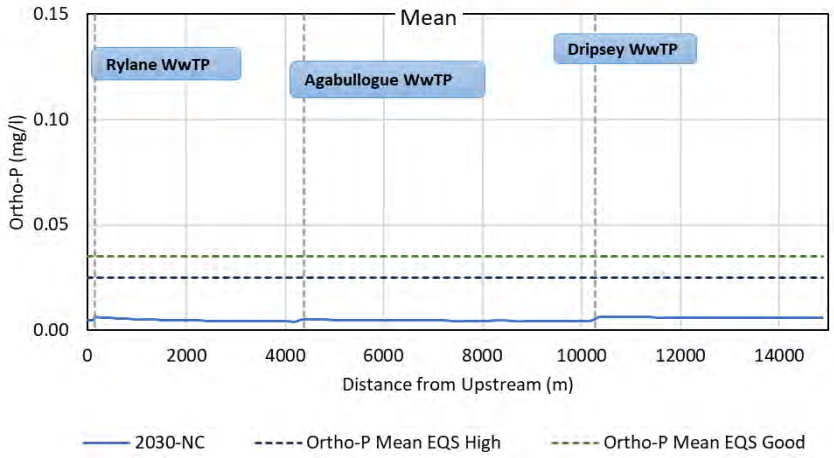
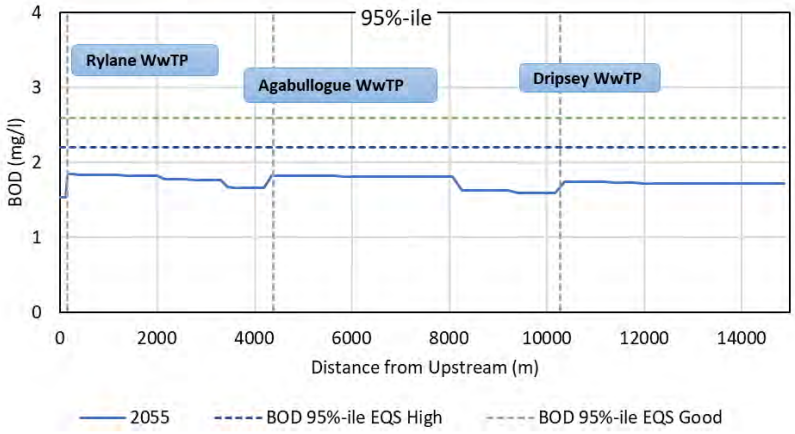


Figure 3-164 BOD Results for 2055 Scenario – Dripsey



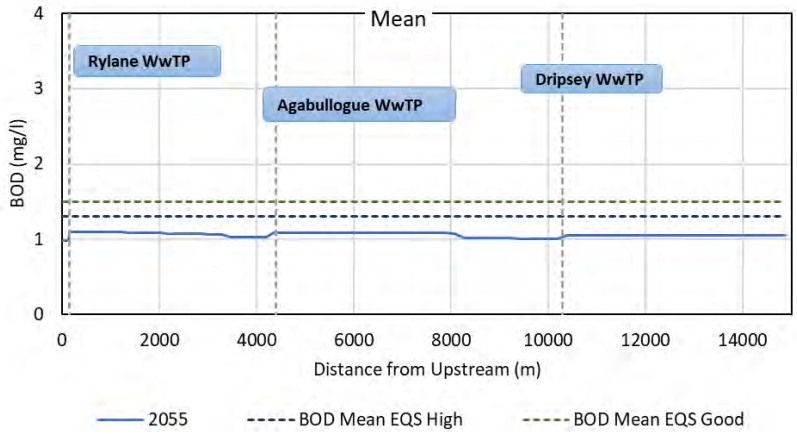
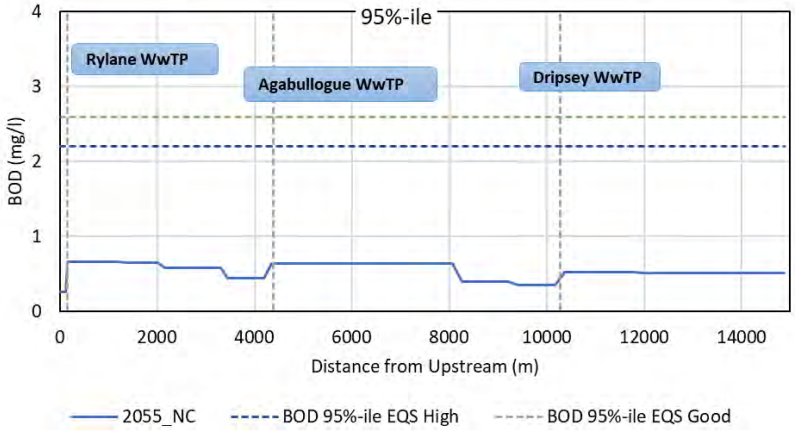


Figure 3-165 BOD Results for 2055 NC Scenario – Dripsey



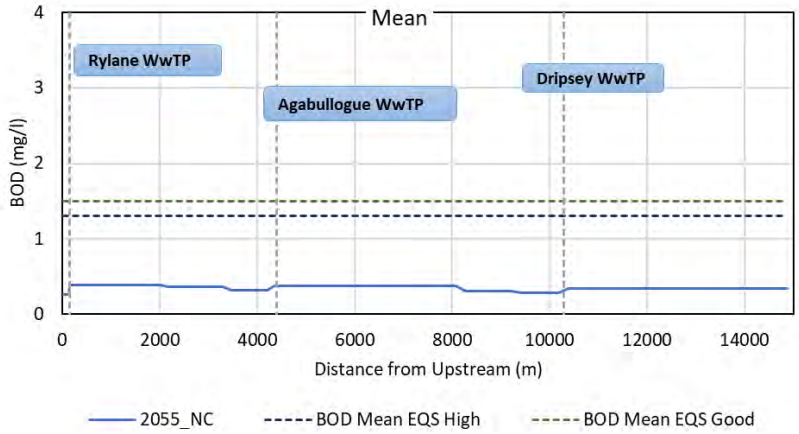
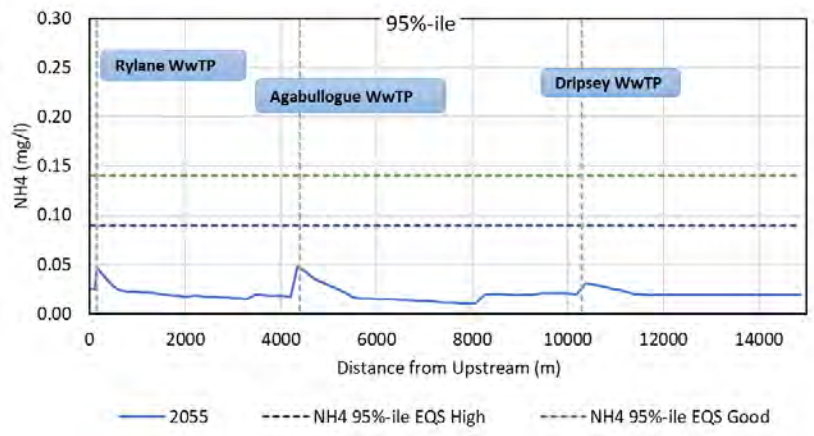


Figure 3-166 Ammonia Results for 2055 Scenario – Dripsey



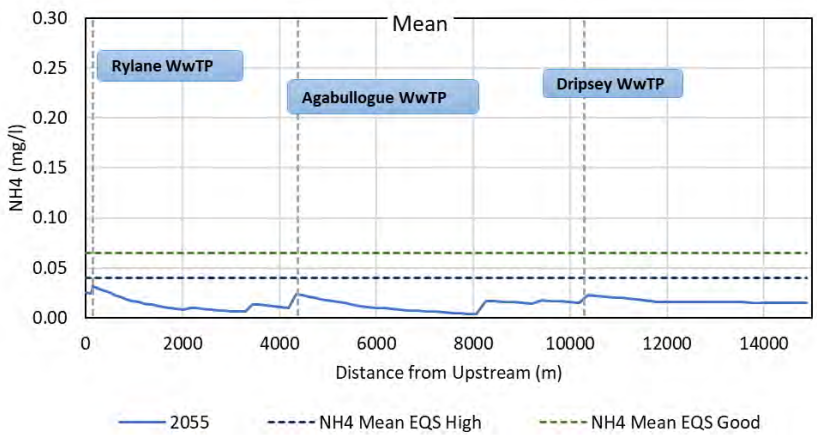
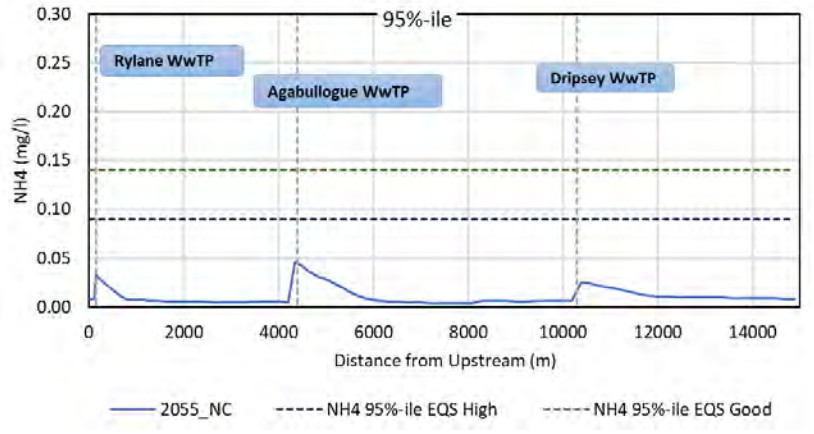


Figure 3-167 Ammonia Results for 2055 NC Scenario – Dripsey



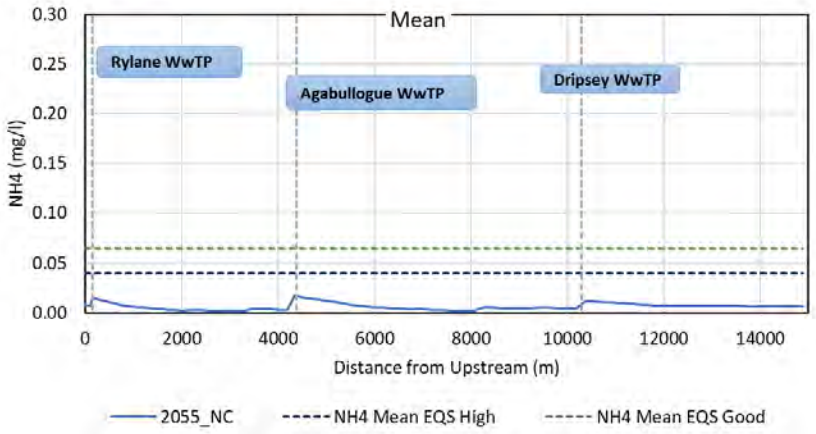
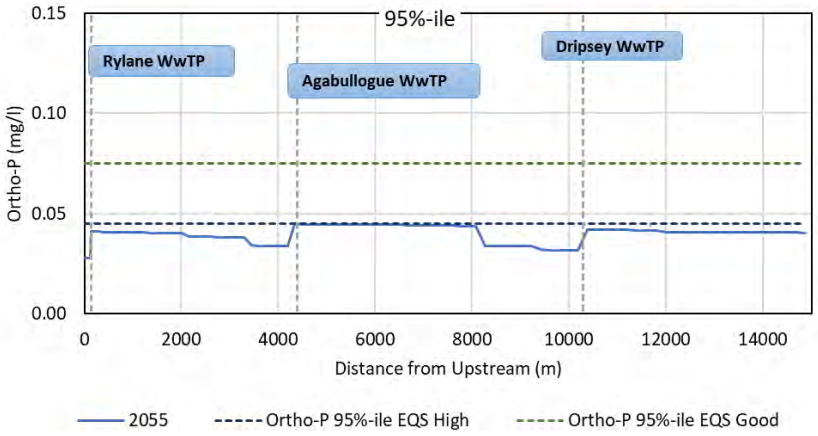


Figure 3-168 MRP Results for 2055 Scenario – Dripsey



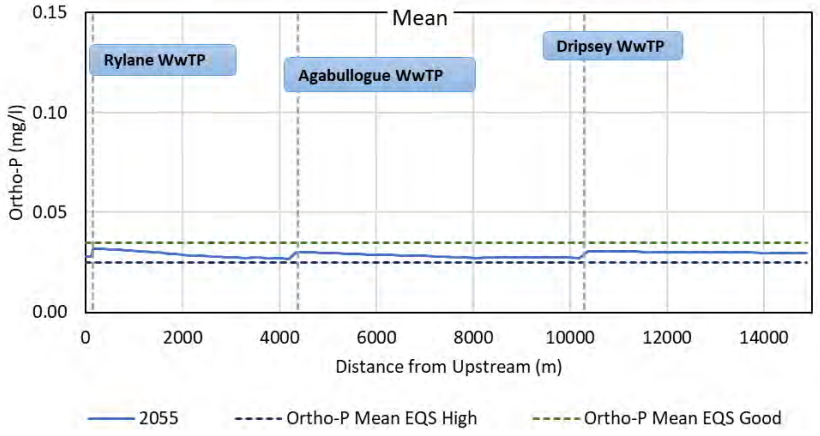
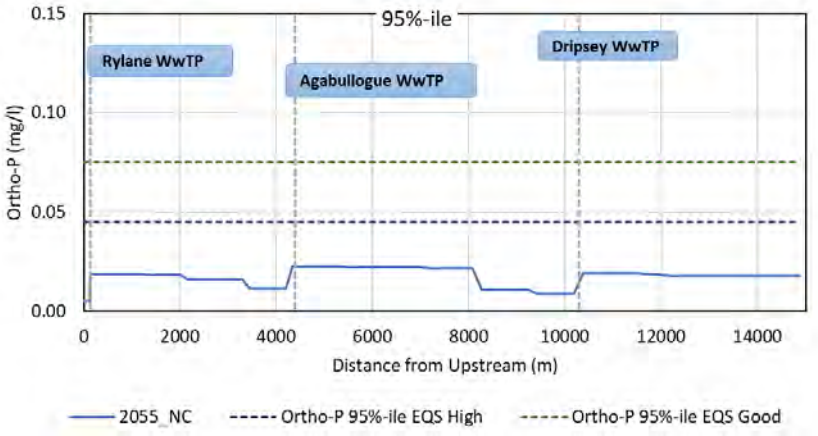


Figure 3-169 MRP Results for 2055 NC Scenario – Dripsey



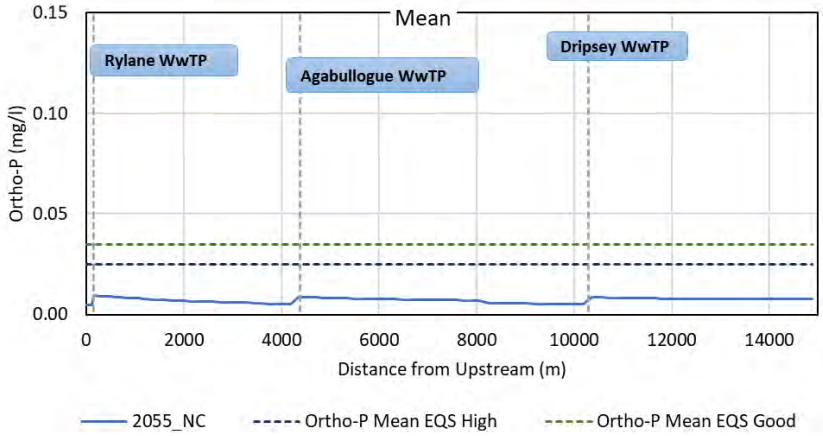
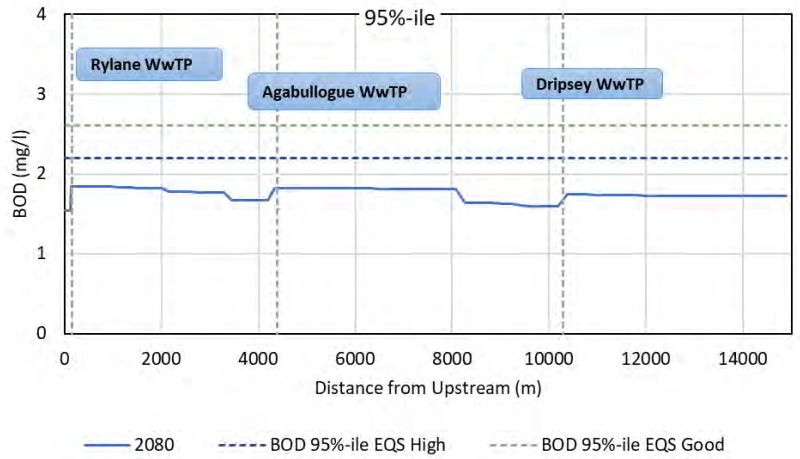


Figure 3-170 BOD Results for 2080 Scenario – Dripsey



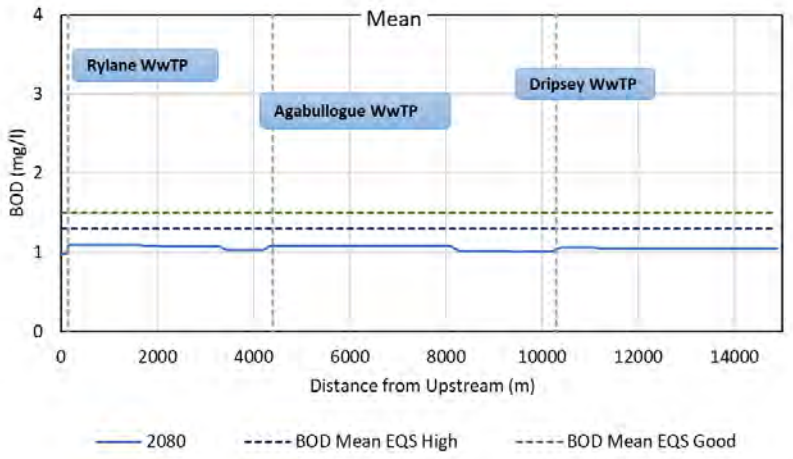
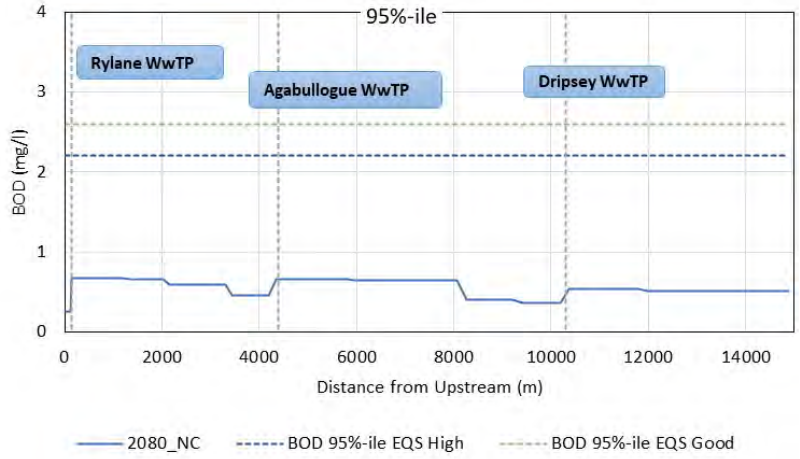


