Annual Environmental Report

2020

Baile Na nGall

D0358-01

CONTENTS

7 APPENDIX

- 7.1 AMBIENT MONITORING SUMMARY
- 7.2 SHELLFISH IMPACT ASSESSMENT
- 7.3 OTHER

Rev 1 : Section 4.1.1 How much sewage was discharged via SWOs in the agglomeration in the year (m3)? Answer changed to "Unknown" Approved 06/07/2021

Rev 2 : Section 2.1.3 Removal of comment on significance of Results; only one ambient monitoring point so no comparison can be made.

1 EXECUTIVE SUMMARY AND INTRODUCTION TO THE 2020 AER

This Annual Environmental Report has been prepared for D0358-01, Baile Na nGall, in Waterford in accordance with the requirements of the wastewater discharge licence for the agglomeration. Specified reports where relevant are included as an appendix to the AER.

1.1 ANNUAL STATEMENT OF MEASURES

A summary of any improvements undertaken is provided where applicable.

Currently there is an ongoing review of the WW agglomeration infrastructure. This is identifying where capital works upgrades are required. To date the much of the agglomeration has been mapped and a model developed, and now engineering solutions are being identified.

1.2 TREATMENT SUMMARY

The agglomeration is served by a wastewater treatment plant(s)

- BAILE NA NGALL WWTP - 2020 with a Plant Capacity PE of 1600, the treatment type is 2 - Secondary treatment

1.3 ELV OVERVIEW

The overall compliance of the final effluent with the Emission Limit Values (ELVs) is shown below. More detailed information on the below ELV's can be found in Section 2.

Discharge Point Reference	Treatment Plant	Discharge Type	Compliance Status	Parameters failing if relevant
TPEFF3100D0358SW001	BAILE NA NGALL WWTP - 2020	Treated	Non-Compliant	Ammonia-Total (as N) mg/l

1.4 LICENCE SPECIFIC REPORTING INCLUDED IN AER

Assessment / Report	Included in AER
Shellfish Impact Assessment	Yes

2 TREATMENT PLANT PERFORMANCE AND IMPACT SUMMARY

2.1 BAILE NA NGALL WWTP - 2020 - TREATED DISCHARGE

2.1.1 INFLUENT MONITORING SUMMARY - BAILE NA NGALL WWTP - 2020

A summary of influent monitoring for the treatment plant is presented below. This monitoring is primarily undertaken in order to determine the overall efficiency of the plant in removing pollutants from the raw wastewater.

Parameters	Number of Samples	Annual Max	Annual Mean
COD-Cr mg/l	7	389	201.13
Total Phosphorus (as P) mg/l	7	5.85	2.91
Total Nitrogen mg/l	7	38.7	19.71
BOD, 5 days with Inhibition (Carbonaceous BOD) mg/l	7	236	107.79
Suspended Solids mg/l	7	141	81.37
Hydraulic Capacity	N/A	700	321

If other inputs in the form of sludge / leachate are added to the WWTP then these are included in Section 2.1.5 if applicable.

Significance of Results:

The annual mean hydraulic loading is less than the peak Treatment Plant Capacity. The annual maximum hydraulic loading is less than the peak Treatment Plant Capacity. Further details on the plant capacity and efficiency can be found under the sectional ‘Operational Performance Summary’. The design of the wastewater tretament plant allows for peak values and therefore the peak loads have not impacted on compliance with Emission Limit Values.

2.1.2 EFFLUENT MONITORING SUMMARY - TPEFF3100D0358SW001

Parameter	WWDL ELV (Schedule A)	ELV with Condition 2 Interpretation included Note 1	Interim % reduction from influent concentration	Number of sample results	Number of exceedances	Number of with Condition 2 Interpretation included	Annual Mean	Overall Compliance (Pass/Fail)
COD-Cr mg/l	125	250	N/A	7	N/A	N/A	32.92	Pass
Suspended Solids mg/l	35	87.5	N/A	7	N/A	N/A	5.4	Pass
Total Oxidised Nitrogen (as N) mg/l	35	42	N/A	6	N/A	N/A	2.54	Pass
BOD, 5 days with Inhibition (Carbonaceous BOD) mg/l	25	50	N/A	7	N/A	N/A	11.88	Pass
Ammonia-Total (as N) mg/l	15	18	N/A	6	3	2	12.98	Fail
pH pH units	9	9	N/A	7	N/A	N/A	7.52	Pass
Enterococci (Intestinal) MPN/100ml	N/A	N/A	N/A	7	N/A	N/A	3715384	
Total Phosphorus (as P) mg/l	N/A	N/A	N/A	7	N/A	N/A	1.3	
E. Coli no./100mls	N/A	N/A	N/A	7	N/A	N/A	2260900	

Parameter	WWDL ELV (Schedule A)	ELV with Condition 2 Interpretation included Note 1	Interim % reduction from influent concentration	Number of sample results	Number of exceedances	Number of with Condition 2 Interpretation included	Annual Mean	Overall Compliance (Pass/Fail)
Faecal coliforms no./100mls	N/A	N/A	N/A	6	N/A	N/A	N/A	

Notes:
1 – This represents the Emission Limit Values after the Interpretation provided for under Condition 2 of the licence is applied

Cause of Exceedance(s):

The WWTP is not designed for nutrient removal.

Significance of Results:

No evidence of impact has been identified.

2.1.3 AMBIENT MONITORING SUMMARY FOR THE TREATMENT PLANT DISCHARGE TPEFF3100D0358SW001

A summary of monitoring from ambient monitoring points associated with the wastewater discharge is provided in the sections below. For discharges to rivers upstream (U/S) and downstream (D/S) location data is provided. For other ambient points in lakes, coastal or transitional waters, monitoring data from the most appropriate monitoring station is selected.

The table below provides details of ambient monitoring locations and details of any designations as sensitive areas.

Ambient Monitoring Point from WWDL (or as agreed with EPA)	Irish Grid Reference	River Station Code	Bathing Water	Drinking Water	FWPM	Shellfish	WFD Status
Downstream	231096, 89342	CW31002108CG2008	No	No	No	Yes	High

The results for ambient results and / or additional monitoring data sets are included in the **Appendix 7.1 - Ambient monitoring summary**

Significance of Results:

The WWTP discharge was not compliant with the ELV's set in the wastewater discharge licence.

The ambient monitoring results does not meet the required EQS. The EQS relates to the Oxygenation and Nutrient Conditions set out in the Surface Water Regulations 2009.

The discharge from the wastewater treatment plant does not have an observable negative impact on the Water Framework Directive

status.

2.1.4 OPERATIONAL PERFORMANCE SUMMARY - BAILE NA NGALL WWTP - 2020

2.1.4.1 Treatment Efficiency Report - BAILE NA NGALL WWTP - 2020

Treatment efficiency is based on the removal of key pollutants from the influent wastewater by the treatment plant. In essence the calculation is based on the balance of load coming into the plant versus the load leaving the plant. The efficiency is presented as a percentage removal rate.

A summary presentation of the efficiency of the treatment process including information for all the parameters specified in the licence is included below:

Parameter	Influent mass loading (kg/year)	Effluent mass emission (kg/year)	Efficiency (% reduction of influent load)
TN	1953	N/A	N/A
COD	19926	3428	83
cBOD	10679	1237	88
TP	288	136	53
SS	8061	562	93

Note: The above data is based on sample results for the number of dates reported

2.1.4.2 Treatment Capacity Report Summary - BAILE NA NGALL WWTP - 2020

Treatment capacity is an assessment of the hydraulic (flow) and organic (the amount of pollutants) load a treatment plant is designed to treat versus the current loading of that plant.

BAILE NA NGALL WWTP - 2020	
Peak Hydraulic Capacity (m^3/day) - As Constructed	923.76
DWF to the Treatment Plant (m^3/day)	307.92
Current Hydraulic Loading - annual max (m^3/day)	700
Average Hydraulic loading to the Treatment Plant (m^3/day)	321
Organic Capacity (PE) - As Constructed	1600
Organic Capacity (PE) - Collected Load (peak week)[Note1]	998
Organic Capacity (PE) - Remaining	602
Will the capacity be exceeded in the next three years? (Yes/No)	No

Nominal design capacities can be based on conservative design principles. In some cases assessment of existing plants has shown organic capacities significantly higher than the nominal design capacity. Accordingly plants that appear to be overloaded when comparing a collected peak load with the nominal design capacity can be fully compliant due to the safety factors in the original design.

2.1.5 SLUDGE / OTHER INPUTS - BAILE NA NGALL WWTP - 2020

'Other inputs' to the waste water treatment plant are summarised in table below

Input type	Quantity	Unit	P.E.	% of load to WWTP	Included in Influent Monitoring (Y/N)?	Is there a leachate/sludge acceptance procedure for the WWTP?	Is there a dedicated leachate/sludge acceptance facility for the WWTP? (Y/N)
There is no Sludge and Other Input data for the Treatment Plant included in the AER.							

3 COMPLAINTS AND INCIDENTS

3.1 COMPLAINTS SUMMARY

A summary of complaints of an environmental nature is included below.

Number of Complaints	Nature of Complaint	Number Open Complaints	Number Closed Complaints
There were no relevant environmental complaints in 2020.			

3.2 REPORTED INCIDENTS SUMMARY

Environmental incidents that arise in an agglomeration are reported on an on-going basis in accordance with our waste water discharge licences. Where an incident occurs and it is reportable under the licence, it is reported to the Environmental Protection Agency through their Environmental Data Exchange Network, or in some instances by telephone. Some incidents which arise in the agglomeration are recorded by Irish Water but may not be reportable under our licence for example where the incident does not have an impact on environmental performance.

A summary of reported incidents is included below.

3.2.1 SUMMARY OF INCIDENTS

Incident Type	Cause	No. of incident occurrences	Recurring (Y/N)	Closed (Y/N)
Uncontrolled release	Network Infrastructure	1	Yes	No
Uncontrolled release	SWO exceptional rainfall and overflow expected	1	Yes	No
Uncontrolled release	Adverse Weather	1	No	Yes

Incident Type	Cause	No. of incident occurrences	Recurring (Y/N)	Closed (Y/N)
Uncontrolled release	EO caused by pump failure	1	Yes	Yes
Uncontrolled release	EO caused by power failure	1	Yes	Yes
Uncontrolled release	EO caused by pump failure	1	No	Yes
Uncontrolled release	EO caused by power failure	1	No	Yes
Uncontrolled release	Adverse Weather	1	No	Yes
Uncontrolled release	Broken Sewer Pipe	1	No	No
Breach of ELV	WWTP not designed for N removal	1	Yes	No

3.2.2 SUMMARY OF OVERALL INCIDENTS

Question	Answer
Number of Incidents in 2020	10
Number of Incidents reported to the EPA via EDEN in 2020	10
Explanation of any discrepancies between the two numbers above	N/A

4 INFRASTRUCTURAL ASSESSMENTS AND PROGRAMME OF IMPROVEMENTS

4.1 STORM WATER OVERFLOW IDENTIFICATION AND INSPECTION REPORT

A summary of the operation of the storm water overflows and their significance where known is included below:

4.1.1 SWO IDENTIFICATION

WWDL Name / Code for Storm Water Overflow	Irish Grid Ref.	Included in Schedule A4 of the WWDL	Significance of the overflow(High / Medium / Low)	Assessed against DoEHLG Criteria	No. of times activated in 2020 (No. of events)	Total volume discharged in 2020 (m3)	Monitoring Status
SW2	230781, 89173	Yes	Medium	Meeting	32	369	Monitored
An Móta PS SWO	228760, 88788	No	Medium	Not Meeting	Unknown	Unknown	Not Monitored
TBC	228748, 88731	No	Medium	Not Meeting	Unknown	Unknown	Not Monitored
Baile na nGall PS SWO	229714, 88872	No	Medium	Not Meeting	Unknown	Unknown	Monitored
TBC	TBC, TBC	No	Medium	Not Meeting	Unknown	Unknown	Unknown

SWO Summary	
How much sewage was discharged via SWOs in the agglomeration in the year (m3)?	Unknown
Is each SWO identified as not meeting DoEHLG Guidance included in the Programme of Improvements?	No
The SWO Assessment included the requirements of relevant of WWDL schedules?	Yes
Have the EPA been advised of any additional SWOs / changes to Schedule C3 and A4 under Condition 1.7?	No

4.2 REPORT ON PROGRESS MADE AND PROPOSALS BEING DEVELOPED TO MEET THE IMPROVEMENT PROGRAMME REQUIREMENTS.

4.2.1 SPECIFIED IMPROVEMENT PROGRAMME SUMMARY

A wastewater discharge licence may require a number of reports on specific subject areas to be prepared for the agglomeration in question. These reports are submitted to the EPA as part of the Annual Environmental Report. This section provides list of the various reports required for this agglomeration and a brief summary of their recommendations.

Specified Improvement Programmes (under Schedule A and C of WWDL)	Description	Licence Schedule	Licence Completion Date	Date Expired? (N/NA/Y)	Status of Works	Timeframe for Completing the Work	Comments
There are no Specified Improvement Programmes for this Agglomeration.							

A summary of the status of any improvements identified by under Condition 5.2 is included below.

4.2.2 IMPROVEMENT PROGRAMME SUMMARY

Improvement Identifier	Improvement Description / or any Operational Improvements	Improvement Source	Expected Completion Date	Comments
There are no Improvements Programme for this Agglomeration.				

4.2.3 SEWER INTEGRITY RISK ASSESSMENT

The utilisation of multiple capital maintenance programmes and the outputs of the workshops with the Local Authority Operations Staff held under the programme can be used to satisfy the requirements of Condition 5 regarding network integrity. Improvement works identified by way of these programmes and workshops will be included in the Improvements Summary Table.

5 LICENCE SPECIFIC REPORTS

A wastewater discharge licence may require a number of reports on specific subject areas to be prepared for the agglomeration in question. These reports are submitted to the EPA as part of the Annual Environmental Report. This section provides list of the various reports required for this agglomeration and a brief summary of their recommendations.

5.a Licence Specific Reports Summary Table

Licence Specific Report	Required by licence	Year included in AER	Included in this AER	Reference to relevant section of AER
Priority Substances Assessment	Yes	2014	No	
Shellfish Impact Assessment	Yes	2020	Yes	5.2

5.1 PRIORITY SUBSTANCES ASSESSMENT

The Priority Substances Assessment Report has been included in the AER 2014

5.2 SHELLFISH IMPACT ASSESSMENT

The Shellfish Impact Assessment Report is included in Appendix 7.2 - Shellfish Impact Assessment. A summary of the findings of this report is included below.

Parameter	Value
Are discharges from the works impacting on the microbiological quality of the shellfish? AND Is there is a requirement to install UV/other disinfection equipment on any of the discharges?	Not Applicable

Parameter	Value
Are the findings and recommendations of the shellfish impact risk assessment included?	Not Applicable
Comment	Refer to Appendix of this AER for full report.
Detailed Study of Shellfish Waters Required	Yes
Does the shellfish programme include results generated by other organisations	Yes
Has this been completed?	Not Applicable
If not yet complete what is the expected date for completion?	Not Applicable
Impact Assessment Report Outstanding	No
Is impact of all discharges from the works considered?	Yes
Is there a shellfish monitoring programme in place?	Yes
List organisations contributing data to the assessment	Sfpa, Mi
List prescribed organisations consulted	Sfpa, Mi, Bim
Priority (A,B,C,D) See Notes	A
Provide details on disinfection system to be employed	Not Applicable
Recommendations	Not Applicable
Status of any improvement measures required	Refer to Section 5 of Shellfish Report
What is the demonstrated efficiency of the disinfection system?	Not Applicable

Parameter	Value
Where disinfection is required, is there a programme in place?	Not Applicable

6 CERTIFICATION AND SIGN OFF

6.1 SUMMARY OF AER CONTENTS

Parameter	Answer
Does the AER include an Executive Summary?	Yes
Does the AER include an assessment of the performance of the Waste Water Works (i.e. have the results of assessments been interpreted against WWDL requirements and or Environmental Quality Standards)?	Yes
Is there a need to advise the EPA for consideration of a Technical Amendment / Review of the licence?	Yes
List reason e.g. additional SWO identified	SWOs
Is there a need to request/advise the EPA of any modification to the existing WWDL with respect to condition 4 changes to monitoring location, frequency etc	Yes
List reason e.g. changes to monitoring requirements	Request that the Ambient Monitoring point be moved to a shore location at Heilbhic Head [rather than 100mm off shore]. Additionally, the agglomeration review may also identify additional issues that may require an Amendment.
Have these processes commenced?	No
Are all outstanding reports and assessments from previous AERs included as an appendix to this AER	N/A

I certify that the information given in this Annual Environmental Report is truthful, accurate and complete:

Signed: Date: 06/07/2021

This AER has been produced by Irish Water's Environmental Information System (EIMS) and has been electronically signed off in that system for and on behalf of ,

Katherine Walshe

Acting Head of Environmental Regulation.

7 APPENDIX

Appendix
Appendix 7.1 - Ambient monitoring summary
Appendix 7.2 - Shellfish Impact Assessment
Appendix 7.3 - Other

Ambient Monitoring Summary

The coordinates of this sampling point as prescribed in the Licence is approximately 100m off Heilbhic Pier. Due to Health and Safety risks associated with undertaking sampling offshore, ambient samples were taken from Baile na nGall Pier.

Table 1 Baile na nGall Pier.

Location	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Annual Average	
Eden Code	CW31002108CG2007	CW31002108CG2007	CW31002108CG2007	CW31002108CG2007		
Date	06-Feb-20	16-Jun-20	09-Sep-20	18-Nov-20		EQS (Coastal Water Body)
pH	7.87	8.32	8.07	8.07	8.08	Not Specified
Dissolved Oxygen (%)	99	144	106	90	109.75	120% < 95%ile> 80%
BOD - 5 days (Total) (mg/l)	*0.5*	*0.5*	1	-	0.67	Not Specified
Ammonia-Total (as N) (mg/l)	*1*	*2.5*	*0.05*	0.01	0.89	Not Specified
Total Nitrogen N (mg/l)	*1*	*2.5*	*1*	-	1.50	Not Specified
Total Oxidised Nitrogen N (mg/l)	*1*	*2.5*	*5*	*0.5*	2.25	
DIN (mg/l)	2	5	5.05	0.51	3.14	≤ 0.17mg/l High Status
Visual	Clear	Clear	Clear	Clear		-

Note: DIN is given as the sum of TON + NH_3.

