8.0 WATER

8.1 INTRODUCTION

This Chapter 8 presents the assessment of likely significant effects of the Proposed Development on the surface water receiving environment during Construction, Operational and Post-Closure Phases. It also presents potential cumulative effects in relation to known other projects near the site. This Chapter 8 includes description or presentation of:

- The assessment methodology that was followed.
- The baseline environmental conditions that served as the basis for assessment of likely significant effects.
- Suitable mitigation measures to reduce or eliminate likely significant effects.

In this Chapter 8, both *potential effects* (pre-mitigation) and *residual effects* (post-mitigation) are addressed. Associated mitigation measures are of two types: *mitigation by avoidance* and *mitigation by design*.

Consistent with existing EIA directives and guidance (see Section 8.3.1), a 'Do Nothing' scenario is included and cumulative effects are considered.

This Chapter 8 should be read in conjunction with:

- Chapter 2: Description of the Existing Infrastructure and Proposed Development
- Chapter 6: Biodiversity
- Chapter 7: Soils, Geology and Hydrogeology

8.2 CONTEXT AND OBJECTIVES

This Chapter 8 directly addresses the technical points that were cited by An Bord Pleanála (ABP) in their refusal of planning permission in November 2020[1], by clarifying and considering:

- The causes of elevated ammonia concentrations in surface water and groundwater at the site.
- The present, relative emissions of ammonia and suspended solids from the existing waste management facility (WMF) and wider Timahoe South Bog (TSB), and from the Proposed Development in the future.
- The hydrological linkages between the WMF and TSB with the Cushaling River.
- The risks to water quality on receiving surface waters, with an emphasis on the Cushaling River (as the principal receptor at risk).
- The proposed mitigation measures to limit the emissions of ammonia and suspended solids as a basis for protecting or improving the water quality and aquatic habitat of the Cushaling River.
- The long-term monitoring of water quality that is recommended to continue to document environmental conditions, check compliance, identify effects, and judge the effectiveness of mitigation measures, during all phases of the Proposed Development.

The focus in this Chapter 8 is firmly on the Cushaling River as the principal surface water receptor of concern. In the ABP refusal, ammonia was highlighted as a principal pollutant of concern for aquatic life in the Cushaling River. The refusal considered that the EIAR for the previous planning application (TCE, 2017) had not adequately determined the principal and relative magnitude of sources of ammonia currently experienced in the river. For this reason,

[1] Planning Board's decision dated 11 November 2020.

this Chapter 8 provides a re-examination of ammonia to determine relative contributions from different sources and to describe suitable mitigation measures that will limit chemical loading to the river.

Accordingly, this Chapter 8 has taken regard of the Timahoe South Bog Decommissioning and Rehabilitation Plan (BnM, 2022) which was prepared a) to comply with Condition 10 of Industrial Pollution Control Licence Ref. P0503-01, and b) with regard to the Peatlands Climate Action Scheme (PCAS)[2].

As documented in this Chapter 8, future improvements to the Cushaling River downstream of the site are tied to limiting emissions from the Proposed Development and implementing the TSB Decommissioning and Rehabilitation Plan[3]. The plan has amongst its objectives a reduction of the chemical and sediment loading from the bog to help improve the ecological conditions in the river.

The TSB Decommissioning and Rehabilitation Plan has undergone a public consultation process. A Natura Impact Statement (NIS) was submitted to NPWS in June 2022 in accordance with Habitats Regulations. Observation received from NPWS in August 2022 were accounted for in the final NIS. It is noted that the Decommissioning and Rehabilitation Plan is not a subject of this planning application. Its implementation covers areas of TSB that are outside the redline boundary of the Proposed Development, as presented in Section 8.5 and 8.6.

This Chapter 8 has also taken regard of information received during the EIA consultation process. Notably, Inland Fisheries Ireland (IFI) stated a need to improve the existing baseline hydromorphological and ecological conditions of the river in order to improve the spawning potential in the Cushaling River. This partly relates to the loading of ammonia and suspended sediments to the river, which is assessed in this Chapter 8. Ecological improvements are further addressed in Chapter 6 (Biodiversity) of this EIAR.

8.3 METHODOLOGY

8.3.1 Regulatory Requirements and Guidance

This Chapter 8 has been prepared based on the following relevant directives, regulations and guidance:

Directives:

- European Union (2011/92/EU) Environmental Impact Assessment Directive (as amended by 2014/52/EU).
- European Union (2000/60/EC) Water Framework Directive.
- European Union (1992/43/EEC) Habitats Directive.

National Legislation:

- S.I. No. 191/2020, European Union (Environmental Impact Assessment) (Environmental Protection Agency Act 1992) (Amendment) Regulations 2020.
- S.I. No. 349 of 1989, European Communities (Environmental Impact Assessment) Regulations, with amendments.
- S.I. No. 722 of 2003, European Communities (Water Policy) Regulations.

[2] Bord na Móna Peatlands Climate Action Scheme (bnmpcas.ie), which is regulated by the National Parks and Wildlife Services (NPWS) on behalf of the Department of Housing, Local Government & Heritage.
[3] Publicly available at: Timahoe-South-Rehab-Plan- Final-v5.pdf (bnmpcas.ie)

- S.I. No 272 of 2009, European Communities Environmental Objectives (Surface Waters) Regulations, as amended (S.I. No. 386 of 2015 and S.I. No. 77 of 2019).
- S.I. No. 9 of 2010, European Communities Environmental Objectives (Groundwater) Regulations, as amended (S.I. No. 366 of 2016).
- S.I. No. 293/1988: Quality of Salmonid Water Regulations.

Guidance:

- EPA (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (May 2022).
- European Commission (2017) Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report
- Department of Housing, Planning and Local Government (2018): Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August 2018).
- National Roads Authority (NRA) (2009): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters.

8.3.2 Appraisal Methodology

The appraisal methodology considers the source-pathway-receptor model of environmental risk assessment which underpins water protection initiatives in Ireland. For potential effects to occur or be realised, there must be a source or cause of effect, a pathway that connects the source with a receptor, and a receptor which can be affected.

The assessment of likely significant effects uses EPA's "*Effect Classification Terminology*" shown in Table 8-1 (EPA, 2022), whereby effects are considered in terms of their quality, significance, extent, probability, duration, and type.

Table 8-1 Effect Classification Terminology (EPA, 2022)

Impact Characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment
	Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An effect capable of measurement but without significant consequences.
	Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
	Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
	Moderate	An effect that alters the character of the environment in a manner consistent with existing and emerging baseline trends
	Significant	An effect, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment

Impact Characteristic	Term	Description
	Very significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
	Profound	An effect which obliterates sensitive characteristics
Extent and Context	Extent	Describe the size of the area, number of sites and the proportion of a population affected by an effect
	Context	Describe whether the extent, duration, or frequency will conform or contrast with established (baseline) conditions
Probability	Likely	Effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented
	Unlikely	Effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented
Duration and Frequency	Momentary	Effects lasting from seconds to minutes
	Brief	Effects lasting less than one day
	Temporary	Effects lasting less than one year
	Short-term	Effects lasting 1-7 years
	Medium-term	Effects lasting 7-15 years
	Long-term	Effects lasting 15-60 years
	Permanent	Effects lasting over 60 years
	Reversible	Effects that can be undone, for example through remediation or restoration
	Frequency	Describe how often the effect will occur (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)
Types	Indirect	Effect on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway
	Cumulative	The addition of many minor or insignificant effects, including effects of other Proposed Developments, to create larger, more significant effects.
	'Do Nothing'	The environment as it would be in the future should the subject project not be carried out
	'Worst Case'	The effects arising from a project in the case where mitigation measures substantially fail
	Indeterminable	When the full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost
	Residual	The degree of environmental change that will occur after the proposed mitigation measures have taken effect
	Synergistic	Where the resultant effect is of greater significance than the sum of its constituents

8.3.2.1 Importance/Sensitivity of the Existing Environment

Descriptors of likely significant effects are contextualised with the importance or sensitivity of the receiving water environment and criteria for rating attributes of receiving waters. The attributes that were considered in this Chapter 8 are presented in Table 8-2. Receiving waters that are designated sites or protected areas are intrinsically more important and sensitive to potential effects compared to water bodies that are not designated or otherwise protected, and of local importance only.

Table 8-2 Criteria Considered for Rating Attributes of Receiving Waters

Importance/ Sensitivity	Criteria	Attributes Considered
Very High	Important at a national or international scale	Receiving water: • Is a designated site or protected area. • Is a designated WFD High Status objective water body.
High	Important at a national or regional scale	Receiving water: • Is hydraulically connected with a designated site or protected area within 5 km downstream. • Is important for social or economic uses, including navigation.
Medium	Important at a regional or local scale	Receiving water: • Is hydraulically connected to a designated site or protected area greater than 5 km downstream. • May support populations of protected species. • Has some potential for spawning of salmonid species. • Has limited social or economic uses.
Low	Important at a local scale	Receiving water: • Is not hydraulically connected with a designated site or protected area. • Does not support populations of protected species. • Has limited potential for spawning of fish (generally). • Has limited social or economic uses.
Negligible	Important at a local scale	Receiving water: • Is not hydraulically connected with a designated site or protected area. • Has naturally low aquatic fauna and flora biodiversity. • Has no potential for spawning of fish. • Has minimal importance for social or economic uses.

To judge the attributes of receiving water bodies, publicly available information were researched and used, such as NPWS' mapping of designated and protected sites (available from Maps and Data | National Parks & Wildlife Service (npws.ie)) and EPA's assigned WFD status of water bodies (available at EPA Maps).

Subsequently, the magnitude of effects were assigned based on the attributes that were assigned, as presented in Table 8-3. Effects can be adverse, neutral, or positive, as well as be major, moderate, minor or imperceptible.

Table 8-3 Criteria Considered for Estimating Magnitude of Effects on Receiving Water Attributes

Magnitude of Effects	Criteria	Effects on Attributes Considered
Negative Major	**Adverse:** Results in loss of attribute and/or quality and integrity of attribute	• Loss of, or extensive damage to, the environmental or ecological supporting conditions of a designated sites or protected area. • High risk of failure to meet the conservation objectives or environmental requirements of a designate site or protected area. • Loss of WFD High status or high risk of failure to meet High status objectives.

Magnitude of Effects	Criteria	Effects on Attributes Considered
		• Causes, on its own, a deterioration of WFD status. • Induces, on its own, a negative chemical quality trend. • Calculated risk of serious pollution incident >2% annually.[1] • Significantly reduces streamflow conditions. • Significantly adds flood risk. • Significantly alters river morphology. • Loss of fishery production. • Unacceptable loss of social or economic uses. • Effects cannot be mitigated.
Negative Moderate	**Adverse:** Results in effect on integrity of attribute or loss of part of attribute	• Manageable change to the environmental or ecological supporting conditions of a designated site or protected area. • Manageable risk of not meeting the conservation objectives or environmental requirements of a designated site or protected area. • Contributes to the deterioration of WFD water body status. • Contributes to inducing a negative chemical quality trend, • Calculated risk of serious pollution incident >1% annually.[1] • Causes a measurable loss of streamflow. • Adds a manageable flood risk. • Causes some alteration to river morphology. • Potential loss of fishery production. • Potential loss of social or economic uses. • Effects can be mitigated.
Negative Minor	**Adverse:** Results in a manageable effect on integrity of attribute or loss of part of attribute	• Low risk to the environmental or ecological supporting conditions of a designated site or protected area. • Low risk of not meeting the conservation objectives or environmental requirements of a designated site or protected area. • Low risk of causing a deterioration of WFD status. • Low risk of inducing a negative chemical quality trend. • Calculated risk of serious pollution incident <0.5%.[1] • May cause a measurable loss of streamflow. • May add flood risk. • May cause alteration of river morphology. • Low risk of loss of fishery production. • Low risk of loss of social or economic uses. • Effects can be mitigated.
Imperceptible (Neutral)	Imperceptible alteration to one or more characteristics, features or elements of attribute	• No measurable effect on receiving water (all attributes). • Calculated risk of serious pollution incident <0.5%.[1]
Positive Minor	**Beneficial:** Results in some positive effect on attribute or a reduced	• Potential improvements to the environmental and/or ecological supporting conditions of designated sites or protected areas.

Magnitude of Effects	Criteria	Effects on Attributes Considered
	risk of negative effect occurring	• Potential for achieving the conservation objectives or environmental requirements of a designated site or protected area, where needed. • Potential for improvement of WFD status, where needed. • Potential for reversing an existing negative chemical quality trend. • Potential for improving baseline streamflow conditions. • Potential for alleviating an existing flood risk. • Potential for improvements to river morphological conditions. • Potential for improving an existing poor fishery production. • Potential for improving already impaired social or economic uses.
Positive Moderate	**Beneficial:** Results in moderate improvement in attribute quality integrity	• Measurable improvements to the environmental or ecological supporting conditions of a designated site or protected area. • Contributes to achieving the conservation objectives or environmental requirements of a designated site or protected area, where needed. • Contributes to improving WFD water body status. • Contributes to neutralising an existing negative chemical quality trend. • Improves baseline streamflow conditions. • Reduces an identified flood situation or risk. • Improves river morphological conditions. • Improves the potential for fishery production. • Improves social or economic uses.
Positive Major	**Beneficial:** Results in major improvement in quality and integrity of attribute	• Significant improvements to the environmental or ecological supporting conditions of a designated site or protected area. • Restoring supporting conditions which help to achieve conservation objectives or environmental requirements of a designated site or protected area, where needed. • High probability of achieving WFD High status, where needed. • High probability of achieving at least WFD Good status, where needed. • Reverses, on its own, an existing negative chemical quality trend. • Restores baseline streamflow conditions to meet requirements. • Eliminates an identified flood situation or risk. • Restores or significantly improves river morphological conditions to meet requirements. • Restores, secures or significantly improves fishery production. • Restores or significantly enhances social or economic uses.

Notes: [1] Based on NRA guidelines (2009)

With reference to Tables 8-2 and 8-3, designated sites and protected areas are:

- Special Areas of Conservation (SAC) and Special Protected Areas (SPA), which combined are referred to as European Sites or Natura 2000 Sites.
- Salmonid Waters
- Nutrient Sensitive Areas
- Drinking Water Protected Areas
- Freshwater Pearl Mussel Waters
- Shellfish Waters
- Bathing Waters

Protected areas have environmental requirements which are stipulated in protected area regulations, as follows:

- Birds and Natural Habitats Regulations, S.I. No. 477 of 2011, as amended
- Quality of Salmonid Water Regulations, S.I. No. 293 of 1998, as amended
- Urban Wastewater Treatment Regulations S.I. No. 208/1999, as amended
- Drinking Water (No. 2) Regulations, S.I. No. 278 of 2007, as amended
- Freshwater Pearl Mussel Regulations, S.I. No. 296 of 2009
- Quality of Shellfish Waters Regulations 2006, as amended (repealed in 2013 but still serving as the guide until new legislation comes into effect).
- Bathing Water Quality Regulations 2008, S.I. No. 79 of 2008, as amended

8.3.3 Desk Study

A desk study was undertaken as part of the characterisation of baseline conditions. This involved a review of past reports related to the site (including the 2017 EIAR, with appendices), scientific journal articles that are relevant to the scientific topics involved, and publicly available information which is listed in Appendix D of the Institute of Geologists of Ireland (IGI) guidance for the preparation of the soils, geology and hydrogeology chapters of EIARs.

The publications and materials used are referenced throughout this Chapter 8, as appropriate.

BnM also produces water quality data under their current Industrial Emissions Discharge (IED) license conditions (license W0201-03). These are used and referenced throughout this Chapter 8.

Geographic Information System (GIS) files and monitoring data generated by BnM and public bodies like EPA and GSI were also received and used, and are also referenced, as appropriate.

8.3.4 Monitoring of Surface Water Conducted for This EIAR

Monitoring of surface water features within Timahoe Bog was undertaken to describe and quantify the hydrological characteristics of the bog and the hydrological interrelationship between the bog and receiving waters. Specifically:

- Streamflow measurements were taken between October 2021 and April 2022 at three stations representing main outflow points; one from Timahoe North Bog (TNB) and two from Timahoe South Bog (TSB). The flow measurements were taken on different days across a winter season to establish the range of outflows that occur. Findings are provided in Sections 8.4.8 and 8.4.9.
- Pressure transducers were installed at the same locations to record water levels continuously between August 2021 and June 2022 to see how stream water levels

(hence also flow, qualitatively) respond to rainfall across a winter season. Details and findings are provided in Sections 8.4.8 and 8.4.9.

- Surface water locations were sampled by BnM on a regular weekly to bi-weekly basis across TSB between August or September 2021 (depending on location) and April 2022 to supplement BnM's ongoing compliance surface water quality monitoring under the existing Industrial Emissions (IE) license for the existing WMF (License W0201).

The purpose of the monitoring was to add spatial and temporal resolution to the existing monitoring carried out by BnM under their existing IE license. Further details and findings are provided in Section 8.4.

8.3.5 Difficulties Encountered in Compiling Information

No significant constraints were encountered during the compilation of this Chapter 8 and a robust assessment of likely significant effects of the Proposed Development has been undertaken.

8.4 BASELINE ENVIRONMENT

8.4.1 Physiography and Topography

The Proposed Development is situated entirely within TSB (purple outline in Figure 8-1). TSB covers a total area of approximately 17.07 km^2 (BnM, 2022) and ranges in elevation between approximately 81 and 90 mOD. The bog is surrounded by gentle hills that reach maximum elevations of 116 mOD in the townland of Hodgestown to the east and 142 mOD in Carbury to the west.

TSB is contiguous with but not within the same surface water catchment as Timahoe North Bog (TNB, blue outline in Figure 8-1). The two are contiguous but separated geographically by a gentle topographic saddle which reaches elevations of 93 mOD just north of the existing WMF.

Since industrial peat extraction in TSB ceased in the 1980s, residual peat depths in TSB range from zero (where peat has been completely removed/stripped) to 8.5 m (Chapter 7). Private sod-turf cutting still occurs in peripheral areas of TSB.

8.4.2 Rainfall and Evapotranspiration

The average annual rainfall for the 30-year period 1960-1990 was 816 mm/year, with average monthly rainfall ranging from 54 mm/month in April to 83 mm/month in December (TCE, 2017).

At the nearest synoptic weather station operated by Met Éireann (at the Casement Aerodrome), the 30-year long term average annual rainfall for the period 1981-2010 was 754.3 mm/yr, with average monthly rainfall ranging from 48.5 mm/month in February to 81.6 mm/month in October.[4]

The estimated annual average actual evapotranspiration at the site is approximately 467 mm/yr (TCE, 2017). Based on the site-specific rainfall data, the long-term annual average effective rainfall is approximately 389 mm/yr (816 minus 467 mm/year).

[4] https://www.met.ie/climate-ireland/1981-2010/casement.html

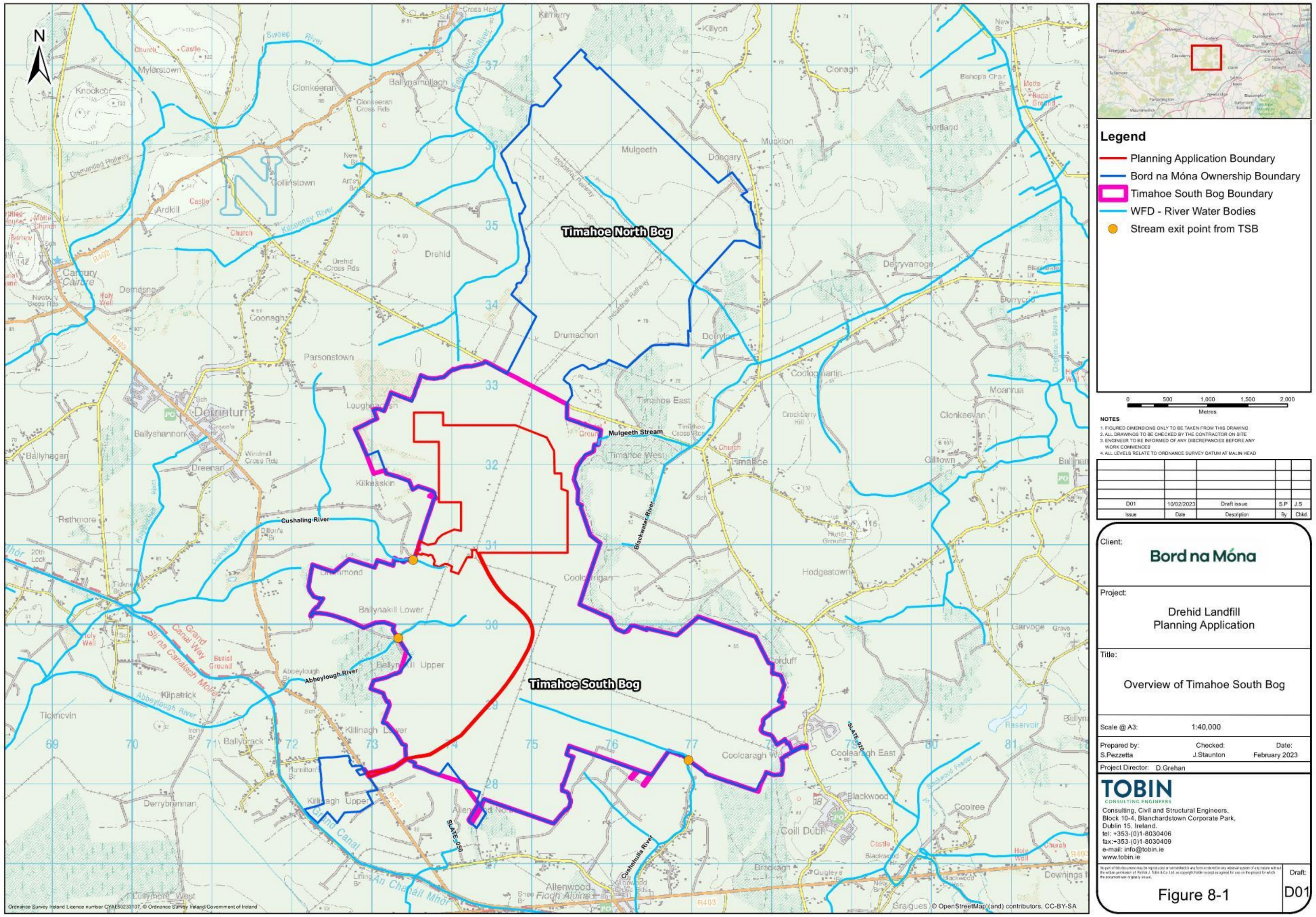

Figure 8-1 Location of TSB and TNB

Rainfall depths for the site, for different rainfall return periods as obtained from Met Éireann, are presented in Appendix 8-1 and summarised in Table 8-4.

Table 8-4 Summary of Rainfall Depths (mm) for Selected Rainfall Return Periods

Duration	Interval		
	1 Year	10 year	100 Year
1 hour	9.6	18.5	32.8
6 hours	19.0	34.1	56.8
12 hours	24.8	43.2	70.2
24 hours	32.4	54.8	86.8
48 hours	38.1	62.1	95.3

Thus, a one-day storm even with a recurrence interval of 100 years is defined by a rainfall depth of 86.8 mm, which equates to an average rainfall intensity over 24 hours of approximately 3.6 mm/hour.

8.4.3 Drainage Network Within and Outflow From TSB

As depicted in Figure 8-2, TSB contains a network of artificial drains which serve to manage water levels in the bog. The drains are mainly oriented northwest-southeast and are spaced roughly 250 m apart. The drainage network directs runoff and bog water to the following outflowing streams (Figure 8-2):

- The Cushaling River, which flows to the west and is identified by EPA water body code 'Figile_010'.
- The Mulgeeth Stream, which flows east into the Blackwater (Longwood) River, and is identified by EPA water body code 'Blackwater_Longwood_010'.
- The Abbeylough River, which flows to the southwest and is identified by EPA water body code 'Abbeylough_010'.
- The Cushahulla River (also referred to as the Ballynakill Upper River), which flows to the south and is identified by EPA code 'Slate_040' (part of the Slate River subcatchment).

Each of the named streams originate within, but near, the margins of TSB. The Ordnance Survey Ireland (OSI) six-inch to 1-mile scale field sheets from the mid-19th century do not indicate that any of the streams historically cross the bog.

Although the topographic relief within TSB is subtle, subcatchments withing TSB have been delineated from Lidar survey data. Two of the subcatchments are relevant to the Proposed Development, as follows:

1. One subcatchment incorporates both the existing WMF and the landfill expansion area, and drains to the Cushaling River (Figure 8-3).
2. One subcatchment drains the area to the north of the WMF to the Mulgeeth Stream (Figure 8-3). In a future planned TSB rehabilitation scenario (being implemented as part of the TSB Decommissioning and Rehabilitation Plan), the Proposed Development becomes indirectly linked to Mulgeeth Stream via a new planned drain in TSB. This indirect link is described further and assessed in Sections 8.5 and 8.6.