Figure 3-171 BOD Results for 2080 NC Scenario – Dripsey



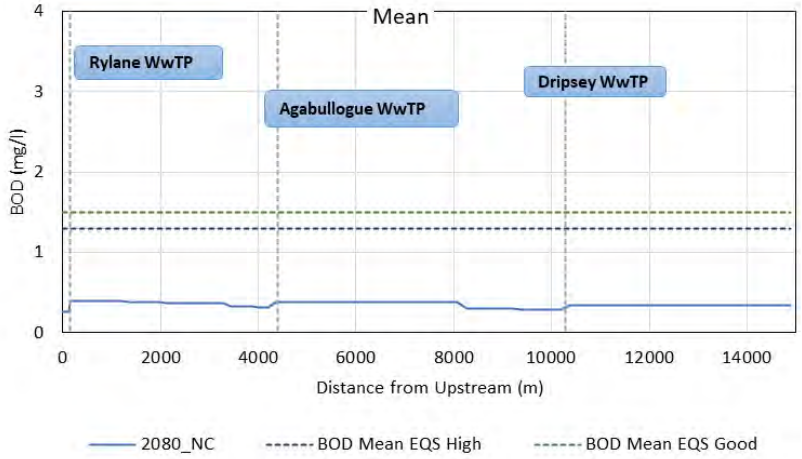
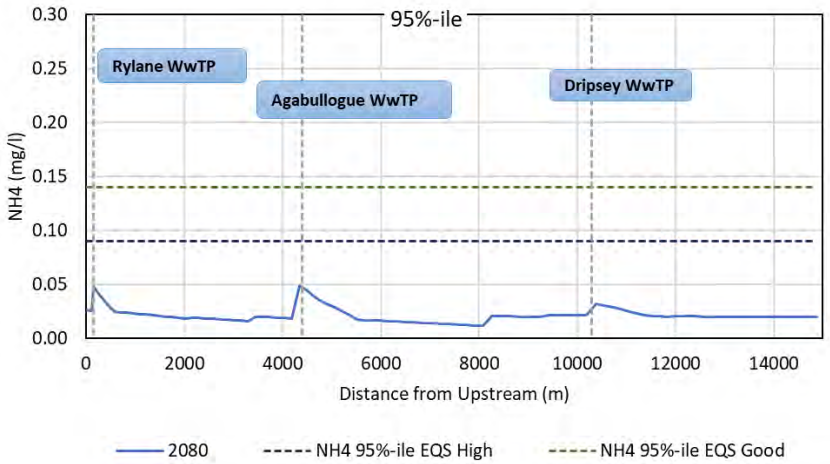


Figure 3-172 Ammonia Results for 2080 Scenario – Dripsey



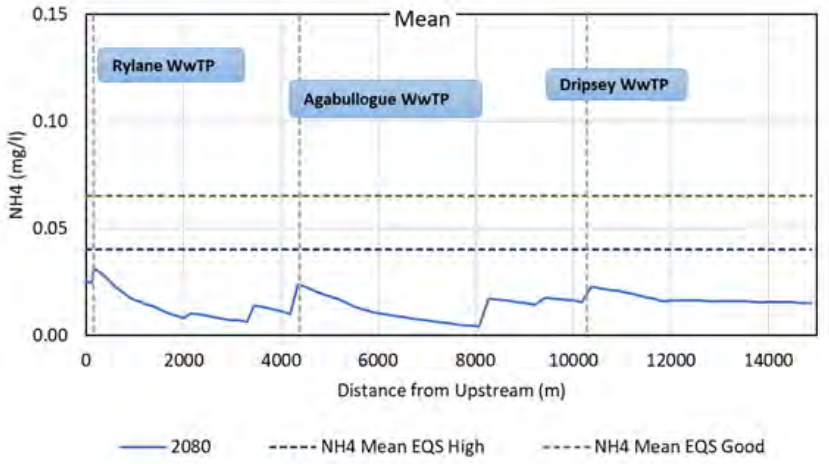
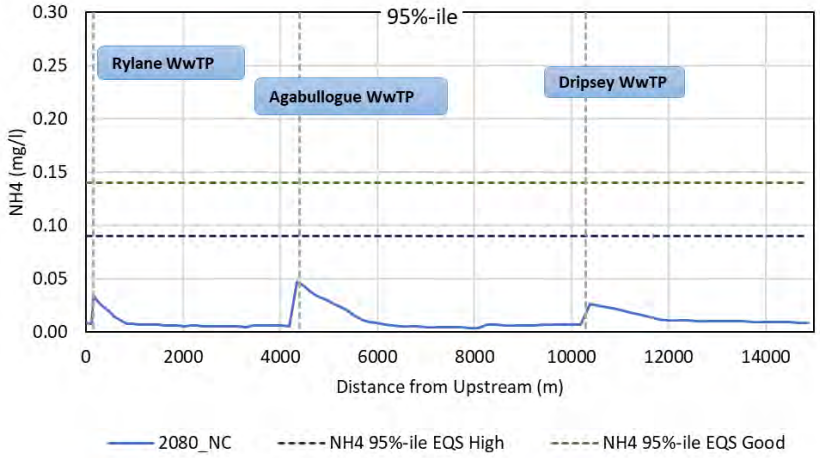


Figure 3-173 Ammonia Results for 2080 NC Scenario – Dripsey



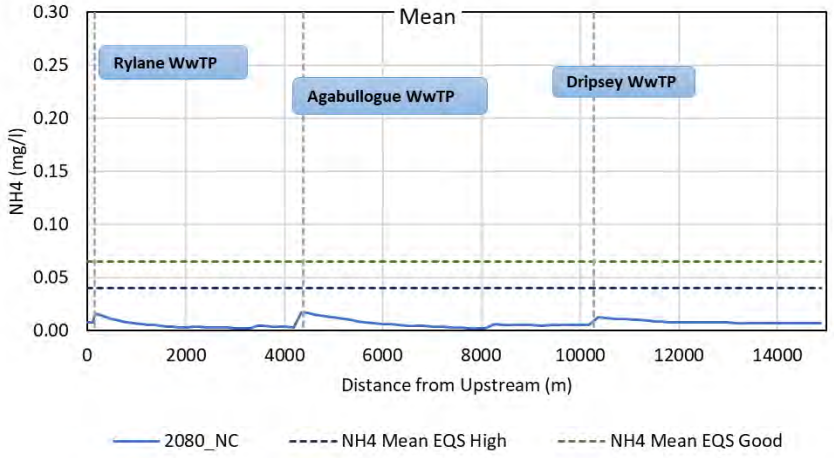
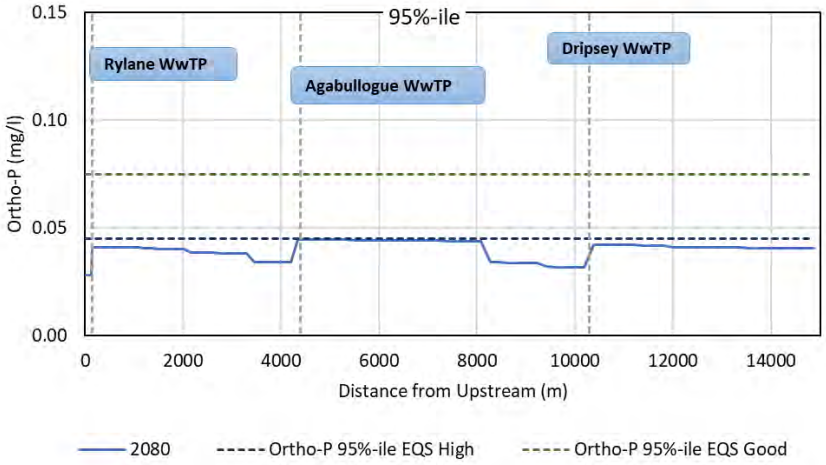


Figure 3-174 MRP Results for 2080 Scenario – Dripsey



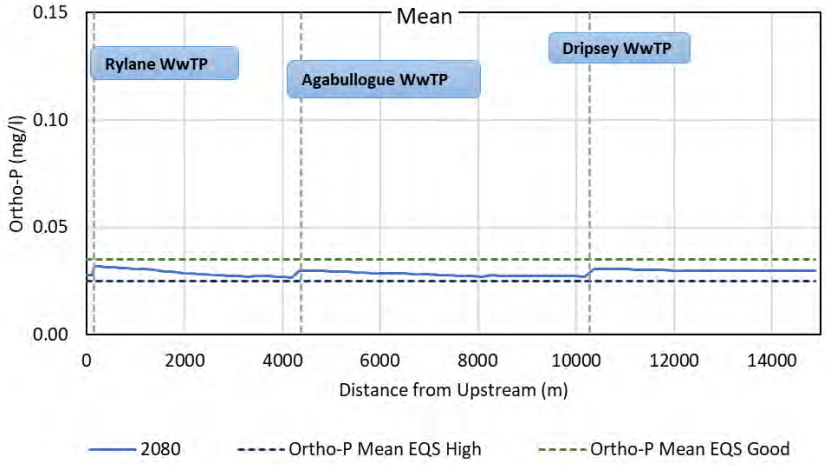
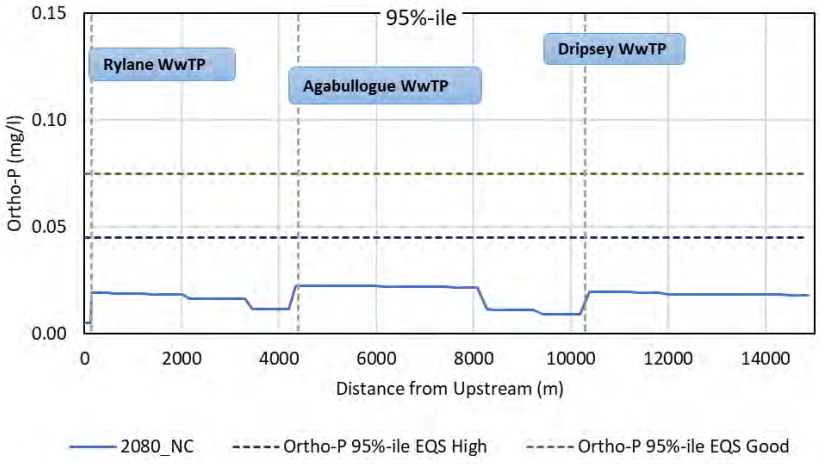


Figure 3-175 MRP Results for 2080 NC Scenario – Dripsey



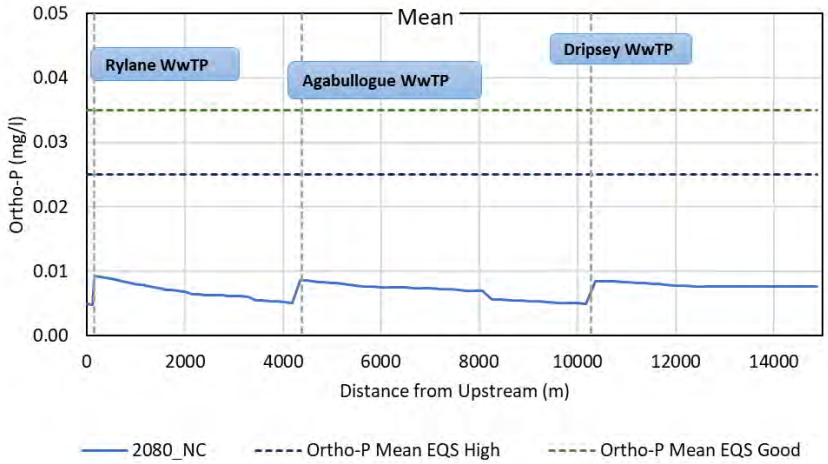
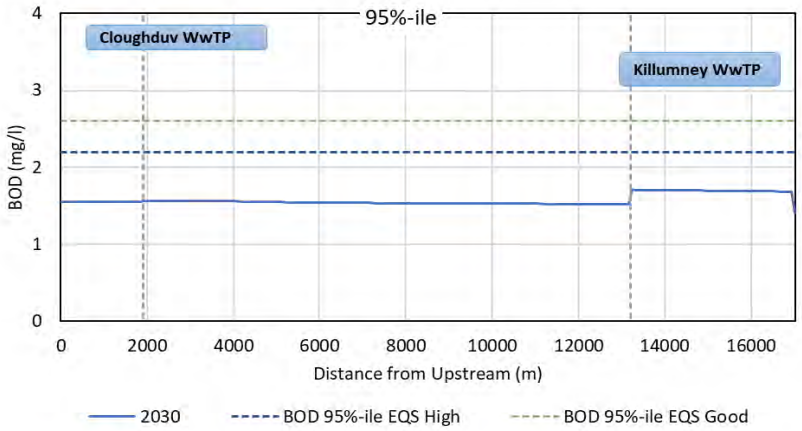


Figure 3-176 BOD Results for 2030 Scenario – Bride



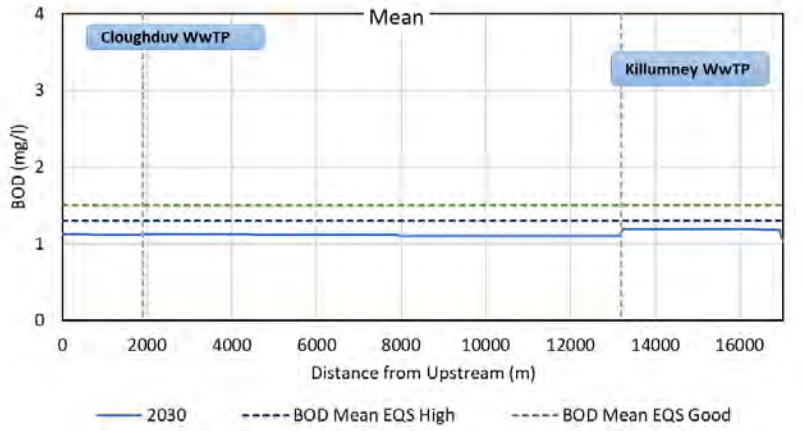
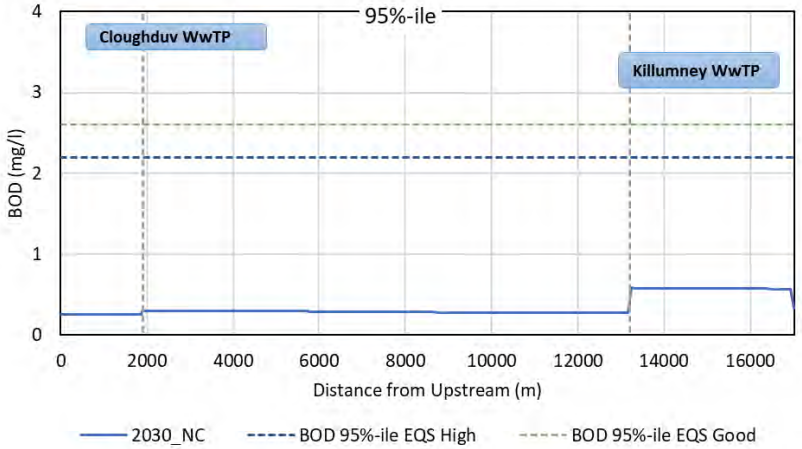


Figure 3-177 BOD Results for 2030 NC Scenario– Bride



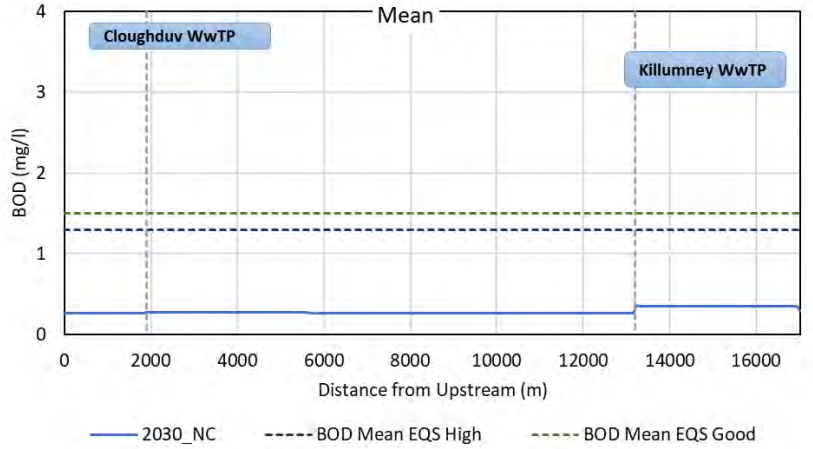
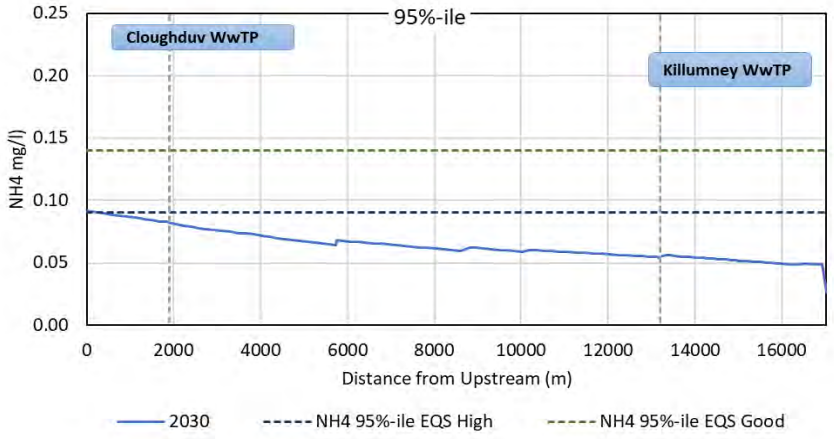