Also, some of the TON and NH_3 were returned from the Laboratory were ”< ” [less than] therefore half the value was used to calculate the Averages.

WwTP Disinfection Programme

Dungarvan Shellfish Water

Stage 4a – Detailed Assessment of the Existing Primary Discharges

Employer:	**Irish Water**
Irish Water Project Number:	**10020264**
Project Supervisor Design Process (PSDP):	**Nicholas O'Dwyer Ltd.**
PSDP Project Number:	**20745**
Modelling Consultant	**RPS Consulting**

Project Name: WwTP Disinfection Programme
Document: Dungarvan Shellfish Water - Stage 4a – Detailed Assessment of the Existing Primary Discharges

Revision History

Revision	Reason for Revision	Prepared By	Reviewed By	Approved By	Issue Date
DRAFT	-	Z. Morgan	N. Shannon	M. Brian	18/12/2019
A	Draft Final	Z. Morgan	N. Shannon	M. Brian	27/07/2020
B	River inputs corrected	Z. Morgan	N. Shannon	M. Brian	05/08/2020
C	Final with client comments	Z. Morgan	N. Shannon	M. Brian	12/08/2020
D	Final Issue	Z. Morgan	N. Shannon	M. Brian	25/08/2020
E					

Contents

List of Figures

List of Tables

Abbreviations

ADCP	Acoustic Doppler Current Profiler
CFU	Colony Forming Units
EC	Escherichia Coli (E.coli)
HD	Hydrodynamic
IW	Irish Water
LOD	Limit of Detection
MPN	Most Probable Number (equivalent to CFU)
NOD	Nicholas O'Dwyer
PMS	Performance Management Systems
SWO	Storm Water Overflow
TSMM	Technical Standards for Marine Modelling
WQ	Water Quality
WwTP	Wastewater Treatment Plant

1. Background

As part of the Irish Water Wastewater Treatment Plant (WwTP) Disinfection Programme[1], RPS has been commissioned by Nicholas O'Dwyer (NOD) on behalf of Irish Water to undertake a modelling impact assessment of the main outfall discharges on the water quality of the Designated Shellfish Waters in Dungarvan Harbour.

The main objective of this modelling study was to assess whether discharges from agglomerations discharging directly to Dungarvan Harbour are impacting microbial water quality of the Designated Shellfish Waters, and identify the final effluent quality required in order to eliminate the impact of any discharges identified as impacting Designated Shellfish Water's microbial water quality.

1.1. Study Area

Dungarvan Harbour is situated on the coast of County Waterford in the South-Eastern River Basin District. Three small rivers discharge into the Harbour; the Colligan, the Brickey and the Glendine. It is bounded by Ballynacourty Point to the north and Helvick Head to the south. It is divided into two distinct areas by a spit of land known as Cunnigar spit.

The Dungarvan Harbour shellfish waters were designated in 2009 under the European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009 (S.I. 55 of 2009). The total area of the Dungarvan Harbour designated as a shellfish area is circa 6.96 km^2 which is located to the eastern side of the spit and is delineated by straight lines from the tip of the Cunnigar Spit to the slip/pier at Ballynacourty and by the Cunnigar and Ring Peninsula. Figure 1-1 shows the extent of the designated shellfish waters at Dungarvan.

[1] Irish Water Wastewater Treatment Plant Disinfection Programme, Terms of Reference, No.12/085-29

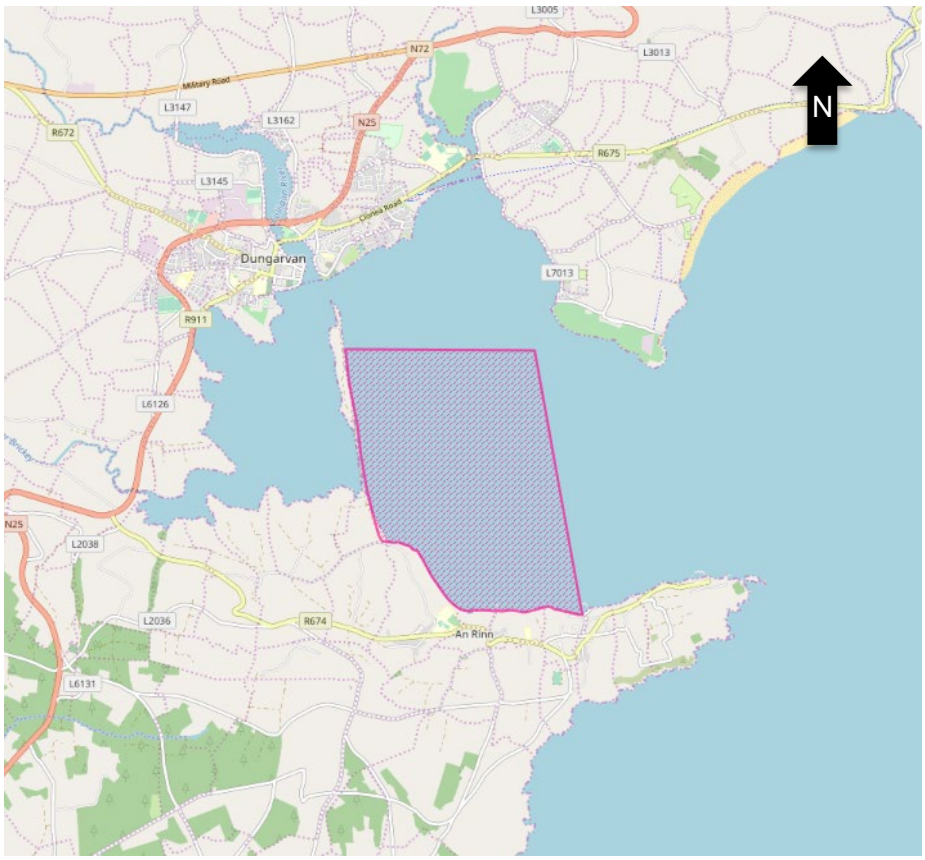

Figure 1-1: Dungarvan Harbour Designated Shellfish Water (EPA, 2019a)

The assessment included modelling of two WwTPs, which were the focus of the study. These were: Dungarvan and Baile Na nGall. In addition, the diffuse or background load from the three main rivers that drain into the harbour were also included (Colligan, Brickey and Glendine) to ensure that any effect on the hydrodynamics due to these fresh water inputs was captured in the modelling. Therefore, there were 5 discharges included in the hydrodynamic model in total.

The location of the Dungarvan and Baile Na nGall WwTPs primary discharge points (SW1) and the three rivers are shown in Figure 1-2 and Figure 1-3 respectively.

Figure 1-2: Location of Dungarvan and Baile Na nGall WwTPs primary discharge points (SW1)

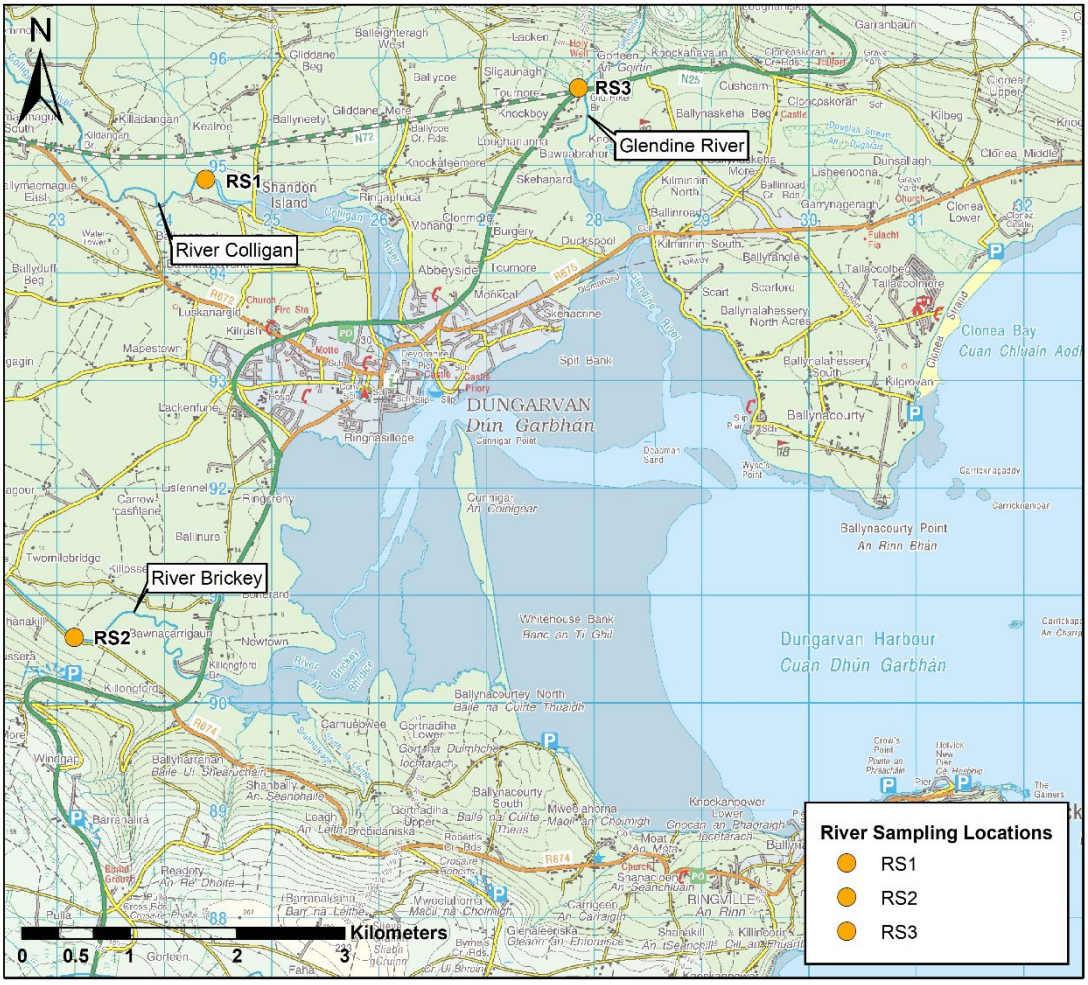

Figure 1-3: Location of Colligan, Brickey and Glendine Rivers

2. Objectives

Three key specific objectives of the assessment are as follows;

1. Assess whether untreated, primary and secondary discharges from agglomerations discharging in the proximity of Dungarvan Harbour are impacting Escherichia coli (hereafter referred to as *E. coli* or EC) water quality of the Designated Shellfish Waters.
2. Identify the final effluent quality required in order to ensure discharges do not impact Designated Shellfish Water's microbial water quality.
3. Assess the impact of Surface Water Overflows (SWO) on the microbial water quality of the Designated Shellfish Waters.

Separate to the Disinfection Programme, the Dungarvan City Drainage Area Plan (DAP) Study is currently ongoing which will provide detailed information on the volume, duration and frequency of discharges from SWOs. A Stage 4B SWO assessment will therefore be carried out in due course, once this information is available.

This current assessment for the Disinfection Programme has therefore only considered discharges of final effluent from the WwTPs, as well as other continuous sources.

3. Approach

3.1. Hydrodynamic (HD) Model – Development

A hydrodynamic model of Dungarvan Harbour was developed using the MIKE suite of models in line with the requirements of the Irish Water (IW) Technical Standards for Marine Modelling[2]. The model domain (Figure 3.1) covers the whole of Dungarvan Harbour plus part of the adjoining coastal waters from Ballydowane Beach in the north to Mine Head in the south.

Bathymetry data from a range of sources was used including data from the INFOMAR project which covered the south coast of Ireland to 10m resolution and data from C-Map Norway. An additional dataset supplied by Irish Hydrodata collected for the preparation of the Water Quality Management Plan for Dungarvan Harbour was also utilised.

The Dungarvan Harbour model utilised a flexible mesh approach where the model resolution varied across the domain with coarser cells at the boundaries and finer cells around the shellfish waters and WwTP outfalls. This flexible mesh approach allowed the detailed bathymetry of the area to be accurately represented whilst maintaining a good level of computational efficiency. A two dimensional depth integrated modelling approach was adopted for Dungarvan as field data did not indicate the presence of any stratification within the water column, see **Appendix A**.

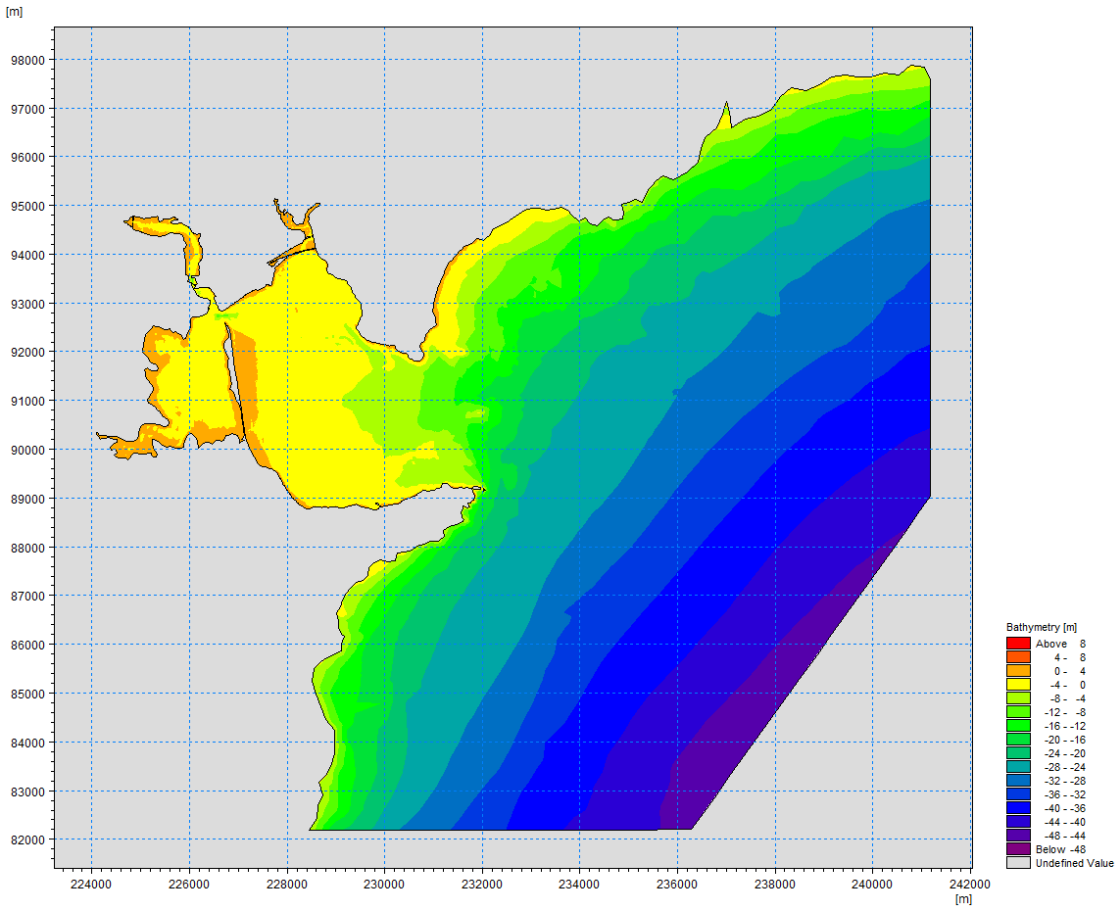

Figure 3.1: Dungarvan Model Domain

[2] Irish Water (IW) Technical Standards for Marine Modelling version 1.83

3.2. Hydrodynamic Model

The Dungarvan Harbour hydrodynamic model was calibrated and validated by comparing modelled water levels, current speeds and directions to a series of field observations collected over spring and neap tidal cycles. In addition to tidal forcing the hydrodynamic model also included a representation of the three principal fluvial inputs to Dungarvan Harbour: the Colligan River, the River Brickey and the Glendine River.

A sufficient level of correlation was achieved for the model to be considered suitable for assessing the dispersion of effluent from a range of sources within Dungarvan Harbour and consequently establishing the potential impact of these discharges on water quality within the Designated Shellfish Waters. Full details of the model development and verification are contained in the calibration and validation report[3], while some key examples of the calibration plots are shown in **Appendix A**.

3.3. Dispersion Model

Dye tracing data was used to demonstrate the suitability of the model dispersion coefficients by simulating a series of dye patches recorded over spring tides and adjusting the model dispersion coefficients until the model outputs were adjudged to correlate with the field observations. Once calibrated the dispersion model parameters were validated by comparing a second set of predicted dye patches against observed dye patches recorded during neap tidal cycles. Again validation performance was evaluated by reference to the visual assessment standards set out in the IW TSMM. Full details of the dispersion model calibration and validation are contained in the calibration and validation report.

Overall the results from the dispersion calibration/validation exercise demonstrated that the model was appropriate for the assessment of the dispersion and fate of micro-biological pollution associated with the wastewater discharges to Dungarvan Harbour.

[3] Irish Water Wastewater Treatment Plant Disinfection Programme, Model Calibration & Validation Report, Dungarvan,

3.4. Baseline Water Quality Modelling

3.4.1 Water Quality Standards

The IW TSMM provides guidance on the environmental standards to be used in assessing the impacts on designated Shellfish Waters. In the absence of a regulatory standard in the water column, as an interim criteria, Irish Water require all continuous discharges to be such that microbiological water quality would meet the Good Bathing Waters standard of 500 *E.coli* per 100ml (95%ile) within Designated Shellfish Waters.