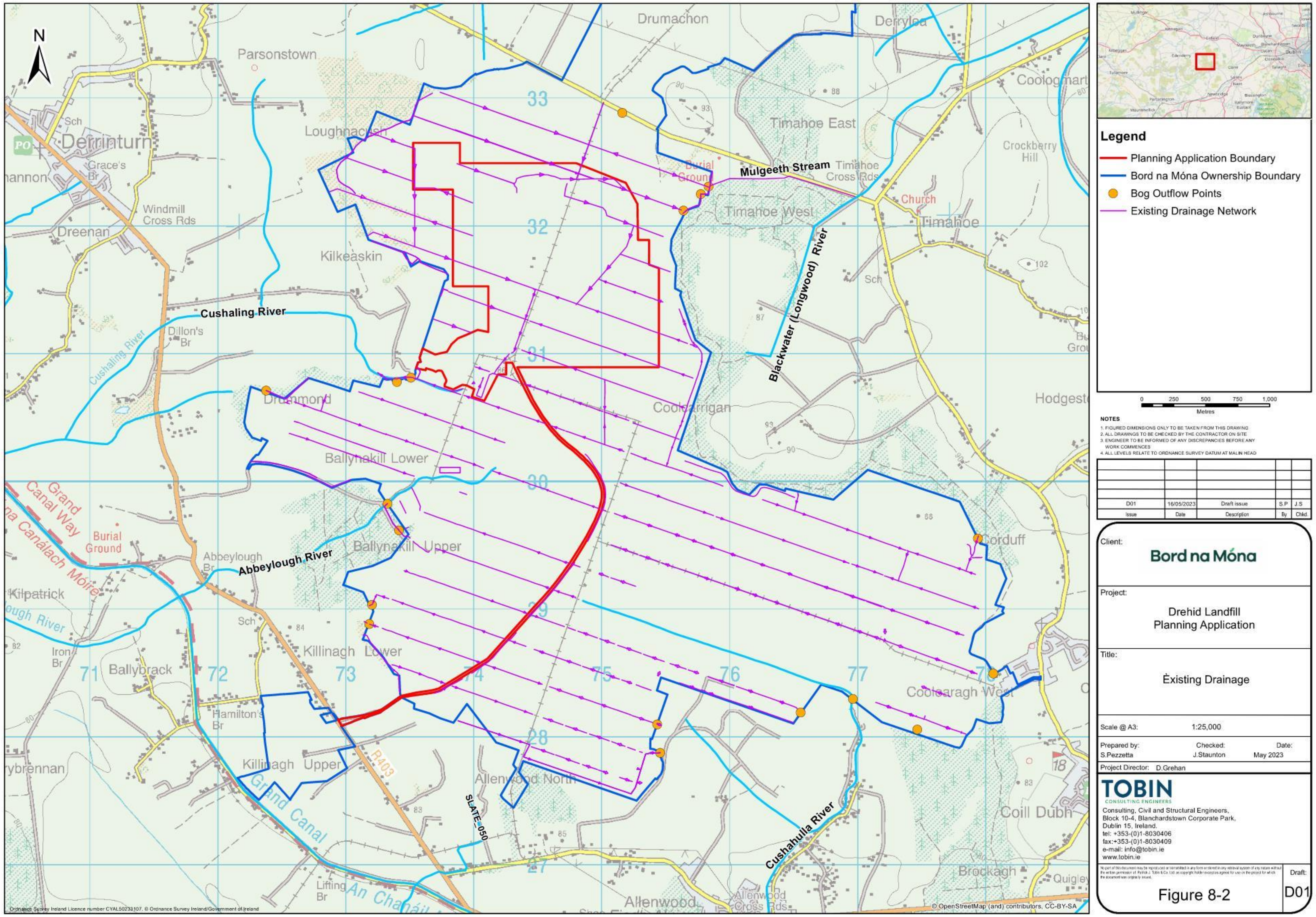

Figure 8-2 Present Drainage Network in TSB

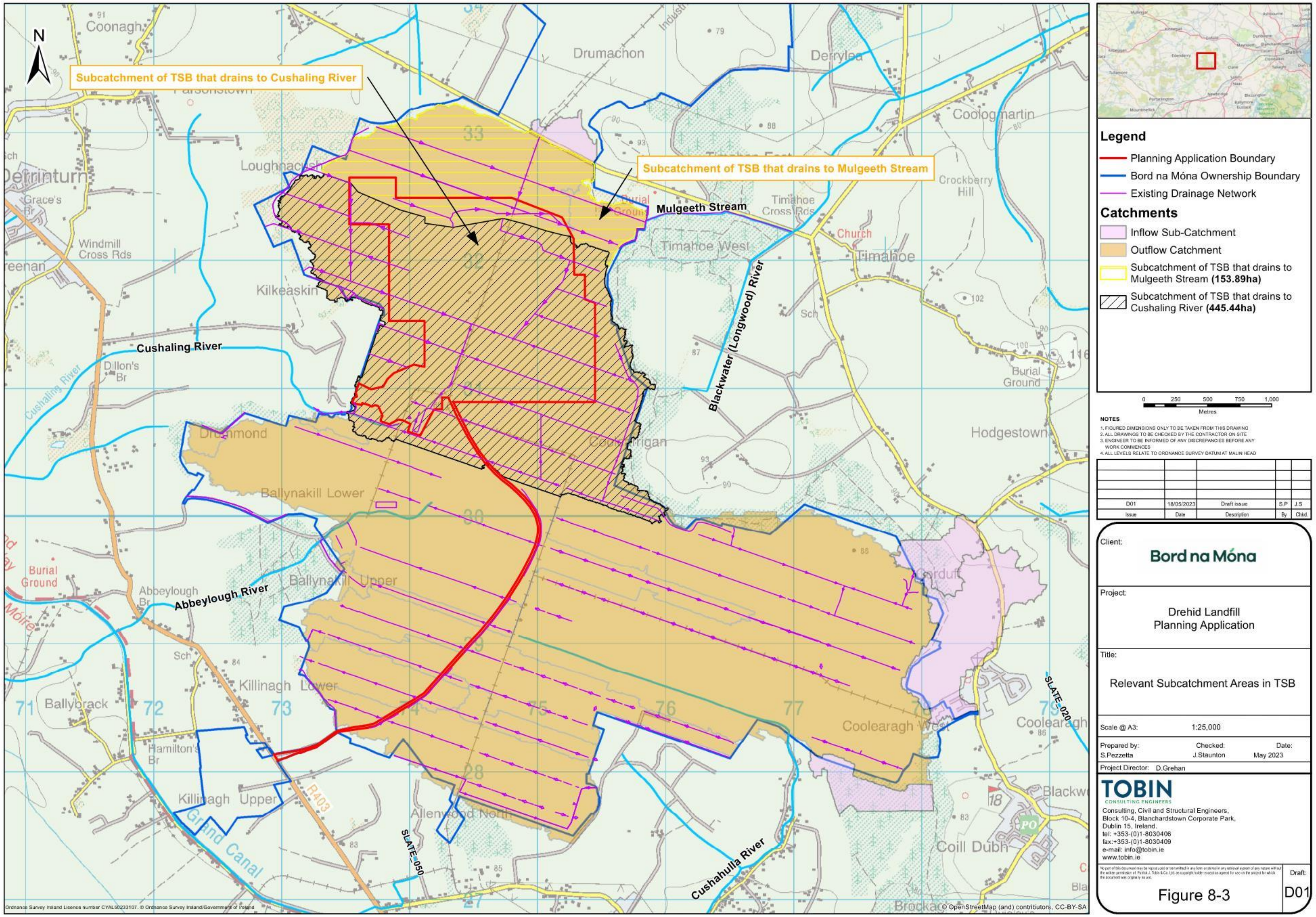

Figure 8-3 Existing Drainage Subcatchments in TSB That Are Relevant To The Proposed Development

Within the subcatchment of the Cushaling River, there are several existing, linked features (Figure 8-4) that define drainage towards the Cushaling River, as follows:

- A perimeter swale that surrounds the WMF and collects stormwater from the WMF.
- An under-cell drainage system which captures shallow groundwater beneath actively filled waste cells in the WMF.
- Attenuation lagoons south of the WMF, which receives the stormwater and groundwater from the under-cell drainage system.
- An ICW south of the existing attenuation lagoons which receives overflow from the attenuation lagoons.
- A main channel which conveys surface water from the ICW and bog drains to the existing 'old settlements ponds' to the south of the 'Borrow Pits'. This channel is also sometimes referred to as the 'bog culvert'.
- The old settlement ponds.
- A pipe culvert outflow from the old settlement ponds to Cushaling River.

These key features (Figure 8-4) are referenced throughout this Chapter 8.

Figure 8-4 Key Drainage Features From WMF Towards Cushaling River

8.4.4 Receiving Surface Waters

With the exception of the access road to the WMF from the south, the Proposed Development is located entirely within the subcatchment of TSB that drains to the Cushaling River. The Cushaling River is, therefore, the main receiving water body associated with the Proposed Development. Based on the original OSI drainage maps from the mid-19th Century, the Cushaling River originates at a location just east of the current Borrow Pit.

The only other stream which is hydrologically situated such that it could be affected by the Proposed Development is the Mulgeeth Stream to the east/northeast of the existing WMF. This is explained further in Section 8.5.

The other named streams that originate along the margins of TSB are in separate subcatchments from the Proposed Development. As such, they are hydrologically separate from and will not be affected by the Proposed Development.

TNB is also hydrologically separated from TSB. As such, activities in TSB will not affect TNB.

As the main receiving water body at risk from the Proposed Development, the Cushaling River presently receives:

- Surface runoff and peat drainage from TSB.
- Groundwater baseflow from Quaternary sediments and bedrock (see Chapter 7).
- Industrial emission licensed discharges from the WMF, via the existing attenuation lagoons and ICW immediately south of the WMF (see Section 8.4.12 for further details).

Under the Proposed Development, the Cushaling River will receive additional discharges (under licence) from the new landfill, comprising stormwater runoff and groundwater captured by a planned, designed under cell drainage system, via the new ICW (see Chapter 2 and Appendix 2-3 of this EIAR for further details).

8.4.5 Designated Sites and Protected Areas

The Cushaling River is not a designated site or protected area. However, it is a headwater of the River Barrow and as shown in Figure 8-5, the Cushaling River is hydrologically connected to:

- The River Barrow and River Nore Special Area of Conservation (SAC), at the confluence with the River Barrow near Monasterevin, c. 20 km (straight line distance) southwest of TSB.
- The "Barrow 130" Drinking Water Protected Area, further downstream on the River Barrow near Athy, and c. 35 km (straight-line distance) south of TSB.

Based on Figure 8-5, the designated sites that are geographically closest to the Proposed Development are:

- Ballynafagh Lake SAC (Site Code 00138), a shallow alkaline lake which is located c. 6 km southeast of the Project. This SAC has as its qualifying interests: [7230] Alkaline Fens [1016]; Desmoulin's Whorl Snail (*Vertigo moulinsiana*); and [1065] Marsh Fritillary (*Euphydryas aurinia*). The SAC includes the "Blackwood Feeder" of the Grand Canal.
- Ballynafagh Bog SAC (Site Code 000391), which is located c. 6.5 km southeast of TSB. This SAC has as its qualifying interests: Active raised bogs [7110], Degraded raised bogs still capable of natural regeneration [7120] and Depressions on peat substrates of the Rhynchosporion [7150].

Both SACs are located in topographic and hydrological catchments that are separate from TSB, hence surface water drainage to and from TSB does not interact hydrologically with either of the SACs. Both SACs are also in separate groundwater catchments from TSB. This statement is guided by topographic considerations whereby groundwater flow directions in Irish aquifers tend to mimic topographic gradients. As documented in Chapter 7, groundwater flow gradients in TSB are generally towards the west and south, depending on location within TSB. The SACs are located east of a topographic high area in the townlands of Corduff-Hodgestown-Timahoe (east of TSB).

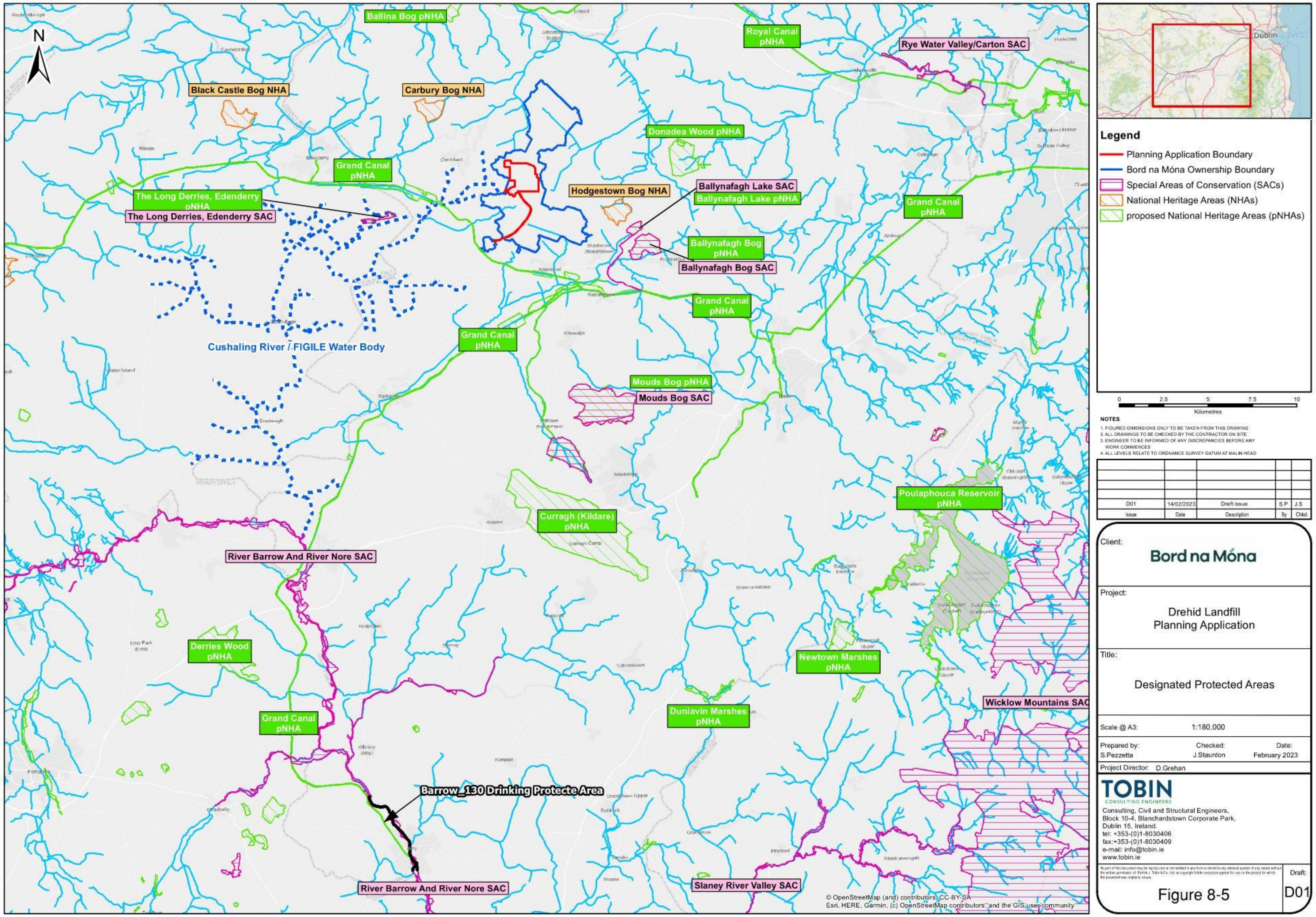

Figure 8-5 Designated Sites and Protected Areas Indirectly Connected South of TSB

Other designated sites in the immediate regions surrounding TSB are:

- The Long Derries, Edenderry SAC, which is located c. 7.5 km west of the Project. The SAC has calcareous grassland as its qualifying interest, which is unrelated to the water environment of the Cushaling River.
- The Hodgestown Bog natural heritage area (NHA). This occurs c. 1 km to the east of TSB on elevated ground. It is designated for Raised Bog habitat but also comprises cutover bog. Parts of this bog have been reclaimed for forestry and agriculture. It is not hydrologically connected with TSB.
- The Grand Canal proposed NHA. This runs east-west less than 1 km to the south of TSB, but is hydrologically distinct from TSB.

Although the Cushaling River is not a designated Salmonid water, Inland Fisheries Ireland informed during EIA consultation that "*salmon spawning/recruitment occurs on the Figile River, with salmon spawning also recorded on the Cushaling (during winter 2021-2022), a relatively short distance downstream of the Drehid site*". IFI noted that the extent of "*salmon spawning on these systems is limited by hydromorphological/habitat damage to habitat undertaken to facilitate commercial peat harvesting*". IFI moreover stated that that the restoration of salmon spawning recruitment on the Figile/Cushaling and other rivers is important for improving salmon stocks in the Barrow River system as a whole.

With regard to Mulgeeth Stream, this is not a designated site or protected area. However, it is one of many headwater streams of the River Boyne and connects indirectly to the River Boyne via the Blackwater (Longwood) River (Figure 8-6). The distance of flow from the TSB exit point to the confluence with the River Boyne is nearly 30 km. The River Boyne is:

- A designated Special Area of Conservation (SAC).
- A designated Salmonid Water.
- A Drinking Water Protected Area in a section of River Boyne just downstream of Trim.

8.4.6 WFD Status – Surface Water Bodies

The Cushaling River is part of the larger Figile River further downstream, south of Ticknevin. In term of EPA's WFD reporting schema, the Cushaling River is defined by:

- The 'Figile_010" river water body (code IE_SE_ 14F010061)
- The "Figile_SC_010" subcatchment (EPA subcatchment ID14.3)

These, in turn, are part of the much larger Barrow catchment (EPA catchment ID 14).

The "Figile_010" water body subcatchment incorporates other tributaries which are west of TSB. The Cushaling River merges with the Abbeylough River to the southwest of Ticknevin, becoming the "Figile_020" water body downstream of Ticknevin.

According to EPA's latest WFD status classification for the period 2016-2021, the Figile_010 water body is at "Poor ecological status" (Figure 8-7)[5], thereby failing to meet the WFD default "Good status" objective.

[5] Information Obtained from EPA's website: https://gis-stg.epa.ie/EPAMaps/Water

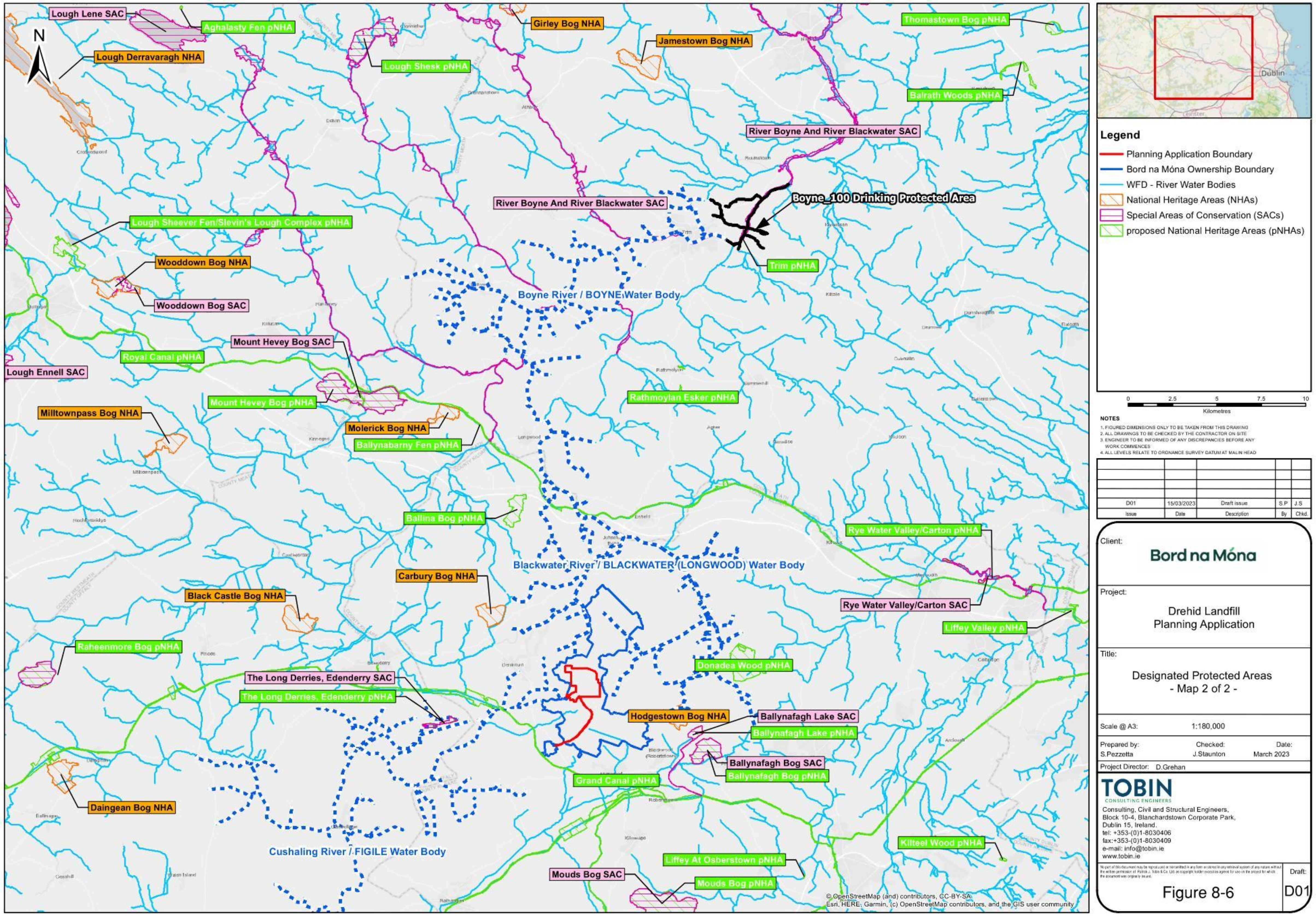

Figure 8-6 Designated Sites and Protected Areas Indirectly Connected North of TSB

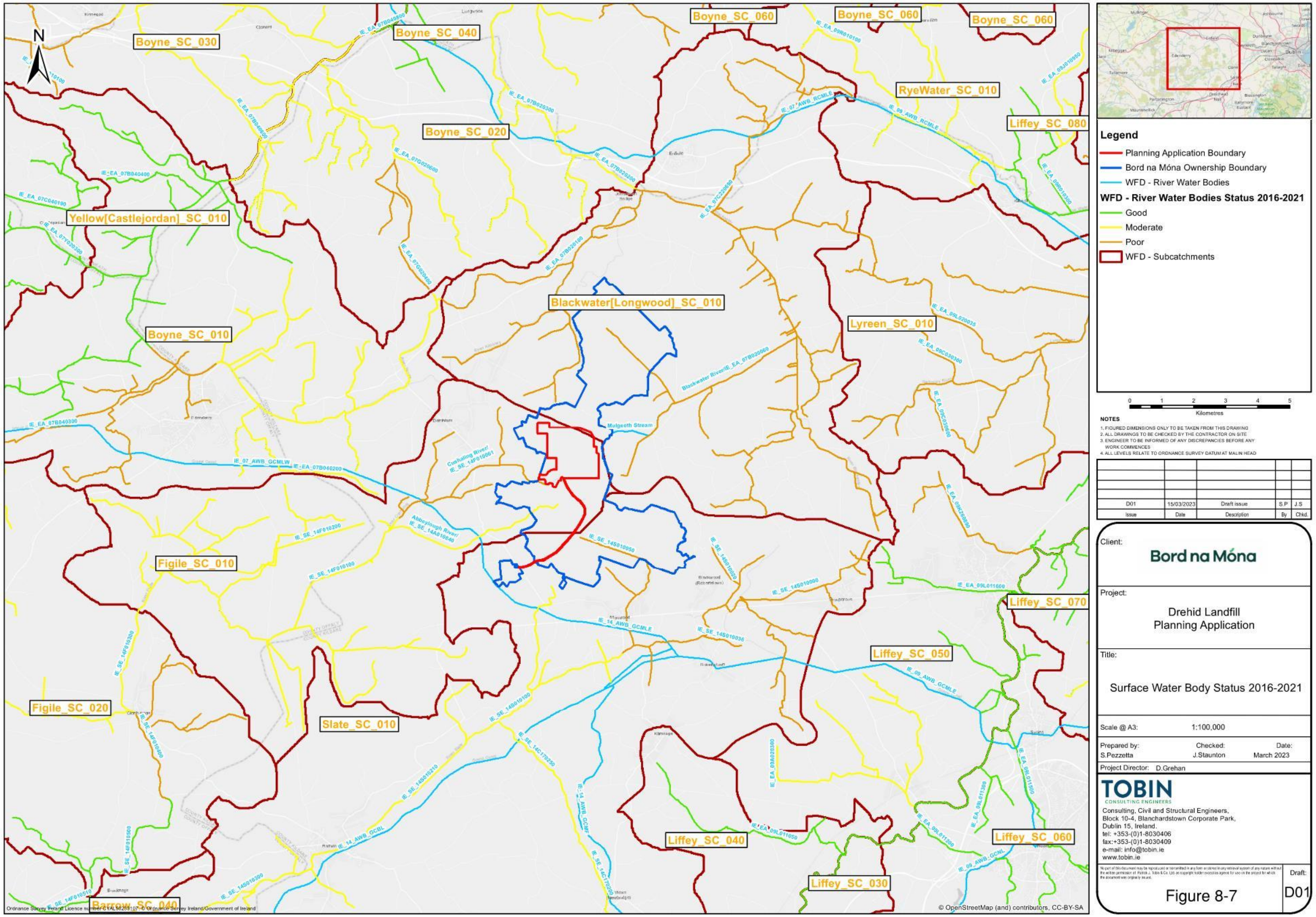

Figure 8-7 WFD Status Classification (2016-2021)

The main cause of the "*Poor ecological status*" classification is reported by EPA as "*Poor invertebrate status or potential*" (Figure 8-8), noting that the outcome of EPA's chemical test for nutrient conditions is also "*Fail*" on account of "*Moderate*" nitrate and orthophosphate conditions. Ammonium conditions are given as "*High*". This means there is a concern with nitrate and orthophosphate concentrations in the river, which may contribute to the "*Poor invertebrate status or potential*". EPA's water quality data are presented in Section 8.4.13.

SW 2016-2021

Status	Assessment Technique	Status Confidence	Value
▾ Ecological Status or Potential	Monitoring	medium confidence	Poor
▾ Biological Status or Potential			Poor
Invertebrate Status or Potential			Poor
▾ Supporting Chemistry Conditions			Moderate
▾ General Conditions			Moderate
▾ Oxygenation Conditions			Pass
Dissolved Oxygen (% Sat)			Pass
Other determinand for oxygenation conditions			High
▾ Acidification Conditions			Pass
pH			Pass
▾ Nutrient Conditions			Moderate
▾ Nitrogen Conditions			Moderate
Nitrate			Moderate
Ammonium			High
▾ Phosphorous Conditions			Moderate
Orthophosphate			Moderate

Figure 8-8 Screenshot of WFD Status Classification – "Figile_010" Water Body (Source: EPA[6])

The latest biological Q-value for macroinvertebrates produced by EPA in 2019 at a river location just downstream of the BnM landholding was 2-3, *i.e.,* Poor, or "*moderately polluted, unsatisfactory condition*".[7] The location of the Q-value monitoring station (EPA station ID RS14F010005, also referred to as "*0.6 km u/s Parsonstown 14 Trib*"), is shown in Figure 8-9.