Figure 3-178 Ammonia Results for 2030 Scenario – Bride



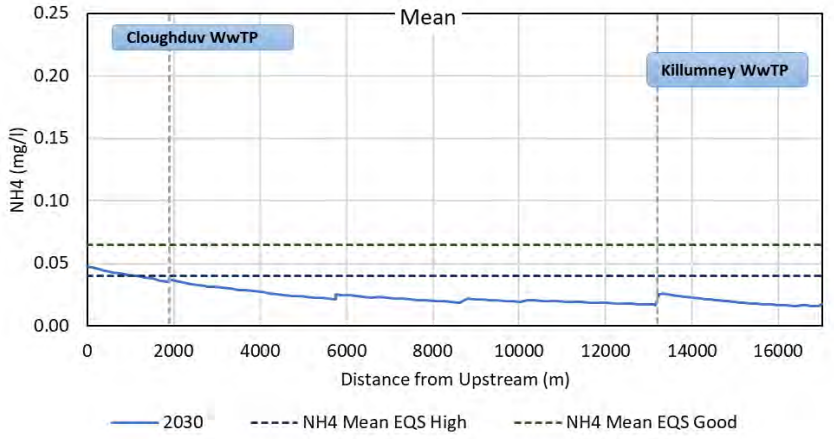
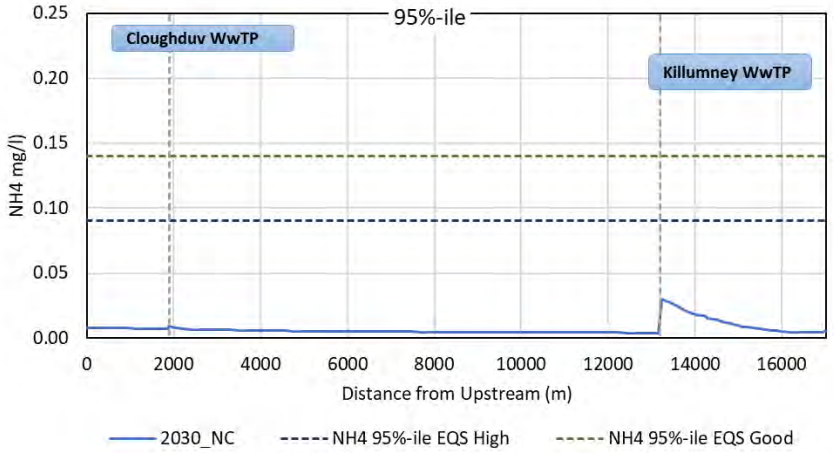


Figure 3-179 Ammonia Results for 2030 NC Scenario– Bride



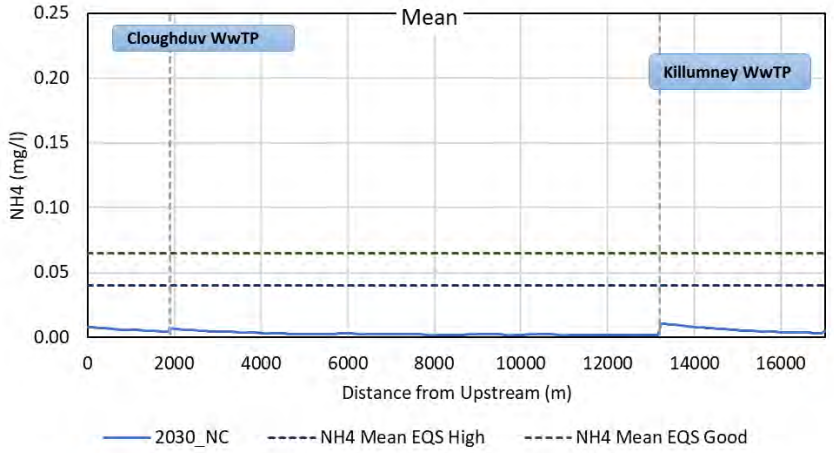
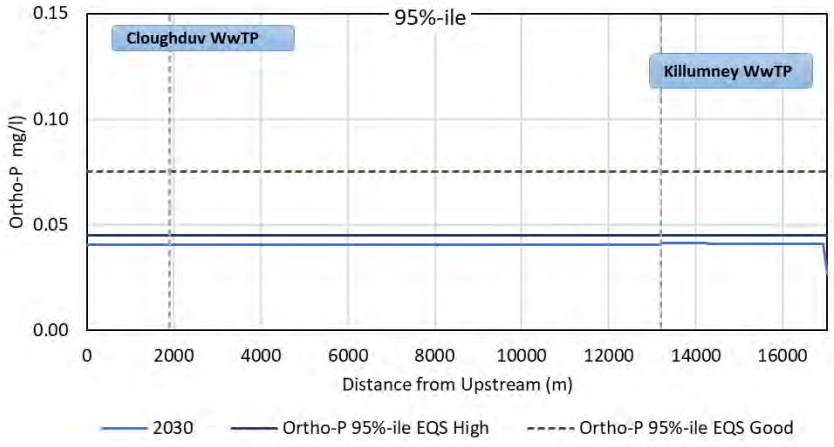


Figure 3-180 MRP Results for 2030 Scenario – Bride



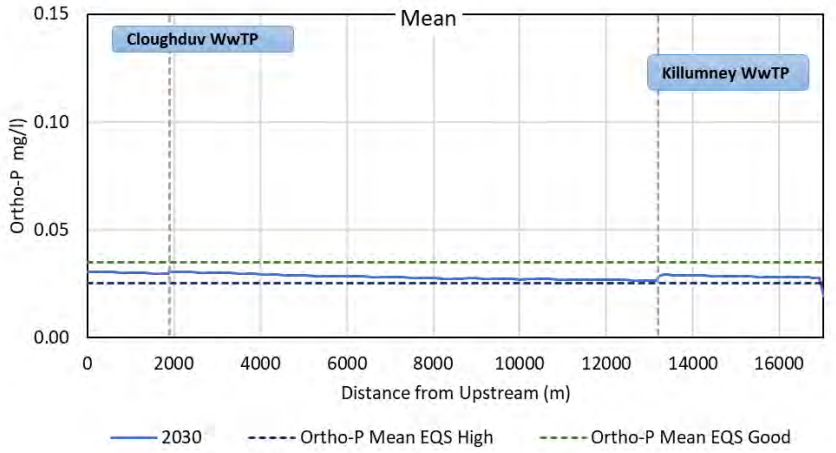
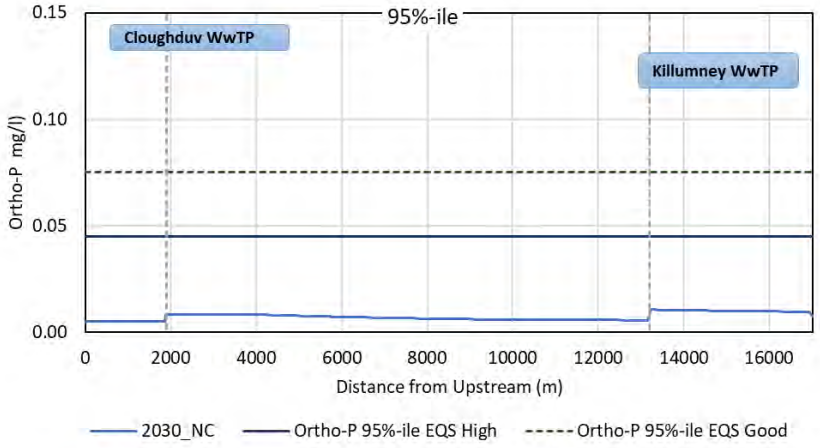


Figure 3-181 MRP Results for 2030 NC Scenario– Bride



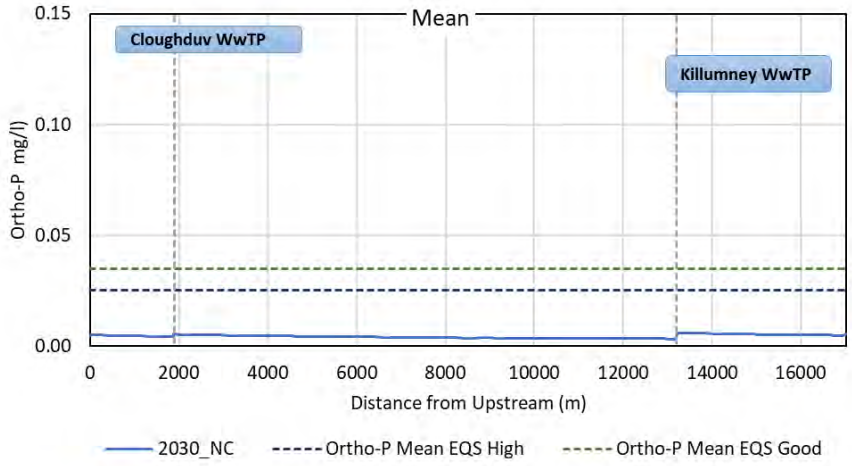
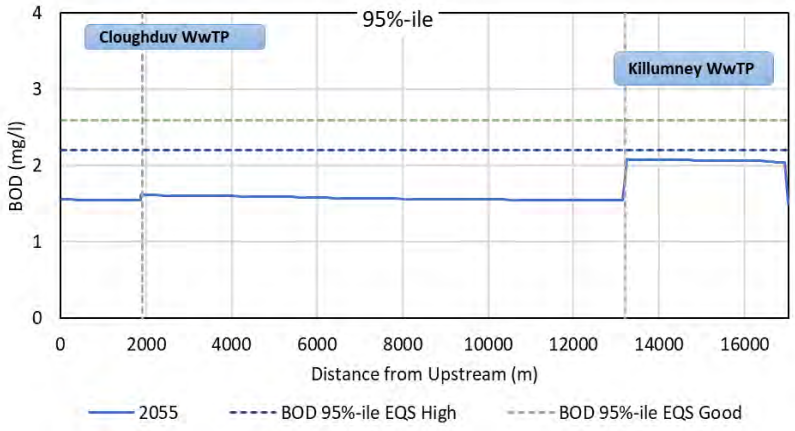


Figure 3-182 BOD Results for 2055 Scenario– Bride



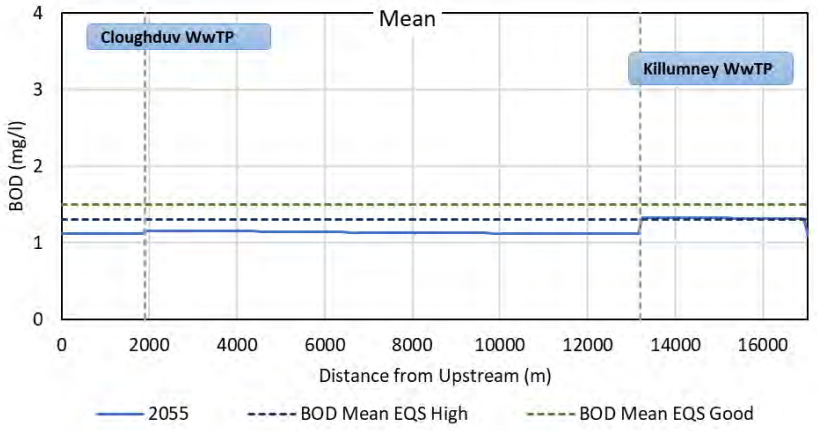
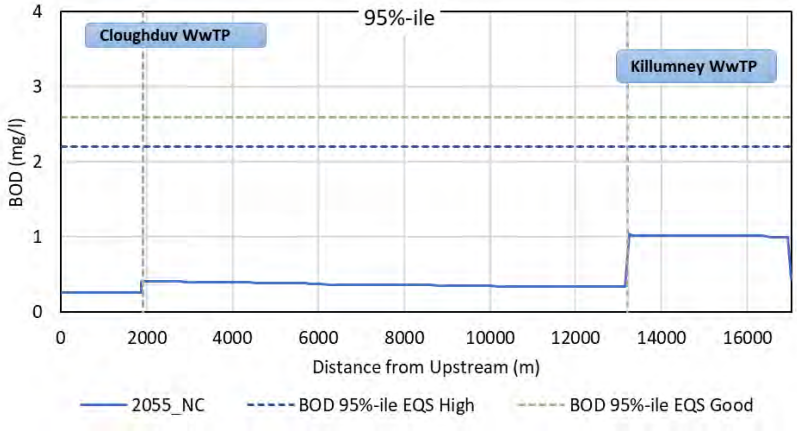


Figure 3-183 BOD Results for 2055 NC Scenario– Bride



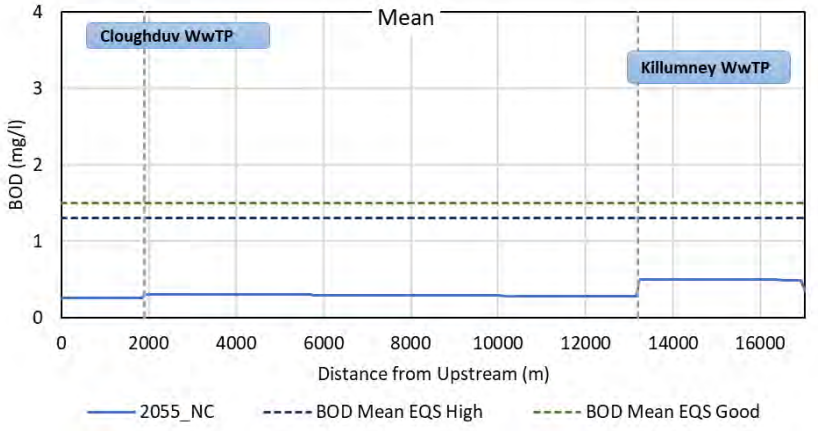
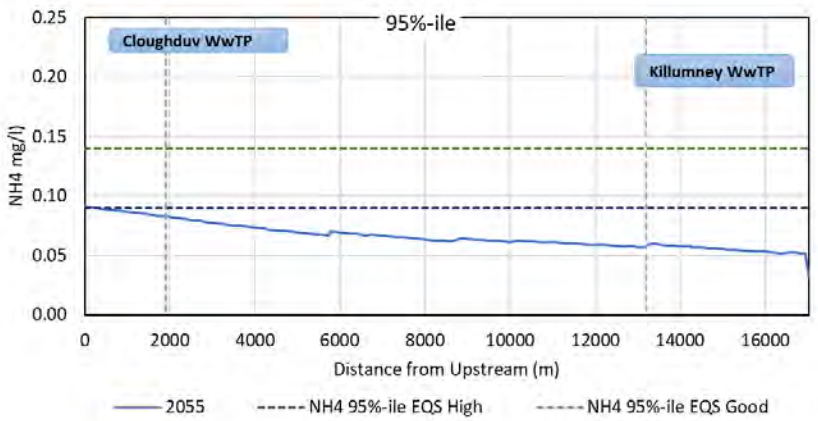


Figure 3-184 Ammonia Results for 2055 Scenario– Bride



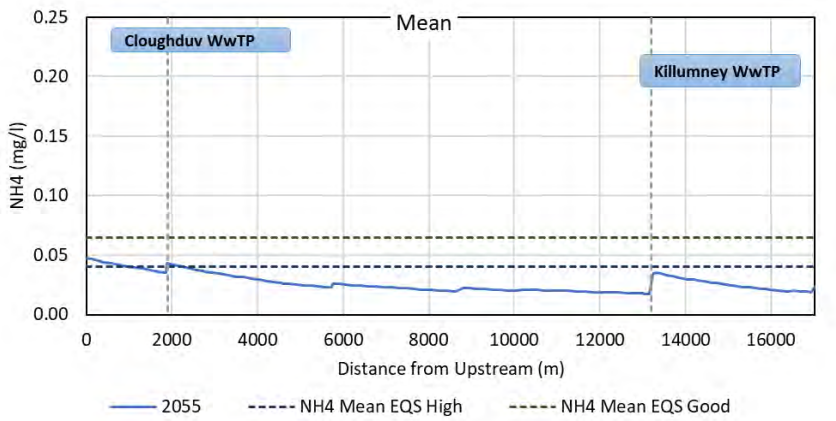
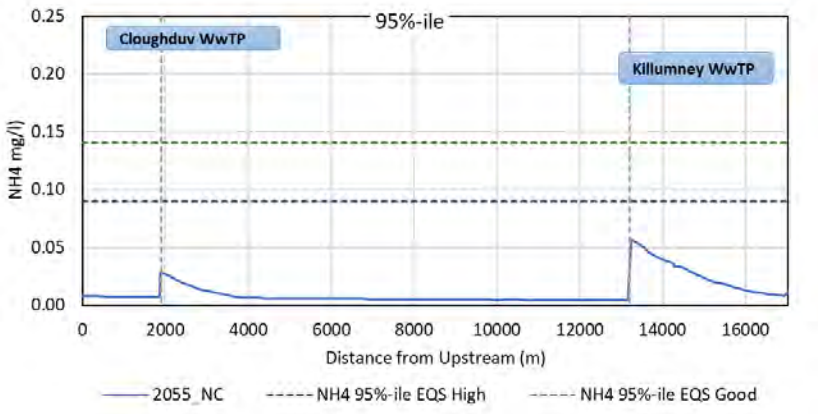