3.4.2 Model Input Parameters

Irish Water Discharges

E.coli concentrations

E.coli sampling results for effluent from the two WwTPs discharging to Dungarvan Harbour, as supplied by Irish Water were used to derive representative inputs for the model simulations. For these discharges, a geometric mean of the available *E.coli* sampling, which indicates the central tendency or typical value of a set of numbers, was calculated. The geometric mean is generally considered the most representative approach to determine *E.coli* contributions from longer term sampling datasets, such as those for the respective WwTPs, where a wide variation in the numeric value of individual readings can be expected. Table 3.1 presents the values calculated for input to the model.

Discharge Flow Rate

Flow data from the two WwTPs collected by Irish Water was used to derive representative discharge flows for input into the model. For each plant an average flow was calculated from the datasets provided for input to the hydraulic model. Average flows are considered to better represent the flow contributions from the WwTPs, as opposed to a geometric mean, as long term flow data sets do not present the same wide variation in values as expected with effluent E.coli concentrations. Table 3.1 below shows the parameters used for input into the water quality model.

Table 3.1: Model inputs for E.coli and discharge flow from WwTPs in Dungarvan Harbour

WwTP	Treatment	Period of IW WQ Data Available	*E.coli* (cfu/100ml)	Source of Flow Data	Current Hydraulic Loading (m^3/s)
Dungarvan	Secondary	01/01/2017 – 31/03//2018	20,071	2017 PMS[4] 2018 PMS[4]	0.126959
Baile Na nGall	Secondary	01/01/2018 – 30/04/2018	$3.2x10^5$	2018 PMS[4]	0.006587

Riverine Inputs

E.coli concentrations

The water quality sampling also included data for the three main riverine inputs to Dungarvan Harbour. The fluvial *E.coli* sampling locations are shown in Figure 1-3 above.

[4] Irish Water Performance Management Systems

All river water samples were taken on the 16/05/2019 with three samples lifted at each of the three sample sites. The results showed the *E.coli* levels to vary significantly on the River Brickey. Consequently riverine concentrations were taken to be the worse-case values from the limited field sampling provided for each of the river inputs i.e. a conservative approach was taken, as the dataset was not considered statistically robust for the calculation of a geomean or average. The *E.coli* concentrations adopted are shown in Table 3.2.

Table 3.2: E.coli concentrations used for modelling river discharges

Watercourse	Sample Reference	E.coli [cfu/100ml]
River Colligan	RS1-1	111.2
River Brickey	RS2-1	816.4
Glendine River	RS3-1	344.1

Discharge Flow Rate

For the calibration modelling runs low flow estimates were used as a review of Met Éireann rainfall gauges close to the study area had identified that there had been little rainfall around the time of the sampling. The Marine Survey Report also stated that the water depth was shallow at the river sample locations which suggests the use of dry weather flows with the observed concentrations is valid.

The river flows were represented in the model as point sources where they enter the model domain, and for this assessment were assumed to be equivalent to the 50th percentile value derived using the EPA Hydrotool for ungauged catchments. The resulting flows are shown in Table 3.3.

Table 3.3: River flow inputs to Dungarvan Harbour

Source	River Name	Flow (m^3/s)
1	Colligan River	0.664
2	River Brickey	1.964
3	Glendine River	0.201

3.4.3 Decay Rate

Table 9-1 of the Irish Water Technical Standards for Marine Modelling set out appropriate decay rates to be used in marine outfall modelling. In the case of Dungarvan as the principal concern is impact on shellfish waters the modelling was undertaken for a winter scenario. Dungarvan can be classified as 'Coastal Waters' therefore, the T90 used for *E.coli* at Dungarvan was defined as 24 hours.

4. Model Results

The model was used to simulate the dispersion and fate of effluent over a period of 18 days to ensure a spring-neap cycle was captured whilst allowing sufficient warm up time for any instabilities at the beginning of the simulation to settle out.

Figure 4.1 below illustrates the resulting 95 percentile *E.coli* concentrations within Dungarvan Harbour resulting from the combined discharges from Dungarvan and Baile Na nGall WwTPs and the Brickey, Colligan and Glendine Rivers. The 95%ile values presented have been calculated over the final fifteen day period of the simulations, to exclude the influence of the values predicted during the initial model spin up period. A more detailed plot of the predicted 95%ile *E.coli* levels around the South-eastern boundary of the Designated Shellfish Waters is shown in Figure 4.2. In both plots the yellow and red colour bands highlight *E.coli* concentrations greater than 500cfu/100ml whilst the locations of the two outfalls and the extent of the Designated Shellfish Waters are also shown in Figure 4.1.

The results indicate that a small area (approximately 200m in length along the coastline) around the Baile Na nGall WwTP discharge and an area within the mouth of the Brickey would experience *E.coli* concentrations greater than 500cfu/100ml on a 95%ile basis. Within the designated Shellfish Waters, the 95%ile *E.coli* concentrations are always less than the required target level specified by the Irish Water Standards.

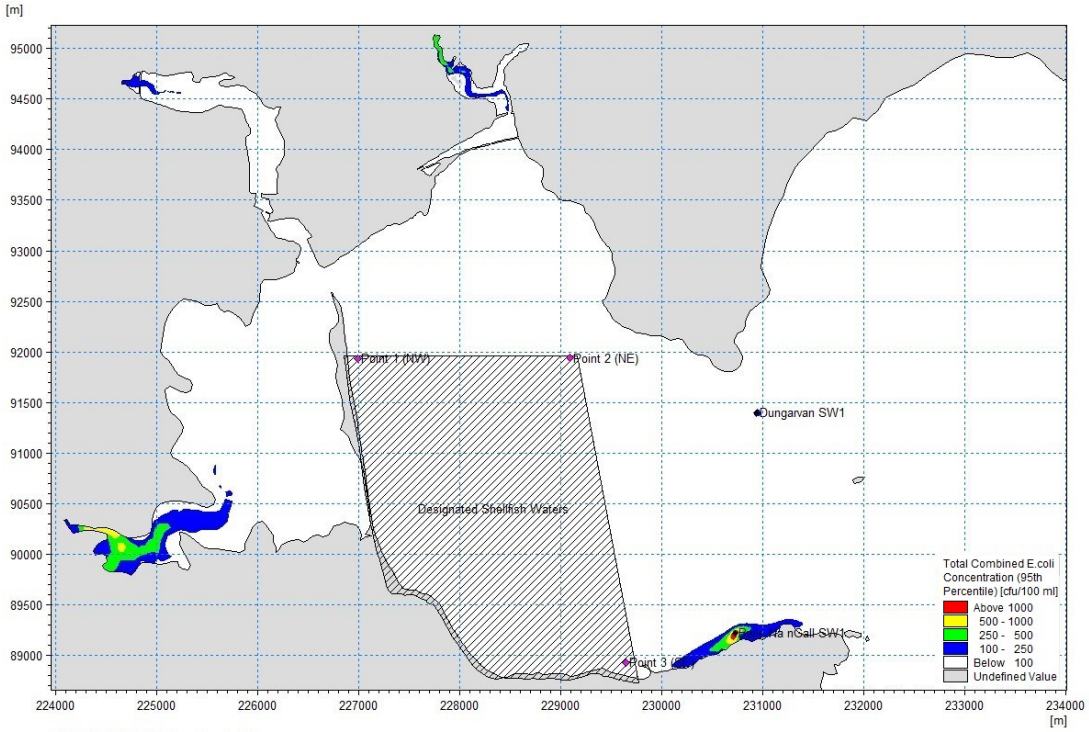

Figure 4.1: 95%ile modelled winter E.coli concentrations in Dungarvan Harbour over spring-neap cycle

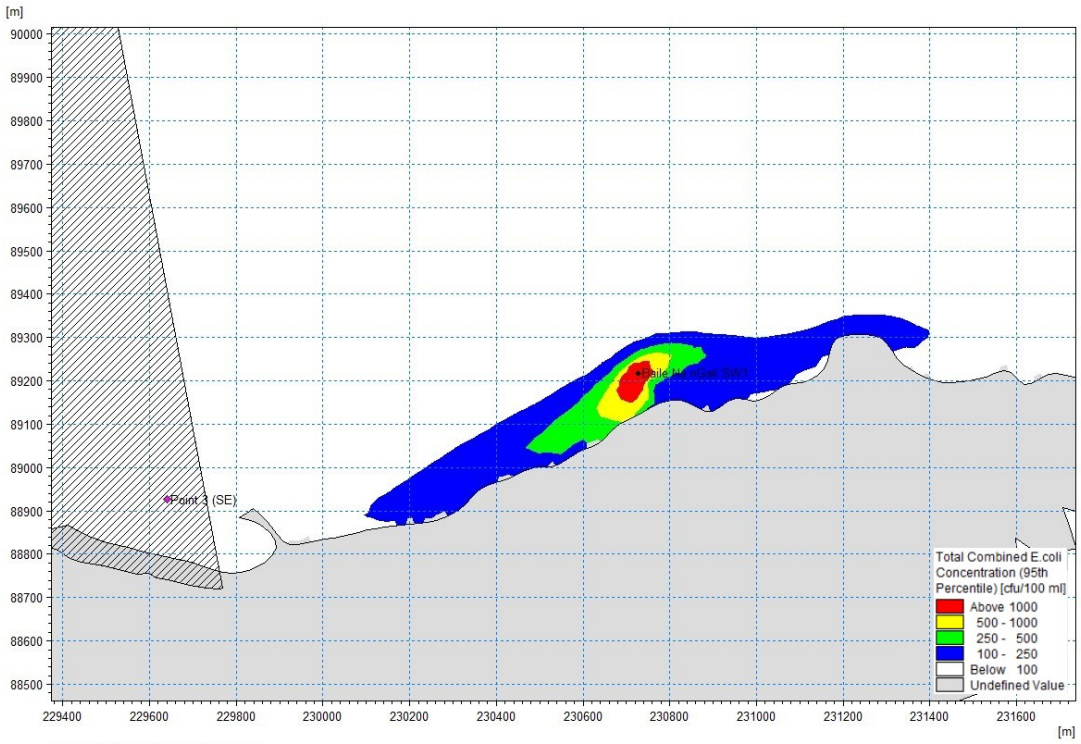

Figure 4.2: 95%ile modelled winter E.coli concentrations at SE corner of Designated Shellfish Waters over spring-neap cycle

The temporal variation in *E.coli* levels over the spring – neap cycle at each of the three analysis locations shown in Figure 4.1 is illustrated in Figure 4.3 to Figure 4.5. These plots clearly show significant variation in *E.coli* levels over the individual tidal cycles and also a variation in mean levels between spring and neap tides. Significantly these plots show that even the maximum modelled *E.coli* levels are significantly below the 500 cfu/100ml threshold specified in the Irish Water Standards.

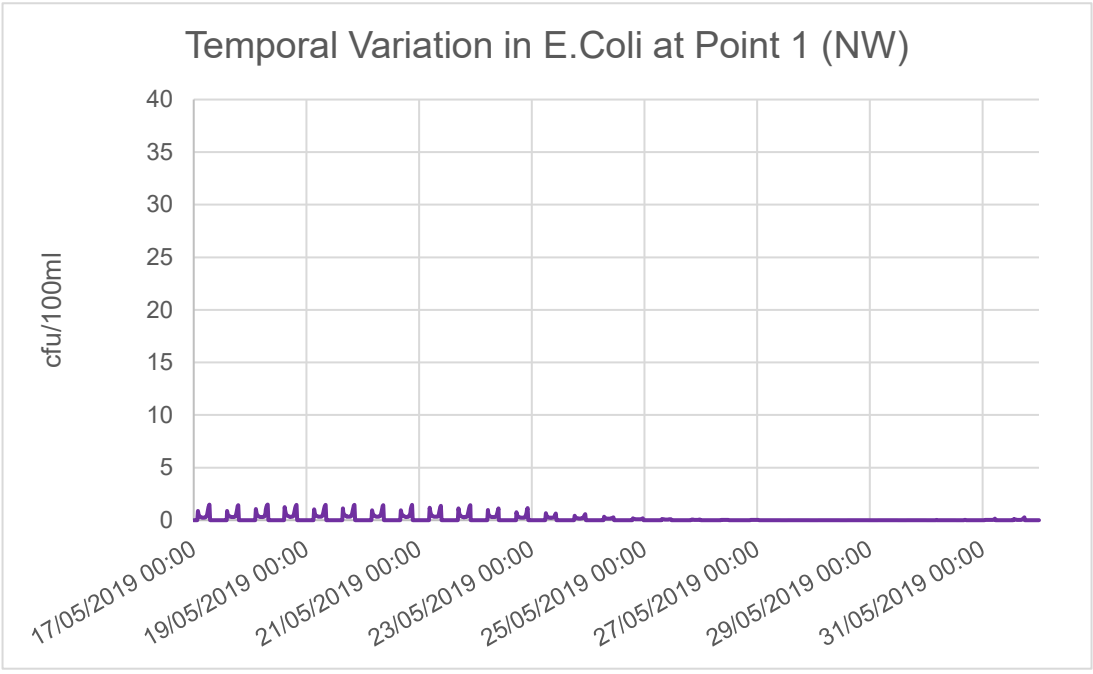

Figure 4.3: Temporal variation in E.coli concentration at Point 1

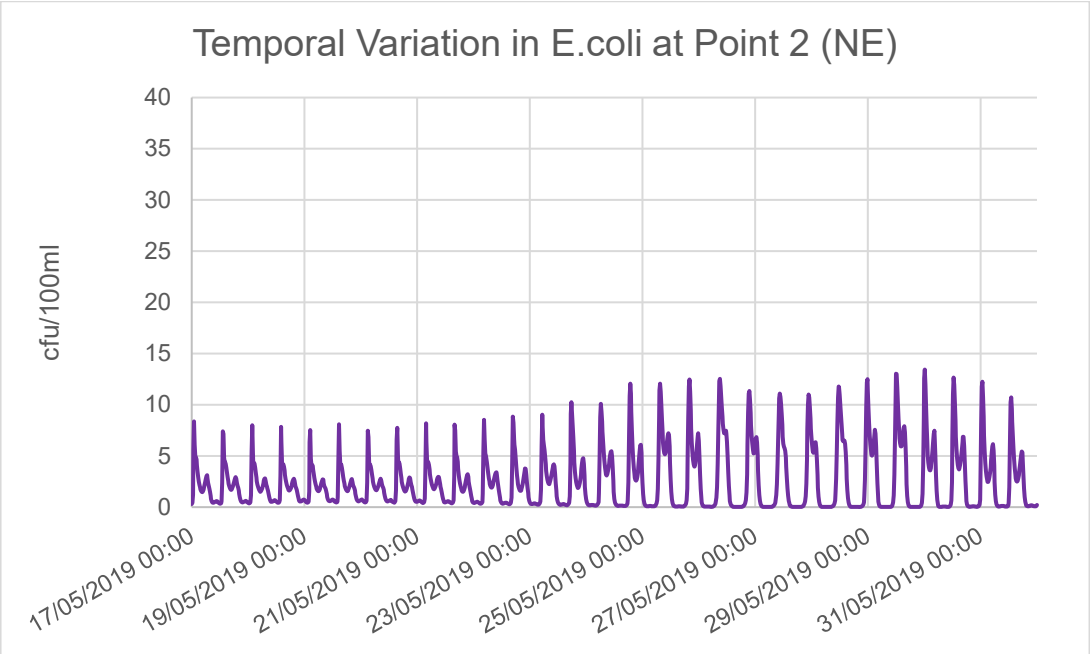

Figure 4.4: Temporal variation in E.coli concentration at Point 2

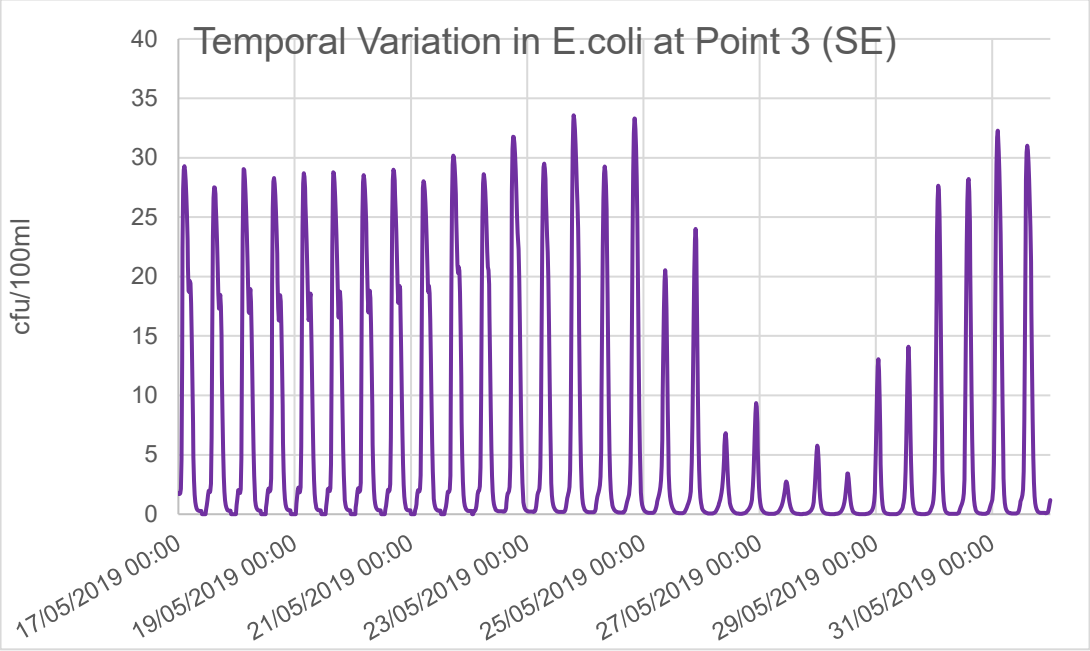

Figure 4.5: Temporal variation in E.coli concentration at Point 3

The relative contribution of each of the modelled sources, Dungarvan and Baile Na nGall WwTPs and the three rivers to the interim 500 E.coli/100ml threshold level at the three locations within the designated shellfish waters, indicated in Figure 4.1 (Point 1 (NW), Point 2 (NE) and Point 3 (SE)), is illustrated in Figure 4.6 to Figure 4.8 below. The overall 95%ile *E.coli* levels at all three locations are low, less than 30 EC/100ml, and the impact of the discharges from the two IW WwTPs whilst more prevalent than the indicated impact from the rivers is shown to account for less than 6% of the interim standard within the designated shellfish waters.