In the latest available local catchment assessment report for the subcatchment of the "Figile_010" water body, EPA (2019) identifies the following "*significant pressures*":

- Urban wastewater discharges (agglomeration population equivalent (PE) of 1001 to 2000)
- Industry (Section 4 discharges and industrial emissions)
- Extractive Industry (peat)
- Hydromorphology (channelisation and embankment)

[6] From www.catchments.ie
[7] Information accessed from EPA's Web viewer at https://gis-stg.epa.ie/EPAMaps/Water

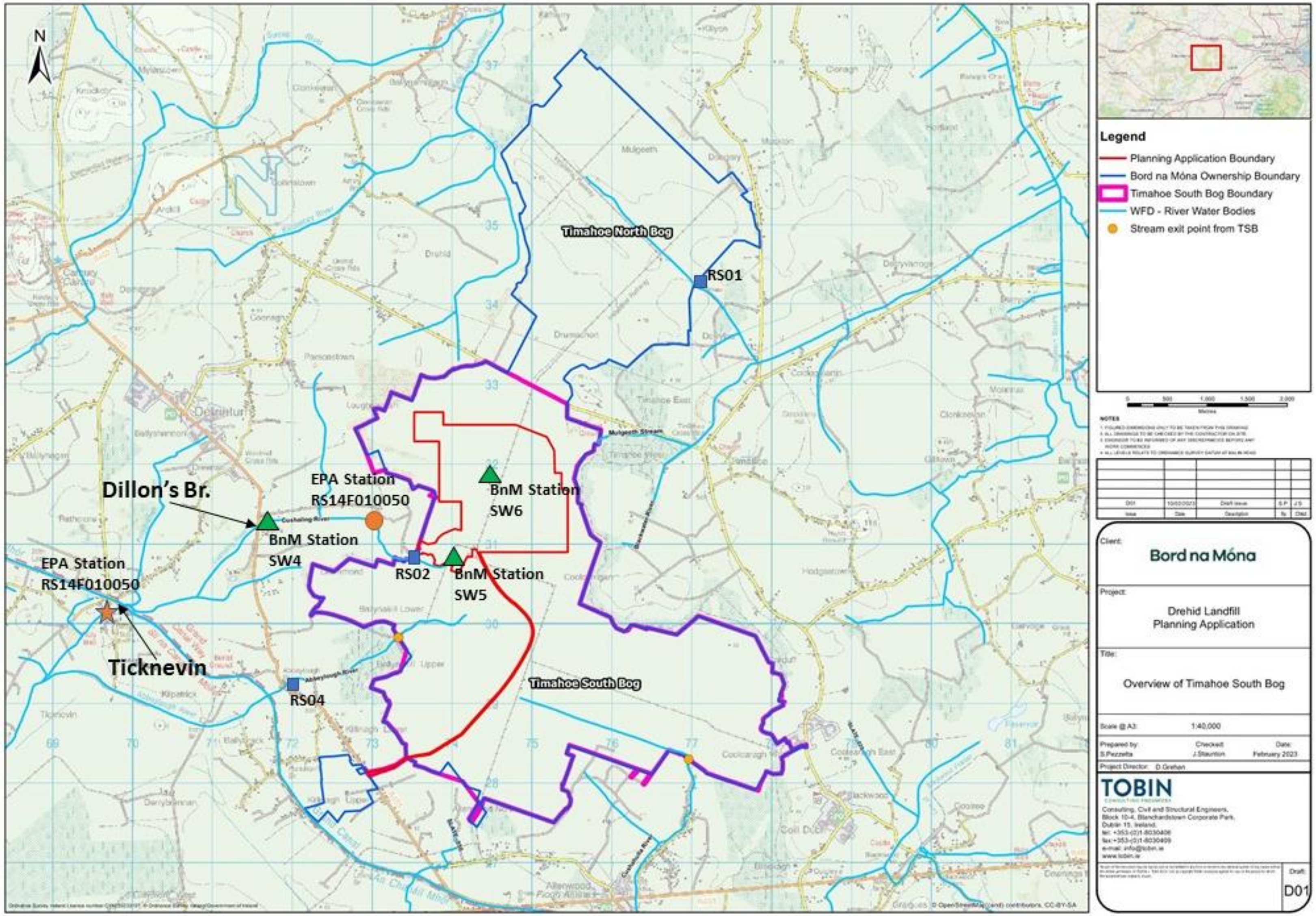

Figure 8-9 EPA and BnM Surface Water Monitoring Stations

Agricultural land uses in the subcatchment can also contribute. Specific waste water discharges which contribute to the water quality issues in the 'Figile_010' water body are in Ticknevin[8] and Derrinturn[9].

As part of the Industrial Emission (IE) discharge license held by BnM for the existing WMF, BnM conducts its own routine biological monitoring of the Cushaling River. In the ecological monitoring report for 2020 (Hibernica Ecology 2020), a macroinvertebrate community representative of Q2-3 was recorded at the biological monitoring location just upstream of Dillon's Bridge (Figure 8-9). Importantly, the ecological monitoring report notes that "*the river has been drained and channelised, banks are over-deepened*", and concludes:

> "*The paucity of taxa, with low densities is attributed to the poor geomorphological diversity within the reach. This is characterised by the combined effect of a deepened channel and low flow velocities, with high siltation and a fully shaded riparian corridor, leading to unfavourable aquatic habitat conditions*".

The river is, therefore, affected by hydromorphological alterations in areas at and downstream of the BnM landholding (Photo 1). This was also pointed by IFI during EIAR scoping and consultation in 2022, specifically:

> "*Site visits by IFI to the Drehid site have highlighted significant modifications to watercourses flowing through, adjacent to and downstream. The modifications noted included:*
>
> - *Realignment/Straightening;*
> - *Deepening*
> - *Widening*
> - *Culverting/piping of waters*
> - *Construction of on-line silt ponds*"

Photo 1 Cushaling River Downstream of Landholding Boundary (Looking West, Downstream)

[8] Wastewater discharge authorisation A0124-01
[9] Urban wastewater discharge license D0244-01

EPA's pre-WFD data by Dillon's Bridge also indicated Q-values of 2-3 (Poor) in 1989 and 3 (Poor) in 1993 [10], implying that Poor biological conditions existed before WMF construction and operations began in 2006 and 2008, respectively.

The Figile_010 water body is also classified by EPA to be "*At Risk*" of failing to meet the WFD "*Good status*" objectives in 2027.[11] As a result, EPA has assigned "*further characterisation action*" to assess "*multiple sources in multiple areas*" for the river water body as a whole, as outlined in the third cycle River Basin Management Plan for Ireland (EPA, 2021).

As was shown in Figure 8-7, the other surface water bodies that originate along the margins of TSB are also considered to be at "*Poor ecological status*" (2016-2021). These surface water bodies are also "*At Risk*" of failing to meet WFD environmental objectives in 2027.

Mulgeeth Stream is part of the Blackwater (Longwood) River water body. The latter is also classified at "*Poor ecological status*" (2016-2021), driven by "*Poor invertebrate status*". The significant environmental pressures in the subcatchment of the Blackwater (Longwood) water body are only identified by EPA as "*anthropogenic*" (EPA, 2018), but it is noted that EPA's published catchment assessment (EPA, 2018) refers to the 2nd cycle of WFD implementation (*i.e.,* 2015-2021).

8.4.7 Surface Water Importance and Sensitivity

With the Cushaling River identified as the main receiving surface water associated with the Proposed Development, and using the attributes presented in Table 8-2 to determine the importance/ sensitivity of the receiving water environment, the Cushaling River is considered to be of medium importance/sensitivity. Specifically, the Cushaling River:

- Is hydraulically connected to a designated site and protected area which are situated more than 5 km downstream.
- Is not a salmonid water but has potential for spawning (especially downstream of the site).
- Is not used for other purposes, including drinking water, and has limited social or economic uses.
- Is at 'Poor ecological status'.

Accordingly, the Cushaling River is in the category of a river that is important at the local scale. The Mulgeeth Stream can be described with the same attributes. Being a significantly smaller stream than Cushaling River, it is conservatively assigned medium importance/sensitivity.

8.4.8 Streamflow – Cushaling River

The Cushaling River is not gauged. The nearest active gauging station with continuous level and flow data is "Clonbulloge" (station ID 14004 operated by OPW) on the Figile River c. 13 km (straight line) southwest of TSB. The OPW-reported Q_{50} and Q_{95} flows for this station (period 1972-2018) are 3.084 and 1.158 m^3/s, respectively. These flow values are included for reference purposes even though this station is considered too remote to be of practical relevance to the EIA.

[10] Information sources from EPA's Water web viewer at https://gis-stg.epa.ie/EPAMaps/Water
[11] Information accessed from EPA's Web viewer at https://gis-stg.epa.ie/EPAMaps/Water

Closer to the BnM landholding boundary, there are estimated flow percentiles available for the Cushaling River based on EPA's 'Qube' model (EPA 2020; Quinlan and Quinn 2018). The relevant reference point is model node "RWSEG_CD 14_839" between Ticknevin and Dillon's Bridge (red cross in Figure 8-10). At this location, the Qube model provides a naturalised Q_{95} flow estimate of 0.028 m^3/s and, as an indicator of mean flow, the naturalised Q_{30} flow (LAWPRO/EPA 2022) is 0.171 m^3/s (Figure 8-11). Hence, the Q_{95} (low) flow is 16% of the Q_{30} (mean) flow. This is consistent with poorly drained and poorly productive aquifer settings in which surface runoff and shallow pathways dominate the hydrological responses of streams.

Reference point RWSEG_CD 14_839 has a catchment area of 11.34 km^2 which incorporates the subcatchment of TSB that contributes flow to the Cushaling River. From Figure 8-10, roughly 50% of the catchment area of the reference point is within TSB and the other half is mainly agricultural land to the west of TSB. This means the baseflow component from within TSB is less than the 0.028 m^3/s. Pro-rating the Q_{95} flow estimate of 0.028 m^3/s (from the Qube model) to the 50% catchment area within TSB, the indicative value of groundwater baseflow from the groundwater catchment within TSB becomes 0.014 m^3/s.

8.4.9 Measured (Estimated) Flow Rates From TSB

Spot measurements of streamflow were taken between October 2021 and April 2022 at outflow point RS02 (Cushaling River near the western BnM landholding boundary). The flow measurements are presented in Figure 8-12 along with outflow points to Abbeylough River (RS04) and TNB (RS01).

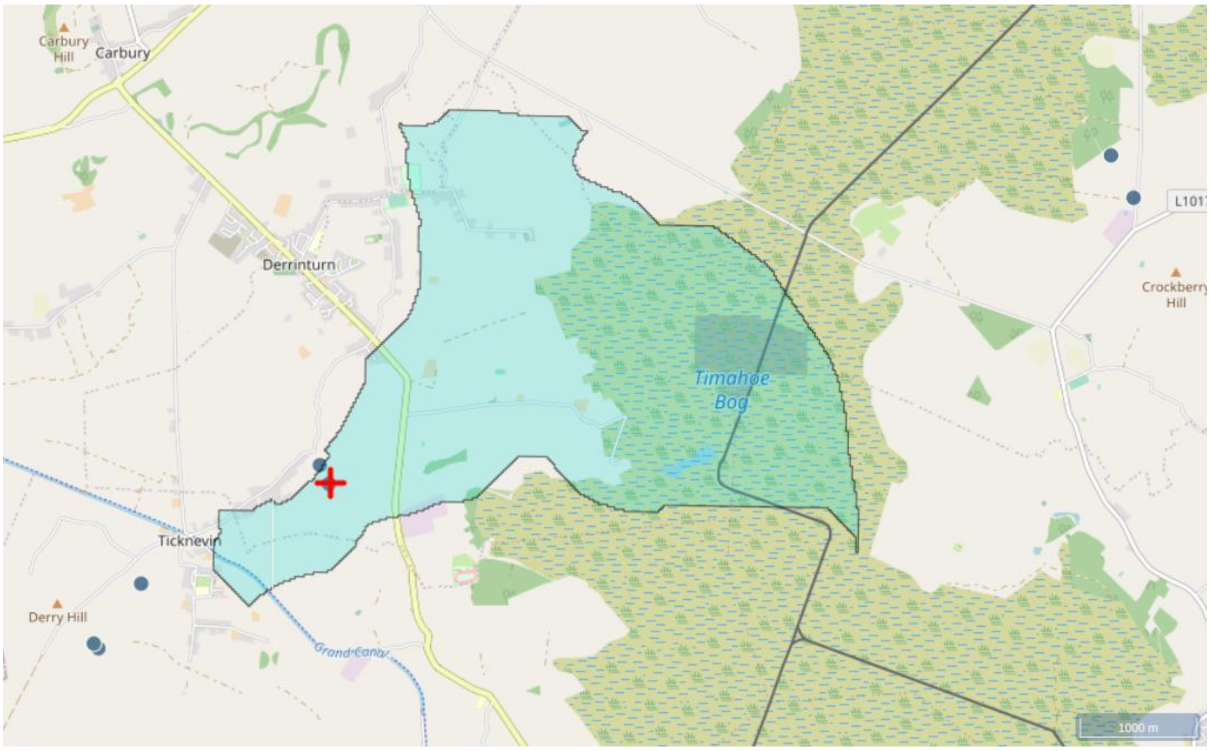

Figure 8-10 Location of Model Node RWSEG_CD 14_839 and Its Catchment Area

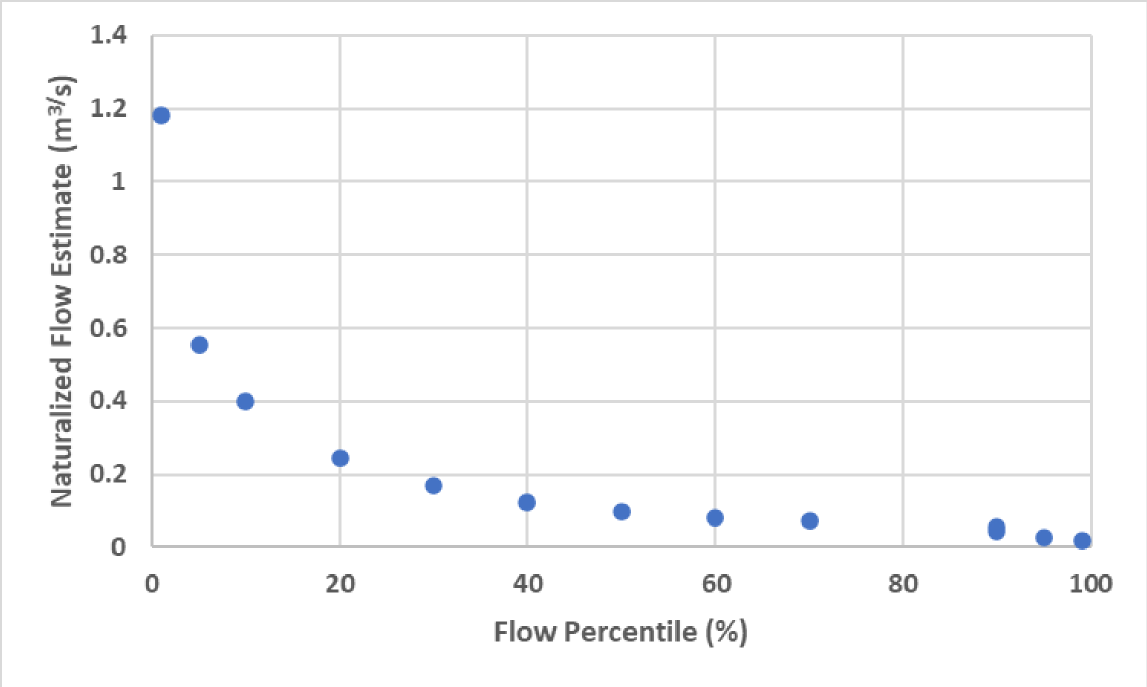

Figure 8-11 Model-Derived Flow Percentiles for Model Node "RWSEG_CD 14_839"

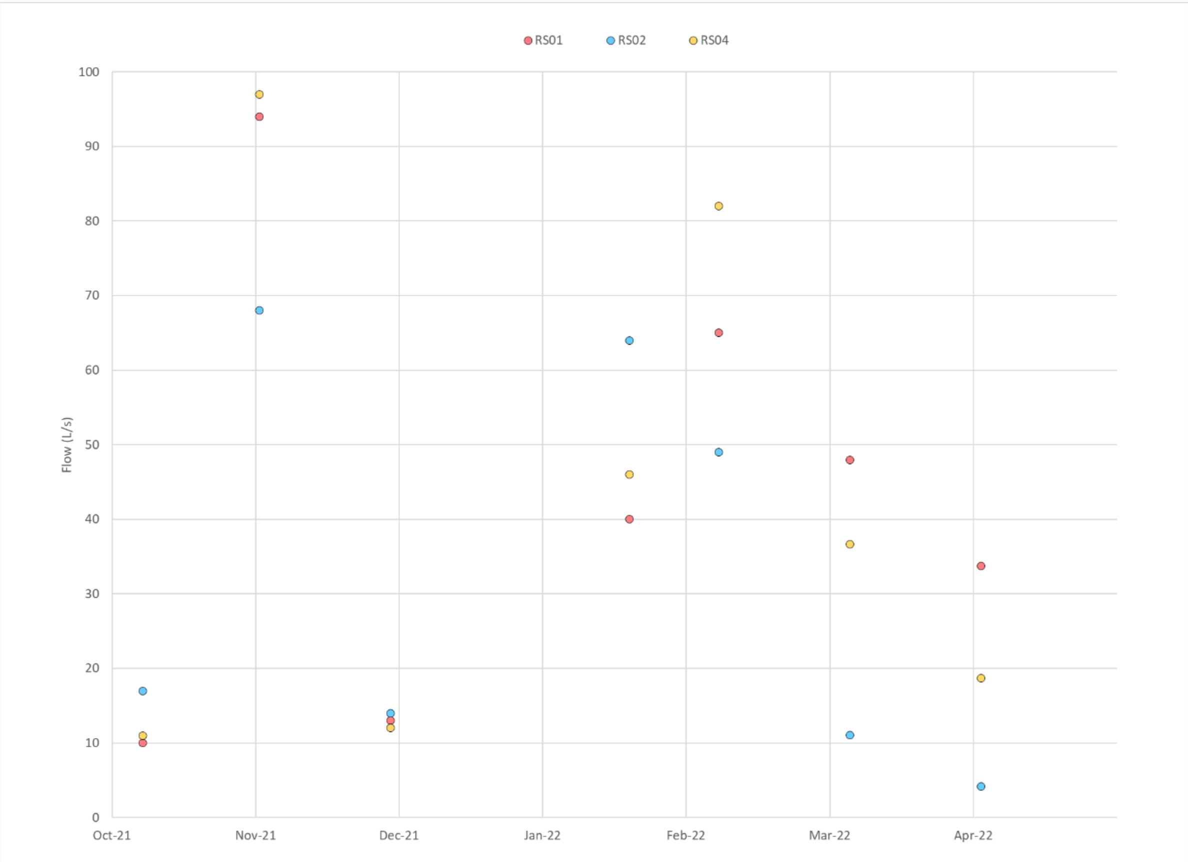

Figure 8-12 Estimated (Spot) Flow Measurements October 2021-April 2022

The measured flows at RS02 (Cushaling River) ranged from 5 to 68 l/s (0.005 to 0.068 m^3/s), with a mean of 30 l/s (0.03 m^3/s). For a baseflow component of 16% of mean flow (from Section 8.4.8), the baseflow component would be on the order of 0.005 m^3/s, although this is based on a small number of measurements across a winter season (n=7).

In 2003 and 2004 (which pre-dates the WMF development) the flow of Cushaling River was measured at two temporary monitoring stations THASW 1 and THASW 2 (TCE, 2017). Flow at THASW1 was measured at a 12-inch concrete pipe located at the outfall from the main channel ("central drain", TCE, 2017). Flow at THASW2 was measured at a weir installed approximately 1 km downstream of the outfall point from the main channel (i.e. on the river west of the BnM landholding). The maximum recorded flows were 60.6 l/s (0.061 m^3/s) at THASW1 and 93.9 l/s (0.094 m^3/s) at THASW2. Respective average flows for the period of record were 18 l/s (0.018 m^3/s) and 28 l/s (0.028 m^3/s). Conceptually, therefore, the groundwater baseflow component of flow (as 16% of mean flow) would be 0.0045 m^3/s at THASW2.

The previous EIAR (TCE, 2017) also reported that the average recorded flow on the Cushaling River, as it exits the BnM landholding, was approximately 0.0376 m^3/s, which is slightly higher than the value reported from THASW2. The average flow on the Cushaling River at Dillon's Bridge, approximately 2.25 km downstream, was reported as 0.0771 m^3/s, indicating that the flow had increased between the two stations, which is partly explained by baseflow contributions but also surface runoff and stream inflow from a northern tributary of the Cushaling River to the west of TSB.

With regard to the Mulgeeth Stream as it exits TSB, this is a very small stream with an estimated mean streamflow of less than 10 l/s (0.01 m^3/s). Owing to its small size, it has not been possible to derive reliable or accurate flow metrics.

8.4.10 Flood Risk

A flood risk assessment (FRA) of the Proposed Development is presented Appendix 8-2. Key findings are:

- Areas within TSB are liable to pluvial flooding, but this is part of the bog's environmental supporting conditions.
- OPW's indicative fluvial flood maps show "*medium probability*" flood risk on the Cushaling River at a location c. 700 m upstream of Dillon's Bridge (Figure 8-13). "*Medium probability*" flood risk is defined by a flood with a 100 year recurrence interval (1 in 100 probability of occurring in any given year). An area of "*Low probability*" flood risk, which is defined by a 1,000 year recurrence interval, extends only marginally higher up the Cushaling River (Figure 8-13).

Hence, TSB remains outside OPW's indicative fluvial flood risk areas, and the Proposed Development site is considered to be located in Flood Zone C where the risk of fluvial flooding is low.

Fluvial flooding has not historically occurred within the BnM landholding. As described in the FRA (Appendix 8-2), OPW records do not contain incidents of flooding on the Cushaling River. The nearest records of recurring flooding in other low-lying areas outside TSB in in Allentown to the south of TSB.

Surface water from TSB is led to the Cushaling River from the old settlement ponds via the two 600 mm diameter concrete pipes shown in Photo 2. The pipes extend approximately 100 m to the southwest, and for approximate gradient of 0.005 (elevation difference of 0.5 m over 100 m), the total flow capacity of the two pipes (running full) is estimated to be approximately 1 m^3/s. In comparison, the estimated maximum carrying capacity of the river at the landholding boundary is 8.5 m^3/s. At Dillon's Bridge further downstream, the carrying capacity is 9.9 m^3/s (TCE 2017).

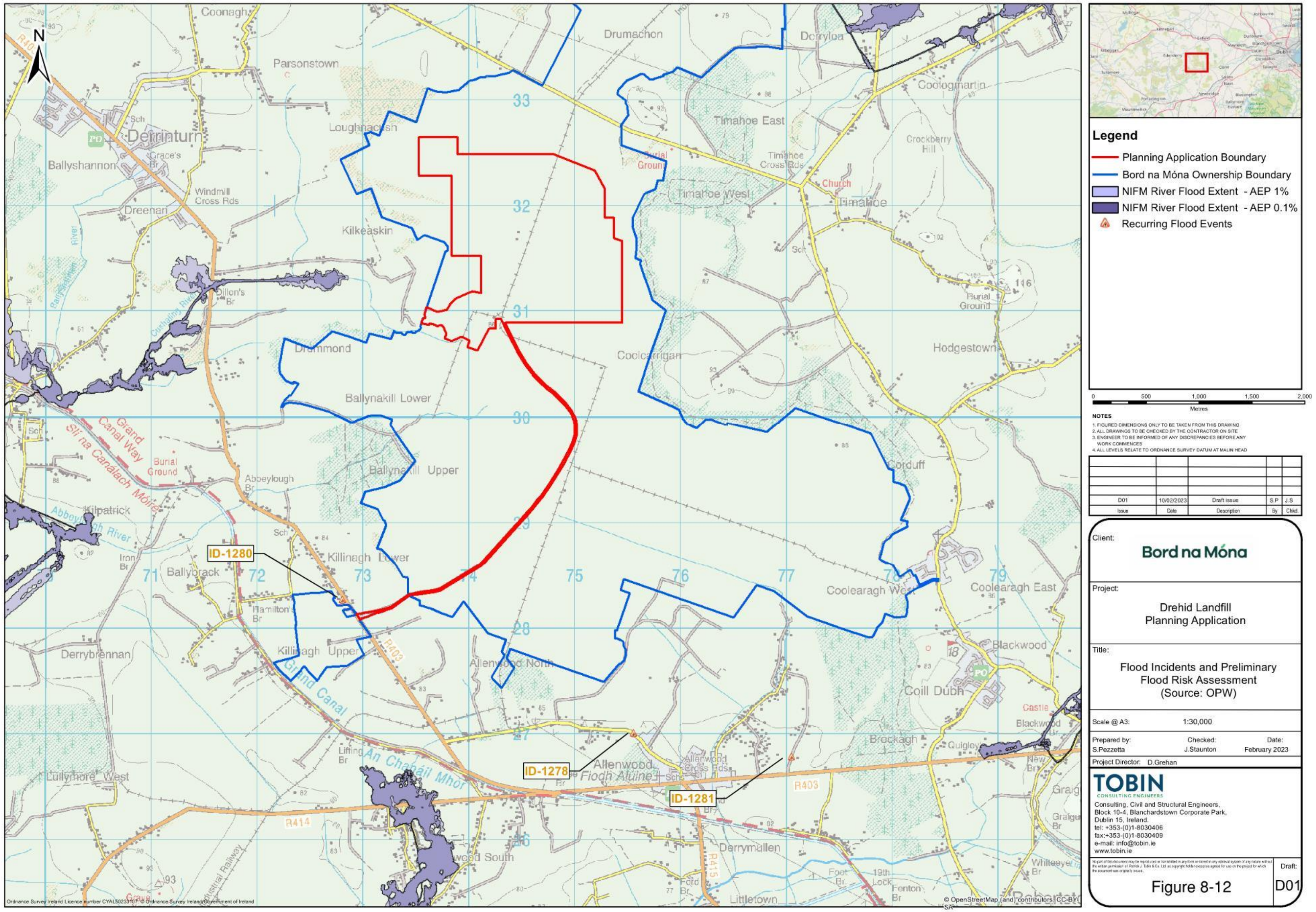

Figure 8-13 Flood Incidents and Indicative Fluvial Flood Areas (Source of Mapping Information: OPW)

Photo 2 Current Outflow Pipes from Old Settlement Ponds

During storm events, water levels in the old settlement ponds fluctuate by approximately 0.6 m on average (BnM, pers. comm.). The absence of recorded flood events at the site means that the pipes have hydraulic capacity to convey surface water without excessive build-up of water levels in and upstream of the old settlement ponds.