Figure 3-185 Ammonia Results for 2055 NC Scenario– Bride



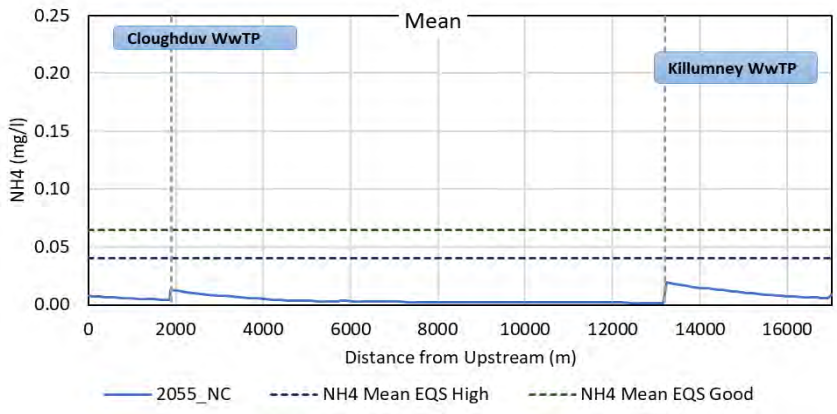
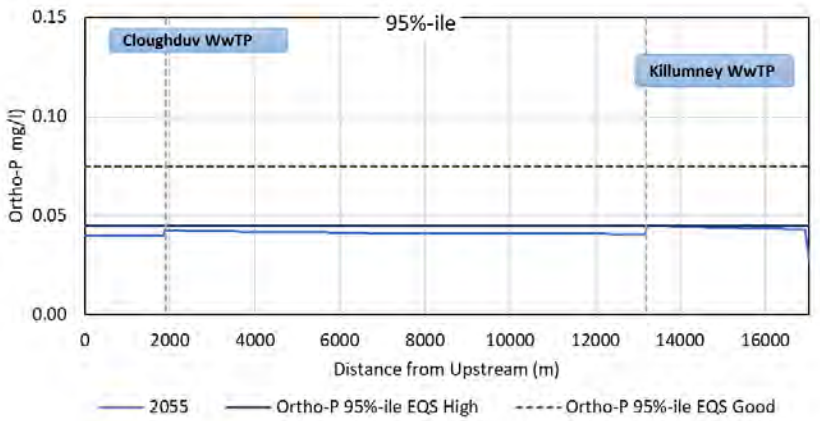


Figure 3-186 MRP Results for 2055 Scenario– Bride



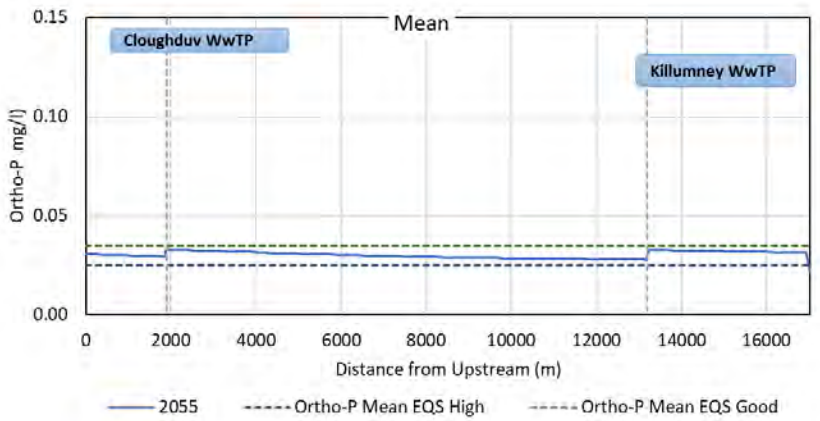
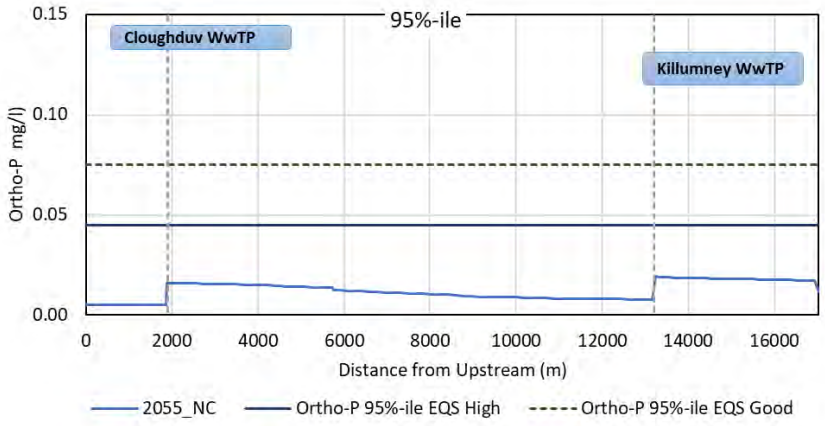


Figure 3-187 MRP Results for 2055 NC Scenario– Bride



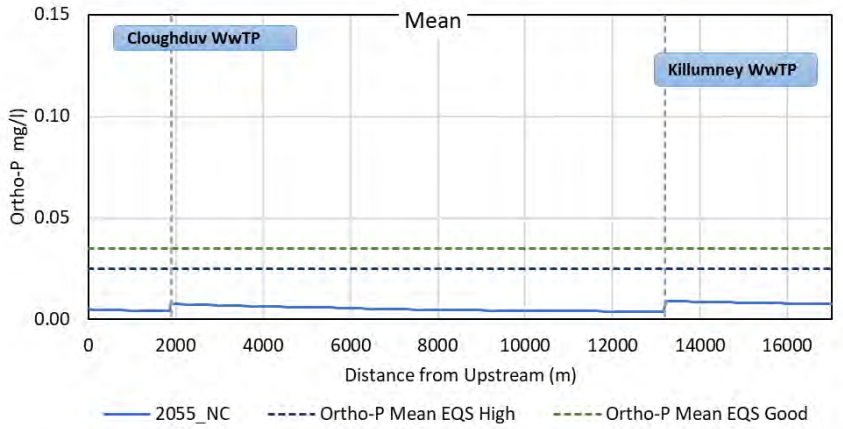
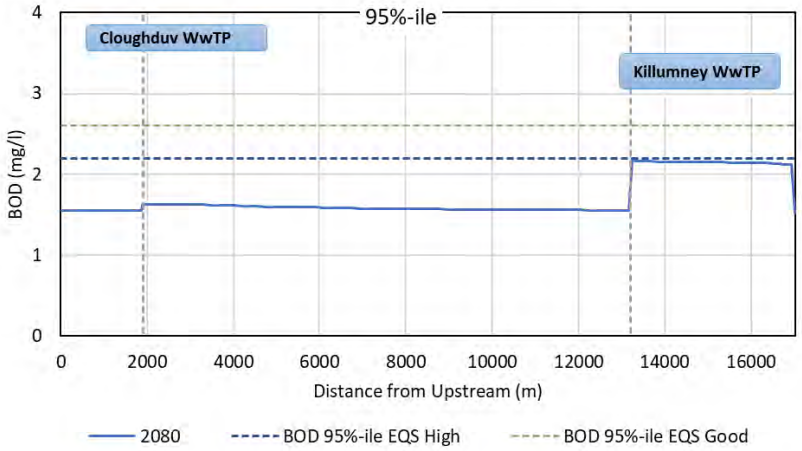


Figure 3-188 BOD Results for 2080 Scenario– Bride



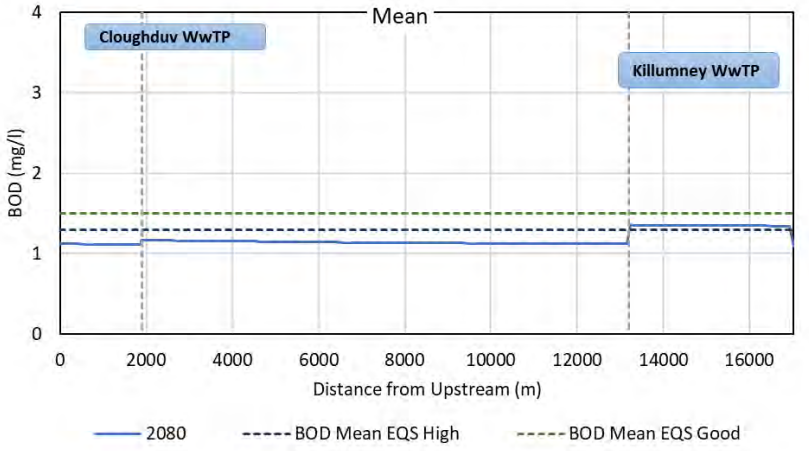
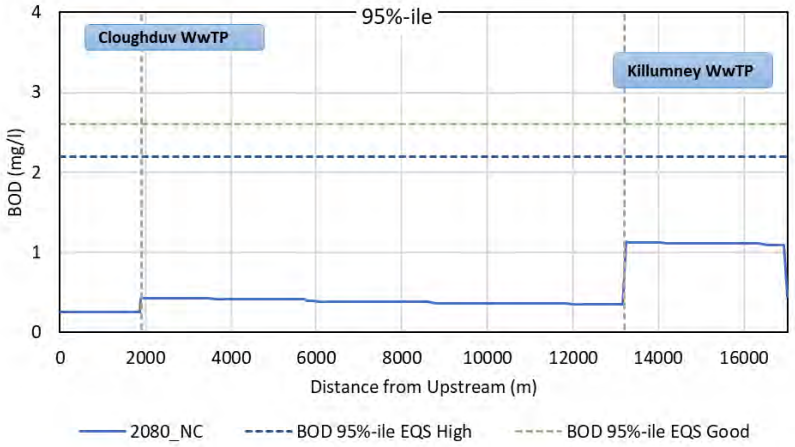


Figure 3-189 BOD Results for 2080 NC Scenario – Bride



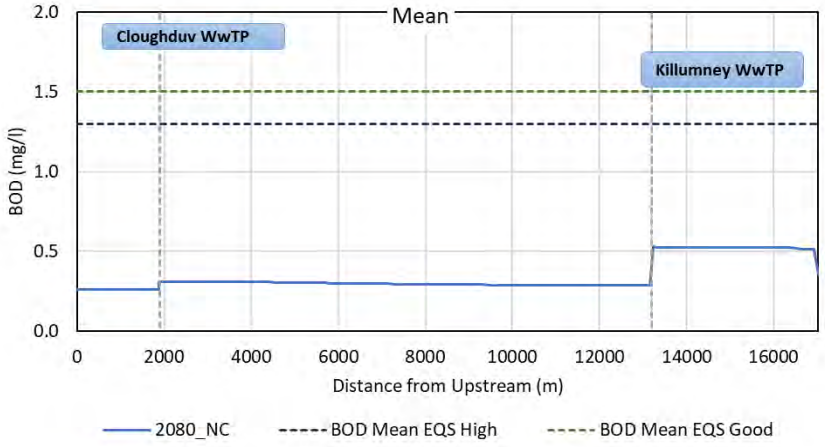
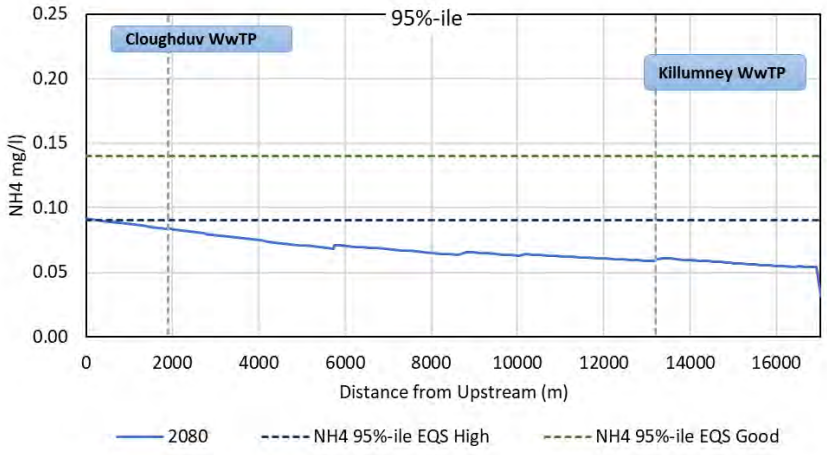


Figure 3-190 Ammonia Results for 2080 Scenario– Bride



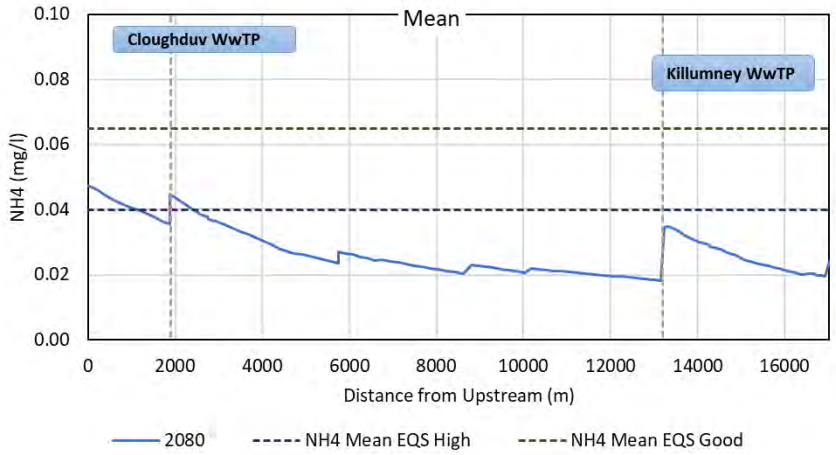
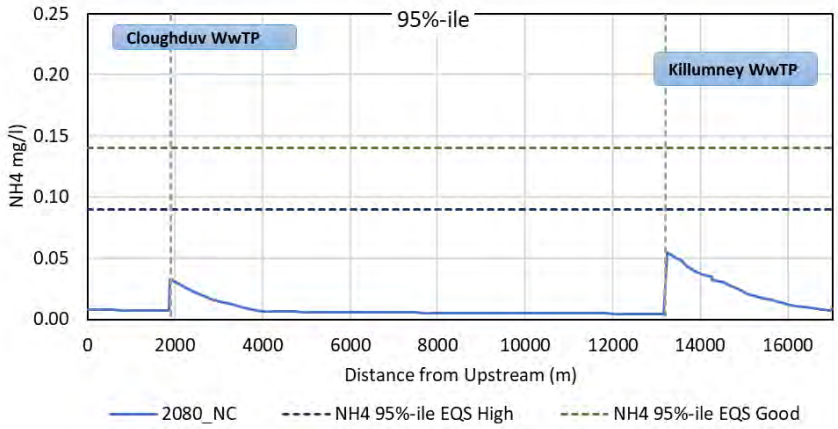


Figure 3-191 Ammonia Results for 2080 NC Scenario – Bride



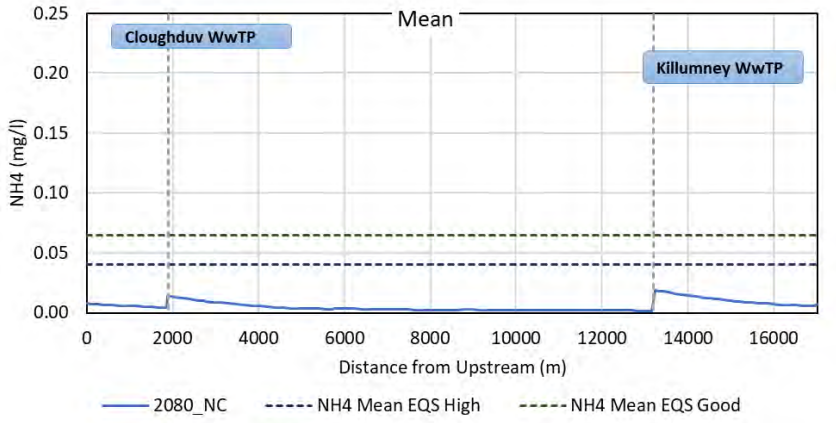
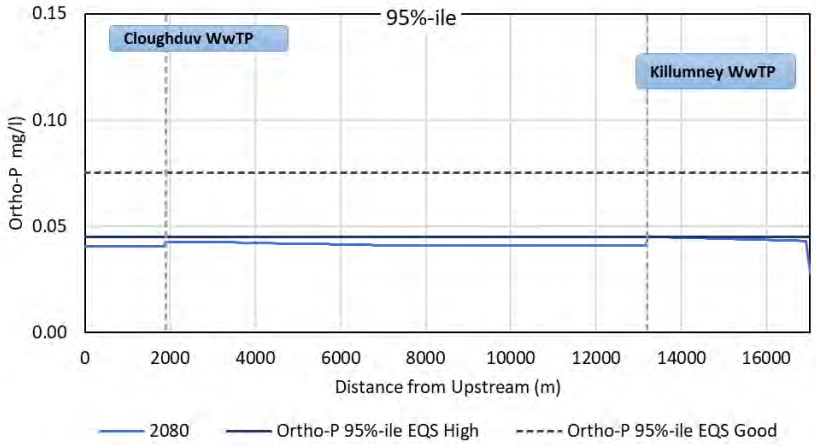


Figure 3-192 MRP Results for 2080 Scenario– Bride



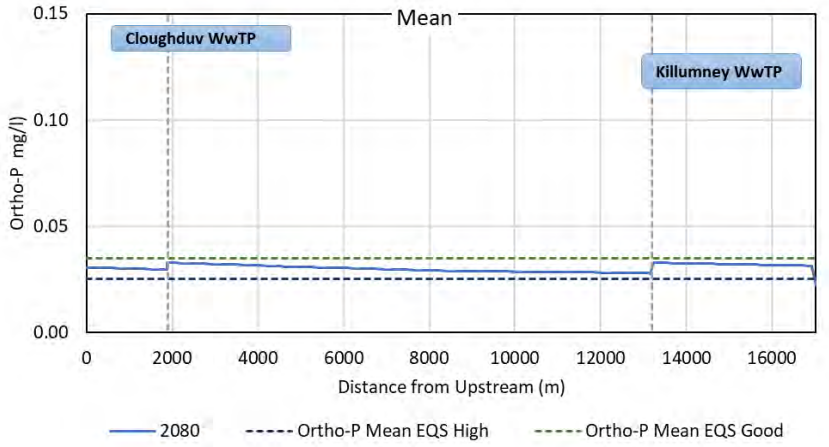
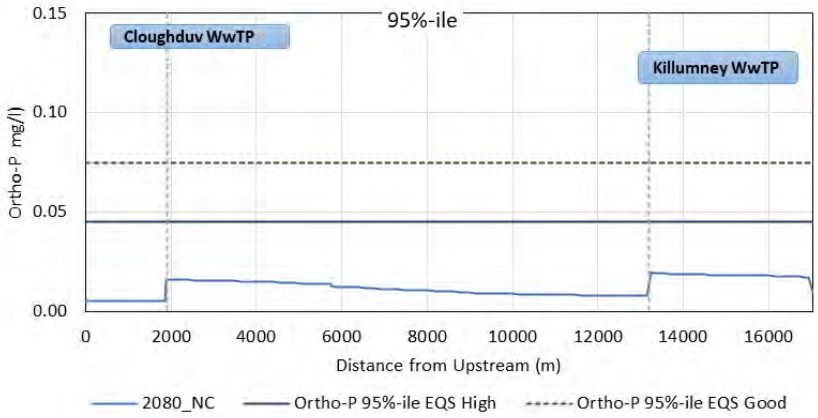