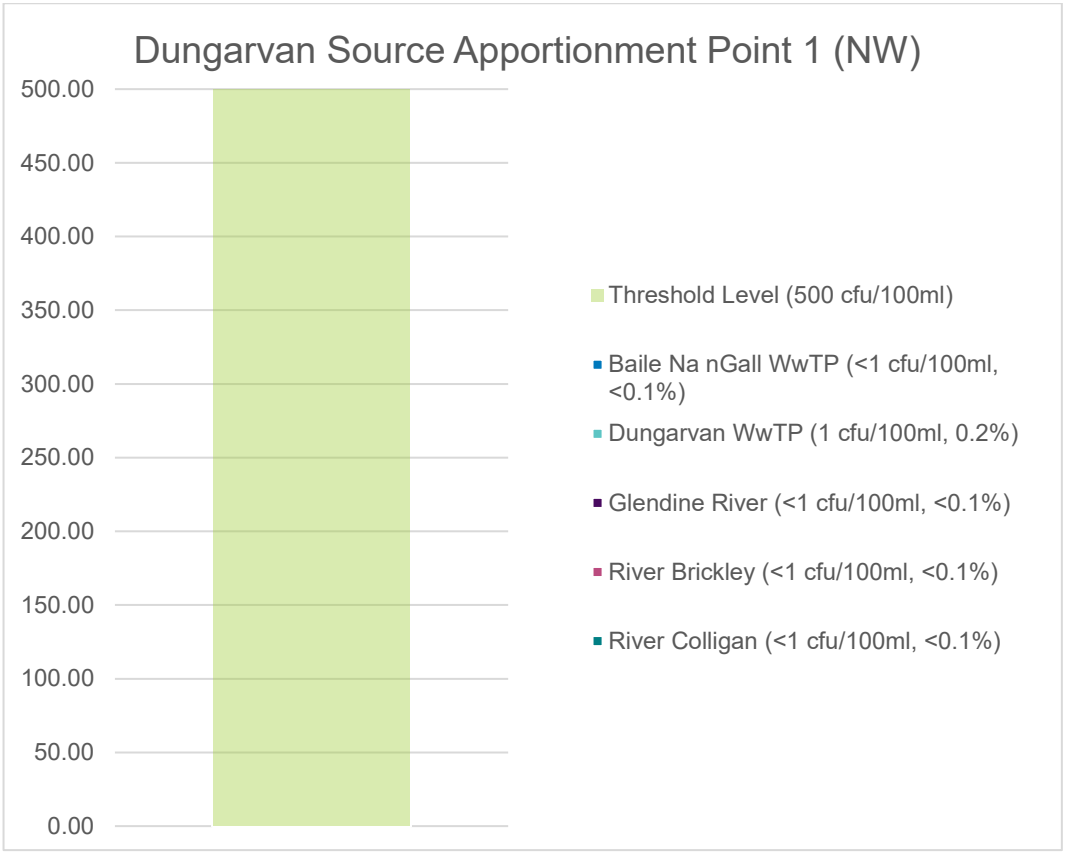

Figure 4.6: Relative contribution of each modelled source to the threshold level at Point 1

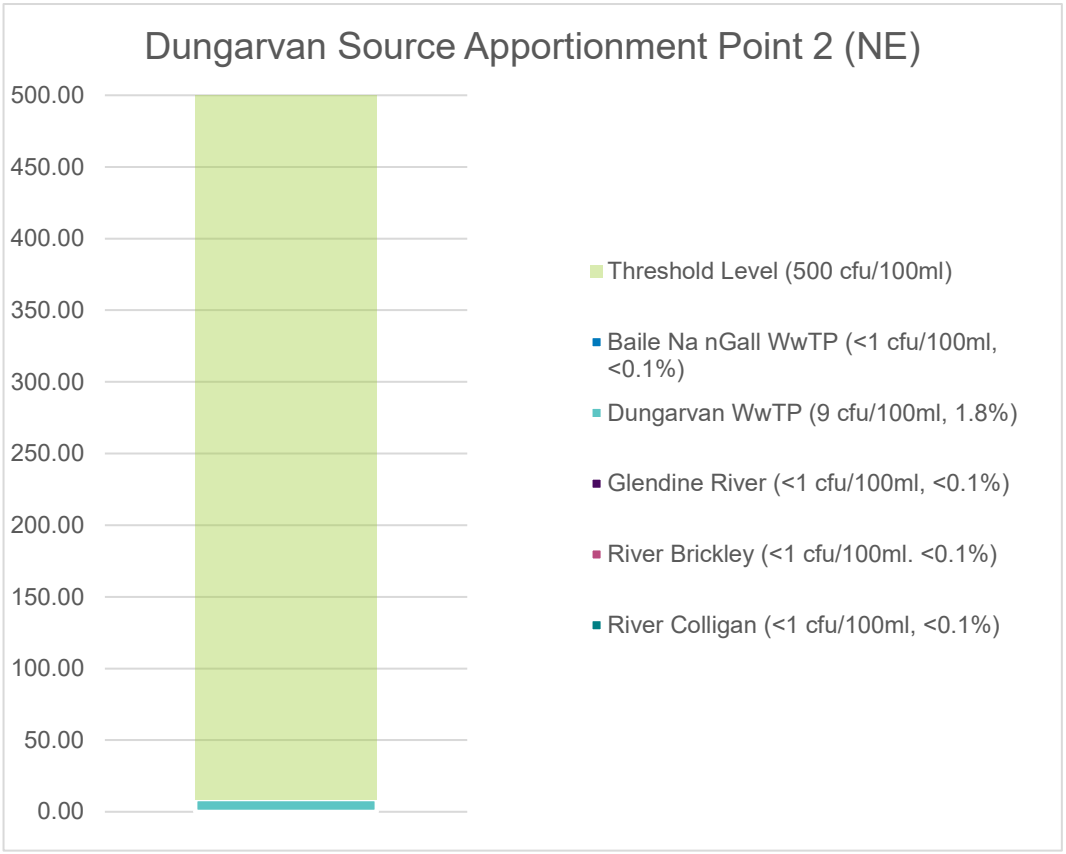

Figure 4.7: Relative contribution of each modelled source to the threshold level at Point2

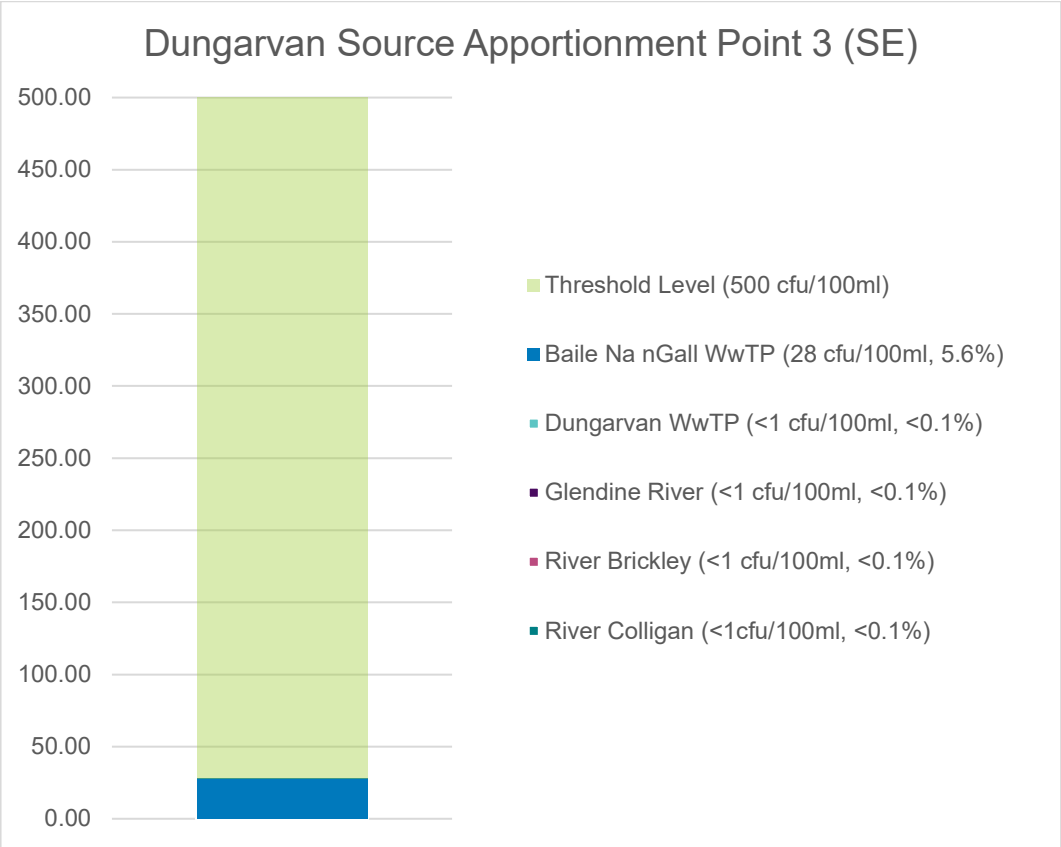

Figure 4.8: Relative contribution of each modelled source to the threshold level at Point 3

5. Conclusions

The key conclusions taken from the Baseline scenario are as follows;

- The modelled 95%ile *E.coli* concentration across the whole of the Designated Shellfish Water at Dungarvan is less than the 500 EC/100ml threshold.
- The primary discharges from the IW Dungarvan and Baile Na nGall WwTPs do not cause 95%ile *E.coli* levels within the Designated Shellfish Waters to exceed the interim threshold of 500 EC/100ml for Shellfish Waters.
- There is no requirement to improve the level of treatment at either Dungarvan or Baile Na nGall WwTPs.

6. References

1. Irish Water Wastewater Treatment Plant Disinfection Programme, Terms of Reference, No.12/085-296
2. Irish Water (IW) Technical Standards for Marine Modelling version 1.83 (TSMM)
3. Irish Water Wastewater Treatment Plant Disinfection Programme, Model Calibration & Validation Report, Dungarvan,

Appendix A

Model Dimensionality

Temperature and salinity profiles were obtained for the four ADCP locations and five additional water quality sample locations as illustrated in Figure A.1 which gave good spatial coverage of the outer harbour in the vicinity of the wastewater discharge points.

Figure A.1: Temperature and salinity survey locations

Full depth profiles were prepared so that the presence (or otherwise) of stratification could be evaluated. Figure A.2 illustrates the salinity profile with depth at each of the sampling locations based on the data collected at three-hourly intervals over both a spring and neap tide. Thus this information is representative of conditions at all tidal states and shows no discernible variation in salinity with depth, or significant variation between locations. Figure A.3 shows the comparable temperature data at each of the water quality sampling locations and illustrates a lack of temperature gradient between the sampling locations. This, lack of variation in temperature and salinity with depth irrespective of tidal state, in conjunction with the ADCP profile data, was considered sufficient to demonstrate that a 2D depth averaged tidal model would be representative of the flow conditions in the study area.

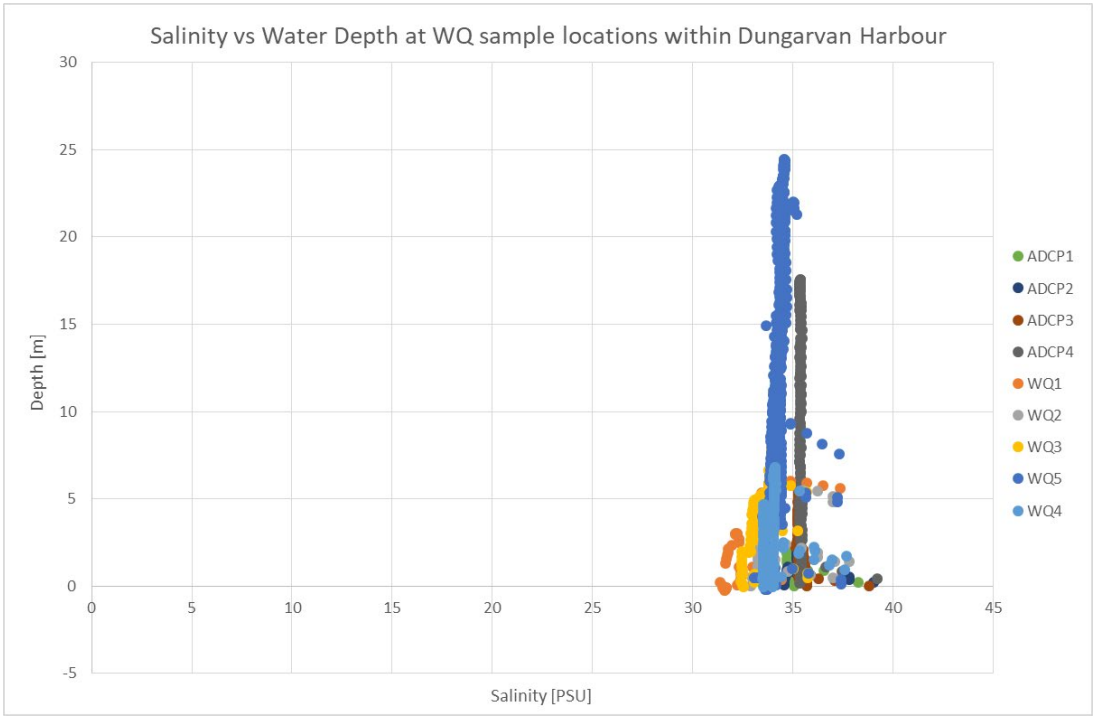

Figure A.2: Analysis of salinity profiles at ADCP and WQ sampling locations

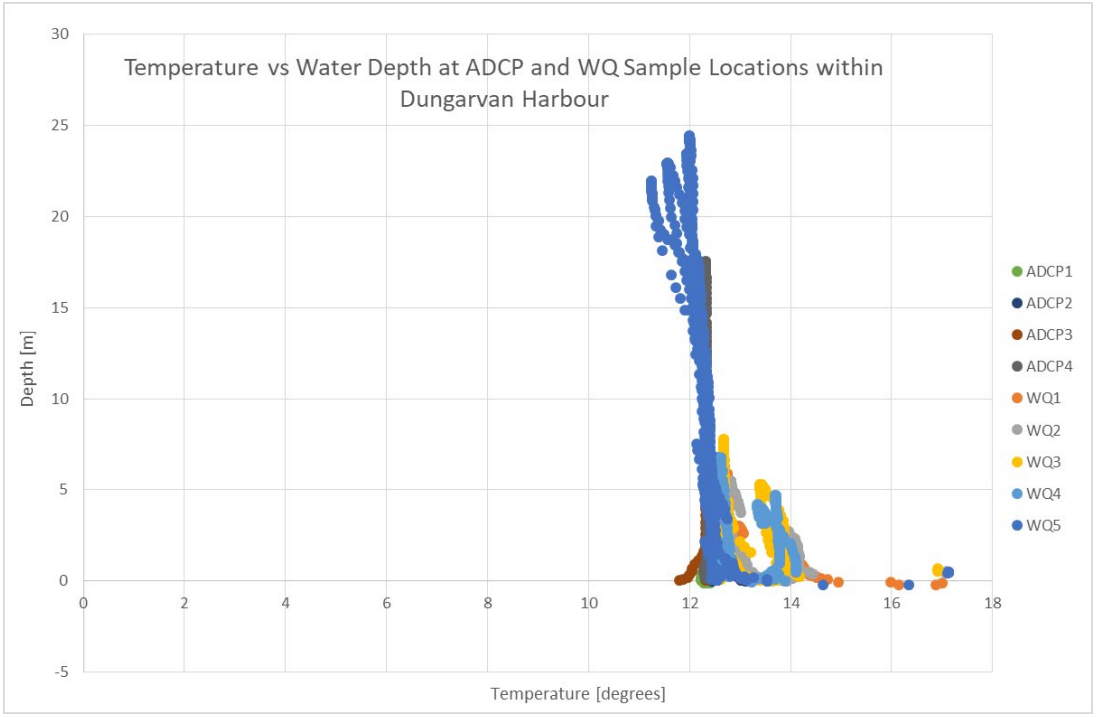

Figure A.3: Analysis of temperature profiles at ADCP and WQ sampling locations

HD Model Verification

The hydrodynamic model was verified by comparing model predictions of tidal levels and tidal currents to observed data recorded over both spring and neap tides. Tidal current information was recorded at the four ADCP locations shown in Figure A.1, while tidal levels were recorded via a temporary tide gauge installed in Helvick Harbour.

Tidal Levels

Figure A.4 illustrates the comparison between the predicted tidal levels at Helvick Harbour and the modelled tidal levels. Generally, there is reasonable correlation in terms of levels and tidal range and good correlation in terms of tidal phase.