8.4.11 Streamflow Characteristics

As shown in Figure 8-14, stream hydrographs at three outflow points from TSB (RS01, RS02 and RS04) show rapid rises and peak water levels that coincide with rainfall events (marked by sharp increases in the cumulative rainfall graph) and subsequent quick recessions following the cessation of rainfall (marked by flat sections of cumulative rainfall graph). The stream hydrographs document a flashy response to rainfall events through the 2021-2022 winter season which reflects build-up and episodic releases of water from the bog during and following storm events.

8.4.12 Discharge from the Existing WMF

The existing WMF discharges water under licence from lined attenuation lagoons and an ICW south of the WMF (Photo 3). As introduced in Chapter 7, the lagoons receive:

- Runoff from the WMF.
- Shallow groundwater collected from an under-cell drainage system beneath the WMF.

The latter allows groundwater levels to be controlled beneath waste cells as a means of relieving basal heave until such time that the weight of the waste is sufficient to counter the upward hydraulic pressure from groundwater. This serves to reduce the risks of damage to the landfill liner system. The drained water is directed to a wet-well from where it flows into the lined attenuation lagoons.

Rainfall on roof and paved areas of the WMF discharge to the main channel directly, and are directed to the old settlement ponds prior to outflow to the Cushaling River.

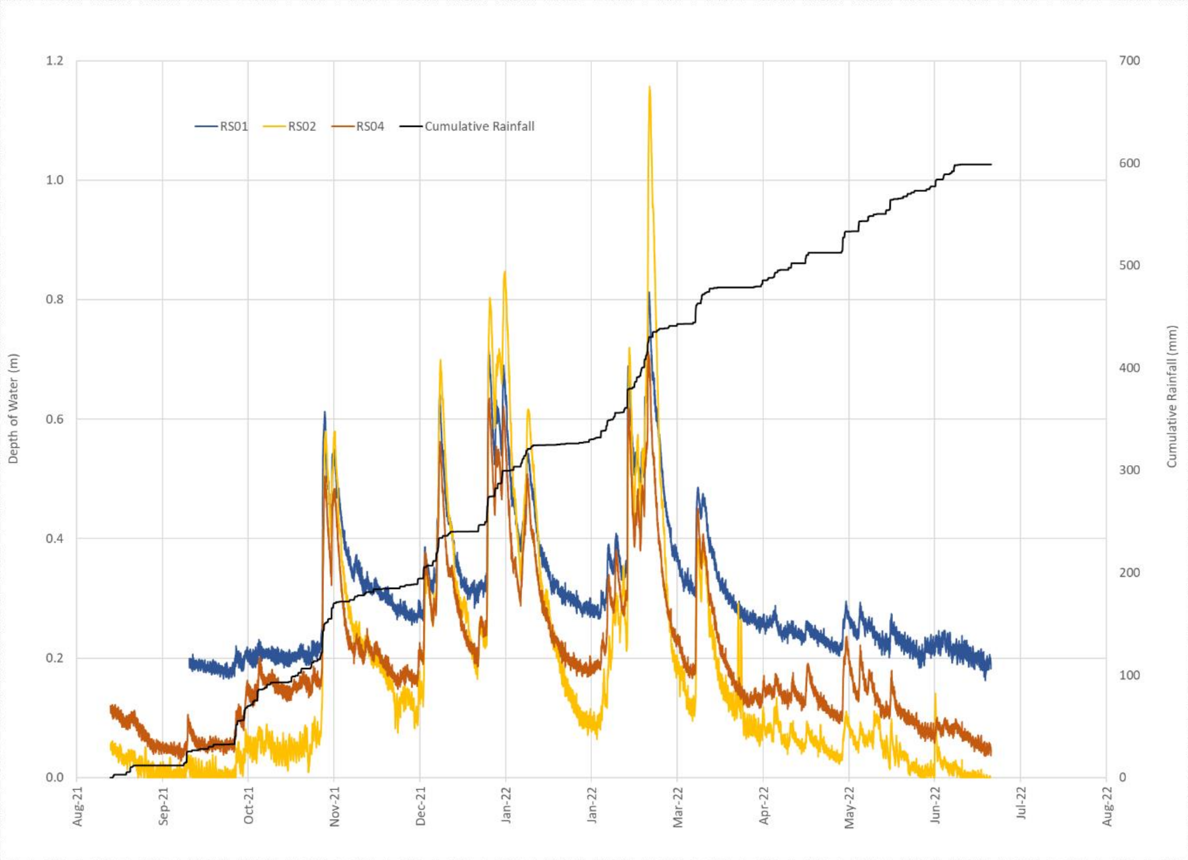

Figure 8-14 Water Level Hydrographs at Three Outflow Stations from Timahoe Bog

Photo 3 Lined Attenuation Lagoons South of the WMF (Wet-Well on Left)

Figure 8-15 shows the metered, monthly volumes of water collected from the under-cell drainage system between January 2015 and March 2022 in three stages of WMF operations, as follows:

- Stage "GW9" reflects Phases 9 & 10 of the existing landfill, completed in 2015 and 2016, respectively.
- Stage "GW11" reflects Phases 11 & 12 of the existing landfill, where Phase 11 was completed in 2016.
- Stage "GW13" reflects Phases 13 & 14 of the existing landfill which along with Phase 12 are both active/ongoing.

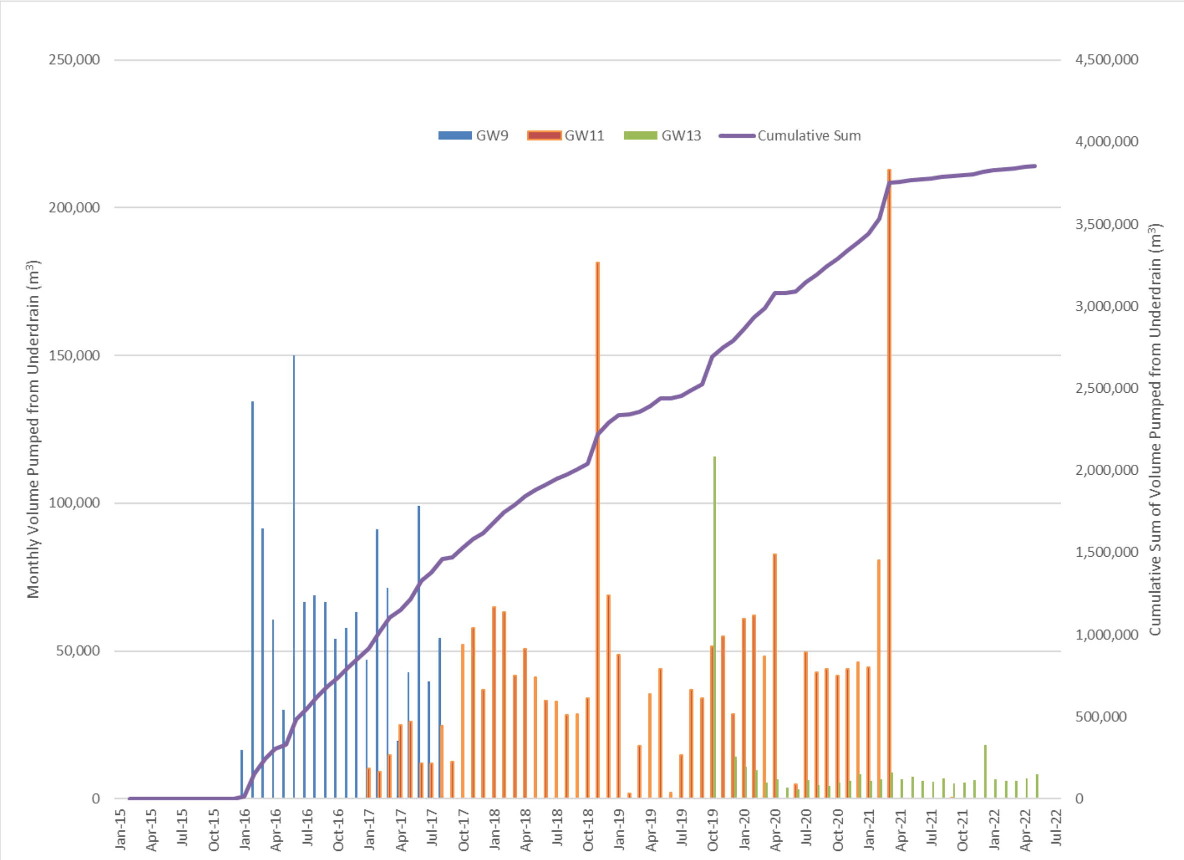

Figure 8-15 Quantities Discharged from the Under Cell Drainage System at the WMF

The quantities of water collected by the under-cell drainage system vary significantly from one month to another. This is dictated by seasonal groundwater levels and the stages of filling landfill cells. As shown in Figure 8-15, quantities between 2015 and 2022 ranged from zero to 221,608 m^3/month, the latter being equivalent to 0.085 m^3/s. The monthly average for the same period was 50,530 m^3/month, equivalent to 0.019 m^3/s. The cumulative sum of water collected over the period of record (2015-2022) is nearly 3.8 million m^3.

Metered volumes that flow out of the attenuation lagoons to the existing ICW are shown in Figure 8-16, and ranged from zero to 100,000 m^3/month, or 0.038 m^3/s, with an average of 21,547 m^3/month, or 0.0083 m^3/s. The cumulative sum of outflows for the same period of record (2015-2022) was 1.9 million m^3. Thus, the sum of outflows is half the sum of inflow. The apparent imbalance is inferred to reflect evaporation from the lagoons and water used daily for WMF operations (e.g., for cleaning, wash-down, dust suppression and landscaping purposes).

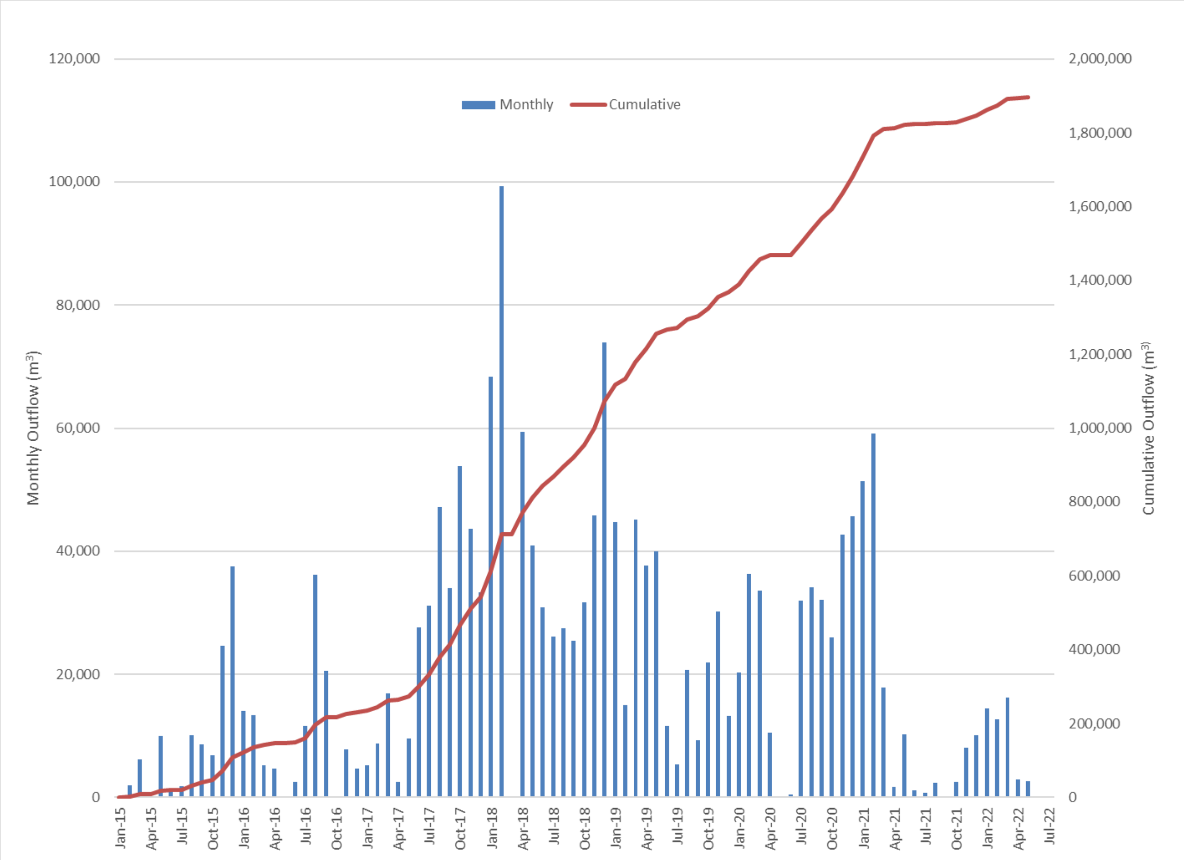

Figure 8-16 Measured Outflow from Attenuation Lagoons

The discharges from the attenuation lagoons influence flow across the ICW and main channel south of the ICW. As described in Chapter 7, some of the water will, accordingly, likely migrate laterally and interact with the peat and shallow groundwater flow system. This is a localised effect which depends on prevailing water levels and the permeability of the peat and Quaternary materials along its length.

8.4.13 Surface Water Quality – EPA Data

The nearest routine EPA water quality monitoring station on the Cushaling River is station ID RS14F010050. The station is part of EPA's WFD operational monitoring network for rivers, and is downstream of the village of Ticknevin and approximately 4 km (straight line distance) downstream of the western boundary of the BnM landholding. The sampling station is also downstream of urban agglomeration wastewater discharge licences A0124-01 and D0244-01 at Ticknevin and Derrinturn, as well as agricultural lands along the Cushaling River between the TSB and Ticknevin.

Based on EPA's data for WFD monitoring station RS14F010050, the water quality is characterised by elevated concentrations of nitrate, orthophosphate and true colour, as presented in Figures 8-17, 8-18 and 8-19. The orthophosphate concentrations are consistently above the AA-EQS of 0.035 mg/L, and both nitrate and orthophosphate concentrations show increasing trends over the period of record, while concentrations of ammonia are generally decreasing in the period of record (2007-2022).

Nitrite is detected in all EPA samples between 2007 and 2022 at concentrations which range from 0.008 to 0.17 mg/L-N (Figure 8-20).

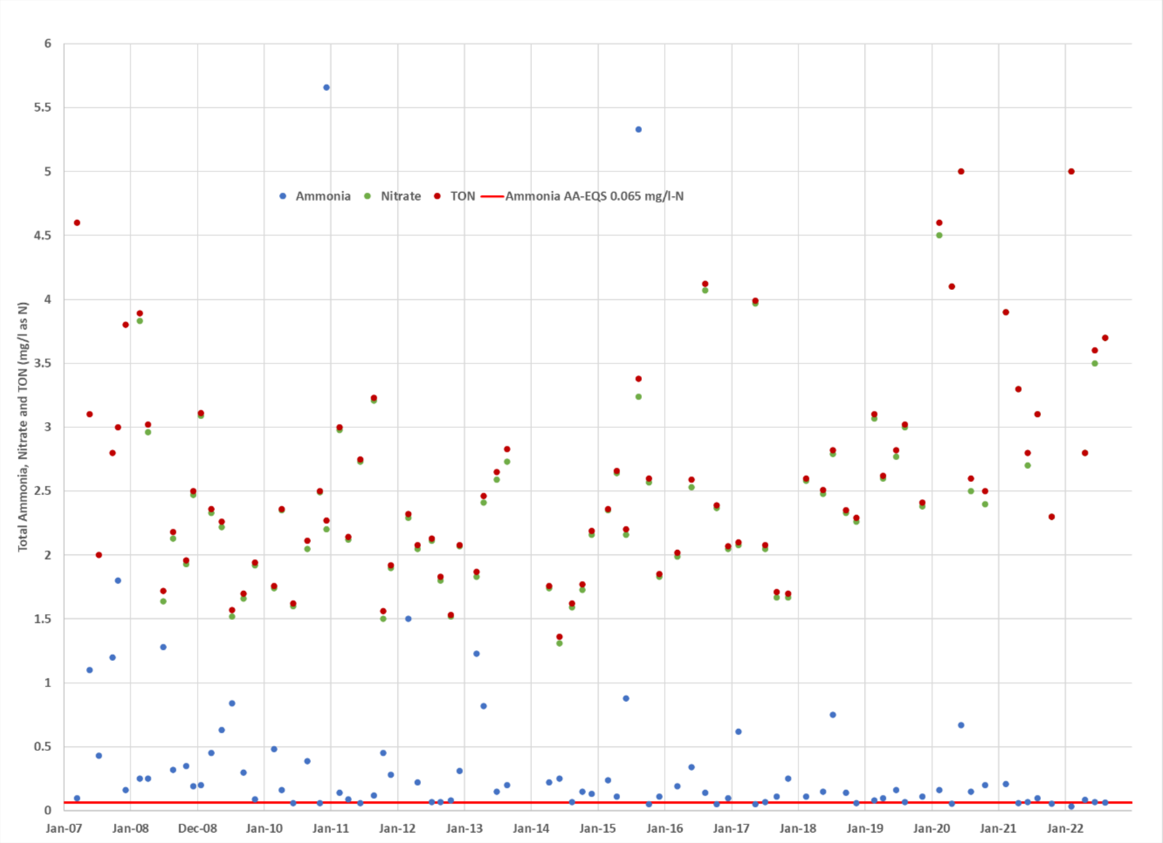

Figure 8-17 Nitrogen Compounds, EPA Station RS14F010050, 2007-2022 (Data Source: EPA)

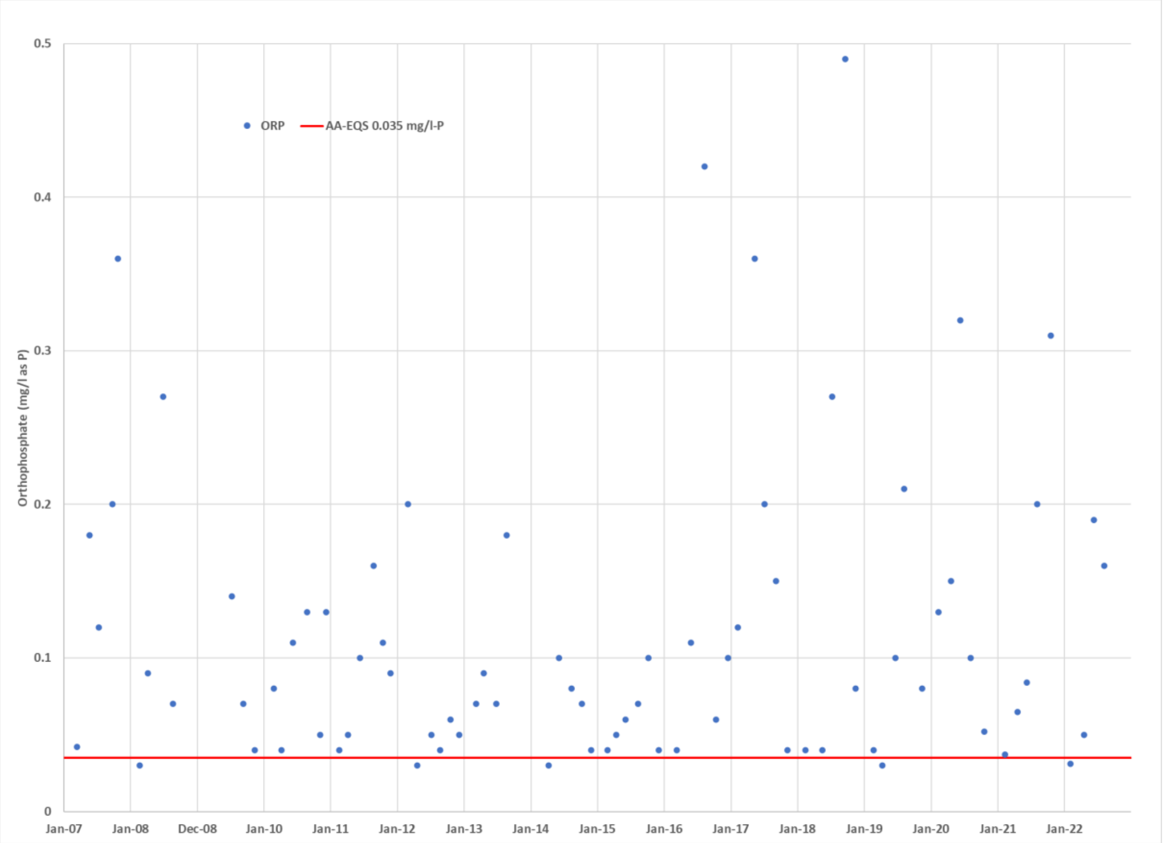

Figure 8-18 Orthophosphate, EPA Station RS14F010050, 2007-2022 (Data Source: EPA)

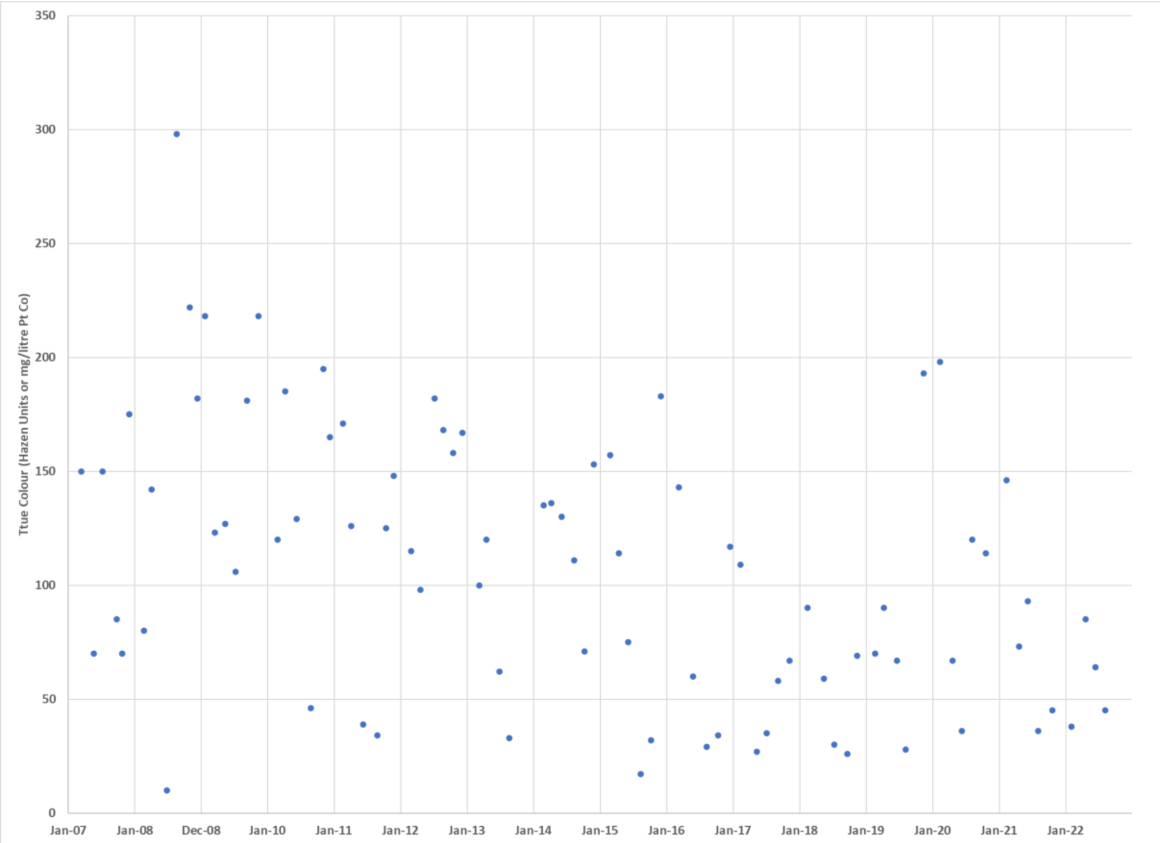

Figure 8-19 True Colour, EPA Station RS14F010050, 2007-2022 (Data Source: EPA)

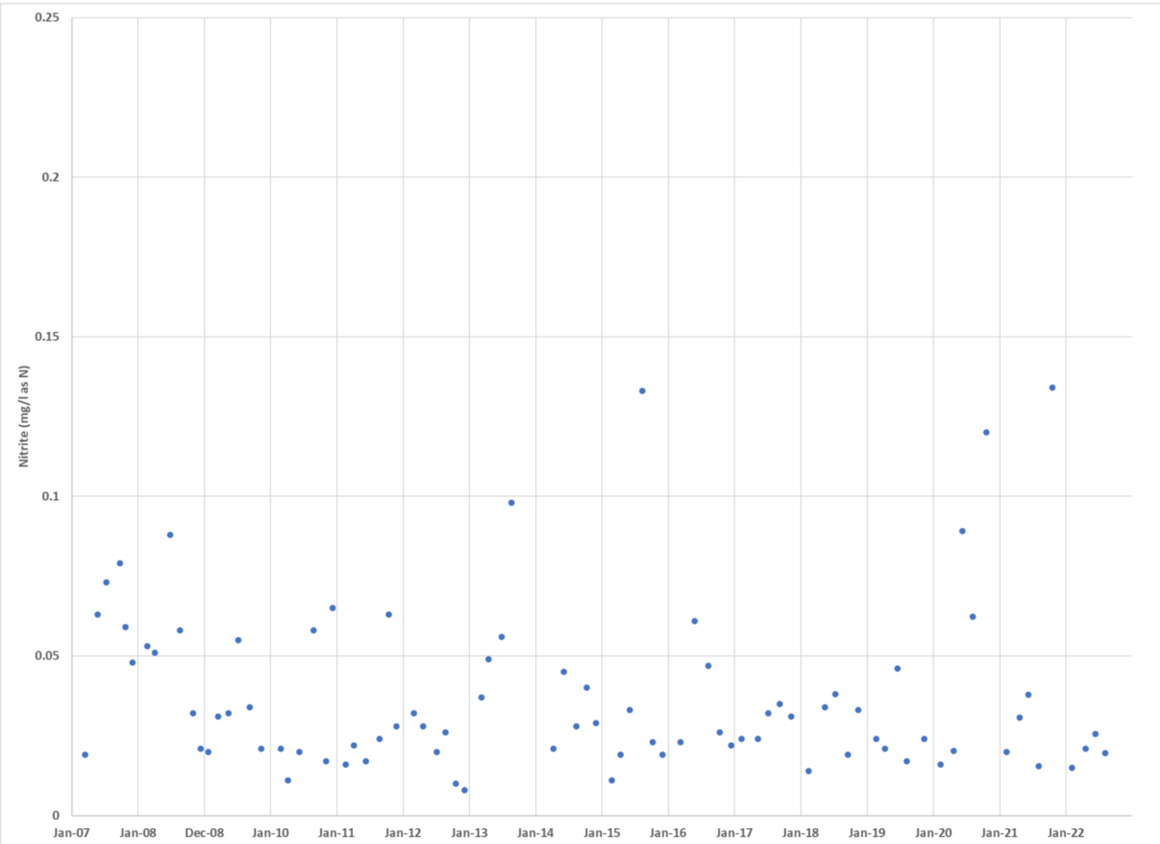

Figure 8-20 Nitrite, EPA Station RS14F010050, 2007-2022 (Data Source: EPA)

Given its downstream location in Ticknevin, WFD monitoring station RS14F010050 is influenced by both wastewater discharges (especially from the Derrinturn wastewater treatment plant) and agricultural land uses, in addition to the Cushaling River from TSB.