Figure 3-193 MRP Results for 2080 NC Scenario – Bride



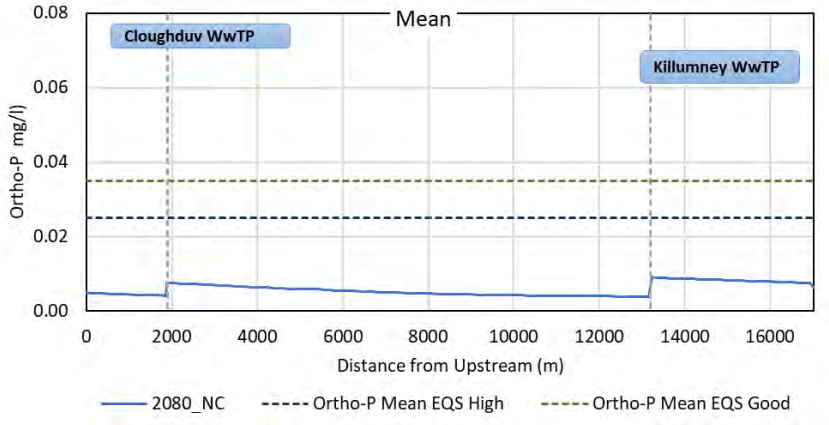
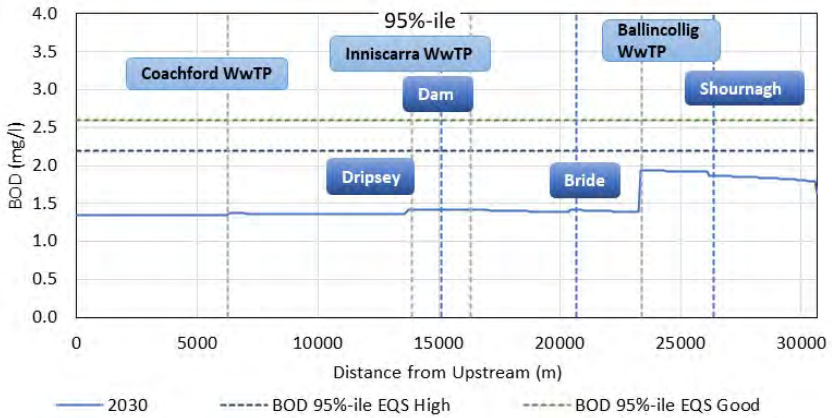


Figure 3-194 BOD Results for 2030 Scenario – Lee



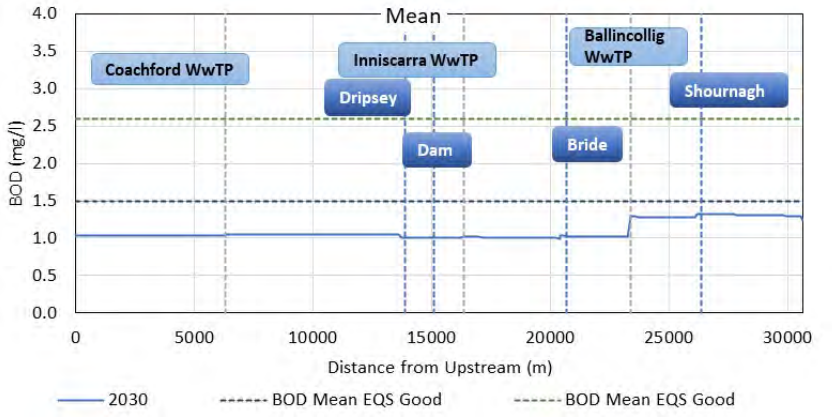
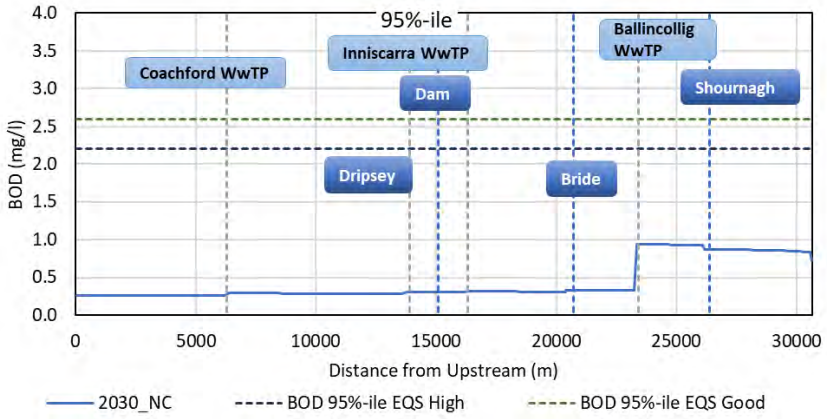


Figure 3-195 BOD Results for 2030 NC Scenario – Lee



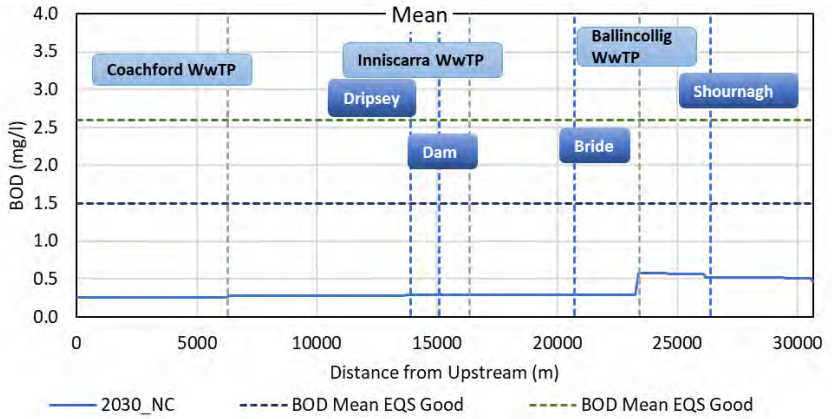
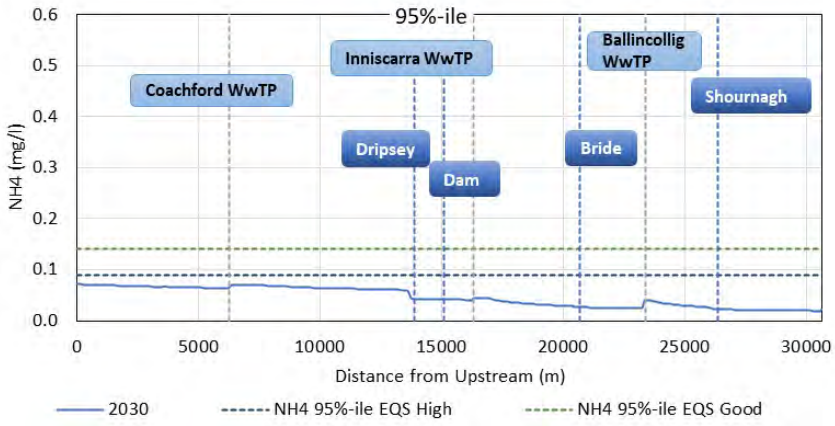


Figure 3-196 Ammonia Results for 2030 Scenario – Lee



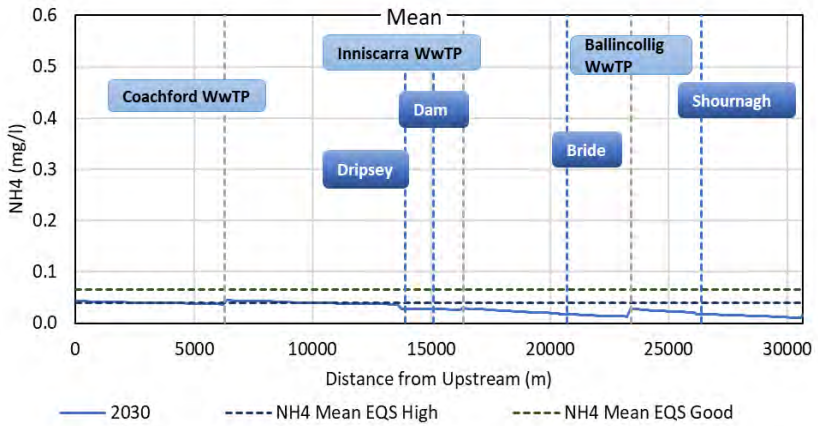
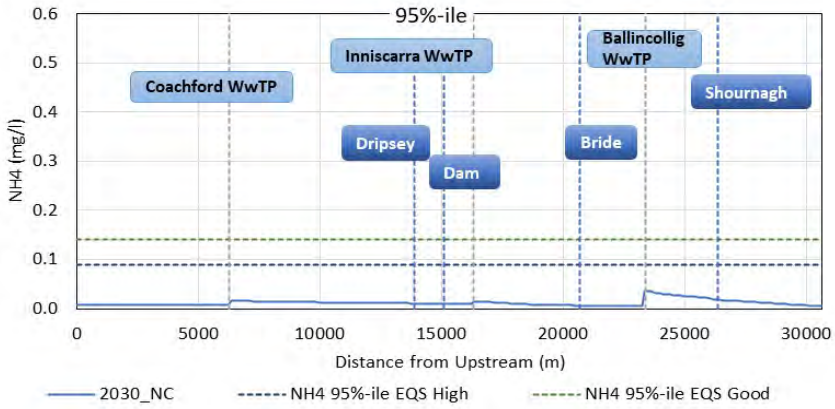


Figure 3-197 Ammonia Results for 2030 NC Scenario – Lee



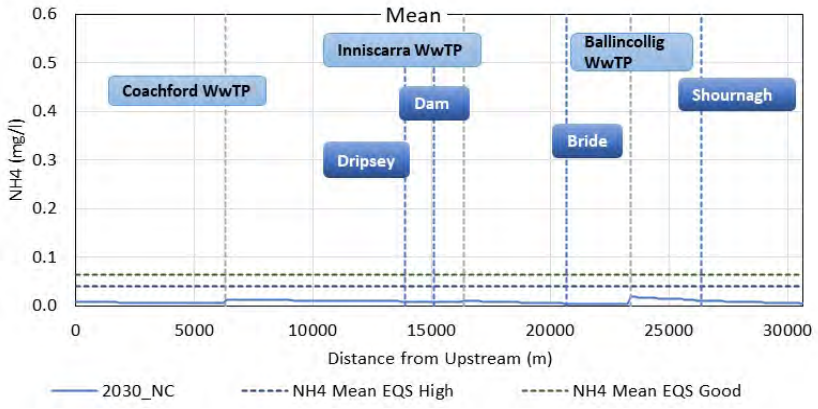


Figure 3-198 MRP Results for 2030 Scenario – Lee

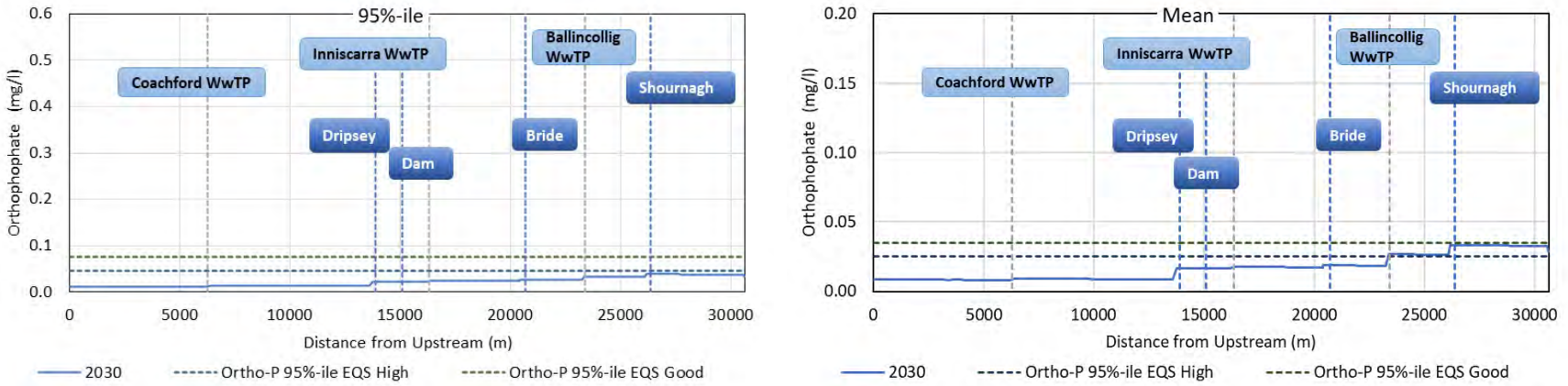


Figure 3-199 MRP Results for 2030 NC Scenario – Lee

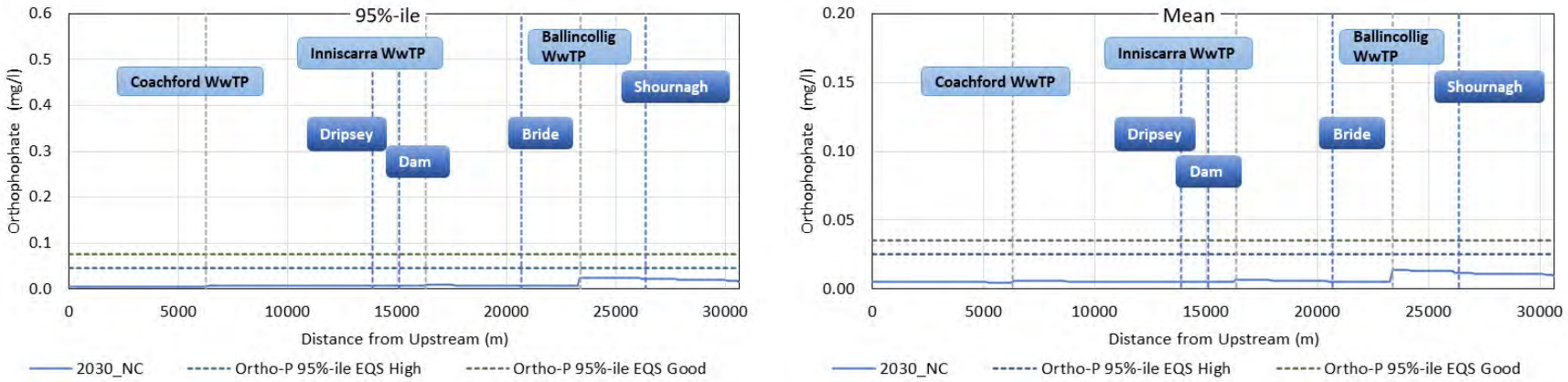
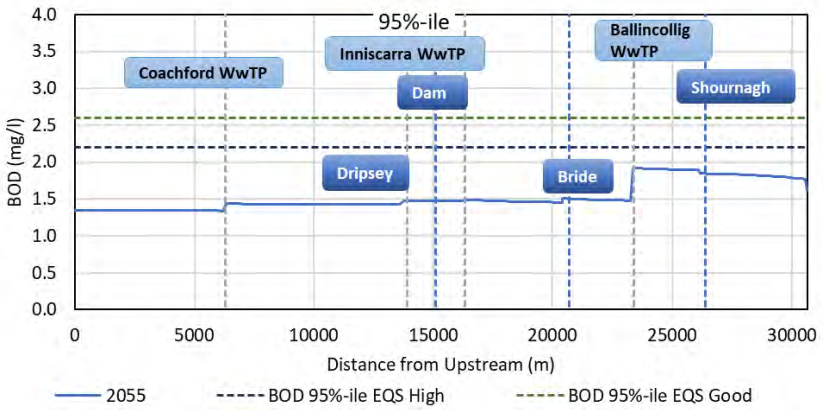


Figure 3-200 BOD Results for 2055 Scenario – Lee



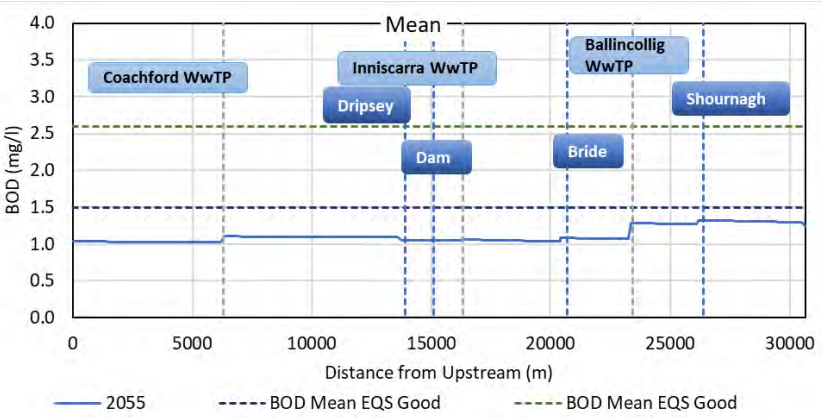
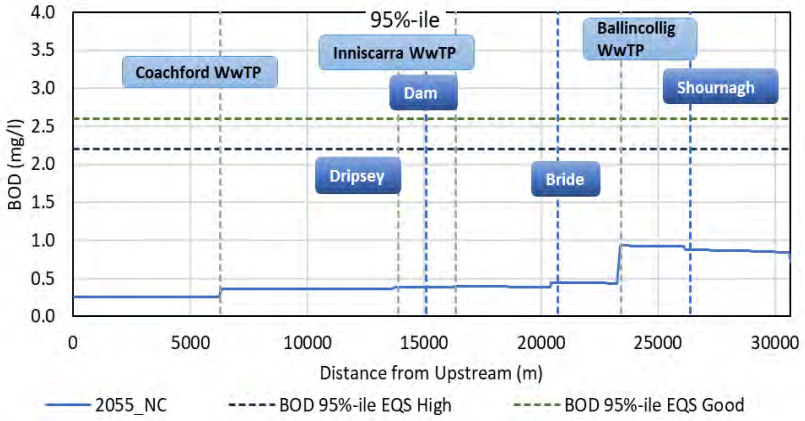