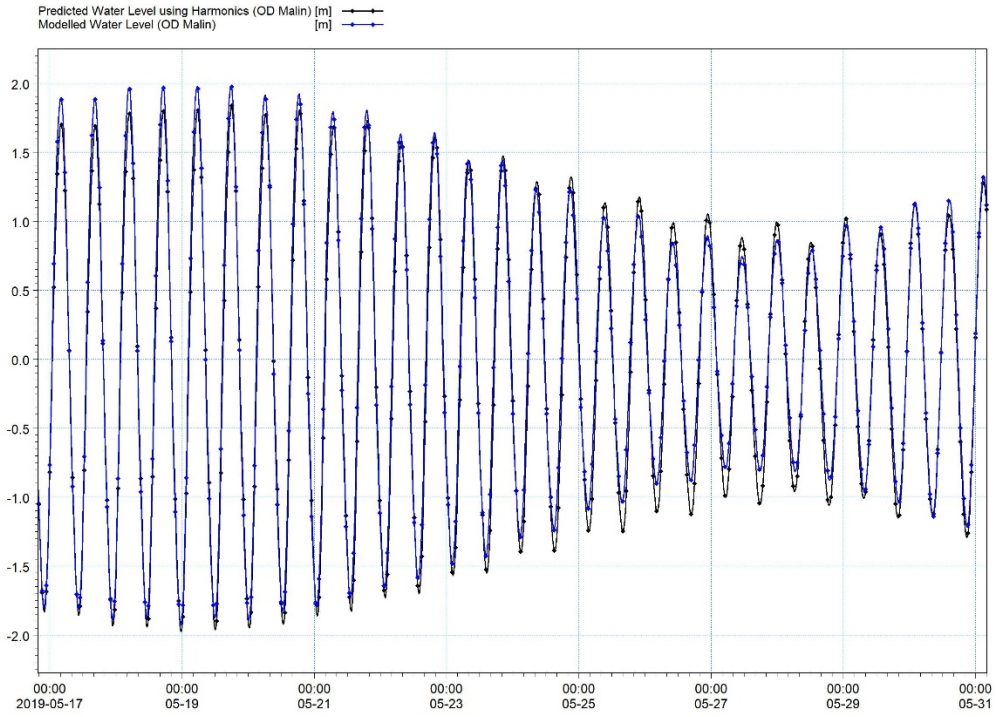

Figure A.4: Predicted vs modelled water level

Tidal Currents

Figure A.5 illustrates the correlation between the model predictions of depth averaged tidal current speeds and directions and the corresponding observed depth averaged information at ADCP site 1, the closest to the Designated Shellfish Waters, over spring tides. The corresponding correlation between the model predictions and observed depth averaged tidal current speed and direction over neap tides is shown in Figure A.6.

Quantitative assessment of the correlation between the modelled results and observed data was also undertaken in accordance with the requirements of the IW TSSM which established that the correlation was within the required accuracy thresholds.

Overall the results achieved from the calibration and validation of the hydrodynamics were demonstrated to be acceptable and as such the Dungarvan Harbour model was considered appropriate for the assessment of bacteriological (*E. Coli*) impacts and hence deemed to be fit for purpose within the Irish Water Disinfection Study.

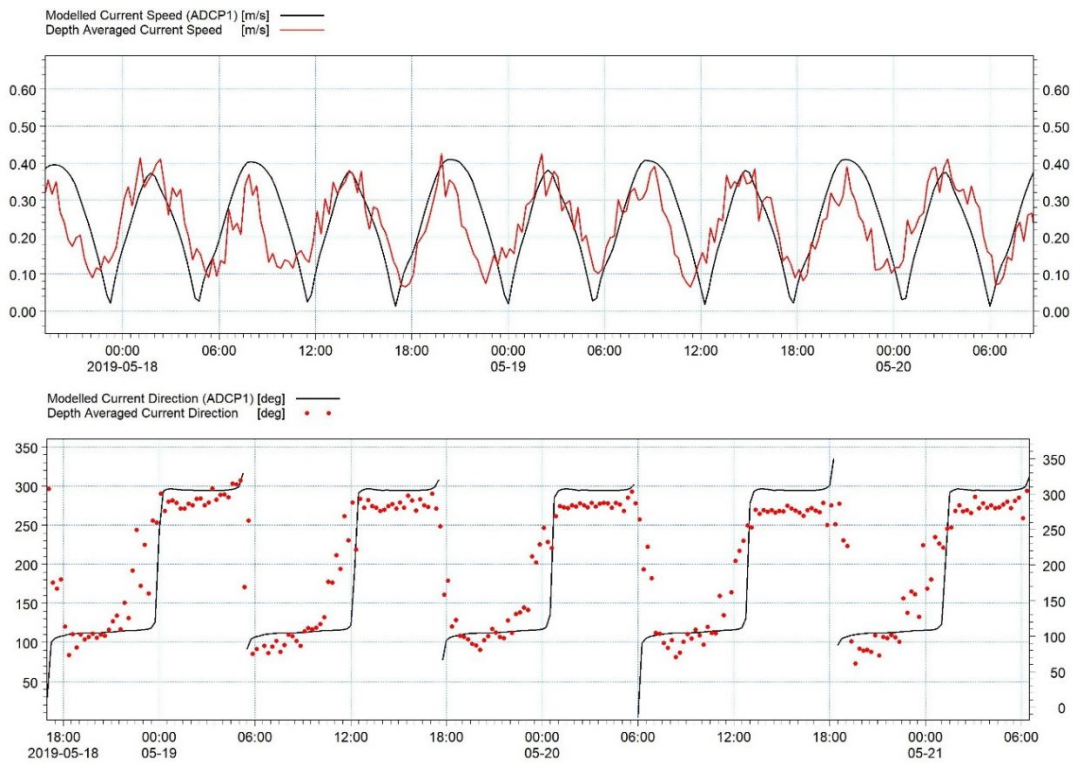

Figure A.5: ADCP1 - Modelled vs depth averaged observed current speed and direction (Spring)

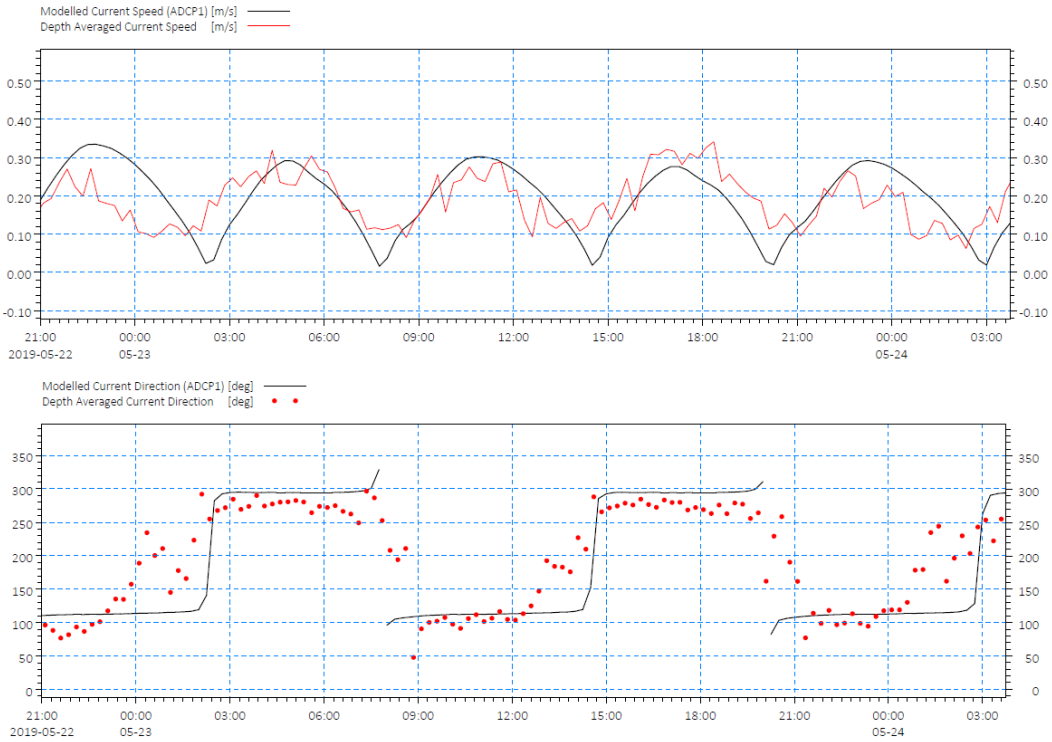

Figure A.6: ADCP1 - Modelled vs depth averaged observed current speed and direction (Neap)

Water Quality

Water quality sampling data, including *E.coli*, was obtained for five locations throughout Dungarvan harbour as shown in Figure A.1. The collected data showed very low concentrations of faecal bacteria present with almost all samples measuring below the Limit of Detection (LOD <10 MPN/100ml).

Model simulations using sampled effluent concentrations and flow rate for the WwTP discharges and sampled concentrations with 50%ile river flows produced a similarly low level of bacteriological impact to that shown by the field data as shown in Table A.1.

Table A.1: Simulated and Measured E.coli Concentrations at the 5 WQ Sampling Locations

Sample Location	Date	Tide	Measured E.coli Boundaries	Overall Mean Simulated E.coli	Maximum Simulated E.coli
WQ1	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	10MPN/100ml
WQ1	16/05/2019	Spring	<10MPN/100ml		
WQ2	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ2	16/05/2019	Spring	<10MPN/100ml		
WQ3	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ3	16/05/2019	Spring	<10MPN/100ml – 10MPN/100ml		
WQ4	29/05/2019	Neap	<10MPN/100ml – 20MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ4	16/05/2019	Spring	<10MPN/100ml		
WQ5	29/05/2019	Neap	<10MPN/100ml – 10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ5	16/05/2019	Spring	<10MPN/100ml		

Ambient Monitoring Summary

The coordinates of this sampling point as prescribed in the Licence is approximately 100m off Heilbhic Pier. Due to Health and Safety risks associated with undertaking sampling offshore, ambient samples were taken from Baile na nGall Pier.

Table 1 Baile na nGall Pier.

Location	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Cg300 - Ballynagaul Pier	Annual Average	
Eden Code	CW31002108CG2007	CW31002108CG2007	CW31002108CG2007	CW31002108CG2007		
Date	06-Feb-20	16-Jun-20	09-Sep-20	18-Nov-20		EQS (Coastal Water Body)
pH	7.87	8.32	8.07	8.07	8.08	Not Specified
Dissolved Oxygen (%)	99	144	106	90	109.75	120% < 95%ile> 80%
BOD - 5 days (Total) (mg/l)	*0.5*	*0.5*	1	-	0.67	Not Specified
Ammonia-Total (as N) (mg/l)	*1*	*2.5*	*0.05*	0.01	0.89	Not Specified
Total Nitrogen N (mg/l)	*1*	*2.5*	*1*	-	1.50	Not Specified
Total Oxidised Nitrogen N (mg/l)	*1*	*2.5*	*5*	*0.5*	2.25	
DIN (mg/l)	2	5	5.05	0.51	3.14	≤ 0.17mg/l High Status
Visual	Clear	Clear	Clear	Clear		-

Note: DIN is given as the sum of TON + NH_3.

Also, some of the TON and NH_3 were returned from the Laboratory were ”< ” [less than] therefore half the value was used to calculate the Averages.

WwTP Disinfection Programme

Dungarvan Shellfish Water

Stage 4a – Detailed Assessment of the Existing Primary Discharges

Employer:	**Irish Water**
Irish Water Project Number:	**10020264**
Project Supervisor Design Process (PSDP):	**Nicholas O'Dwyer Ltd.**
PSDP Project Number:	**20745**
Modelling Consultant	**RPS Consulting**

Project Name: WwTP Disinfection Programme
Document: Dungarvan Shellfish Water - Stage 4a – Detailed Assessment of the Existing Primary Discharges

Revision History

Revision	Reason for Revision	Prepared By	Reviewed By	Approved By	Issue Date
DRAFT	-	Z. Morgan	N. Shannon	M. Brian	18/12/2019
A	Draft Final	Z. Morgan	N. Shannon	M. Brian	27/07/2020
B	River inputs corrected	Z. Morgan	N. Shannon	M. Brian	05/08/2020
C	Final with client comments	Z. Morgan	N. Shannon	M. Brian	12/08/2020
D	Final Issue	Z. Morgan	N. Shannon	M. Brian	25/08/2020
E					

Contents

List of Figures

List of Tables

Abbreviations

ADCP	Acoustic Doppler Current Profiler
CFU	Colony Forming Units
EC	Escherichia Coli (E.coli)
HD	Hydrodynamic
IW	Irish Water
LOD	Limit of Detection
MPN	Most Probable Number (equivalent to CFU)
NOD	Nicholas O'Dwyer
PMS	Performance Management Systems
SWO	Storm Water Overflow
TSMM	Technical Standards for Marine Modelling
WQ	Water Quality
WwTP	Wastewater Treatment Plant

1. Background

As part of the Irish Water Wastewater Treatment Plant (WwTP) Disinfection Programme[1], RPS has been commissioned by Nicholas O'Dwyer (NOD) on behalf of Irish Water to undertake a modelling impact assessment of the main outfall discharges on the water quality of the Designated Shellfish Waters in Dungarvan Harbour.

The main objective of this modelling study was to assess whether discharges from agglomerations discharging directly to Dungarvan Harbour are impacting microbial water quality of the Designated Shellfish Waters, and identify the final effluent quality required in order to eliminate the impact of any discharges identified as impacting Designated Shellfish Water's microbial water quality.

Study Area

Dungarvan Harbour is situated on the coast of County Waterford in the South-Eastern River Basin District. Three small rivers discharge into the Harbour; the Colligan, the Brickey and the Glendine. It is bounded by Ballynacourty Point to the north and Helvick Head to the south. It is divided into two distinct areas by a spit of land known as Cunnigar spit.

The Dungarvan Harbour shellfish waters were designated in 2009 under the European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009 (S.I. 55 of 2009). The total area of the Dungarvan Harbour designated as a shellfish area is circa 6.96 km^2 which is located to the eastern side of the spit and is delineated by straight lines from the tip of the Cunnigar Spit to the slip/pier at Ballynacourty and by the Cunnigar and Ring Peninsula. Figure 1-1 shows the extent of the designated shellfish waters at Dungarvan.

[1] Irish Water Wastewater Treatment Plant Disinfection Programme, Terms of Reference, No.12/085-29

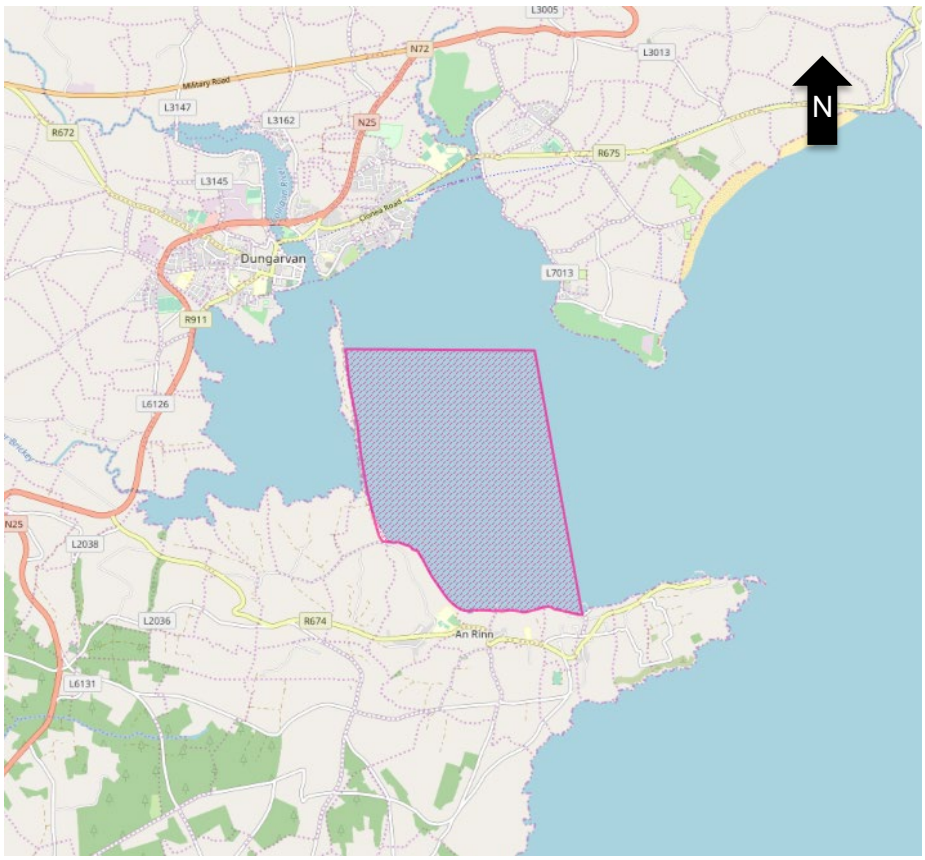

Figure 1-1: Dungarvan Harbour Designated Shellfish Water (EPA, 2019a)

The assessment included modelling of two WwTPs, which were the focus of the study. These were: Dungarvan and Baile Na nGall. In addition, the diffuse or background load from the three main rivers that drain into the harbour were also included (Colligan, Brickey and Glendine) to ensure that any effect on the hydrodynamics due to these fresh water inputs was captured in the modelling. Therefore, there were 5 discharges included in the hydrodynamic model in total.

The location of the Dungarvan and Baile Na nGall WwTPs primary discharge points (SW1) and the three rivers are shown in Figure 1-2 and Figure 1-3 respectively.