Because WFD monitoring station RS14F010050 is influenced by other environmental pressures, the data from this station is not representative of the water leaving the landholding. For this reason, water quality data generated by BnM as part of their environmental monitoring programme (under license) were relied on for characterisation of surface water quality in and from TSB.

8.4.14 Surface Water Quality – BnM Data

BnM samples surface water at three key surface water monitoring locations as part of their IED license, namely at stations SW6, SW5 and SW4 shown in Figure 8-9:

- Station SW6 is at the outflow from the existing ICW which receives water from the attenuation lagoons south of the WMF.
- Station SW5 is located at the outfall of the old settlement ponds c. 0.8 km south of SW6. This location represents surface water leaving the BnM landholding (Photo 4). It receives the outflow from the existing ICW, peat drainage water, and groundwater baseflow to the south of the existing WMF.
- SW4 is on the Cushaling River at Dillon's Bridge, which is 2 km west of the BnM landholding boundary. SW4 also receives runoff and groundwater baseflow from offsite areas (mainly agricultural lands).

Photo 4 Sample Station SW5

Based on the IE discharge license conditions, stations SW6, SW5, and SW4 are compliance monitoring locations, and samples are analysed by an external laboratory for total ammonia, suspended solids, specific electrical conductivity, biological oxygen demand, pH and chloride. The license emission limit value (ELV) for ammonia is given as ammonium (NH_4^+). BnM's external laboratory reports total ammonia as NH_3-N based on the analytical method that is applied, but results reflect both the ammonium ion (NH_4^+) + and unionised ammonia (NH_3). Because NH_3 is only a high pH species of ammonia (Emerson et al., 1975), the ammonium ion (NH_4^+) is calculated based on a conversion from NH_3-N. The relative amounts of ammonium and ammonia that are present in water depends on both the pH and temperature of the water. This is described further in Section 8.4.14.1.

8.4.14.1 Ammonium/Ammonia

As shown in Figure 8-21, ammonium (as NH_4^+) concentrations at SW6 are compliant with the ELV 0.5 mg/L (stipulated in Schedule 2 of licence W0201-03) from year 2015 onward. This is consistent with the construction and commissioning of the existing ICW to the south of the WMF. In Figure 8-21, the gaps in the data at SW6 reflect times when there was no outflow from existing ICW (*i.e.,* samples could not be taken).

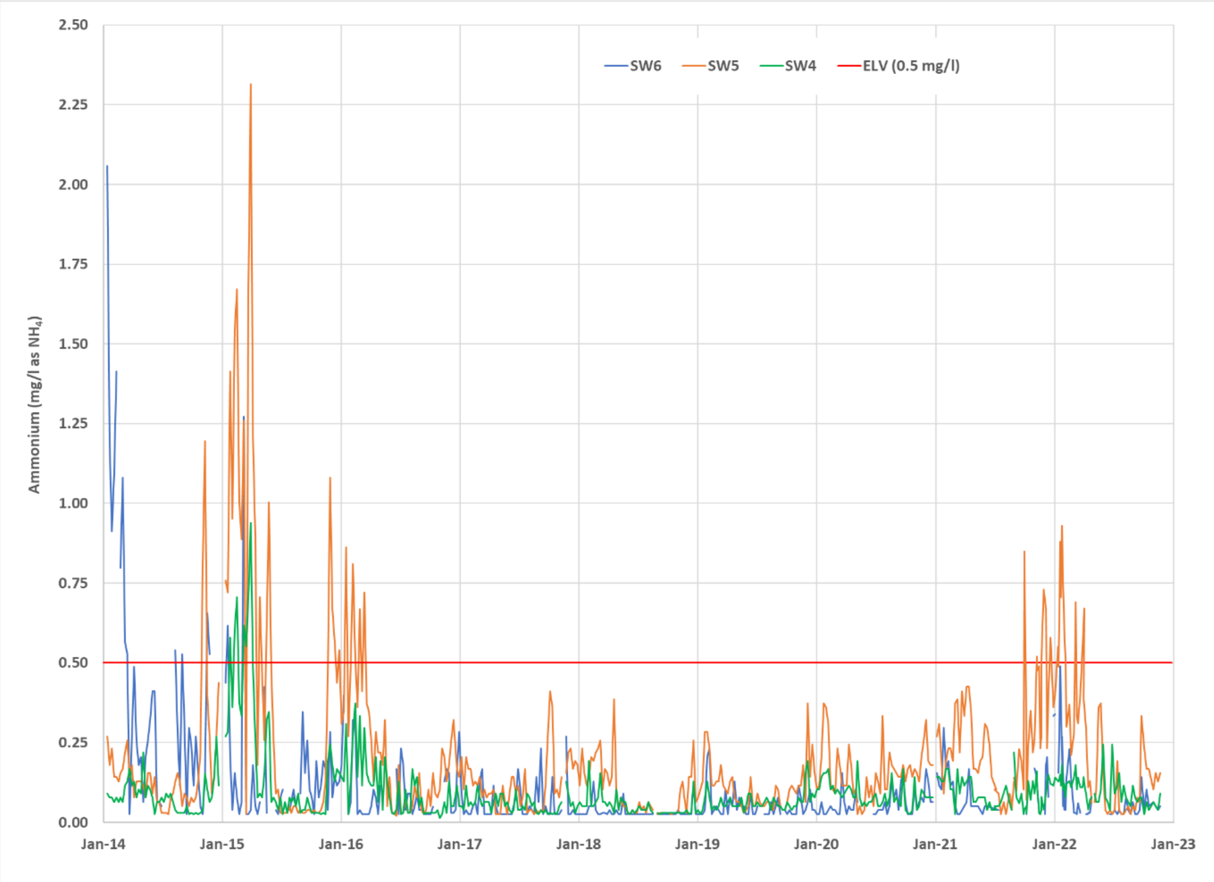

Figure 8-21 Ammonium (as NH_4) Concentrations, SW6, SW5 and SW4, 2014-2022

Compared to the concentrations recorded at SW6, concentrations at location SW5 are higher. This means that SW5 receives additional chemical load between SW6 and SW5. The added contribution is from the subcatchment of TSB which drains westward towards the Cushaling River.

Corresponding concentrations in Cushaling River sample SW4 are higher than at SW6 but lower than SW5, which means that attenuation of ammonia (by dilution and the process of nitrification) takes place in the river downstream of SW5.

As presented in Figure 8-22, the same behaviour is observed for total ammonia (which is reported by the laboratory as NH_3-N). The total ammonia concentrations at SW5 frequently exceed the AA-EQS concentration of 0.065 mg/L-N which is stipulated in the Surface Water Regulations. Concentrations at SW4 are lower than at SW5, but track the response at SW5, attesting to the attenuation mechanism that takes place in the downstream direction.

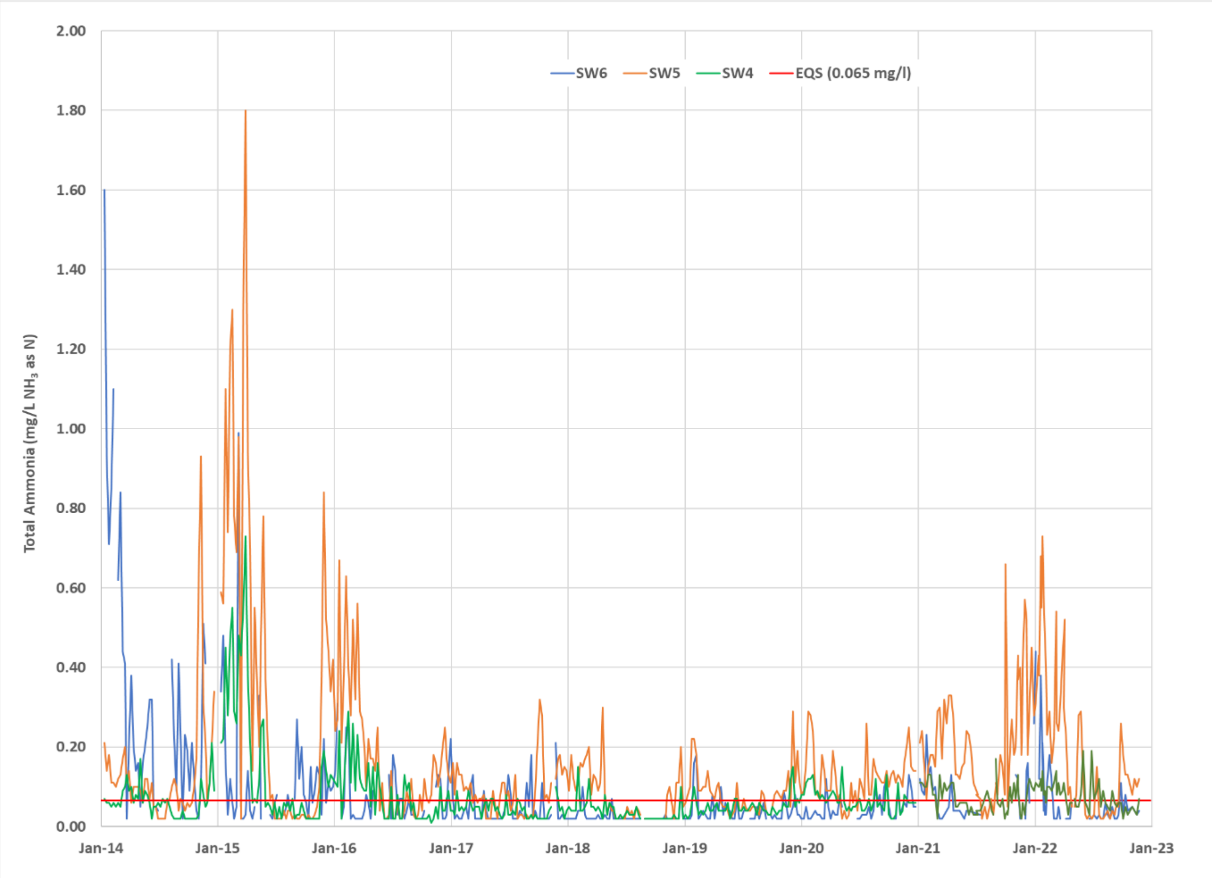

Figure 8-22 Total Ammonia (NH_3 as N) Concentrations, SW6, SW5 and SW4, 2014-2022

Concentrations tend to be higher in winter months compared to summer months, likely due to wetter conditions and less uptake by plants during the winter season. The elevated concentrations of total ammonia at SW5 during the winter of 2021-2022 are coincident with the higher water levels and flow from TSB that were described in Sections 8.4.11 and 8.4.12. Higher ammonia loads to the Cushaling River occur as a function of water levels building up in TSB over time, and periodically 'spilling over' into the river.

Table 8-5 presents calculated annual average ammonia concentrations at SW6, SW5 and SW4 in relation to the AA-EQS of 0.065 mg/L-N. Annual average concentrations in SW5 exceed the AA-EQS in all years. Annual average concentrations are lower at SW6 and SW4, and the AA-EQS was exceeded at SW4 downstream only in some of the years within in the period of record. Notable is an apparent upward concentration trend in annual average concentrations since 2018, as shown graphically in Figure 8-23. This is primarily due to the chemical load from the bog, as indicated by the higher concentrations at SW5. This is naturally occurring as a function of the existing conditions within the bog.

An objective of the TSB Decommissioning and Rehabilitation Plan (BnM, 2022) is to 're-wet' the bog, which will help to reduce the chemical load from the bog (see Section 8.5), thereby contributing to lowering ammonia and suspended load concentrations in the river.

Table 8-5 Calculated Annual Average Total Ammonia (NH_3-N) Concentrations (mg/l), 2014-2022

Year	*No. of Samples*	SW6	SW5	SW4
2014	42-50	0.327	0.137	0.062
2015	51	0.120	0.380	0.158
2016	47-53	0.071	0.170	0.079
2017	51-52	0.041	0.091	0.043
2018	51-52	0.020	0.073	0.035
2019	52	0.040	0.084	0.049
2020	46-52	0.046	0.122	0.067
2021	51	0.046	0.213	0.068
2022*	42-54	0.064	0.180	0.078

n = the sample size across the three sites. Numbers in red indicate an exceedance of the AA-EQS for "Good" chemical status (0.065 mg/l).
*- data available through 22 November 2021 August 2022.

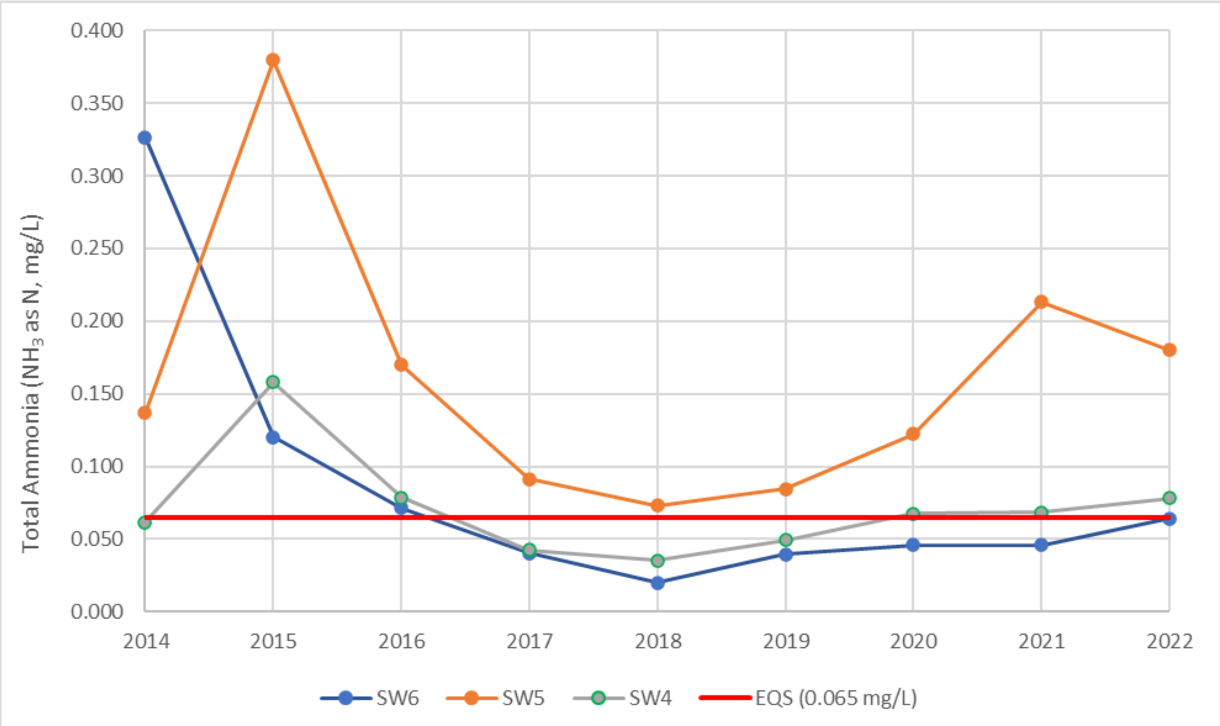

Figure 8-23 Calculated Annual Average Ammonia Concentrations

The calculated annual average concentrations of ammonium (NH_4^+) are presented in Table 8-6. These comply with the ELV of 0.5 mg/L (NH_4^+) in all years. Because the pH of all samples are in the range of 7 to 8 (see Section 8.4.14.6), the ammonia is present mainly as ammonium (NH_4^+). This means that the ammonium (NH_4^+) which is reported for compliance can be considered as concentrations of NH_4 as N.

Table 8-6 Calculated Annual Average Ammonium (NH_4^+) Concentrations (mg/l), 2014-2022

Year	SW6 (mg/l as NH_4)	SW5 (mg/l as NH_4)	SW4 (mg/l as NH_4)
2014	0.338	0.169	0.078

2015	0.131	0.480	0.199
2016	0.075	0.218	0.101
2017	0.051	0.115	0.054
2018	0.025	0.092	0.045
2019	0.048	0.109	0.063
2020	0.052	0.157	0.087
2021	0.059	0.274	0.088
2022	0.080	0.230	0.098

8.4.14.2 Proportion of Unionized Ammonia (NH_3):

As stated previously, the reported concentrations of total ammonia represent both unionized ammonia (NH_3, or 'free ammonia') and ionized ammonia (NH_4^+, or ammonium). It is NH_3 that is more toxic to fish. The concentration of NH_3 in water depends on both the pH and temperature of the water, with pH being the more sensitive parameter. In general, the ratio of NH_3 to NH_4^+ in fresh water increases by 10-fold for each rise of one pH unit, and by approximately two-fold for each 10°C rise in temperature from 0-30°C (USEPA, 2013). The pH and temperature dependency of the ratio between NH_4^+ and NH_3 is depicted graphically in Figure 8-24. As pH and temperature increases, so do concentrations of NH_3 relative to NH_4^+, and in Irish conditions, and TSB specifically, NH_4^+ will be the dominant form of ammonia in all cases.

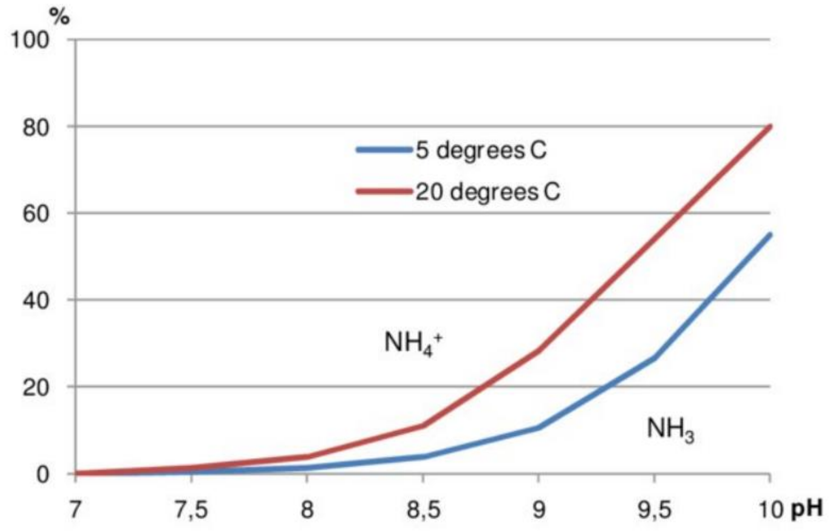

Figure 8-24 pH and temperature dependency of NH_3 and NH_4^+ (Source: Jermakka et al, 2015)

Based on this established principle, spot calculations for NH_3 at locations SW5 (which is indicative of water leaving the BnM landholding) and SW4 (water that has left the landholding) were conducted for the combination of highest recorded total ammonia concentrations and pH values, keeping the water temperature constant at 20°C. Results are summarised in Table 8-7.

Table 8-7 Summary of Ammonia Calculation at SW5 and SW4, At 20°C

Location	Date	Lab-Reported Total Ammonia (mg/L NH_3-N)	pH	Calculated Ammonia (mg/L-NH_3)
SW5	30 Nov 2021	0.57	7.6	0.009
	10 Jan 2022	0.66	7.8	0.016
	25 Jan 2022	0.73	7.7	0.014

Location	Date	Lab-Reported Total Ammonia (mg/L NH_3-N)	pH	Calculated Ammonia (mg/L-NH_3)
	8 Apr 2022	0.23	8.0	0.009
SW4	31 Aug 2021	0.17	7.9	0.005
	25 Jan 2022	0.14	7.8	0.003
	8 Mar 2022	0.14	7.7	0.003
	28 June 2022	0.19	8.2	0.011

Thus, the proportion of total ammonia that is represented by NH_3 is very small. As a check on the hypothetical influence of lower temperatures (in the context of Irish fresh waters), the same calculations were performed for water at 10°C. Results are presented in Table 8-8.

Table 8-8 Summary of Ammonia Calculation at SW5 and SW4, At 10°C

Location	Date	Lab-Reported Total Ammonia (mg/L NH_3-N)	pH	Calculated Ammonia (NH_3)
SW5	30 Nov 2021	0.57	7.6	0.004
	10 Jan 2022	0.66	7.8	0.008
	25 Jan 2022	0.73	7.7	0.007
	8 Apr 2022	0.23	8	0.004
SW4	31 Aug 2021	0.17	7.9	0.002
	25 Jan 2022	0.14	7.8	0.002
	8 Mar 2022	0.14	7.7	0.001
	28 June 2022	0.19	8.2	0.005

The lower temperatures result in lower NH_3 concentrations. In all cases, the combined higher reported total ammonia concentrations and pH values result in ammonia (NH_3) concentrations that are significantly lower than the 0.02 mg/L threshold for "non-ionized ammonia" that is stipulated in the Quality of Salmonid Water Regulations.

8.4.14.3 Suspended Solids

As shown in Figure 8-25, concentrations of suspended solids (SS) at SW6 were below the discharge license ELV of 35 mg/L for the period of record. At sample station SW5 downstream, elevated concentrations (max. 124.4 mg/l, above the y-axis scale shown) were recorded in the winter 2021-2022, which mirrors the elevated concentrations of ammonia at SW5 in the same period. The releases of SS during the winter of 2021-2022 are attributed to the excavation of new drain diversions, drain cleaning and de-silting of the old existing "bog water settling" ponds in TSB, within the subcatchment of TSB that drains toward the Cushaling River.

Concentrations at SW5 (near the BnM landholding boundary) and SW4 (downstream of the landholding) are generally much lower than those measured at EPA monitoring station RS14F010050 near Ticknevin (Figure 8-22), which means the Figile_010 river water body is influenced by other sources of SS downstream of TSB.

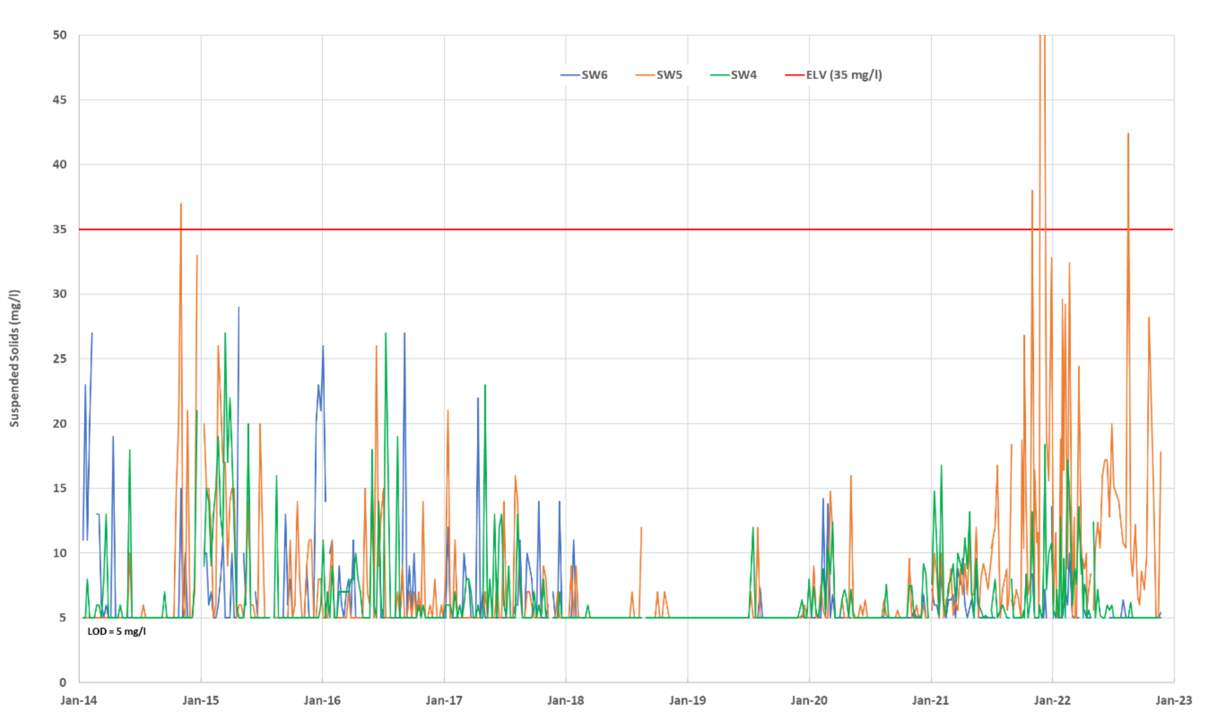

Figure 8-25 SS Concentrations, SW6, SW5 and SW4, 2014-2022 (note: LOD = 5 mg/l)

8.4.14.4 Specific Electrical Conductivity

As shown in Figure 8-26, specific electrical conductivity (SEC) concentrations (in µS/cm):

- Are higher in SW6 (general range 350-700 µS/cm) than in SW5 (general range 250-600 µS/cm)
- Are lower in SW5 compared to SW4 (general range 350-650 µS/cm).