Figure 3-201 BOD Results for 2055 Scenario – Lee



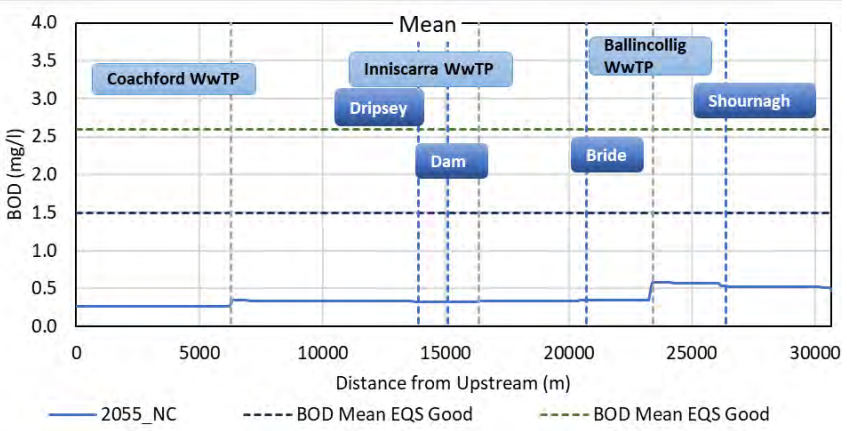


Figure 3-202 Ammonia Results for 2055 Scenario – Lee

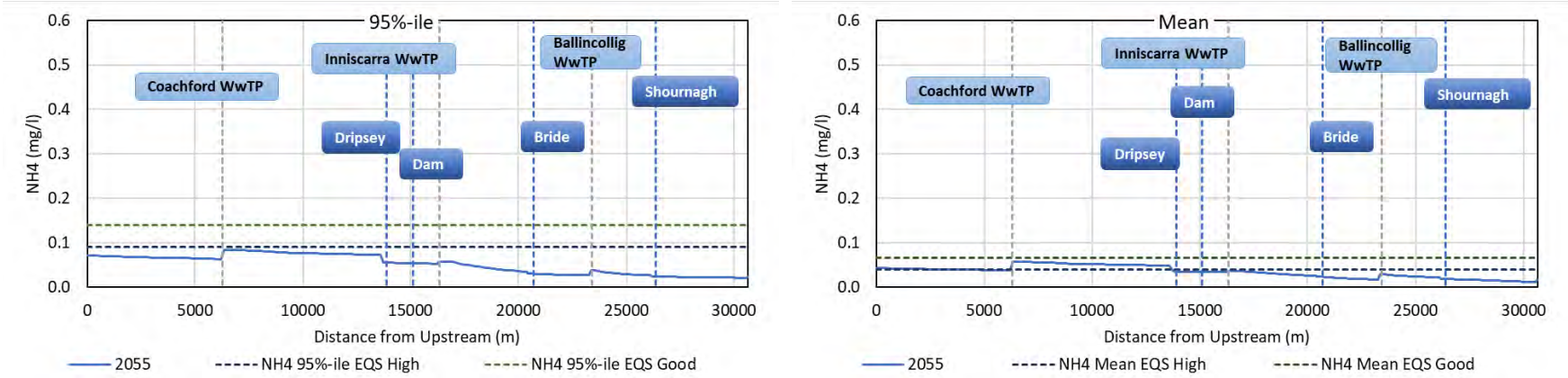


Figure 3-203 Ammonia Results for 2055 NC Scenario – Lee

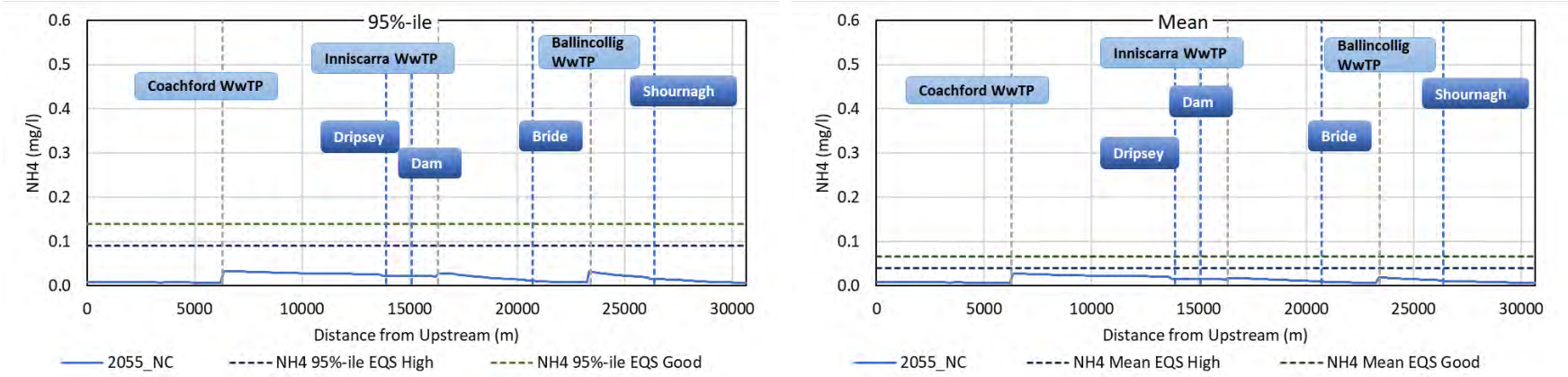


Figure 3-204 MRP Results for 2055 Scenario – Lee

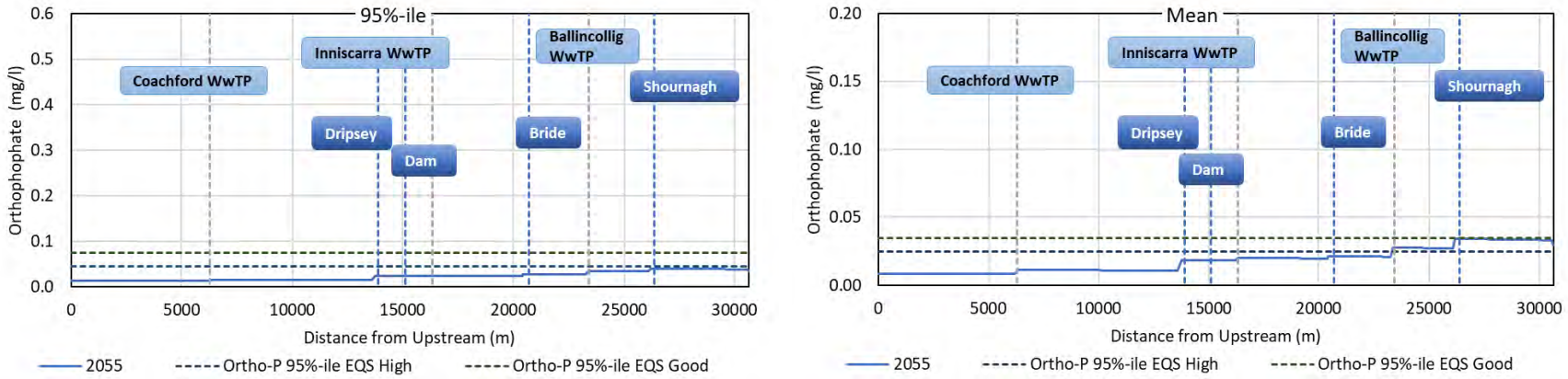


Figure 3-205 MRP Results for 2055 NC Scenario – Lee

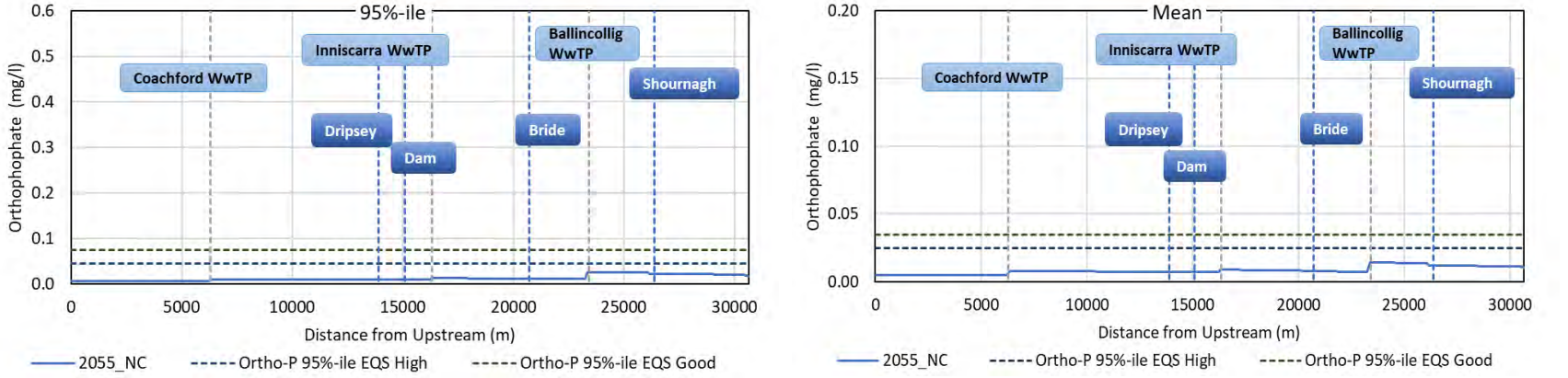
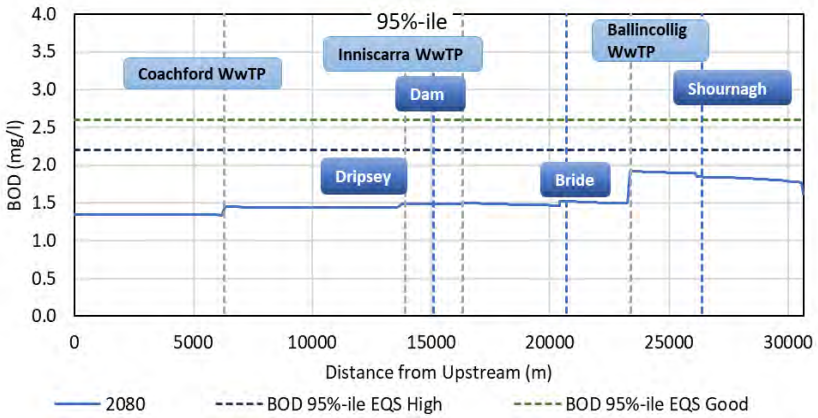


Figure 3-206 BOD Results for 2080 Scenario – Lee



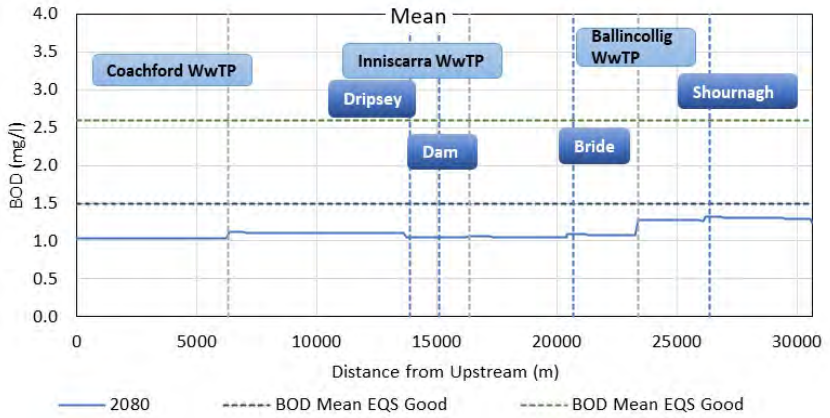
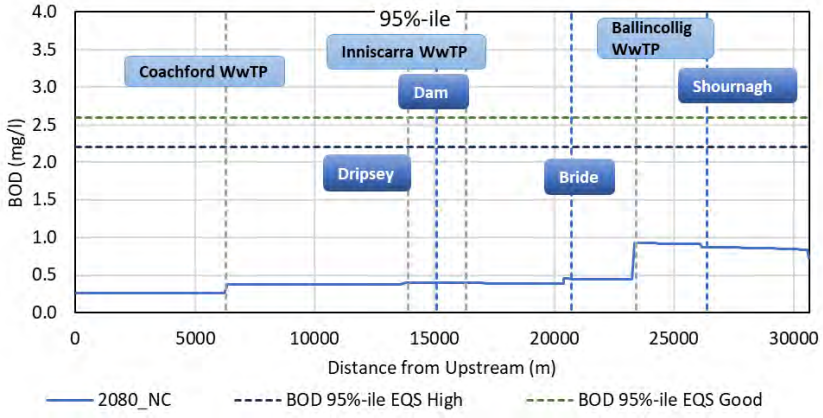


Figure 3-207 BOD Results for 2080 NC Scenario – Lee



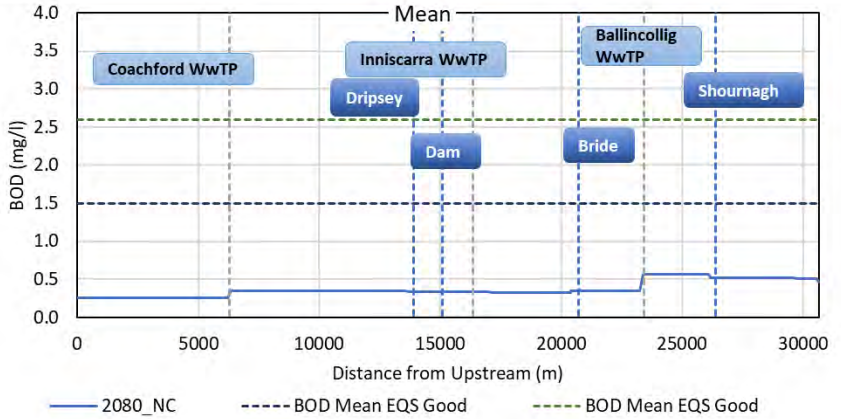
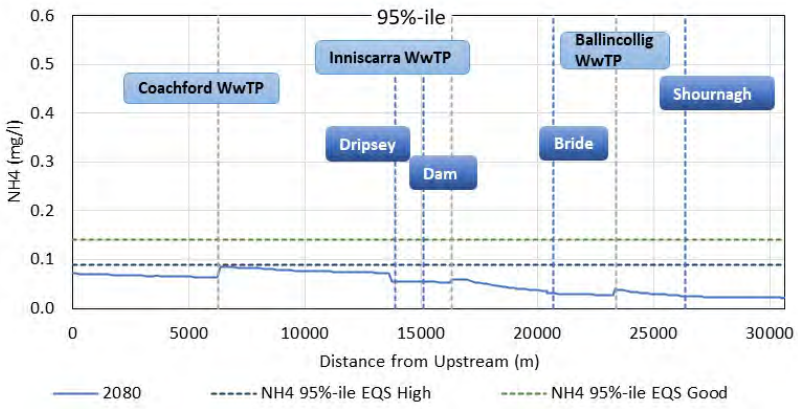


Figure 3-208 Ammonia Results for 2080 Scenario – Lee



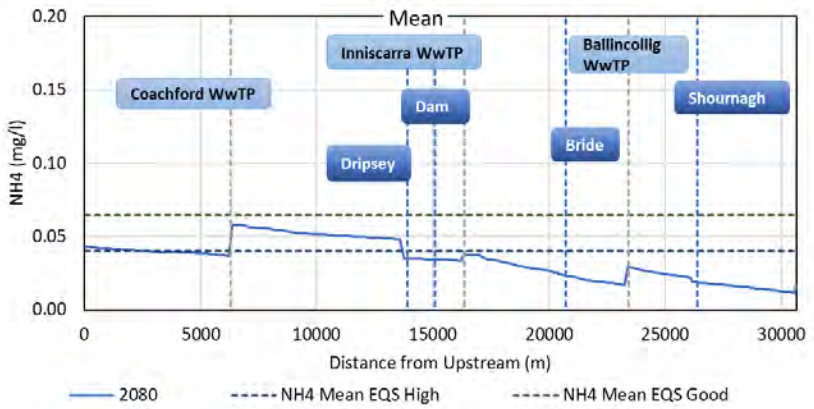
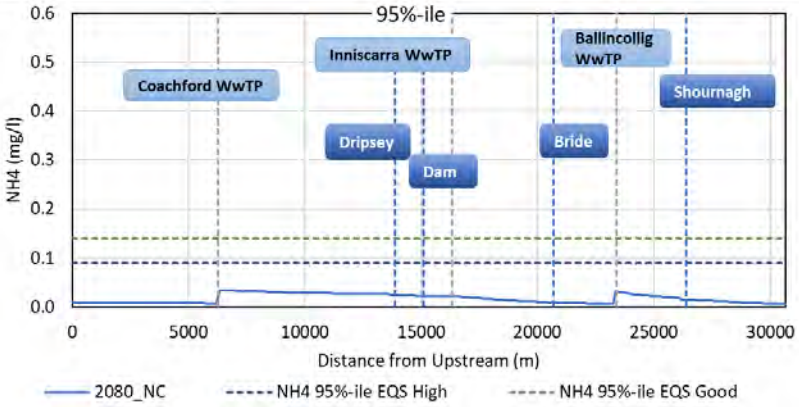