Figure 1-2: Location of Dungarvan and Baile Na nGall WwTPs primary discharge points (SW1)

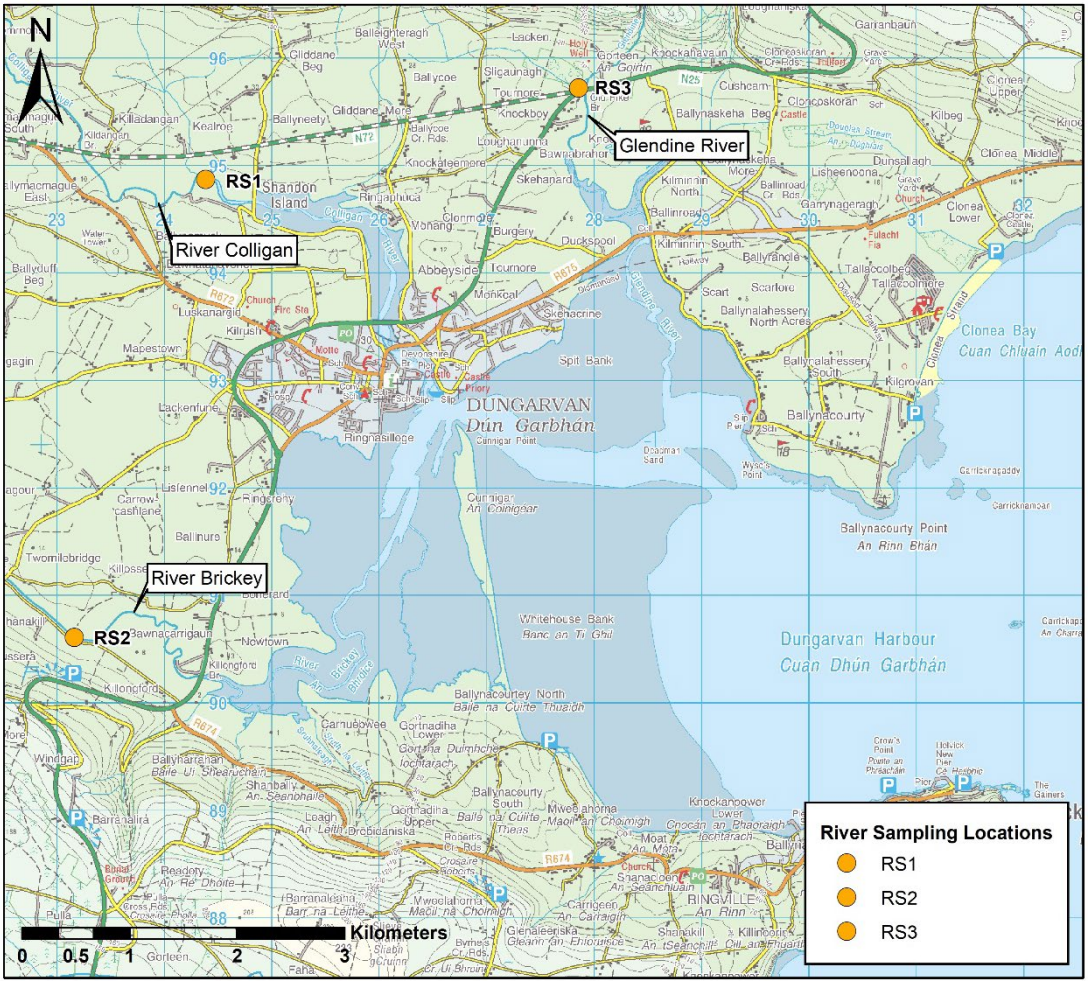

Figure 1-3: Location of Colligan, Brickey and Glendine Rivers

2. Objectives

Three key specific objectives of the assessment are as follows;

1. Assess whether untreated, primary and secondary discharges from agglomerations discharging in the proximity of Dungarvan Harbour are impacting Escherichia coli (hereafter referred to as *E. coli* or EC) water quality of the Designated Shellfish Waters.
2. Identify the final effluent quality required in order to ensure discharges do not impact Designated Shellfish Water's microbial water quality.
3. Assess the impact of Surface Water Overflows (SWO) on the microbial water quality of the Designated Shellfish Waters.

Separate to the Disinfection Programme, the Dungarvan City Drainage Area Plan (DAP) Study is currently ongoing which will provide detailed information on the volume, duration and frequency of discharges from SWOs. A Stage 4B SWO assessment will therefore be carried out in due course, once this information is available.

This current assessment for the Disinfection Programme has therefore only considered discharges of final effluent from the WwTPs, as well as other continuous sources.

3. Approach

Hydrodynamic (HD) Model – Development

A hydrodynamic model of Dungarvan Harbour was developed using the MIKE suite of models in line with the requirements of the Irish Water (IW) Technical Standards for Marine Modelling[2]. The model domain (Figure 3.1) covers the whole of Dungarvan Harbour plus part of the adjoining coastal waters from Ballydowane Beach in the north to Mine Head in the south.

Bathymetry data from a range of sources was used including data from the INFOMAR project which covered the south coast of Ireland to 10m resolution and data from C-Map Norway. An additional dataset supplied by Irish Hydrodata collected for the preparation of the Water Quality Management Plan for Dungarvan Harbour was also utilised.

The Dungarvan Harbour model utilised a flexible mesh approach where the model resolution varied across the domain with coarser cells at the boundaries and finer cells around the shellfish waters and WwTP outfalls. This flexible mesh approach allowed the detailed bathymetry of the area to be accurately represented whilst maintaining a good level of computational efficiency. A two dimensional depth integrated modelling approach was adopted for Dungarvan as field data did not indicate the presence of any stratification within the water column, see **Appendix A**.

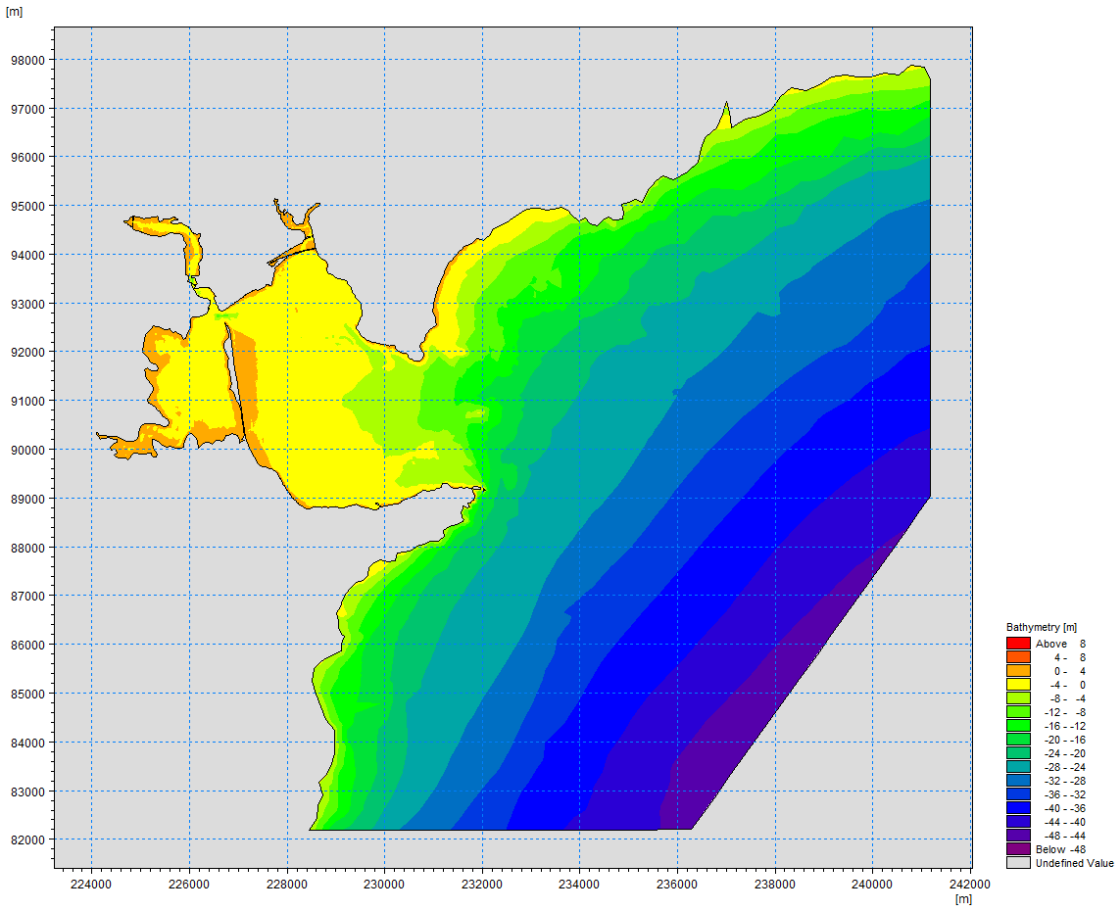

Figure 3.1: Dungarvan Model Domain

[2] Irish Water (IW) Technical Standards for Marine Modelling version 1.83

3.2. Hydrodynamic Model

The Dungarvan Harbour hydrodynamic model was calibrated and validated by comparing modelled water levels, current speeds and directions to a series of field observations collected over spring and neap tidal cycles. In addition to tidal forcing the hydrodynamic model also included a representation of the three principal fluvial inputs to Dungarvan Harbour: the Colligan River, the River Brickey and the Glendine River.

A sufficient level of correlation was achieved for the model to be considered suitable for assessing the dispersion of effluent from a range of sources within Dungarvan Harbour and consequently establishing the potential impact of these discharges on water quality within the Designated Shellfish Waters. Full details of the model development and verification are contained in the calibration and validation report[3], while some key examples of the calibration plots are shown in **Appendix A**.

3.3. Dispersion Model

Dye tracing data was used to demonstrate the suitability of the model dispersion coefficients by simulating a series of dye patches recorded over spring tides and adjusting the model dispersion coefficients until the model outputs were adjudged to correlate with the field observations. Once calibrated the dispersion model parameters were validated by comparing a second set of predicted dye patches against observed dye patches recorded during neap tidal cycles. Again validation performance was evaluated by reference to the visual assessment standards set out in the IW TSMM. Full details of the dispersion model calibration and validation are contained in the calibration and validation report.

Overall the results from the dispersion calibration/validation exercise demonstrated that the model was appropriate for the assessment of the dispersion and fate of micro-biological pollution associated with the wastewater discharges to Dungarvan Harbour.

[3] Irish Water Wastewater Treatment Plant Disinfection Programme, Model Calibration & Validation Report, Dungarvan,

3.4. Baseline Water Quality Modelling

3.4.1 Water Quality Standards

The IW TSMM provides guidance on the environmental standards to be used in assessing the impacts on designated Shellfish Waters. In the absence of a regulatory standard in the water column, as an interim criteria, Irish Water require all continuous discharges to be such that microbiological water quality would meet the Good Bathing Waters standard of 500 *E.coli* per 100ml (95%ile) within Designated Shellfish Waters.

3.4.2 Model Input Parameters

Irish Water Discharges

E.coli concentrations

E.coli sampling results for effluent from the two WwTPs discharging to Dungarvan Harbour, as supplied by Irish Water were used to derive representative inputs for the model simulations. For these discharges, a geometric mean of the available *E.coli* sampling, which indicates the central tendency or typical value of a set of numbers, was calculated. The geometric mean is generally considered the most representative approach to determine *E.coli* contributions from longer term sampling datasets, such as those for the respective WwTPs, where a wide variation in the numeric value of individual readings can be expected. Table 3.1 presents the values calculated for input to the model.

Discharge Flow Rate

Flow data from the two WwTPs collected by Irish Water was used to derive representative discharge flows for input into the model. For each plant an average flow was calculated from the datasets provided for input to the hydraulic model. Average flows are considered to better represent the flow contributions from the WwTPs, as opposed to a geometric mean, as long term flow data sets do not present the same wide variation in values as expected with effluent E.coli concentrations. Table 3.1 below shows the parameters used for input into the water quality model.

Table 3.1: Model inputs for E.coli and discharge flow from WwTPs in Dungarvan Harbour

WwTP	Treatment	Period of IW WQ Data Available	*E.coli* (cfu/100ml)	Source of Flow Data	Current Hydraulic Loading (m^3/s)
Dungarvan	Secondary	01/01/2017 – 31/03//2018	20,071	2017 PMS[4] 2018 PMS[4]	0.126959
Baile Na nGall	Secondary	01/01/2018 – 30/04/2018	$3.2x10^5$	2018 PMS[4]	0.006587

Riverine Inputs

E.coli concentrations

The water quality sampling also included data for the three main riverine inputs to Dungarvan Harbour. The fluvial *E.coli* sampling locations are shown in Figure 1-3 above.

[4] Irish Water Performance Management Systems

All river water samples were taken on the 16/05/2019 with three samples lifted at each of the three sample sites. The results showed the *E.coli* levels to vary significantly on the River Brickey. Consequently riverine concentrations were taken to be the worse-case values from the limited field sampling provided for each of the river inputs i.e. a conservative approach was taken, as the dataset was not considered statistically robust for the calculation of a geomean or average. The *E.coli* concentrations adopted are shown in Table 3.2.

Table 3.2: E.coli concentrations used for modelling river discharges

Watercourse	Sample Reference	E.coli [cfu/100ml]
River Colligan	RS1-1	111.2
River Brickey	RS2-1	816.4
Glendine River	RS3-1	344.1

Discharge Flow Rate

For the calibration modelling runs low flow estimates were used as a review of Met Éireann rainfall gauges close to the study area had identified that there had been little rainfall around the time of the sampling. The Marine Survey Report also stated that the water depth was shallow at the river sample locations which suggests the use of dry weather flows with the observed concentrations is valid.

The river flows were represented in the model as point sources where they enter the model domain, and for this assessment were assumed to be equivalent to the 50th percentile value derived using the EPA Hydrotool for ungauged catchments. The resulting flows are shown in Table 3.3.

Table 3.3: River flow inputs to Dungarvan Harbour

Source	River Name	Flow (m^3/s)
1	Colligan River	0.664
2	River Brickey	1.964
3	Glendine River	0.201

3.4.3 Decay Rate

Table 9-1 of the Irish Water Technical Standards for Marine Modelling set out appropriate decay rates to be used in marine outfall modelling. In the case of Dungarvan as the principal concern is impact on shellfish waters the modelling was undertaken for a winter scenario. Dungarvan can be classified as 'Coastal Waters' therefore, the T90 used for *E.coli* at Dungarvan was defined as 24 hours.

4. Model Results

The model was used to simulate the dispersion and fate of effluent over a period of 18 days to ensure a spring-neap cycle was captured whilst allowing sufficient warm up time for any instabilities at the beginning of the simulation to settle out.

Figure 4.1 below illustrates the resulting 95 percentile *E.coli* concentrations within Dungarvan Harbour resulting from the combined discharges from Dungarvan and Baile Na nGall WwTPs and the Brickey, Colligan and Glendine Rivers. The 95%ile values presented have been calculated over the final fifteen day period of the simulations, to exclude the influence of the values predicted during the initial model spin up period. A more detailed plot of the predicted 95%ile *E.coli* levels around the South-eastern boundary of the Designated Shellfish Waters is shown in Figure 4.2. In both plots the yellow and red colour bands highlight *E.coli* concentrations greater than 500cfu/100ml whilst the locations of the two outfalls and the extent of the Designated Shellfish Waters are also shown in Figure 4.1.

The results indicate that a small area (approximately 200m in length along the coastline) around the Baile Na nGall WwTP discharge and an area within the mouth of the Brickey would experience *E.coli* concentrations greater than 500cfu/100ml on a 95%ile basis. Within the designated Shellfish Waters, the 95%ile *E.coli* concentrations are always less than the required target level specified by the Irish Water Standards.

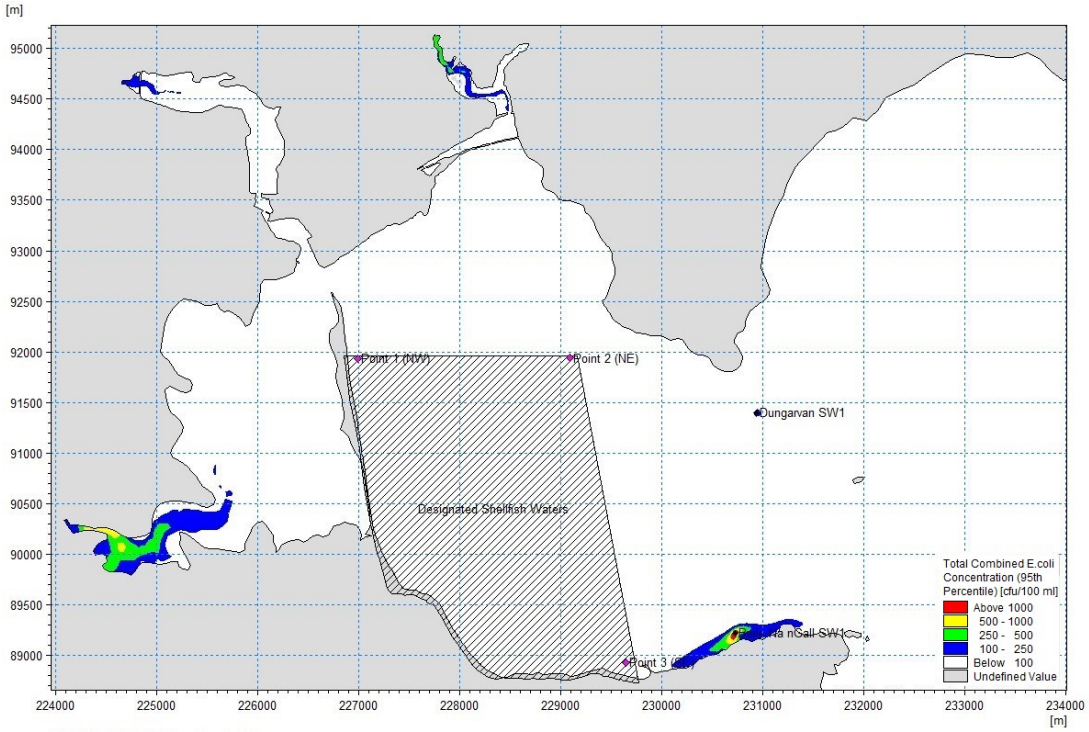

Figure 4.1: 95%ile modelled winter E.coli concentrations in Dungarvan Harbour over spring-neap cycle

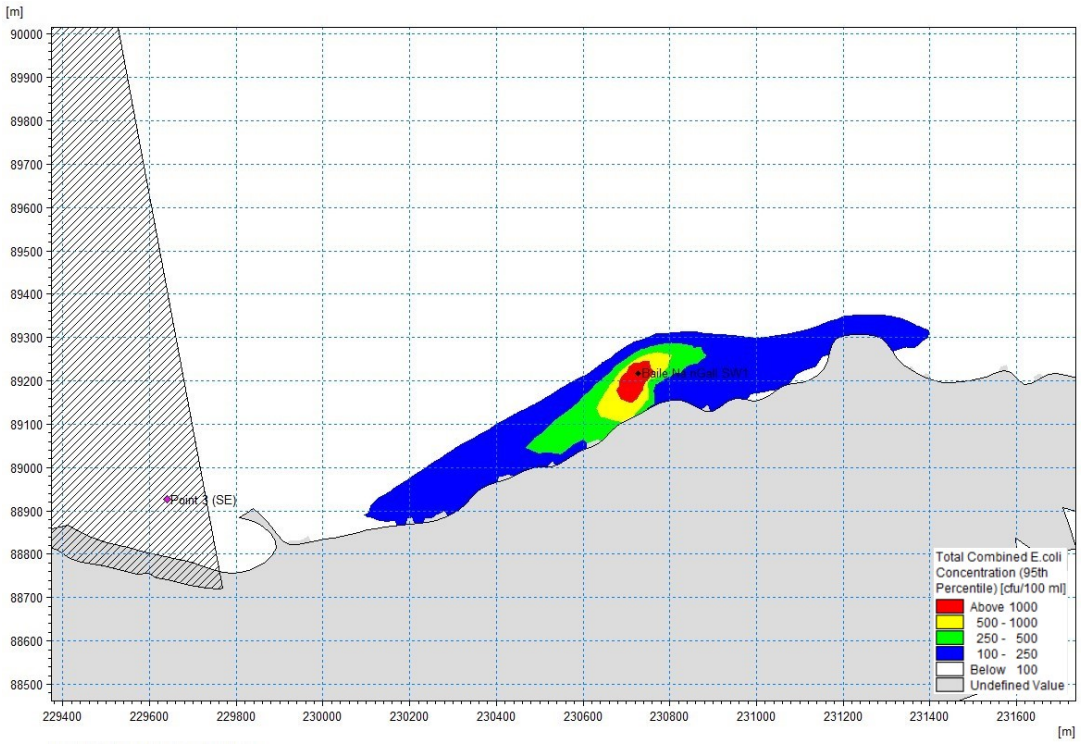

Figure 4.2: 95%ile modelled winter E.coli concentrations at SE corner of Designated Shellfish Waters over spring-neap cycle

The temporal variation in *E.coli* levels over the spring – neap cycle at each of the three analysis locations shown in Figure 4.1 is illustrated in Figure 4.3 to Figure 4.5. These plots clearly show significant variation in *E.coli* levels over the individual tidal cycles and also a variation in mean levels between spring and neap tides. Significantly these plots show that even the maximum modelled *E.coli* levels are significantly below the 500 cfu/100ml threshold specified in the Irish Water Standards.