The higher values in SW6 likely represent a higher proportion of groundwater which is captured and discharged from the under-cell drainage system beneath the WMF. The lower concentrations in SW5 reflect a contribution from runoff in the peat areas south of the WMF, and the increase in values at SW4 reflects hydrogeological and hydrochemical processes along the Cushaling River between SW5 and SW4 (e.g. groundwater baseflow).

The SEC data at SW5 also show consistently lower values in winter, *i.e.,* seasonality, attesting to the greater surface water influence at this location.

8.4.14.5 Biological Oxygen Demand

As shown in Figure 8-27, the concentrations in mg/l of five-day biological oxygen demand (BOD_5) are mostly below the Limit of Detection (LOD), which is either 1 or 2 mg/l depending on sampling round, with episodic concentrations (mainly in SW5 and SW4) above the 95-percentile EQS of 2.6 mg/l stipulated for “Good status” in the Surface Water Regulations.

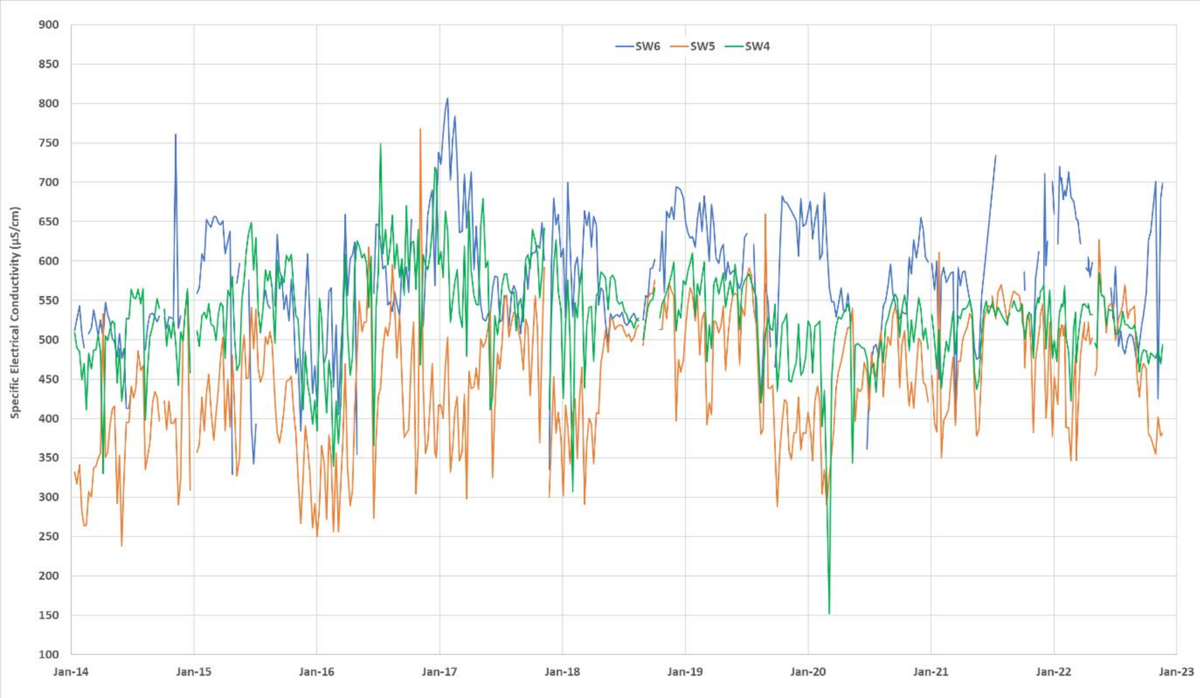

Figure 8-26 SEC Concentrations, SW6, SW5 and SW4, 2014-2022

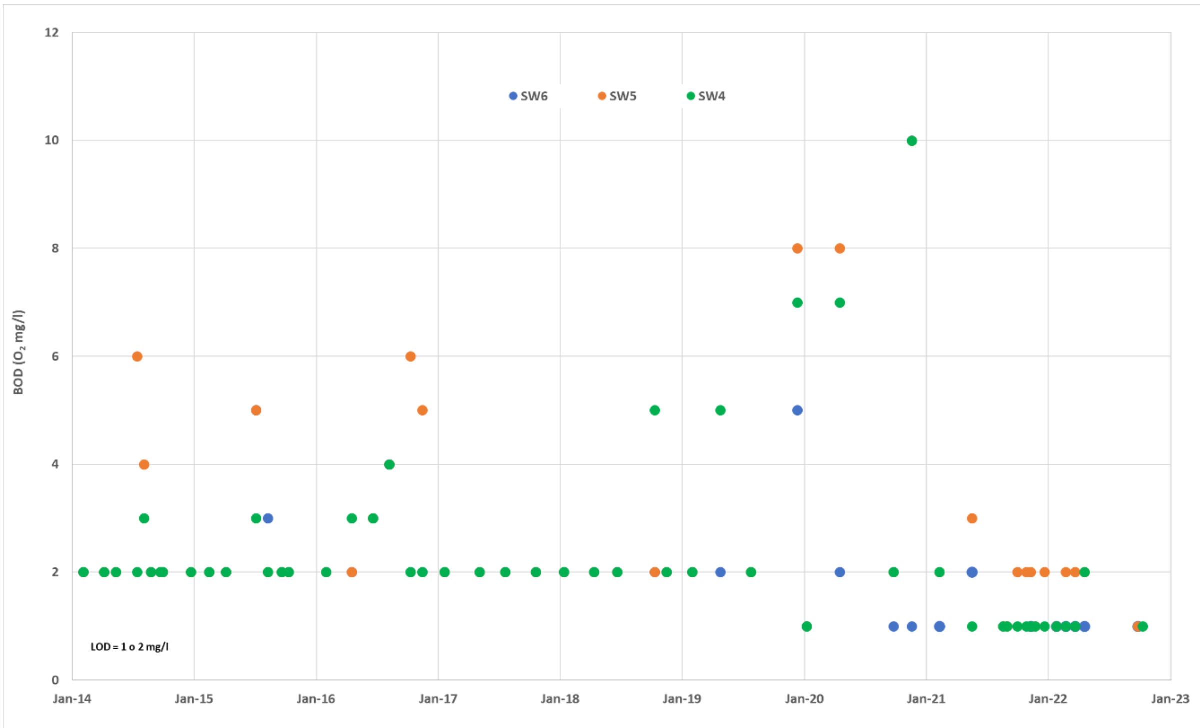

Figure 8-27 BOD_5 Concentrations, SW6, SW5 and SW4, 2014-2022

8.4.14.6 pH

As shown in Figure 8-28, pH ranges from approximately 7 to 8 at the three sample locations, with an apparent weak upward trend across the period of record. The lower concentrations are observed in SW5, reflecting the influence of drainage from the peat bog. Both SW4 and SW5 tend to show higher concentrations in the summer season. SW6 shows a broader range and more diffuse signal throughout the years, except for 2020 through 2022, when higher concentrations were recorded in the winter season, reflecting a higher proportion of runoff in the discharge it represents. SW6 is different from SW5 and SW4 in that the pH reflects the discharge from the WMF (combined runoff and under cell drainage system) as opposed to only the surface water conditions in the bog and stream.

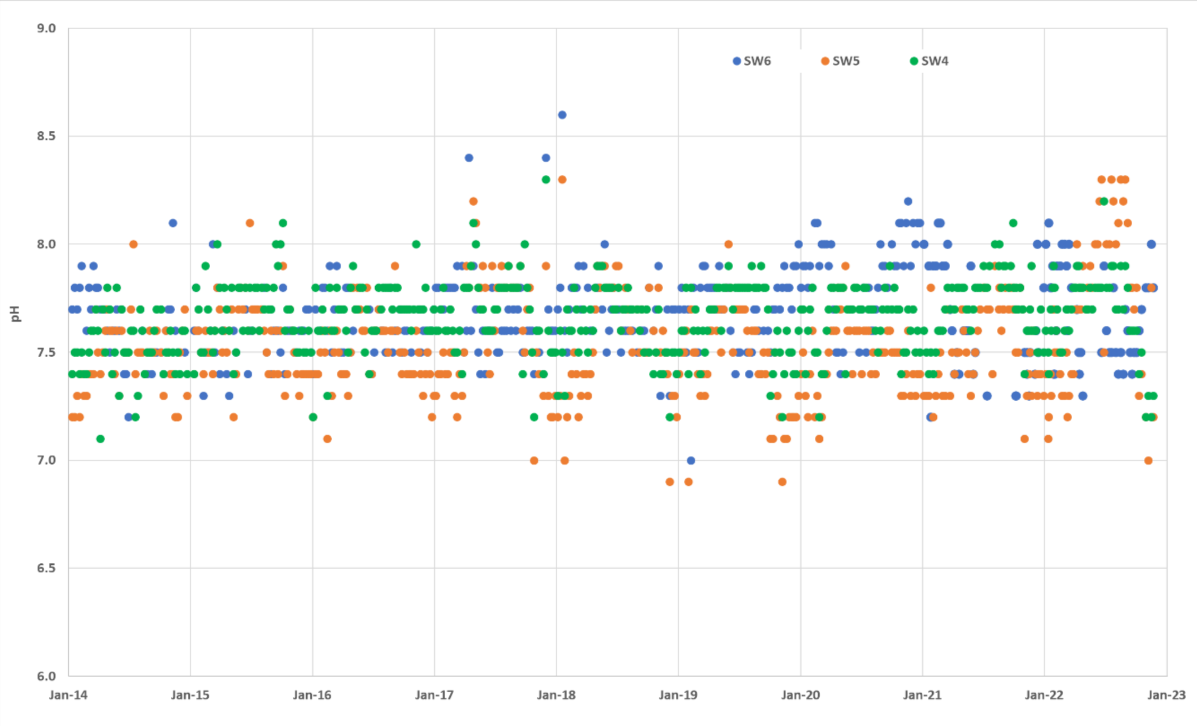

Figure 8-28 pH, SW6, SW5 and SW4, 2014-2022

8.4.14.7 Chloride

As shown in Figure 8-29, chloride concentrations (in mg/l) at SW5 and SW4 are very different from SW6. At SW5 and SW4, concentrations are lower (generally <25 mg/L), ranges are narrower, and the temporal behaviour is more steady compared to SW6. The signal at SW6 reflects the discharge from the existing attenuation lagoons, and the latter receives runoff from the landfill during wet weather events/periods. The periodically higher concentrations at SW6 become muted/blended by the influence of surface water from the bog (between SW6 and SW5). As documented in Chapter 7 of this EIAR, groundwater concentrations near the WMF are generally <20 mg/l. The chloride peaks at SW6 are, therefore, not related to groundwater captured by the under-cell drainage system at the WMF.

8.4.14.8 Surface Water Sampling Conducted for the Current EIAR

In addition to the samples taken by BnM as part of their routine compliance monitoring at locations SW4, SW5, and SW6, more detailed sampling was undertaken for purposes of this EIAR at additional locations in 2021 and 2022:

- Firstly, samples were collected to check or verify the effectiveness of ammonia attenuation across the existing attenuation lagoons and ICW south of the WMF. Samples were analysed both by BnM's external and in-house laboratories.
- Secondly, samples were collected in bog drains and at outflow points to examine in greater detail how the bog responds and contributes to the water quality issues in surrounding streams, notably the Cushaling River, and especially with regard to ammonia and suspended solids. Samples were analysed by BnM's external laboratory.

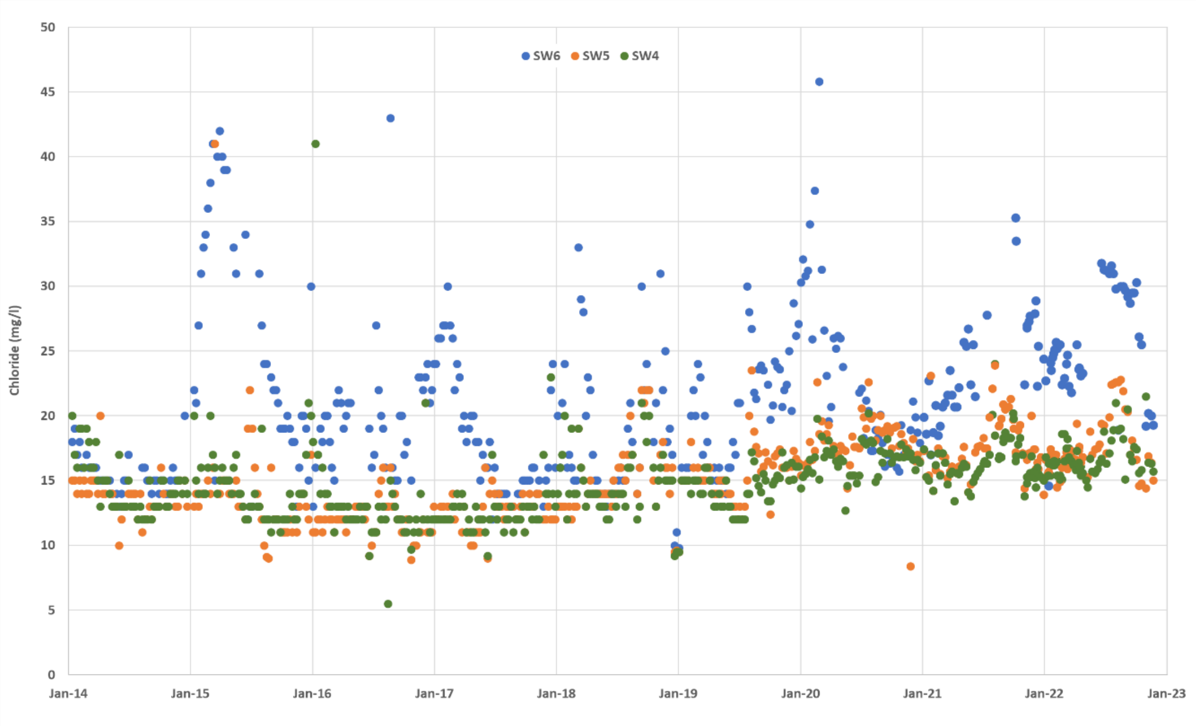

Figure 8-29 Chloride, SW6, SW5 and SW4, 2014-2022

With regard to the former, *i.e.,* checking the effectiveness of ammonia attenuation across the existing attenuation lagoon and ICW, samples were collected at SW6 (outflow from the ICW) and a location SW7 which is at the inflow to the attenuation lagoons. Samples from SW7 represent the combined contribution of stormwater from the existing landfill (including its internal roads) and shallow groundwater that is captured by the landfill's under cell drainage system. The comparison of data between SW7 and SW6 serve as a valuable guide as to what can be expected from the designed attenuation lagoons and ICW at the planned expanded landfill.

With regard to the contribution from the bog, samples were analysed at SW5 and at the additional sampling locations that are shown in Figure 8-30, as follows:

- RS01: Mulgeeth River at the outflow point from TNB, *i.e.,* a headwater sample.
- RS02: Cushaling River at the western boundary of the landholding, approximately 0.6 km downstream of SW5, in a steep, incised (cut) channel section.
- RS03: in the central part of the TSB, within the bog's subcatchment that drains to the Cushaling River. Sampling at this location ended in November 2021 as the water was stagnant. RS03 was substituted by RS09, which is on the same drain network to the west-northwest and thus closer to the Cushaling River.
- RS04: Abbeylough River southwest and downstream of TSB.
- RS05: in the southern part of TSB, within a subcatchment that drains south to the Cushahulla River. Water samples were taken weekly from August 2021 to April 2022. Water was more or less stagnant until December 2021.
- RS06: in the central part of TSB, within a subcatchment that drains to the Abbeylough River. Water samples were taken weekly from August 2021 to April 2022. The drainage channel had very low flow until February 2022.
- RS07: Cushahulla River immediate downstream of the southern landholding boundary. Sampling was discontinued in October 2021 (very low water level and flow, and a suitable monitoring point could not be maintained).

- RS08: headwater of the Allenwood North tributary which merges with the Cushahulla River near Allenwood to the south of TSB. Sampling was discontinued in October 2021 for the same reasons as RS07.
- RS09: drain samples taken weekly in lieu of RS03 from November 2021 to April 2022.
- RS10: in the southwestern part of TSB, within a subcatchment that drains to the Abbeylough River. Weekly samples were taken from November 2021 to April 2022.

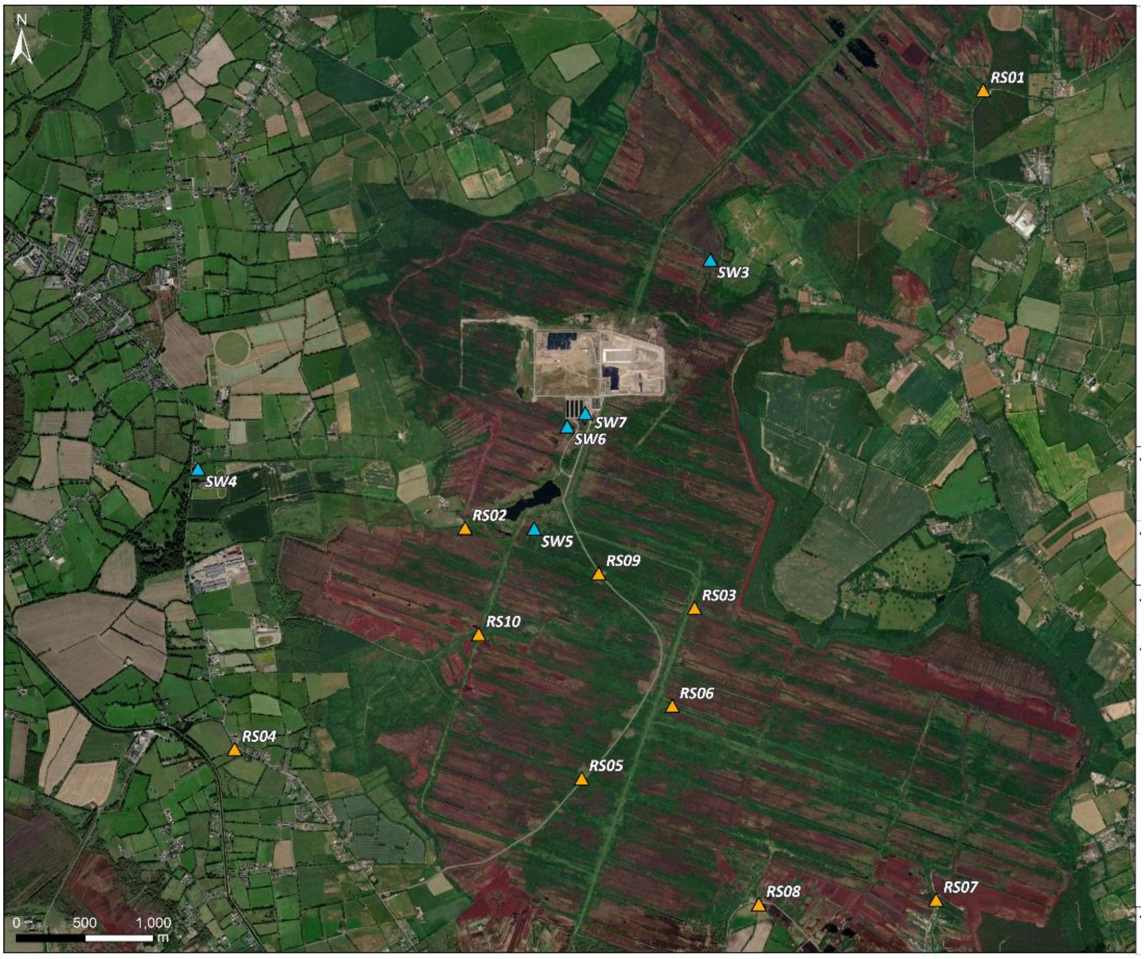

Figure 8-30 Surface Water Sampling Locations Within TSB, August 2021-April 2022

The results provided by BnM 's external laboratory are summarized in Table 8-9. The data are presented graphically and summarised below for key parameters total ammonia, nitrate, suspended solids, SEC, and orthophosphate.

Table 8-9 Summary of Surface Water Sample Results, External Laboratory, August 2021 – April 2022

Parameter	Location													
Total Ammonia (mg/l NH_3-N)	**RS01**	**RS02[1]**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5[2]**	**SW6**	**SW7**
LOD	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
n	32	34	12	35	35	35	10	9	23	23	82	84	55	33
No. detections	32	34	11	35	35	35	10	9	23	23	81	83	44	32
Min	0.170	0.040	0.010	0.030	0.260	0.140	0.110	0.070	0.130	0.070	0.010	0.01	0.010	0.010
Max	0.980	0.520	0.170	0.760	3.100	6.500	0.760	0.230	0.710	0.200	0.170	0.73	0.440	4.200
Mean	0.496	0.226	0.075	0.112	1.933	1.249	0.251	0.153	0.287	0.126	0.077	0.251	0.084	0.636
Median	0.435	0.200	0.060	0.095	1.950	0.515	0.180	0.150	0.240	0.130	0.080	0.215	0.040	0.450
Stdev	0.264	0.157	0.054	0.123	0.714	1.691	0.201	0.060	0.160	0.039	0.035	0.167	0.095	0.789
Ammonium (mg/l-NH_4)	**RS01**	**RS02[3]**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
LOD	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
n	32	34	12	35	35	35	10	9	23	23	33	34	20	33
No. detections	32	34	11	35	35	35	10	9	23	23	33	34	14	32
Min	0.22	0.050	0.02	0.04	0.33	0.18	0.14	0.09	0.16	0.09	0.03	0.06	0.02	0.02
Max	1.26	0.670	0.21	0.98	4.00	8.40	0.98	0.29	0.91	0.26	0.22	0.93	0.49	5.40
Mean	0.64	0.308	0.09	0.14	2.56	1.53	0.32	0.20	0.37	0.16	0.11	0.41	0.12	0.82
Median	0.545	0.270	0.080	0.120	2.650	0.645	0.230	0.195	0.310	0.165	0.120	0.380	0.080	0.585
Stdev	0.341	0.209	0.065	0.159	0.890	2.170	0.260	0.078	0.207	0.052	0.046	0.244	0.129	1.017
Nitrate (mg/l- NO_3)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
LOD	4	4	4	4	4	4	4	4	4	4	4	4	4	4
n	8	9	3	9	9	9	3	2	6	6	10	10	4	9
No. detections	2	6	0	5	1	4	0	0	4	4	6	7	0	4
Min	2.00	2.00	na	2.00	2.00	2.00	na	na	2.00	2.00	2.00	2.00	na	2.00
Max	26.40	18.90	na	36.00	45.10	27.20	na	na	26.90	23.10	23.50	22.40	na	10.90
Mean	6.05	7.42	na	7.73	6.79	6.58	na	na	9.70	7.88	6.38	6.01	na	4.71
Median	2.00	5.80	na	4.60	2.00	2.00	na	na	8.80	6.05	5.15	4.50	na	2.00
Stdev	8.69	5.82	na	10.87	14.37	8.24	na	na	9.13	7.90	6.48	6.03	na	3.59
TON (mg/l-N)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
LOD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
n	8	9	3	9	9	9	3	2	6	6	9	9	4	9
No. detections	2	6	0	5	1	4	0	0	4	4	4	6	0	4
Min	0.05	0.05	na	0.05	na	0.05	na	na	0.05	0.05	0.05	0.05	na	0.05
Max	6.00	4.30	na	8.10	10.20	6.10	na	na	6.10	5.20	15.00	5.10	na	2.50
Mean	1.13	1.56	na	1.57	na	1.26	na	na	2.07	1.63	2.67	1.19	na	0.85