Figure 3-209 Ammonia Results for 2080 NC Scenario – Lee



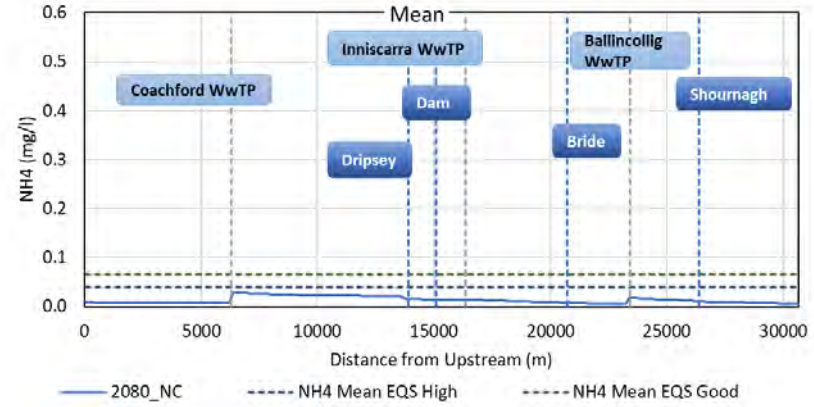
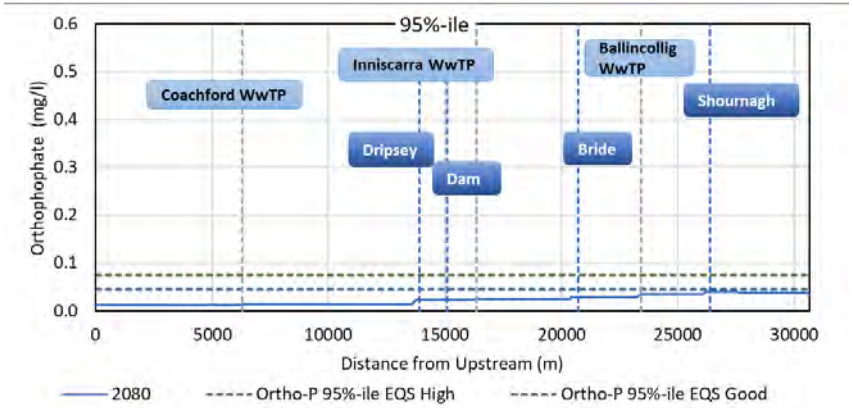


Figure 3-210 MRP Results for 2080 Scenario – Lee



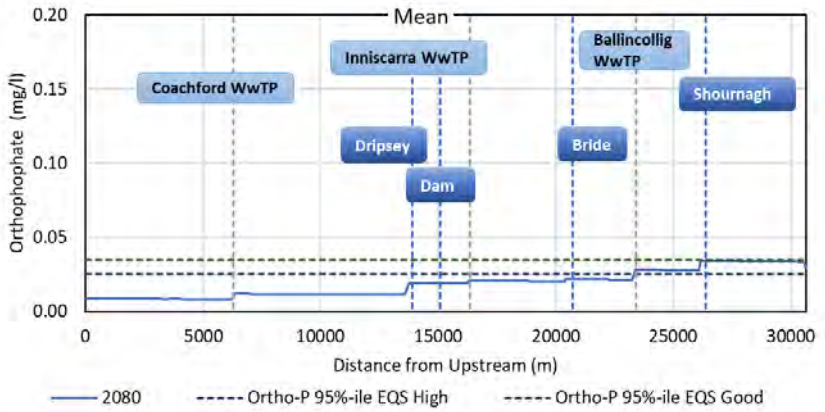
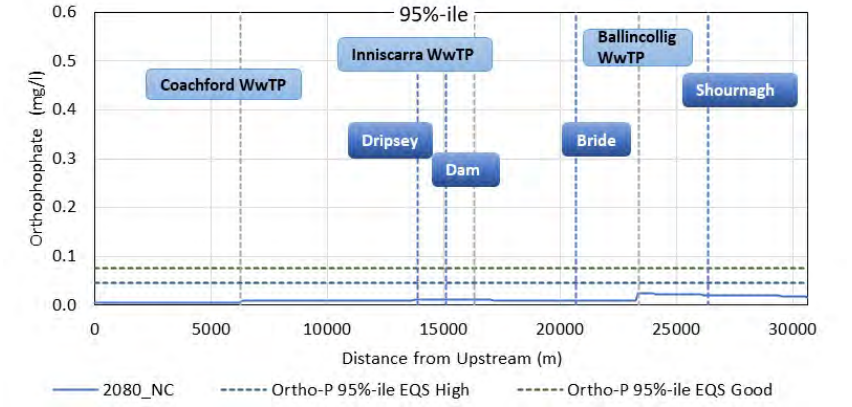
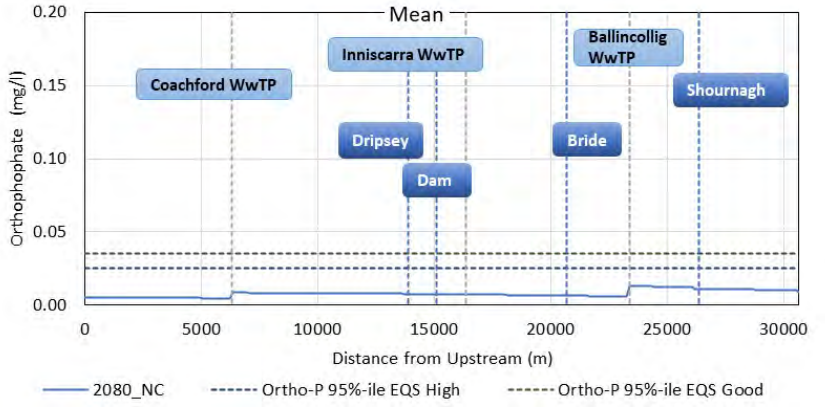


Figure 3-211 MRP Results for 2080 NC Scenario – Lee





x

4. FEASIBILITY STUDIES

4.1 Optioneering Scenarios

Optioneering scenarios have been assessed for a number of WwTPs to explore alternative configurations aimed at reducing environmental impact through improved dilution and more favourable downstream discharge locations. The scenarios assessed in this study are outlined below:

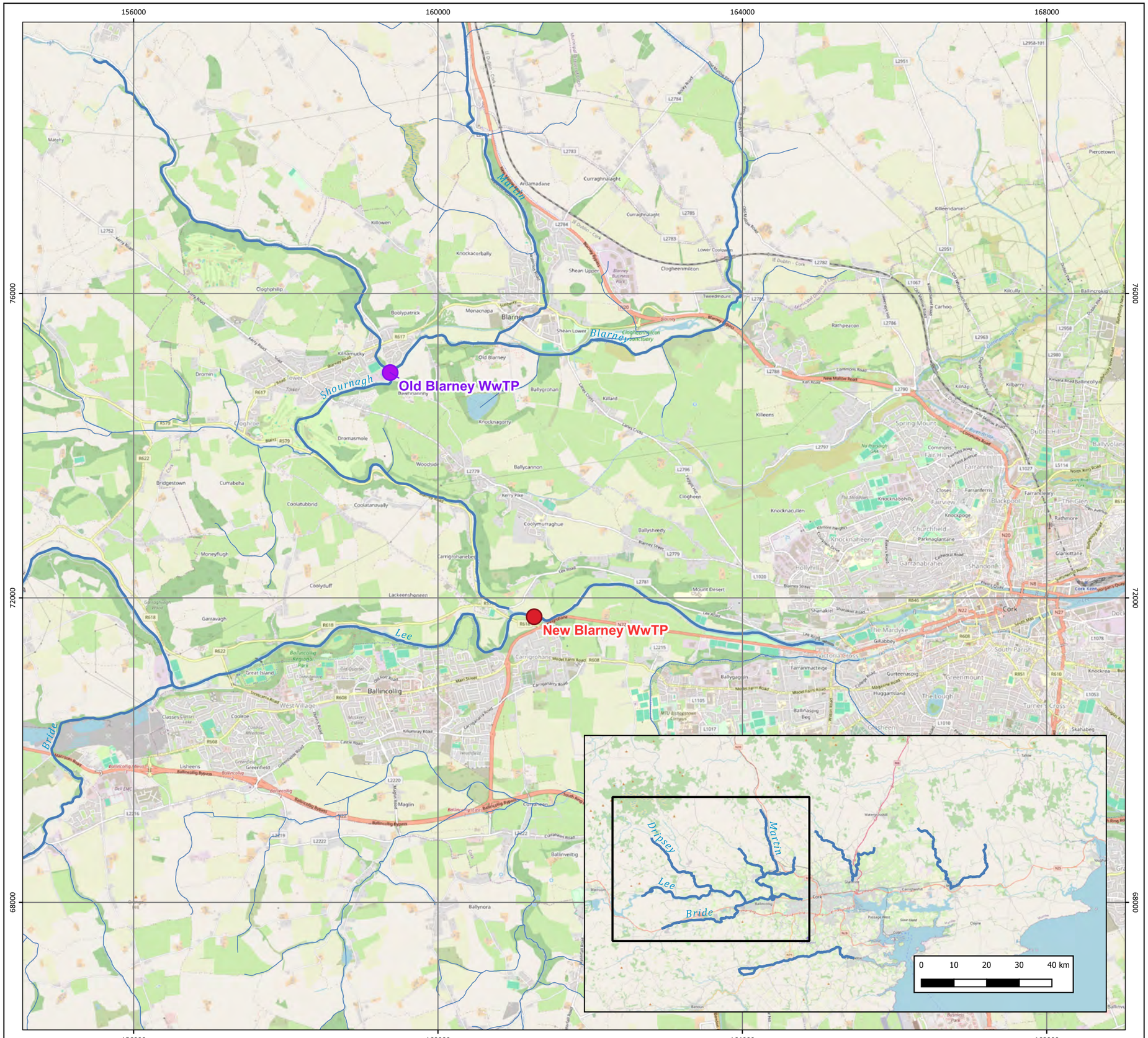
1. **Relocation of Blarney WwTP**: Evaluates the relocation of the discharge point to a downstream location on the River Shournagh in the Lee model as shown in Figure 4-1, to achieve better dilution and reduce water quality impacts.
2. **Relocation of Grenagh WwTP**: Evaluates the relocation of the discharge point to a downstream location on the River Martin in the Lee model as shown in Figure 4-2, to achieve better dilution and reduce water quality impacts.
3. **Relocation of Carrignavar WwTP**: Examines relocation to a downstream location of the Glashaboy River as shown in Figure 4-3, for enhanced dilution and achieve regulatory thresholds.
4. **Flow Transfer from Halfway WwTP to Ballygarvan WwTP**: Evaluates the feasibility of rerouting effluent from Halfway WwTP to Ballygarvan WwTP.
5. **Relocation of Knockraha WwTPs**: Evaluates the relocation of the discharge point from Butlerstown to a downstream location on the River Glashaboy as shown in Figure 4-4 , to achieve better dilution and reduce water quality impacts.
6. **Ballincollig WwTP Scenarios:** Evaluates the feasibility of relocating Ballincollig WwTP discharge to downstream of Shournagh confluence as shown in Figure 4-5. Two scenarios were assessed: 1 – No changes to upstream discharges; 2 – All upstream WwTPs removed.

Cork Strategic Drainage Study

River Lee

Optioneering Scenario: Relocation of Blarney WwTP

Drawing No: P2640-OS-001 | A

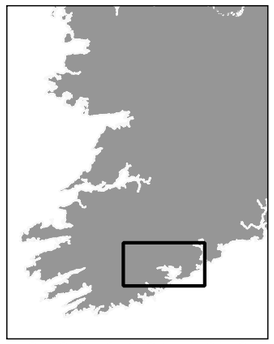


Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.; Data from EPA Ireland

Legend

- Old Blarney WwTP
- New Blarney WwTP
- Tributaries
- River Lee

N



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File Reference	J:\P2640\Mxd_QGZ \Rivers.qgz
Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

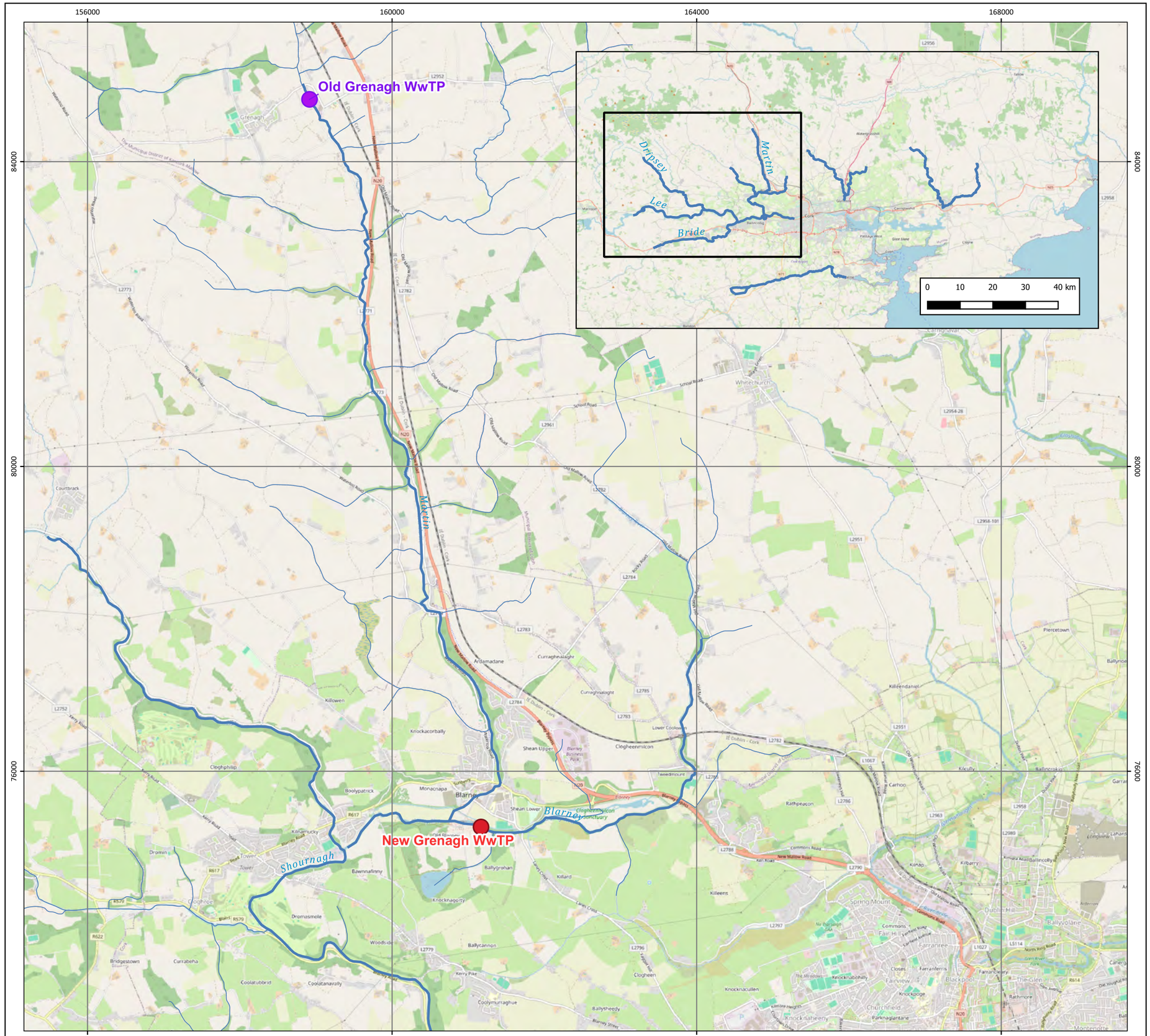
0 0.6 1.2 1.8 2.4 km

Cork Strategic Drainage Study

River Lee

Optioneering Scenario: Relocation of Grenagh WwTP

Drawing No: P2640-OS-002 | A



Legend

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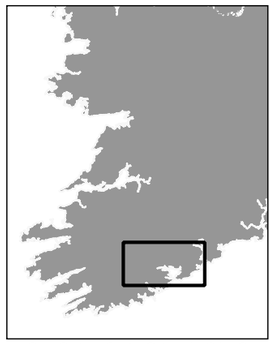
- New Grenagh WwTP
- Tributaries
- River Lee

N



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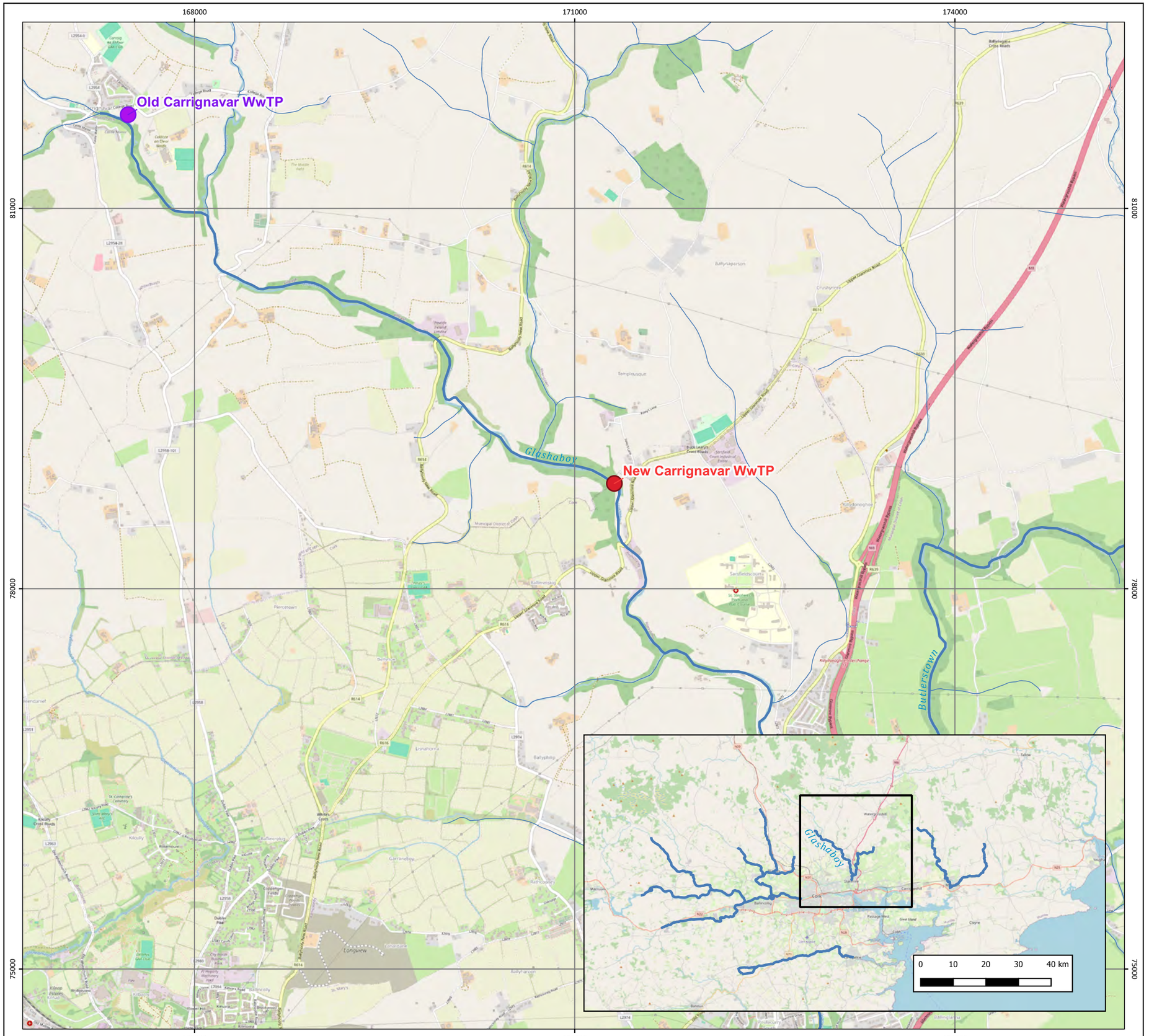
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