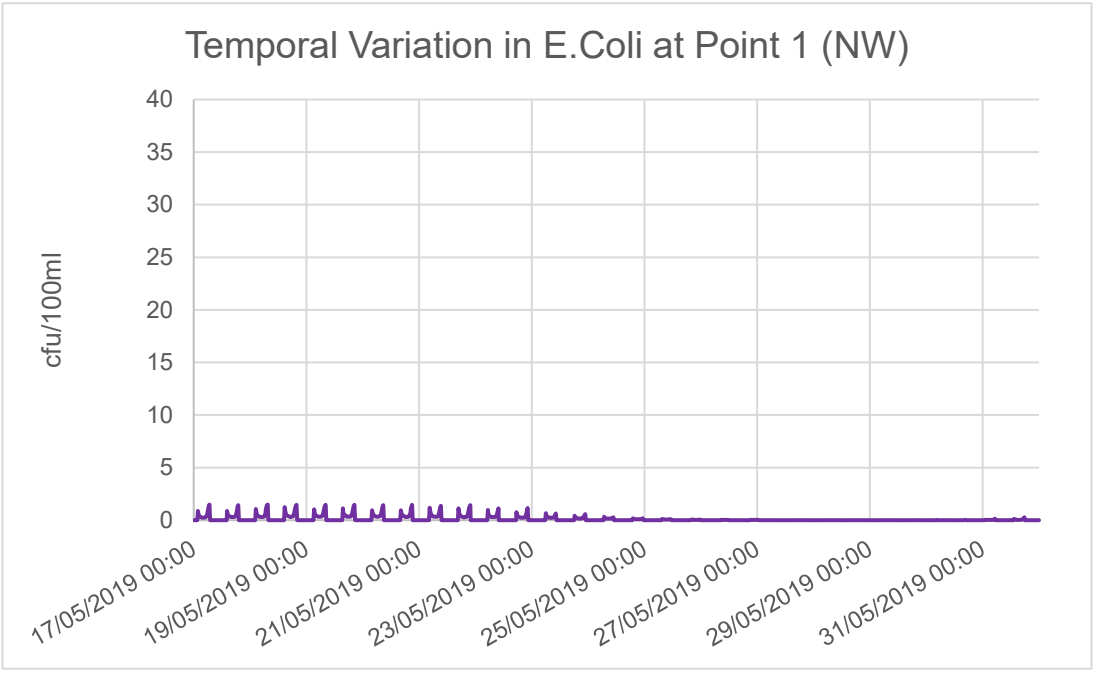

Figure 4.3: Temporal variation in E.coli concentration at Point 1

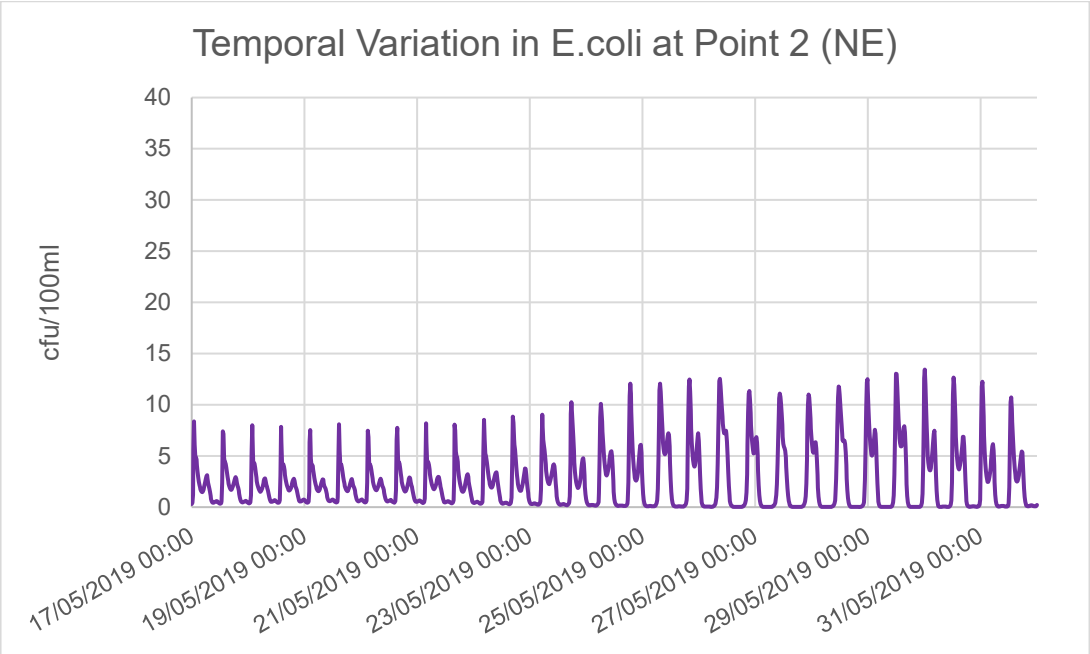

Figure 4.4: Temporal variation in E.coli concentration at Point 2

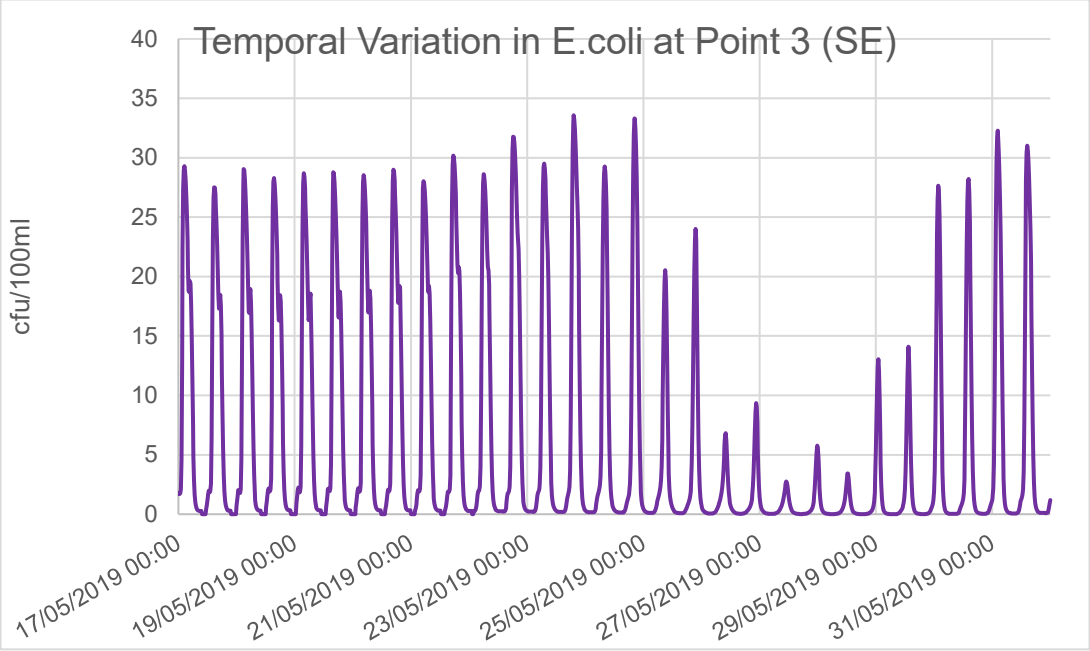

Figure 4.5: Temporal variation in E.coli concentration at Point 3

The relative contribution of each of the modelled sources, Dungarvan and Baile Na nGall WwTPs and the three rivers to the interim 500 E.coli/100ml threshold level at the three locations within the designated shellfish waters, indicated in Figure 4.1 (Point 1 (NW), Point 2 (NE) and Point 3 (SE)), is illustrated in Figure 4.6 to Figure 4.8 below. The overall 95%ile *E.coli* levels at all three locations are low, less than 30 EC/100ml, and the impact of the discharges from the two IW WwTPs whilst more prevalent than the indicated impact from the rivers is shown to account for less than 6% of the interim standard within the designated shellfish waters.

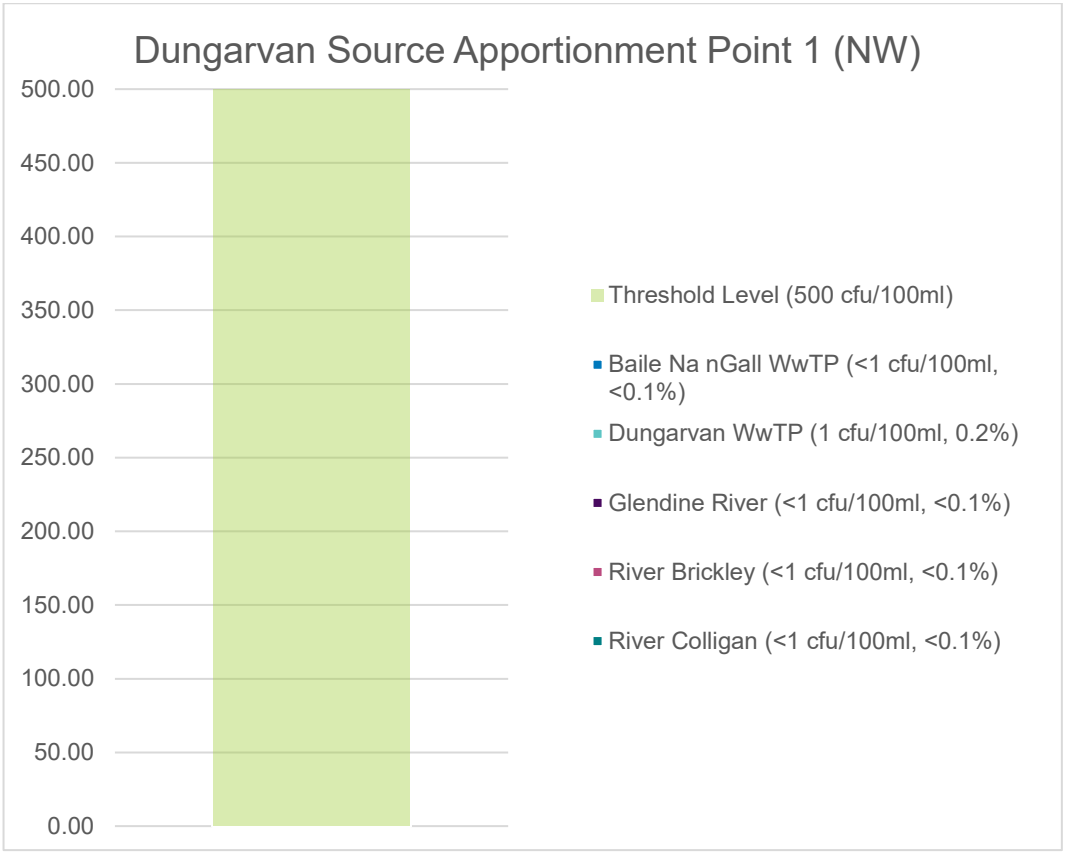

Figure 4.6: Relative contribution of each modelled source to the threshold level at Point 1

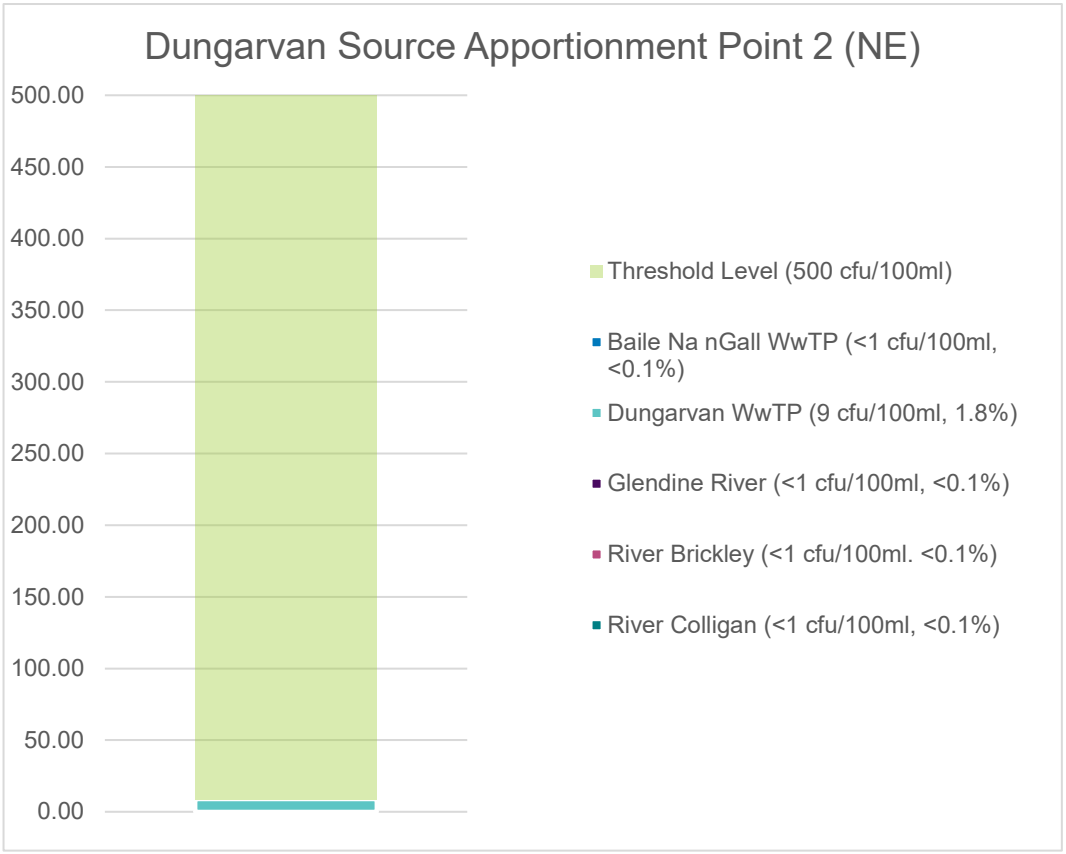

Figure 4.7: Relative contribution of each modelled source to the threshold level at Point2

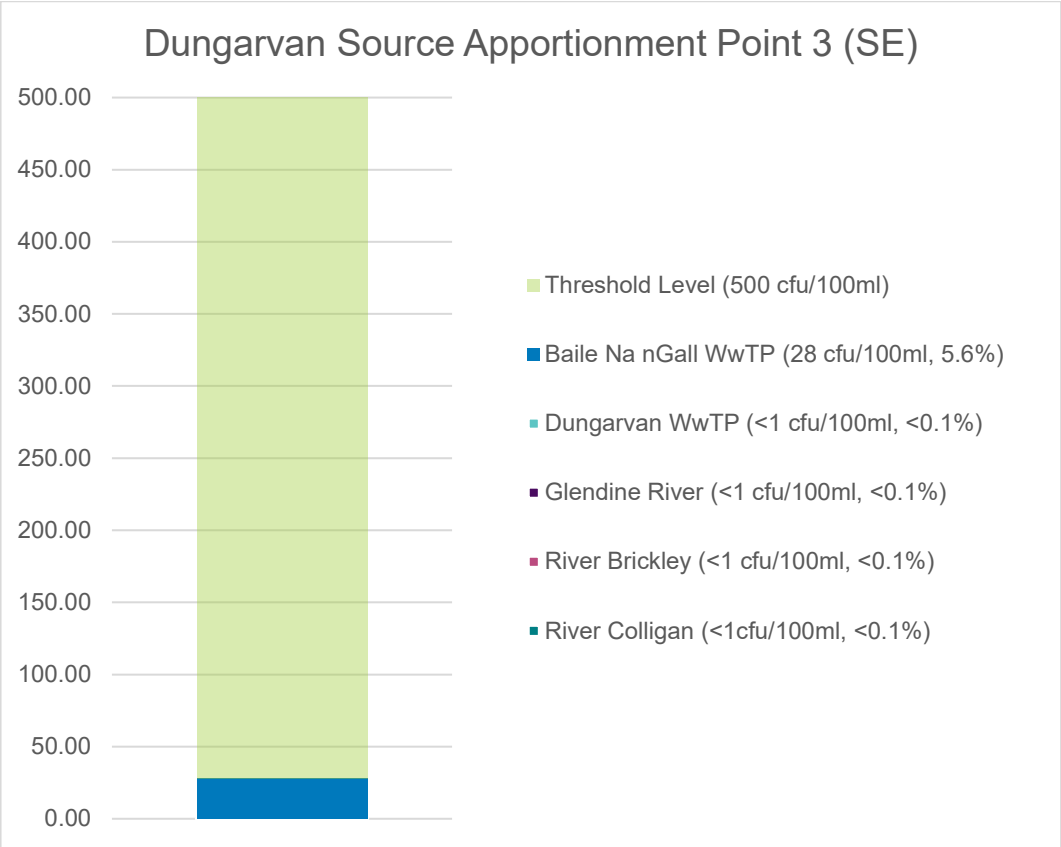

Figure 4.8: Relative contribution of each modelled source to the threshold level at Point 3

5. Conclusions

The key conclusions taken from the Baseline scenario are as follows;

- The modelled 95%ile *E.coli* concentration across the whole of the Designated Shellfish Water at Dungarvan is less than the 500 EC/100ml threshold.
- The primary discharges from the IW Dungarvan and Baile Na nGall WwTPs do not cause 95%ile *E.coli* levels within the Designated Shellfish Waters to exceed the interim threshold of 500 EC/100ml for Shellfish Waters.
- There is no requirement to improve the level of treatment at either Dungarvan or Baile Na nGall WwTPs.