Parameter	Location													
TON (mg/l-N)	RS01	RS02	RS03	RS04	RS05	RS06	RS07	RS08	RS09	RS10	SW4	SW5	SW6	SW7
Median	0.05	1.30	na	1.10	na	0.05	na	na	2.00	1.35	0.05	1.00	na	0.05
Stdev	2.12	1.47	na	2.56	na	2.00	na	na	2.21	1.91	4.94	1.56	na	1.02
Suspended Solids (mg/l)	RS01	RS02	RS03	RS04	RS05	RS06[2]	RS07	RS08	RS09	RS10	SW4	SW5	SW6	SW7
LOD	5	5	5	5	5	5	5	5	5	5	5	5	5	5
n	32	35	12	35	35	34	10	9	23	23	82	85	55	33
No. detections	25	35	4	20	29	34	10	9	15	13	54	73	24	30
Min	2.50	2.50	2.50	2.50	2.50	2.5	85	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Max	268	179	25.2	122	872	6804	3399	36.8	224	1290	18.4	124	13.6	306
Mean	18	21	5.06	16	80	320	1129	16	30	72	7	13	5	47
Median	7.45	9.20	2.50	5.40	20	12.8	835	13	8.40	5.40	6.00	8.80	2.50	15
Stdev	48	34	6.77	31	165	1256	1121	12	53	273	4.05	17	2.69	67
BOD (mg/l-O_2)	RS01	RS02	RS03	RS04	RS05	RS06	RS07	RS08	RS09	RS10	SW4	SW5	SW6	SW7
LOD	1	1	1 or 5	1 or 5	1 or 5	2	1	1 or 5	1	1	1 or 2	1 or 2	1	1
n	8	9	3	9	9	9	3	2	6	6	13	13	6	9
No. detections	8	8	2	8	8	8	3	1		6	10	11	5	8
Min	1	1	1	1	1	1	7	2	1	1	0.5	0.5	0.5	0.5
Max	4	2	2.5	3	2.5	113	70	2.5	2	13	2	3	2	33
Mean	2.38	1.44	1.50	1.94	1.39	13.9	29.7	2.25	1.67	3.33	1.00	1.58	1.08	5.39
Median	2	1	1	2	1	1	12	2.25	2	1.5	1	2	1	2
Stdev	0.916	0.527	0.866	0.635	0.601	37.173	35.019	0.354	0.516	4.761	0.354	0.703	0.492	10.4
COD (mg/l-O_2)	RS01	RS02	RS03	RS04	RS05	RS06	RS07	RS08	RS09	RS10	SW4	SW5	SW6	SW7
LOD	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14	5 or 14
n	8	9	3	9	9	9	3	2	6	6	13	13	6	9
No. detections	8	9	3	9	9	9	3	2	6	6	13	13	4	9
Min	61	33	76	75	79	75	541	66	87	96	35	19	2.5	11
Max	100	134	127	139	173	1499	1077	100	154	961	87	108	25	65
Mean	85.3	79.1	104.0	96.2	108.9	256.6	749.3	83.0	118.0	254.8	57.6	63.1	11.4	23.3
Median	90.5	72.0	109.0	92.0	103.0	104.0	630.0	83.0	116.0	117.0	56.0	67.0	10.5	18.0
Stdev	13.6	34.1	25.9	19.1	28.4	466.1	287.2	24.0	24.7	346.1	15.9	22.5	8.1	16.2
SEC (µS/cm) @ 20° C	RS01[4]	RS02	RS03	RS04	RS05[5]	RS06	RS07	RS08	RS09	RS10	SW4	SW5	SW6	SW7
n	31	32	32	32	32	32	32	32	32	32	32	32	32	32
Min	172	258	258	244	429	513	274	335	286	216	422	346	392	456
Max	420	708	460	414	671	1112	406	431	550	375	570	611	734	1056
Mean	265	485	367	363	581	730	319	388	403	308	521	484	605	744
Median	245	500	338	368	589	671	317	393	376	319	533	503	592	758

Parameter	Location													
Stdev	74	74	83	41	62	141	39	42	73	42	32	62	73	172
Chloride (mg/l)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
n	32	35	12	35	35	35	10	9	23	23	82	84	55	33
No. detections	32	35	12	35	35	35	10	9	23	23	82	84	55	33
Min	10.8	15	13.6	11.7	13.6	12.3	12.3	12.7	14.2	13	13.4	13.9	14.6	15.3
Max	16.3	23.9	17.6	29.8	21.6	47.7	18	14.4	20.9	19	20.2	23.9	35.3	91.9
Mean	13.19	17.65	15.09	16.19	16.01	18.71	14.27	13.14	16.13	15.37	16.21	17.28	23.66	38.32
Median	12.9	16.9	14.7	15.9	15.4	17.2	14.1	13.0	16.0	15.3	16.2	16.9	23.5	32.0
Stdev	1.24	2.03	1.44	3.89	1.92	6.18	1.64	0.58	1.50	1.49	1.26	2.00	3.56	20.15
DO (% saturation)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
n	30	32	9	32	26	21	6	6	21	22	30	32	18	30
Min	36.4	40.5	20	24.4	6.2	16	44.2	11.1	52.1	58.1	55.5	39.1	52.2	36.1
Max	115.1	155	58.4	117.9	139.5	84.2	61.8	78.2	116.4	104.1	132.3	128.8	117.2	140.5
Mean	78.8	82.6	44.6	87.1	42.4	40.6	51.8	53.2	80.2	83.0	90.9	71.6	73.5	84.2
Median	80.3	82.4	49.1	87.8	38.2	39.1	49.7	56.1	78.5	83.1	92.5	69.6	69.9	80.2
Stdev	18.7	21.2	12.3	19.8	26.8	16.7	7.6	24.3	14.2	12.4	16.7	16.3	15.3	23.2
Orthophosphate (mg/l-P)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
LOD	0.03	0.3	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
n	8	9	3	9	9	9	3	2	6	6	10	10	4	9
No. detections	2	0	0	2	1	0	0	0	6	0	2	1	0	0
Min	0.015	na	na	0.015	na	na	na	na	0.015	na	0.015	na	na	na
Max	0.040	na	na	0.090	0.030	na	na	na	0.015	na	0.05	0.030	na	na
Mean	0.020	na	na	0.026	na	na	na	na	0.015	na	0.02	na	na	na
Median	0.015	na	na	0.015	na	na	na	na	0.015	na	0.015	na	na	na
Stdev	0.010	na	na	0.025	na	na	na	na	0.000	na	0.012	na	na	na
Total Phosphorus (mg/l-P)	**RS01**	**RS02**	**RS03**	**RS04**	**RS05**	**RS06**	**RS07**	**RS08**	**RS09**	**RS10**	**SW4**	**SW5**	**SW6**	**SW7**
LOD	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
n	8	9	3	9	9	9	3	2	6	6	10	10	4	9
No. detections	6	6	2	7	9	7	3	2	3	4	8	10	0	5
Min	0.025	0.025	0.025	0.025	0.050	0.025	0.200	0.200	0.025	0.025	0.025	0.050	na	0.025
Max	0.400	0.590	0.280	0.330	0.800	8.800	2.550	0.350	0.300	1.000	0.550	1.000	na	0.750
Mean	0.106	0.136	0.175	0.097	0.348	1.178	1.000	0.275	0.114	0.385	0.117	0.197	na	0.194
Median	0.070	0.060	0.220	0.080	0.200	0.100	0.250	0.275	0.038	0.130	0.070	0.095	na	0.060
Stdev	0.123	0.191	0.133	0.092	0.286	2.876	1.343	0.106	0.129	0.481	0.157	0.295	na	0.278

[1] Recorded value of 5.88 mg/l omitted as a possible outlier.
[2] Recorded value of 13 mg/l omitted as a possible outlier.
[3] Recorded value of 7.57 mg/l omitted as a possible outlier.

Parameter	Location

[4] Recorded value of 3,669 µS/cm omitted as a possible outlier.
[5] Recorded value of 3,338 µS/cm omitted as a possible outlier

Total Ammonia

As shown in Figure 8-31, the total ammonia concentrations are significantly higher at SW7 (orange dots) compared to SW6 (lighter blue dots). From Table 8-9, the mean total ammonia concentration at SW7 for the period of record was 0.636 mg/l (NH_3-N), compared to 0.084 mg/l (NH_3-N) at SW6. This represents a one order of magnitude reduction. The attenuation reflects the combination of dilution, transformation (e.g., by the process of ammonia oxidation/nitrification, McGee, 2020), as well as plant uptake, although the results mostly reflect a winter season when plant uptake is less than in summer.

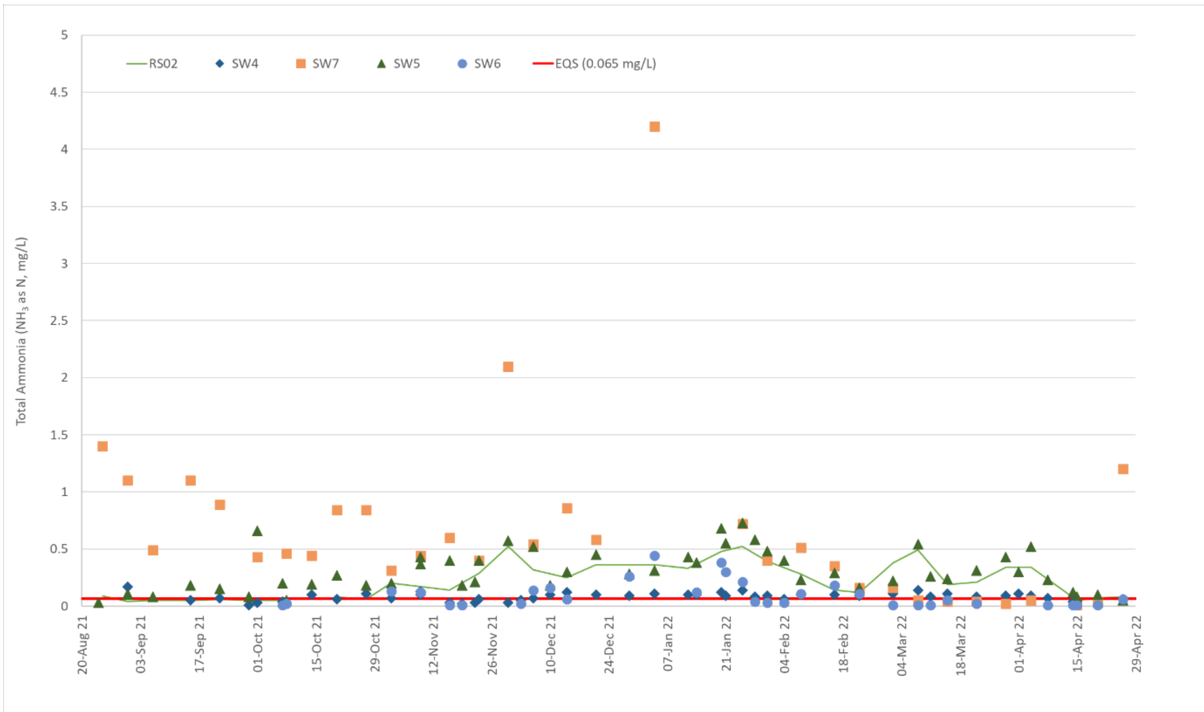

Figure 8-31 Total Ammonia Concentrations Along Surface Water Flow Line SW7 to SW4

In Figure 8-31, concentrations at sampling location RS02 are included (pale green line), representing the Cushaling River near the BnM landholding boundary, just downstream of SW5 (old settlement ponds). RS02 and SW5 are less than 200 m apart and respective concentrations are similar. The respective data confirm the observations in Section 8.4.14, *i.e.,* that water quality in the Cushaling River is mainly influenced by the bog (concentrations are higher at SW5 and RS02 compared to SW6), and ammonia attenuation takes place in the downstream direction in Cushaling River (concentrations at SW5 and RS02 are higher than at SW4).

The effectiveness of total ammonia attenuation between SW7 and SW6 in Figure 8-31 is confirmed by sample results from BnM's in-house laboratory which are depicted in Figure 8-32. BnM's in-house laboratory analysed samples which were taken every few days between January 2021 and December 2022, with the analysis focussed on total ammonia (NH_3-N).

As shown in Figure 8-32, concentrations at SW6 (blue dots) are significantly lower than at SW7 (orange dots). The elevated concentrations at SW7 are mainly associated with capture of shallow groundwater by the under-cell drainage system beneath the WMF, which was described in Chapter 7. This is attested by the red dots in Figure 8-32, which represent water collected from a swale which transmits water from the under-cell drainage system to the attenuation lagoons. As such, the swale samples are 'upstream' of SW7.

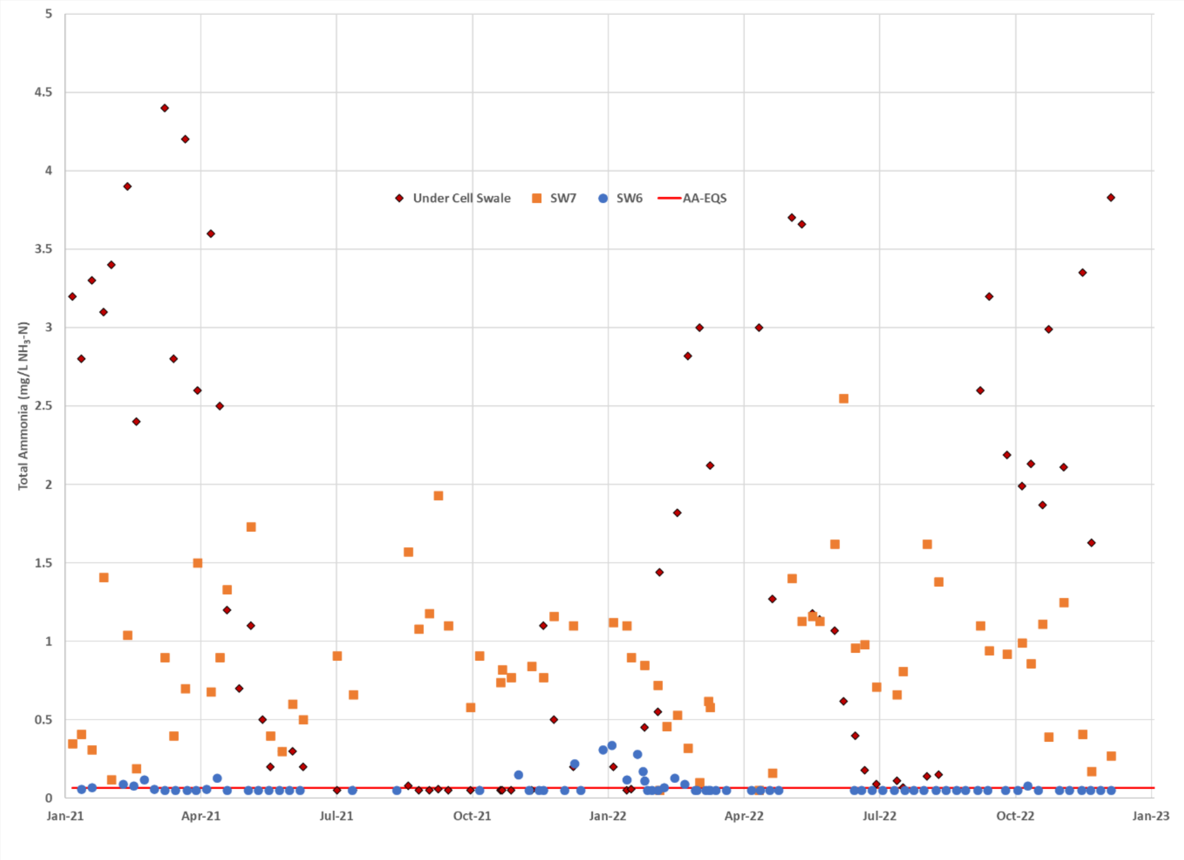

Figure 8-32 Total Ammonia in the WMF Water Management System

The elevated concentrations in groundwater are associated with the peat, and not leachate. As described in Chapter 7, concentrations of leachate indicator parameters in groundwater around the WMF are low and within ranges observed elsewhere in TSB. For example, a leachate sample from the leachate collection system on 28 September 2020 had a chloride concentration of 2,774 mg/l. In comparison, chloride concentrations in monitoring wells close to the landfill (e.g. GW1 series, GW9, GW11 series, and GW12 series wells) are consistently below 25 mg/l. If leachates were escaping, concentrations of chloride and other leachate constituents) in both groundwater and surface water near and downgradient WMF would be significantly higher.

As shown in Figure 8-33, total ammonia concentrations are consistently elevated throughout TSB, especially at RS05 (which is read against the secondary y-axis). The same is true for the total ammonia concentrations at the outflow points from TSB, shown in Figure 8-34, which includes the outflow from TNB (location RS01).

Nitrate

Concentrations of nitrate (NO_3 as N) are lower in SW6 and higher in SW4 compared to SW5 (Figure 8-35). The higher concentrations at SW4 is explained by transformation of ammonia from the site and/or addition of ammonia from offsite sources (e.g. agriculture) between SW5 and SW4.

A significant loading event, naturally occurring from the bog, occurred in February 2022, something that is also observed in drain samples within TSB (Figure 8-36), and outflow points from TSB (Figure 8-37), including RS01. The February 2022 event coincides with the highest river water levels which were shown in Figure 8-15.

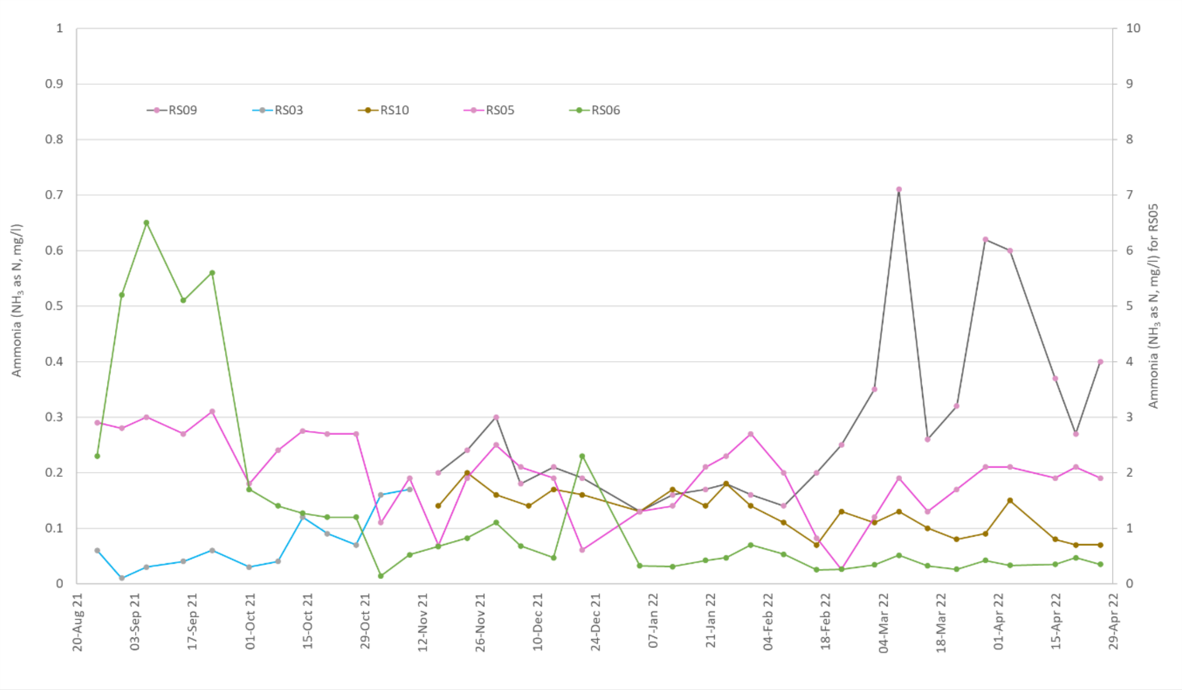

Figure 8-33 Ammonia Concentrations in TSB Artificial Drains

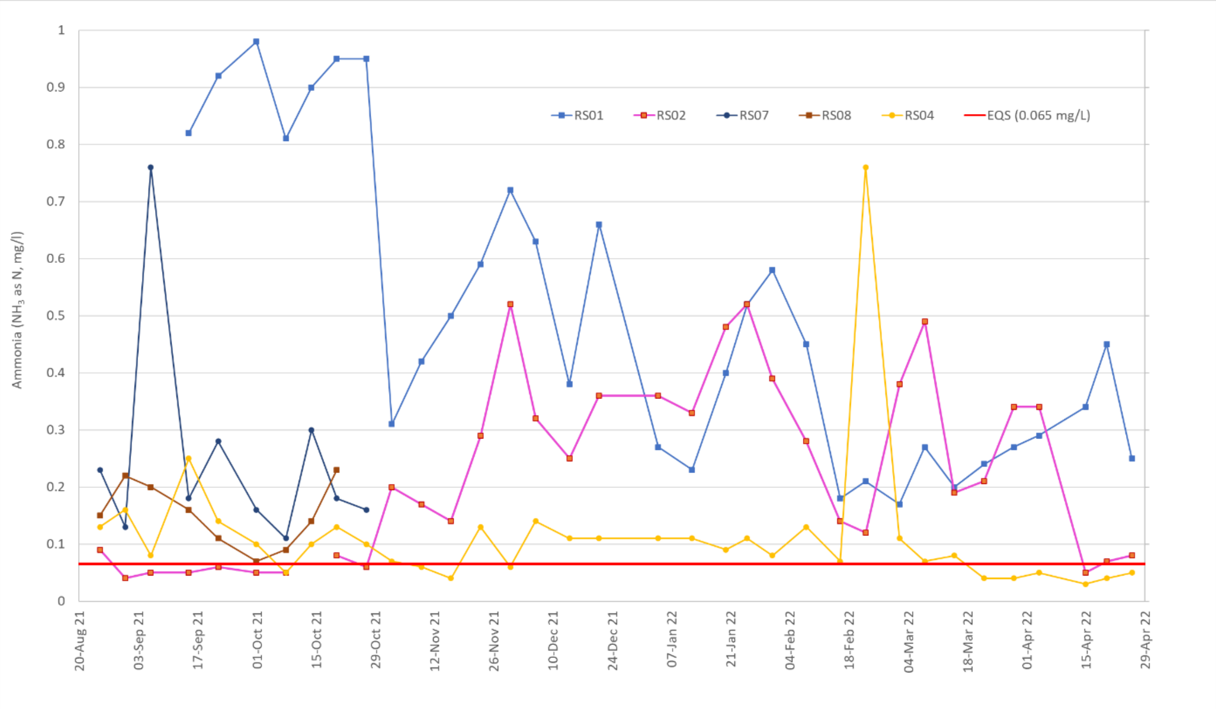

Figure 8-34 Ammonia Concentrations at Outflow Points (TSB and TNB)

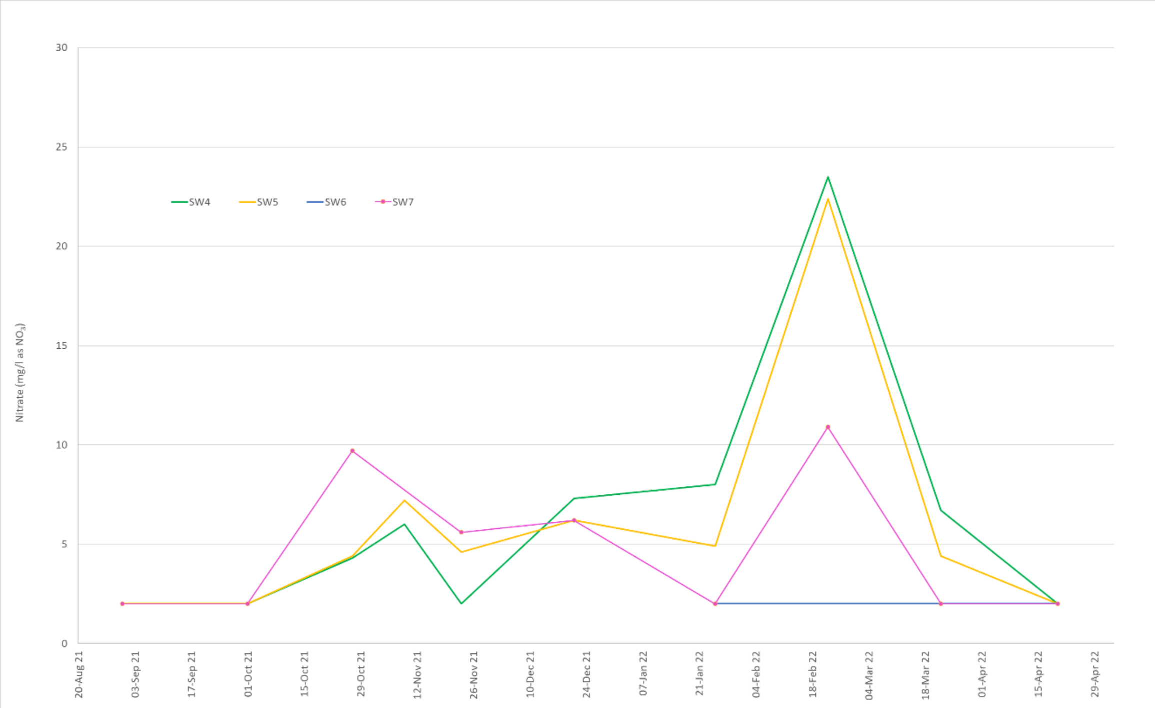

Figure 8-35 Nitrate Concentrations at Locations SW7, SW6, SW5, SW4

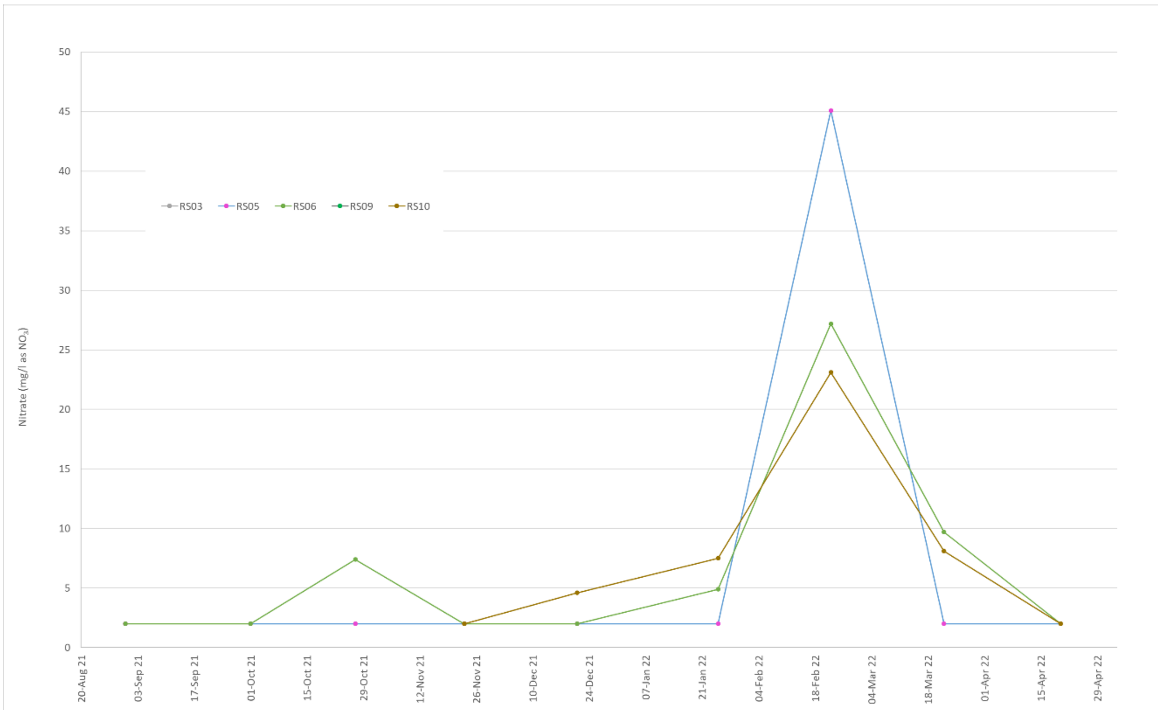

Figure 8-36 Nitrate Concentrations in TSB Artificial Drains

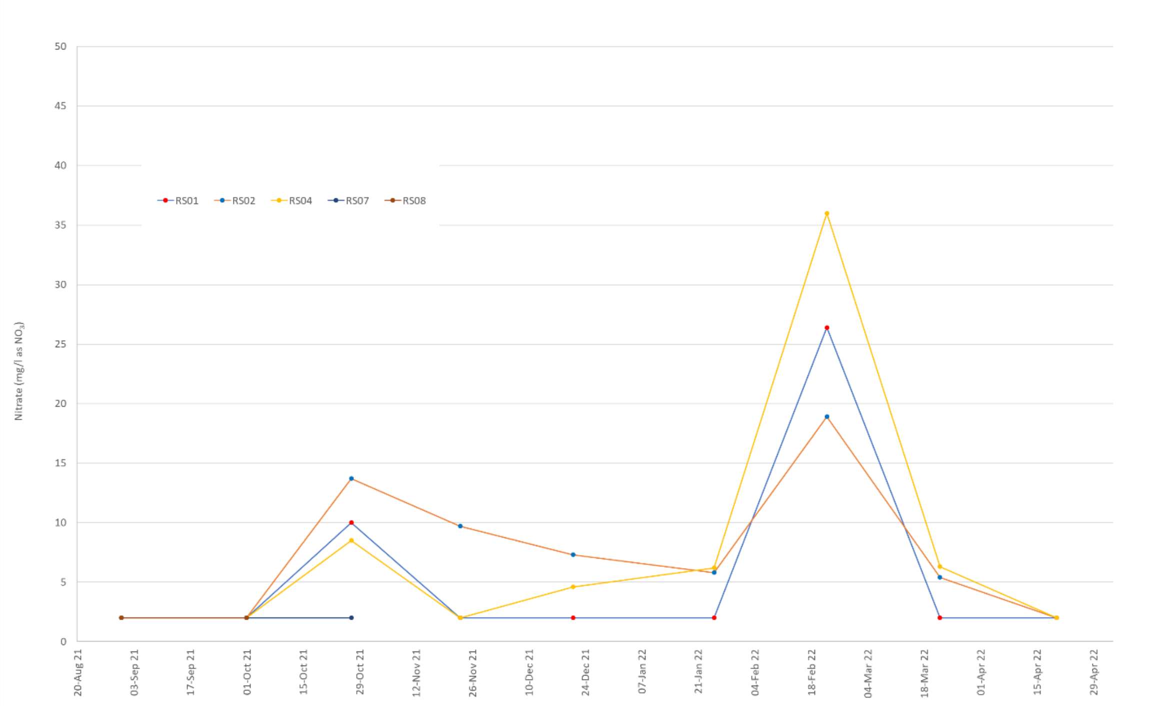

Figure 8-37 Nitrate Concentrations at Outflow Points (TSB and TNB)