0 0.6 1.2 1.8 2.4 km



Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.; Data from EPA Ireland

Cork Strategic Drainage Study

River Glashaboy

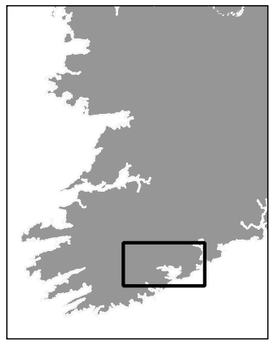
Optioneering Scenario: Relocation of Carrignavar WwTP

Drawing No: P2640-OS-003 | A

Legend

- Old Carrignavar WwTP
- Tributaries
- River Glashaboy

N



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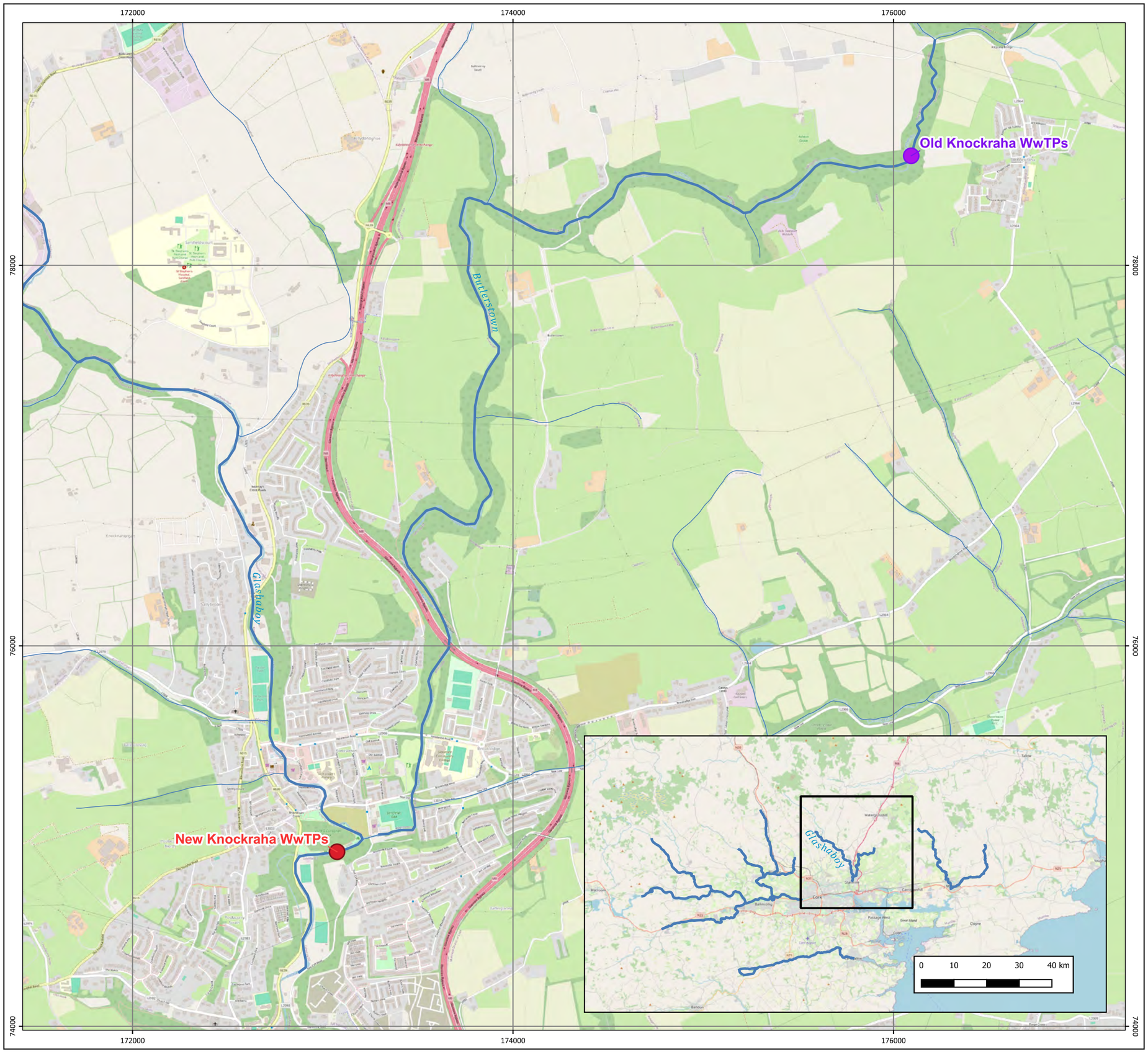
Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

0 0.3 0.6 0.9 1.2 km



Cork Strategic Drainage Study

River Glashaboy

Optioneering Scenario: Relocation of Carrignavar WwTP

Drawing No: P2640-OS-005	A

Legend

- Old Knockraha WwTPs
- New Knockraha WwTPs
- River Glashaboy
- Tributaries

N

NOT TO BE USED FOR NAVIGATION

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Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

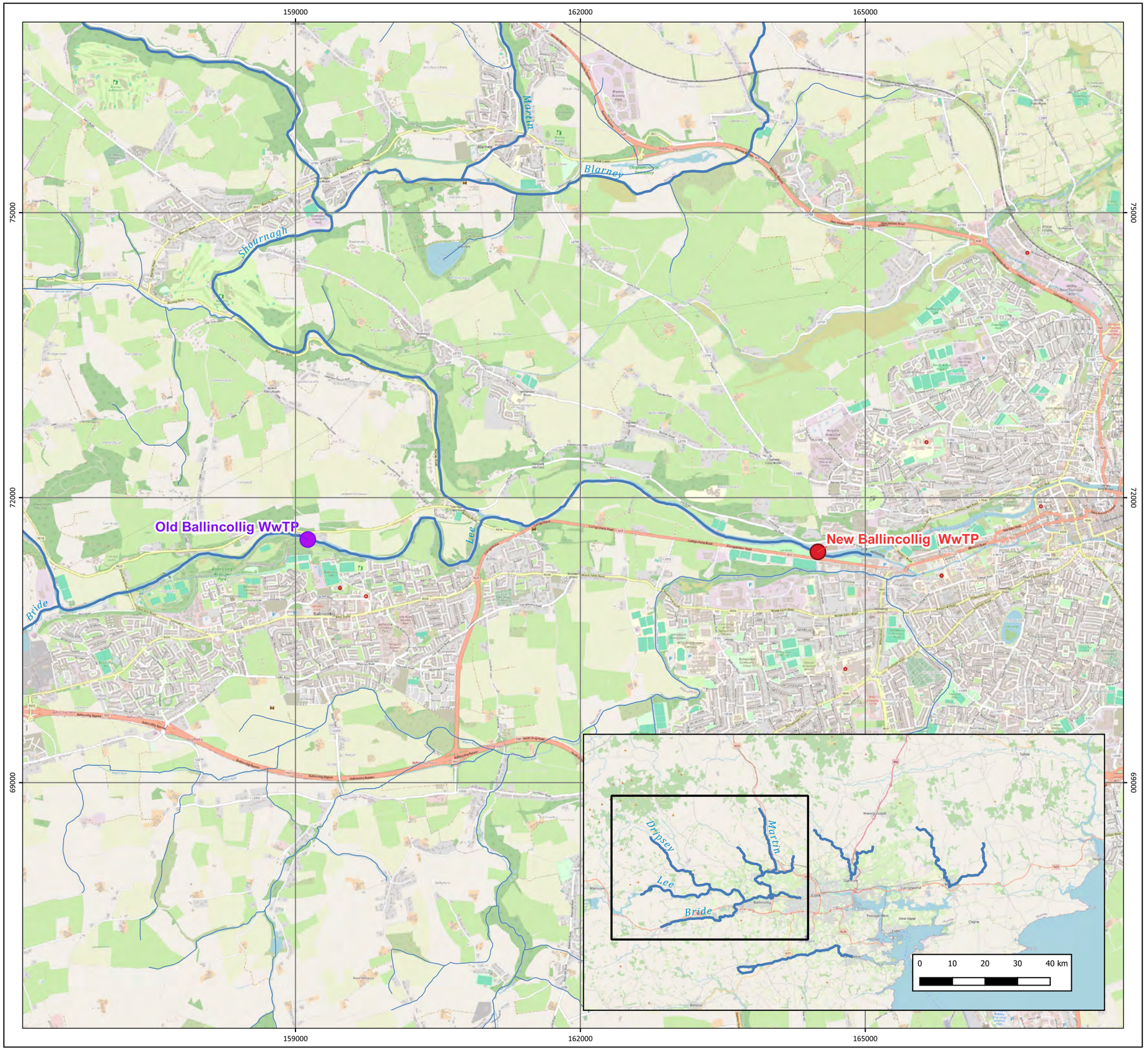
0 0.2 0.4 0.6 0.8 km

Cork Strategic Drainage Study

River Lee

Optioneering Scenario: Relocation of Ballincollig WwTP

Drawing No: P2640-OS-004 | A



Legend

- New Ballincollig WwTP
- Old Ballincollig WwTP
- Tributaries
- River Lee

N

NOT TO BE USED FOR NAVIGATION

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Created By	Shilpa M Swaraj
Reviewed By	Dan Williams
Approved By	Dan Williams

Jacobs

intertek metoc

0 0.4 0.8 1.2 1.6 km

4.2 Maximum ELVs

The revised maximum ELVs, determined following the assessment of the optioneering scenarios, are presented in Table 4-1.

Table 4-1 Allowable ELVs for Optioneering Scenarios: BOD

WwTPs	High Status Objective?	Target Status	Notionally Clean?	BOD			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	20	25	25	25
Relocation of Grenagh WwTP	No	Good	Yes	25	25	25	25
Relocation of Carrignavar WwTP	No	Good	No	25	25	25	25
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	25	25	25	25
Knockraha WwTP Baseline Scenario	Yes	High	Yes	125	125	125	125
Ballincollig WwTP: Scenario 1	Yes	High	Yes	25	13.1	12.1	20.5
Ballincollig WwTP: Scenario 2	No	Good	No	25	17.3	15.9	25

Table 4-2 Allowable ELVs for Optioneering Scenarios: Ammonia

WwTPs	High Status Objective?	Target Status	Notionally Clean?	Ammonia			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	1.5	2.97	2.5	2.16
Relocation of Grenagh WwTP	No	Good	Yes	3	2.97	2.50	2.16
Relocation of Carrignavar WwTP	No	Good	No	2	2	2	2
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	5	3.05	2.69	2.30
Knockraha WwTP Baseline Scenario	Yes	High	Yes	5	5	5	5
Ballincollig WwTP: Scenario 1	Yes	High	Yes	5	1.82	1.18	1.05
Ballincollig WwTP: Scenario 2	No	Good	No	5	1.93	1.24	1.13

Table 4-3 Allowable ELVs for Optioneering Scenarios: MRP

WwTPs	High Status Objective?	Target Status	Notionally Clean?	MRP			
				Permit	2030	2055	2080
Relocation of Blarney WwTP	Yes	High	Yes	0.8	1.65	1.65	1.65
Relocation of Grenagh WwTP	No	Good	Yes	1.65	1.65	1.65	1.65
Relocation of Carrignavar WwTP	No	Good	No	2	1.74	1.46	1.25
Flow Transfer to Ballygarvan WwTP	Yes	High	Yes	3	0.59	0.51	0.46
Knockraha WwTP Baseline Scenario	Yes	High	Yes	3	3	3	3
Ballincollig WwTP: Scenario 1	Yes	High	Yes	2	0.8	0.8	0.8
Ballincollig WwTP: Scenario 2	No	Good	No	2	2	2	2

5. CONCLUSIONS

The river hydrodynamic and water quality models for the Glashaboy River, Owenboy River, Owencurra River and River Lee, originally built, calibrated and validated using the industry-standard MIKE11 software, as part of the Cork Harbour Strategic Modelling Study for Uisce Éireann by Intertek Metoc, have been used to assess the impacts of WwTPs on the river water quality and to evaluate maximum allowable ELVs for WwTPs. Properly defined ELVs for WwTPs can ensure it meets regulatory standards and river water quality is protected.

Impact assessments have been undertaken for the Current condition and planning horizons of 2030, 2055 and 2080, considering projected increases in flows for WwTPs due to future growth and changes in river flows due to potential climate change. Impact assessment results and maximum ELV calculations are detailed in Section 2 for the Current condition and Section 3 for the planning horizons of 2030, 2055 and 2080.

Current Condition

Carrignavar WwTP and Knockraha WwTP are predicted to cause a large increase in concentration for BOD, ammonia and MRP; and Ros Ards WwTP increases ammonia and MRP concentrations in the river. Coole East WwTP has no impact on the water quality in the river. The EQS for Good status is already exceeded upstream of the WwTPs for Glashaboy River for BOD, ammonia and MRP, and therefore ELVs for Carrignavar WwTP, Coole East WwTP and Ros Ards WwTP were determined using the NC condition. For Knockraha WwTP, the NC condition was applied to calculate ELVs for BOD and MRP, as the upstream water quality conditions are within the upper 25% in-band WAC.

Owenboy River: Ballygarvan and Halfway WwTPs are predicted to cause minimal increases in the concentration of BOD, ammonia and MRP. The EQS for Good status is already exceeded upstream of the WwTPs for the Owenboy River for MRP, and therefore MRP ELVs for Halfway WwTP and Ballygarvan WwTP were determined using the NC condition.

Owencurra River: Ballincurrig WwTP, Lisgold South WwTP and Dungourney WwTP are predicted to cause increases in concentration for BOD, ammonia and MRP; while Lisgold North WwTP has little impact on the water quality in the river. Owenacurra River has a High status objective and as the upstream river concentration exceeds the High EQS threshold for MRP, the NC condition was applied to calculate ELVs for MRP.

Lee River: On the Blarney River, Whitechurch WwTP is predicted to cause large increases in concentration for BOD, ammonia and MRP; and Killeens WwTP increases ammonia concentrations. The EQS for Good status is already exceeded upstream of Blarney River for BOD, ammonia and MRP, and therefore ELVs for Whitechurch WwTP and Killeens WwTP were determined using NC condition. Grenagh WwTP shows minimal increases in concentration of BOD, ammonia and MRP. The EQS for Good status is already exceeded upstream of the Grenagh WwTW for MRP and therefore ELVs for MRP were determined using the NC condition. On the Shournagh River, Blarney WwTP leads to a large increase in BOD, ammonia and MRP concentrations whereas the Courtbrack WwTP shows only slight increases in ammonia and MRP. As Shournagh River has a High status objective and the upstream river concentration exceeds the High status threshold for BOD and MRP, the NC condition was applied to calculate ELVs for BOD and MRP for Courtbrack WwTP and Blarney WwTP. Cloughduv WwTP has a negligible effect on water quality, whereas Killumney WwTP contributes to notable increases in BOD, ammonia, and MRP concentrations. For Cloughduv WwTP, the NC condition was applied to calculate ELVs for BOD, ammonia and MRP, as the WwTP discharges to the upstream reach of River Bride, which has a High status objective and upstream water quality conditions are within the upper 25% in-band WAC. On the Dripsey River, Rylane WwTP and Dripsey WwTP are predicted to cause increases in concentration for BOD, ammonia and MRP; while Aghabullogue WwTP has only a minimal impact on the water quality in the river. As the Dripsey River has a High status objective and the upstream river

MRP concentration already exceeds the High EQS threshold, MRP ELVs for Rylane WwTP, Aghabullogue WwTP and Dripsey WwTP were determined using the NC condition. Coachford WWTP and Inniscarra WwTP discharging into the River Lee have minimal impacts on water quality, while Ballincollig WWTW has a large impact on the water quality in the river.

Climate Change Assessment

The river models have also been used to assess climate change effects on the river water quality together with the flow increases at the WwTPS due to population growth for three planning horizons of 2030, 2055, and 2080. Hydrology models have been developed considering climate change for the three planning horizons.

From the model results, the maximum allowable ELVs were determined for 2030, 2055 and 2080. Since the predicted rainfall timeseries including climate change has relatively increased dry flow periods (compared to non-climate change models), maximum allowable ELVs would generally be more stringent under climate change conditions. Therefore, only models representing climate change have been used in calculations of maximum allowable ELVs. Under future climate projections (2030, 2055, and 2080), river-specific assessments revealed varying impacts on water quality:

The 2030 horizon reflects the least stringent ELVs. However, by 2050 and particularly by 2080, the ELVs become progressively more stringent.

For BOD, the ELVs at Dungourney, Killeens, Grenagh, and Rylane WwTPs become significantly more stringent towards 2080. With respect to ammonia, the WwTPs where ELVs become more stringent include Coole East, Ros Ard, Dungourney, Killeens, Grenagh, Kilumney, and Rylane. For MRP, increased stringency in ELVs is observed at Ros Ard, Dungourney, Killeens, Grenagh, Kilumney, and Rylane WwTPs.

Optioneering Scenarios

A number of optioneering scenarios have been assessed to explore alternative configurations aimed at reducing environmental impact through relocating outfalls to more favourable downstream locations, which can provide improved dilution and thereby lower maximum ELVs, or through the transfer of flows to another WwTP. The MIKE11 models have been setup and run for those scenarios and from which their new maximum allowable ELVs were calculated. The relocation of WwTP outfalls and the transfer of flows to other WwTPs resulted in less stringent ELV requirements in all cases.

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