6. References

1. Irish Water Wastewater Treatment Plant Disinfection Programme, Terms of Reference, No.12/085-296
2. Irish Water (IW) Technical Standards for Marine Modelling version 1.83 (TSMM)
3. Irish Water Wastewater Treatment Plant Disinfection Programme, Model Calibration & Validation Report, Dungarvan,

Appendix A

Model Dimensionality

Temperature and salinity profiles were obtained for the four ADCP locations and five additional water quality sample locations as illustrated in Figure A.1 which gave good spatial coverage of the outer harbour in the vicinity of the wastewater discharge points.

Figure A.1: Temperature and salinity survey locations

Full depth profiles were prepared so that the presence (or otherwise) of stratification could be evaluated. Figure A.2 illustrates the salinity profile with depth at each of the sampling locations based on the data collected at three-hourly intervals over both a spring and neap tide. Thus this information is representative of conditions at all tidal states and shows no discernible variation in salinity with depth, or significant variation between locations. Figure A.3 shows the comparable temperature data at each of the water quality sampling locations and illustrates a lack of temperature gradient between the sampling locations. This, lack of variation in temperature and salinity with depth irrespective of tidal state, in conjunction with the ADCP profile data, was considered sufficient to demonstrate that a 2D depth averaged tidal model would be representative of the flow conditions in the study area.

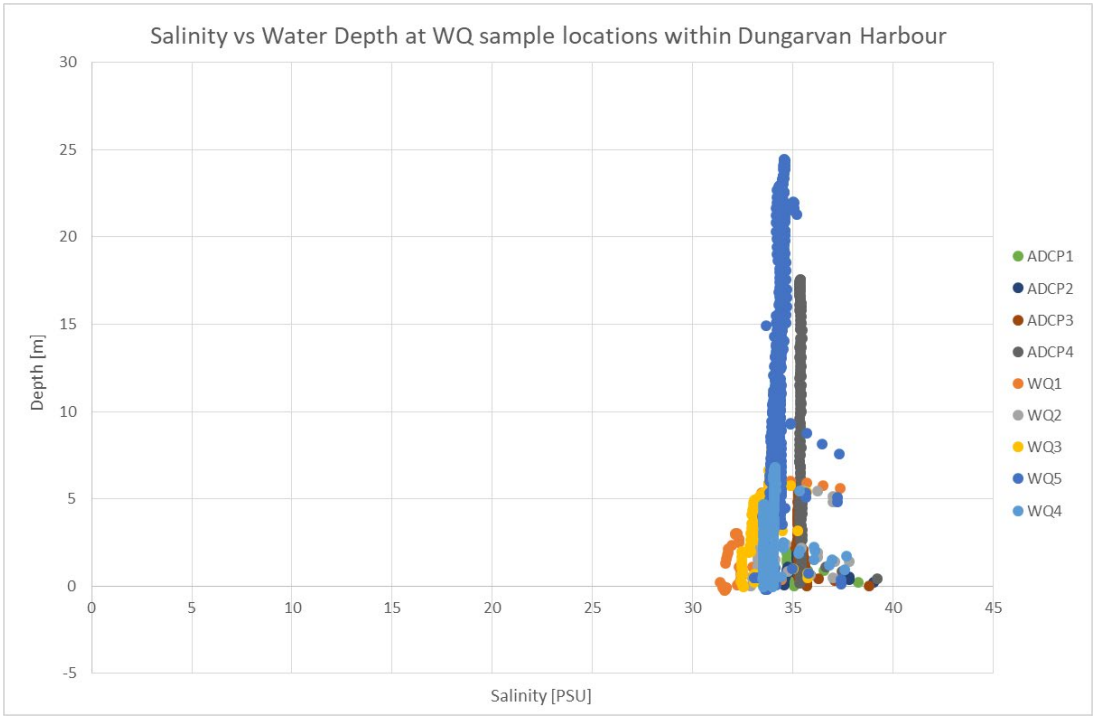

Figure A.2: Analysis of salinity profiles at ADCP and WQ sampling locations

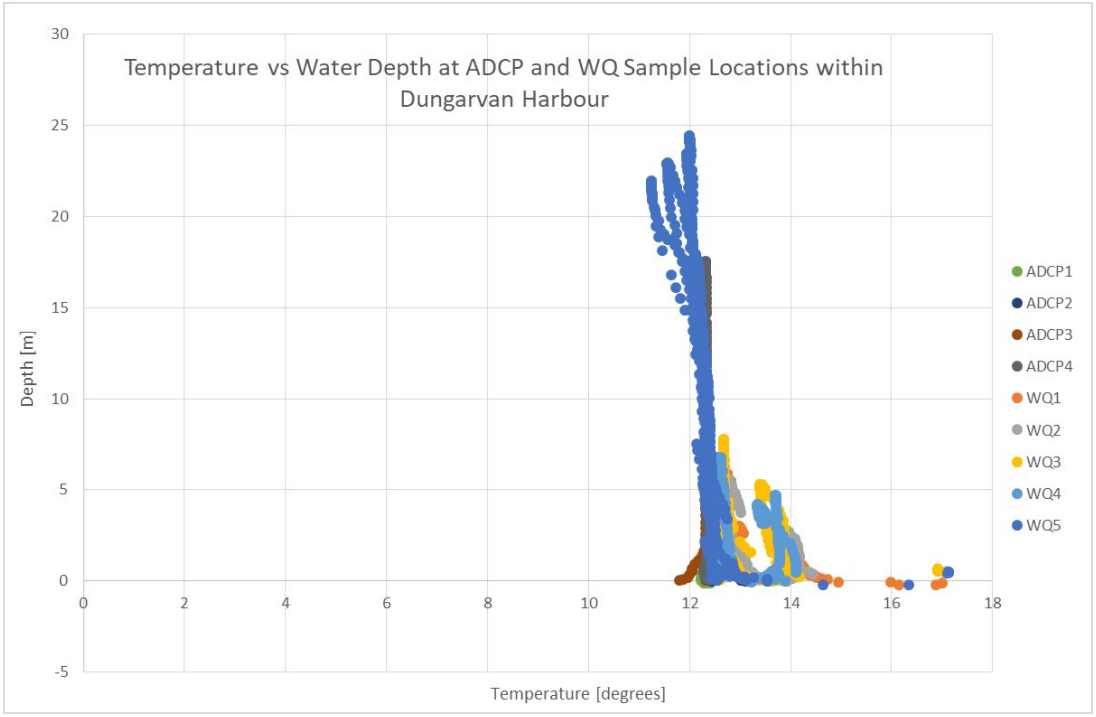

Figure A.3: Analysis of temperature profiles at ADCP and WQ sampling locations

HD Model Verification

The hydrodynamic model was verified by comparing model predictions of tidal levels and tidal currents to observed data recorded over both spring and neap tides. Tidal current information was recorded at the four ADCP locations shown in Figure A.1, while tidal levels were recorded via a temporary tide gauge installed in Helvick Harbour.

Tidal Levels

Figure A.4 illustrates the comparison between the predicted tidal levels at Helvick Harbour and the modelled tidal levels. Generally, there is reasonable correlation in terms of levels and tidal range and good correlation in terms of tidal phase.

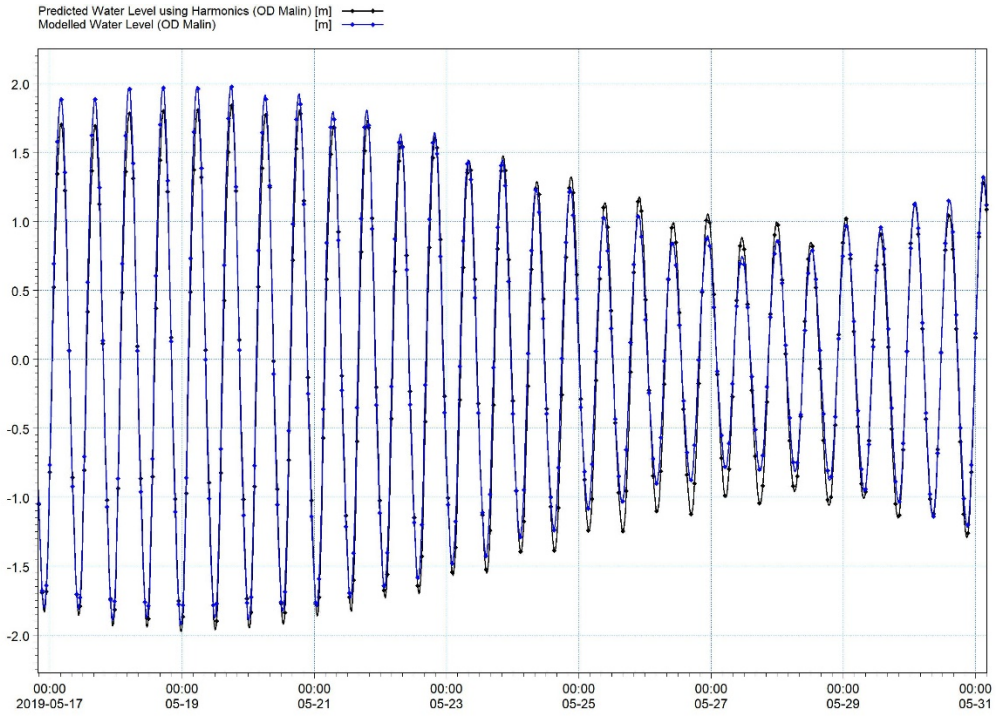

Figure A.4: Predicted vs modelled water level

Tidal Currents

Figure A.5 illustrates the correlation between the model predictions of depth averaged tidal current speeds and directions and the corresponding observed depth averaged information at ADCP site 1, the closest to the Designated Shellfish Waters, over spring tides. The corresponding correlation between the model predictions and observed depth averaged tidal current speed and direction over neap tides is shown in Figure A.6.

Quantitative assessment of the correlation between the modelled results and observed data was also undertaken in accordance with the requirements of the IW TSSM which established that the correlation was within the required accuracy thresholds.

Overall the results achieved from the calibration and validation of the hydrodynamics were demonstrated to be acceptable and as such the Dungarvan Harbour model was considered appropriate for the assessment of bacteriological (*E. Coli*) impacts and hence deemed to be fit for purpose within the Irish Water Disinfection Study.

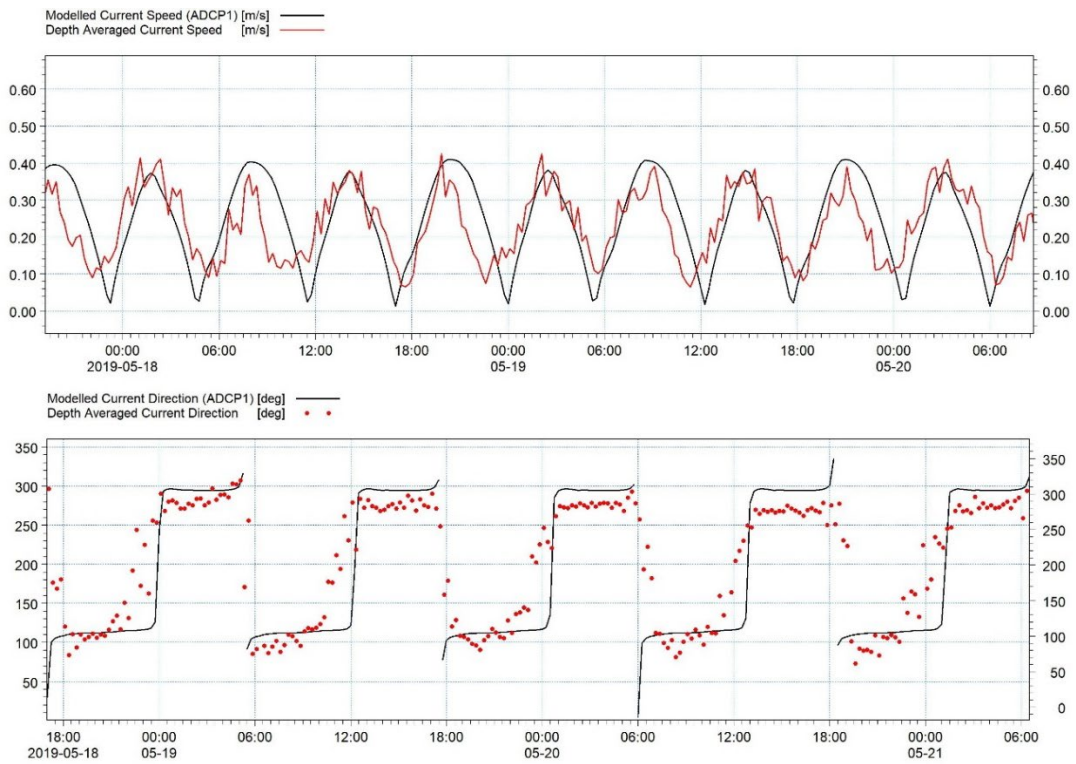

Figure A.5: ADCP1 - Modelled vs depth averaged observed current speed and direction (Spring)

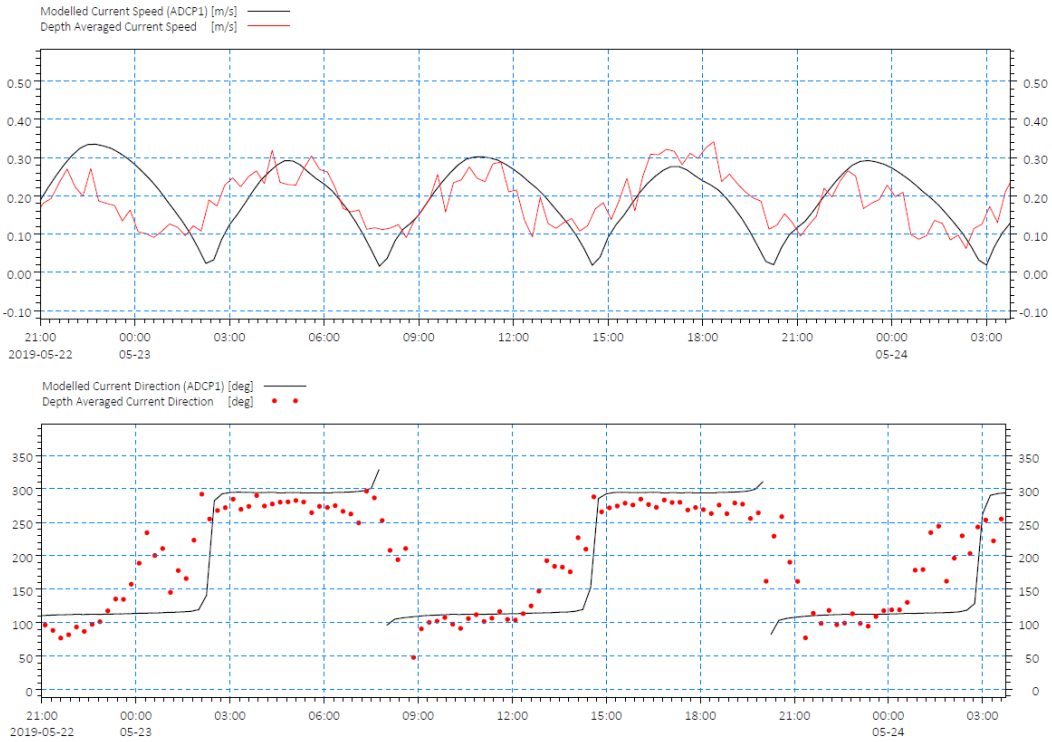

Figure A.6: ADCP1 - Modelled vs depth averaged observed current speed and direction (Neap)

Water Quality

Water quality sampling data, including *E.coli*, was obtained for five locations throughout Dungarvan harbour as shown in Figure A.1. The collected data showed very low concentrations of faecal bacteria present with almost all samples measuring below the Limit of Detection (LOD <10 MPN/100ml).

Model simulations using sampled effluent concentrations and flow rate for the WwTP discharges and sampled concentrations with 50%ile river flows produced a similarly low level of bacteriological impact to that shown by the field data as shown in Table A.1.

Table A.1: Simulated and Measured E.coli Concentrations at the 5 WQ Sampling Locations

Sample Location	Date	Tide	Measured E.coli Boundaries	Overall Mean Simulated E.coli	Maximum Simulated E.coli
WQ1	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	10MPN/100ml
WQ1	16/05/2019	Spring	<10MPN/100ml		
WQ2	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ2	16/05/2019	Spring	<10MPN/100ml		
WQ3	29/05/2019	Neap	<10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ3	16/05/2019	Spring	<10MPN/100ml – 10MPN/100ml		
WQ4	29/05/2019	Neap	<10MPN/100ml – 20MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ4	16/05/2019	Spring	<10MPN/100ml		
WQ5	29/05/2019	Neap	<10MPN/100ml – 10MPN/100ml	<10MPN/100ml	<10MPN/100ml
WQ5	16/05/2019	Spring	<10MPN/100ml		