Suspended Solids

SS concentrations at SW6, SW5 and SW4 (Figure 8-38) are below the discharge license ELV of 35 mg/L. At SW7 (which represents the inflows to the attenuation lagoons by the WMF), episodic spikes are attributed to runoff from the landfill during wet weather events, including runoff from the internal roads leading to and around the landfill. This runoff flows into the perimeter swale which in turn end up in a wet well at SW7. Episodic spikes were also observed in drain samples within TSB (Figure 8-39) and outflows points from the bog (Figure 8-40).

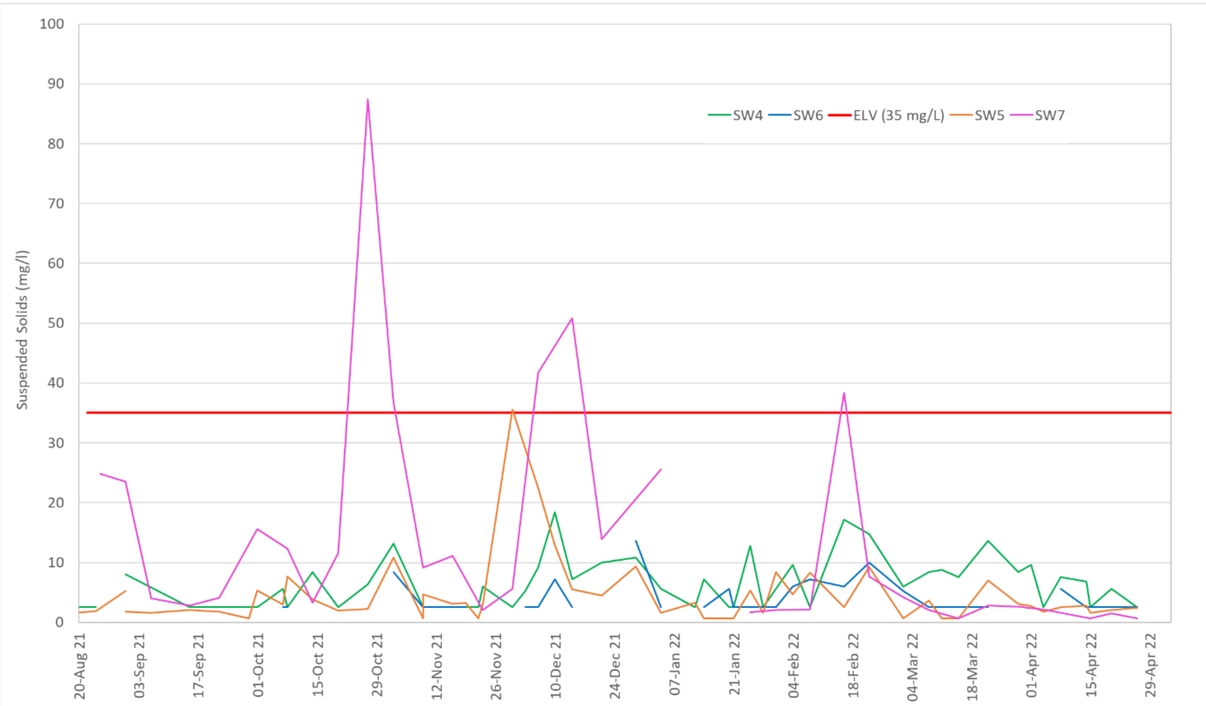

Figure 8-38 SS Concentrations at SW7, SW6, SW5 and SW4

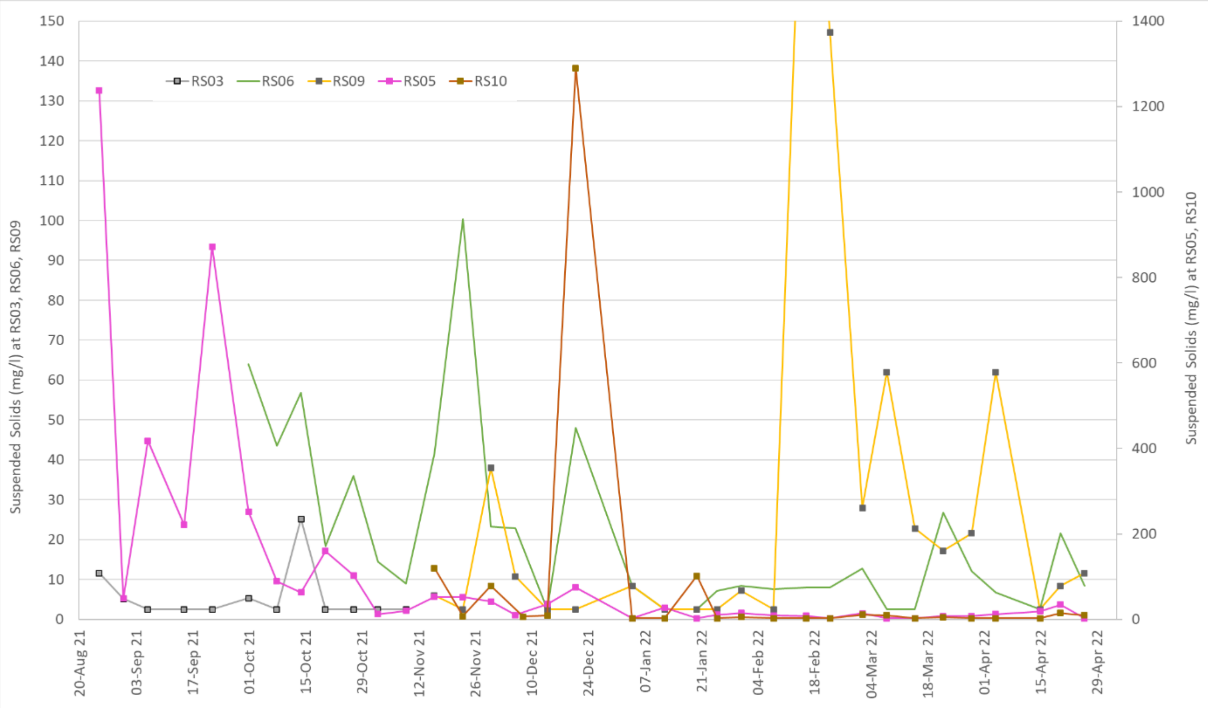

Figure 8-39 SS Concentrations in TSB Artificial Drains

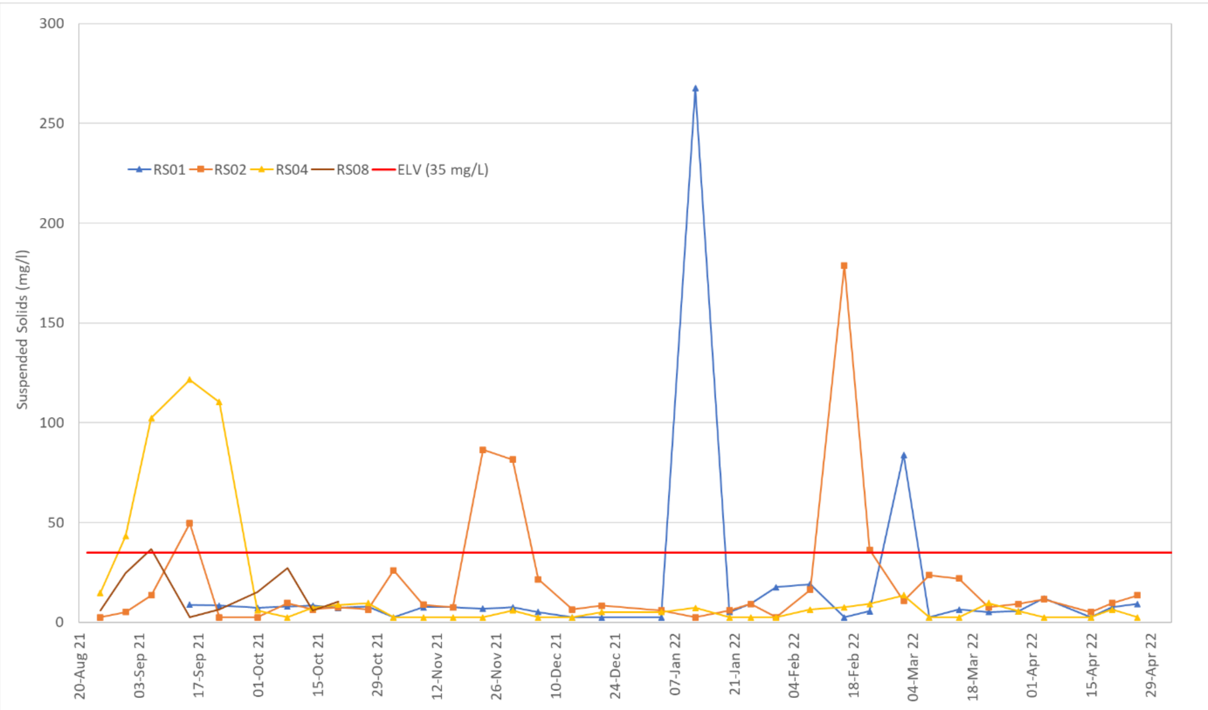

Figure 8-40 SS Concentrations at Outflow Points (TSB and TNB)

Specific Electrical Conductivity

Presented in Figure 8-41, SEC values were generally lowest in RS01 (outflow from TNB) and highest in SW7 (representing the combined inflows to the attenuation lagoons by the WMF).

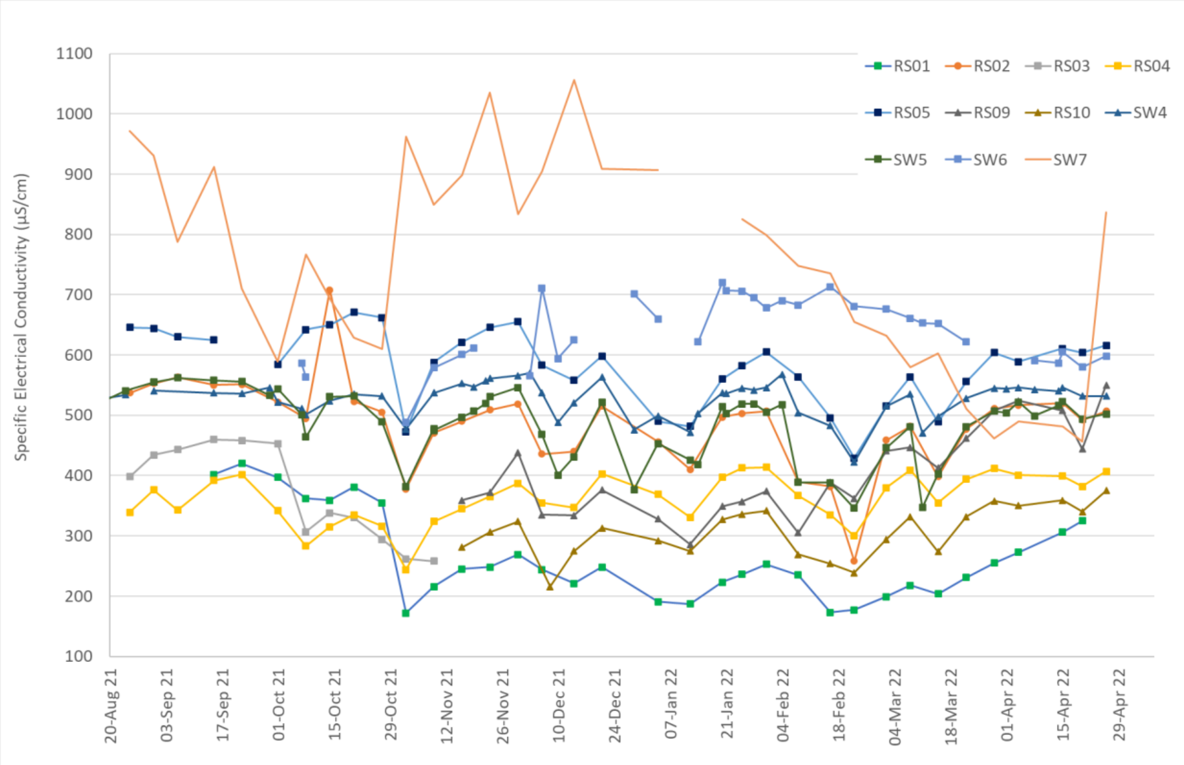

Figure 8-41 SEC Concentrations in Surface Water

The higher SEC values in SW7 are mirrored by higher chloride values (Figure 8-42), although chloride concentrations elsewhere within TSB and at outflow points are generally below 20 mg/l.

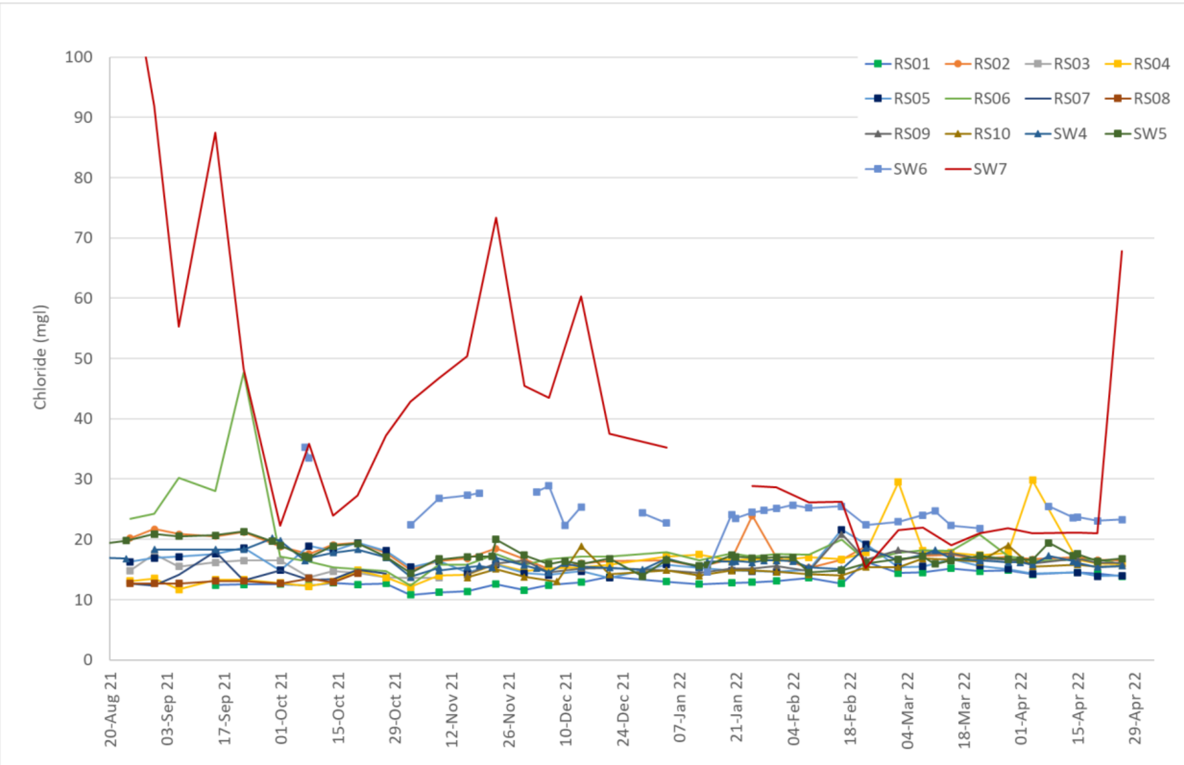

Figure 8-42 Chloride Concentrations in Surface Water

Orthophosphate

ORP was sampled on a roughly monthly schedule between August 2021 and April 2022. As was summarised in Table 8-9, ORP was not detected above its LOD of 0.03 mg/L in nine samples at SW7, was detected only once (at the LOD) in ten samples at SW5, and was detected twice in ten samples at SW4 (max. 0.05 mg/L-P). The sporadic nature of ORP detections implies that TSB does not export a significant load of phosphorus to the Cushaling River. This stands in contrast to the consistently elevated concentrations of ORP (to 0.5 mg/L-P) near Ticknevin (Section 8.4.13).

8.4.15 Relative Ammonia Loads to the Cushaling River

To illustrate the relative significance of TSB as a source of ammonia to the Cushaling River, relative ammonia loads in surface water from the bog and in the discharge from the existing WMF were calculated. The calculations are based on estimates of average flow contributions and annual average concentrations using the available data described below.

8.4.15.1 Average Flows

Average flows were estimated based on the information presented in Sections 8.4.8, 8.4.9, and 8.4.12. For the discharge from the ICW, the flow estimate is derived from the metered outflow from the attenuation lagoons which, as presented in Section 8.4.12, ranged from zero (no outflow) to 0.038 m^3/s in the period of record (between 2015 and 2022), for an average of 0.0083 m^3/s.

The discharge from the ICW will be less than the outflow from the attenuation lagoons due to evapotranspiration. For the purposes of load calculations, the average metered flow was reduced by 50%, assuming that half the water is 'lost' across the ICW by plant uptake. From this, the average outflow from the ICW is taken to be 0.0042 m^3/s.

In comparison, the estimated average flow in the Cushaling River near the western BnM landholding boundary is approximately 0.03 m^3/s, as presented in Sections 8.4.8 and 8.4.9. This flow represents the combined contributions from the bog, ICW and groundwater baseflow. Hence, to derive the surface water flow component from the bog, the flow contributions from the ICW and groundwater baseflow have to be subtracted out:

- Average flow, Cushaling River at BnM landholding boundary: ~0.03 m^3/s
- Mean outflow from existing ICW: ~0.0042 m^3/s
- Groundwater baseflow (Section 8.4.8): ~0.005 m^3/s

8.4.15.2 Average Concentrations

As for average concentrations of total ammonia, these were taken from Table 8-5, beginning in 2016, which is the year the ICW was established. Concentrations discharged from the ICW are represented by sample station SW6. Concentrations related to discharges from the bog are represented by sample station SW5 after subtracting out the contribution from SW6, since concentrations at SW5 are influenced by the discharges from the ICW.

Results of the illustrative calculations are presented in Table 8-10. Based on the inputs used, the calculated loads from the bog are one to two orders of magnitude greater than the loads from the ICW. Even if the flow from the ICW was doubled to account for all of the metered water discharged from the attenuation lagoons, the calculated load from the bog remains considerably greater than that from the ICW. Hence, to improve ammonia concentrations in the Cushaling

River, existing conditions in the bog must also be considered, which is planned by BnM, as described in the assessment of likely effects in Sections 8.5 and 8.6.

Table 8-10 Calculated Illustrative Loads of Ammonia From the ICW and Bog, 2016-2022

Year	Average Flow – ICW	Average Total Ammonia @ SW6	Estimated Load from ICW	Average Flow -Bog	Average Total Ammonia @ SW5[1]	Estimated Load from Bog
	m^3/s	mg/l (NH_3-N)	Kg/yr	m^3/s	mg/l (NH_3-N)	Kg/yr
2016	0.0042	0.071	9.40	0.021	0.099	65.56
2017	0.0042	0.041	5.43	0.021	0.050	33.11
2018	0.0042	0.020	2.65	0.021	0.053	35.10
2019	0.0042	0.040	5.30	0.021	0.044	29.14
2020	0.0042	0.046	6.09	0.021	0.076	50.33
2021	0.0042	0.046	6.09	0.021	0.167	110.60
2022	0.0042	0.064	8.48	0.021	0.116	76.82

[1] adjusted by subtracting out the contribution from SW6 to derive a concentration at SW5 that would result if there was no influence at SW5 from the ICW.

8.4.16 Trace Metals

The naturally occurring trace metals that were highlighted in groundwater in Chapter 7, notably arsenic, iron, manganese and barium, are included in annual surface water samples collected in either the third or fourth quarters since 2014 at locations SW4, SW5 and SW6. Reported results are included as Appendix 8-3, and metals results are summarised in Table 8-11.

Table 8-11 Summary of Metals Analyses, Filtered Samples, SW6, SW5 and SW4, 2014-2022

Parameter	Max. LOD	Unit	SW6	SW5	SW4	AA[1] or MAC[1] EQS
Antimony[2]	0.001	mg/L	<0.001-<0.004	<0.001-<0.004	<0.001-<0.004	--
Arsenic[2]	0.001	mg/L	0.002-0.0042	0.002-0.0067	<0.002-0.0207	0.025 (AA)
Cadmium[2]	0.00002	mg/L	<0.00002-0.00267	<0.00002-0.00006	<0.0002-0.00009	0.00025 (AA)
Total Chromium	0.001	mg/L	0.001-<0.003	0.002-<0.003	<0.001-<0.003	0.0047 (AA)[5] 0.032 (MAC)[5]
Cobalt[2]	0.001	mg/L	<0.001-<0.005	<0.001-<0.005	<0.001-<0.005	--
Copper	0.001	mg/L	<0.001-0.0023	<0.001-0.0042	<0.001-0.002	0.005 (AA)
Lead	0.001	mg/L	<0.001-<0.005	<0.001-<0.005	<0.001-<0.005	--
Manganese	0.002	mg/L	<0.002-0.108	0.028-0.203	0.033-0.105	--
Mercury	0.0003	mg/L	<0.00002-<0.0001	<0.00002-<0.0001	<0.00002-<0.0001	0.00007 (AA)
Nickel	0.001	mg/L	0.002-0.0064	0.0021-0.0096	<0.001-0.0058	--
Selenium[2]	0.001	mg/L	<0.001-0.0062	<0.001	<0.001-0.0044	--
Silver[2]	0.002	mg/L	<0.002	<0.002	<0.002	--
Tin[2]	0.001	mg/L	<0.001-<0.003	<0.001-<0.003	<0.001-<0.003	--

Parameter	Max. LOD	Unit	SW6	SW5	SW4	AA[1] or MAC[1] EQS
Zinc	0.002	mg/L	<0.003-0.0052	0.004-0.009	<0.002-0.0091	0.05 (AA)
Aluminium[2]	0.01	mg/L	0.01-0.04	0.02-0.04	0.01-0.05	--
Barium[2]	0.01	mg/L	0.10-0.244	0.09-0.092	0.08-0.109	--
Beryllium[2]	0.01	mg/L	<0.01	<0.01	<0.01	--
Boron[3,4]	0.01	mg/L	0.02-0.03	0.01-0.02	0.01-0.02	--
Calcium[4]	1	mg/L	89.4-119	71.6-112	101-127	--
Iron	0.01	mg/L	<0.01-0.301	0.15-1.18	0.18-0.468	--
Magnesium[4]	1	mg/L	6.17-9.0	4.87-7.0	7.07-9.48	--
Potassium[4]	1	mg/L	1.0-5.24	0.88-2.0	1.37-4.38	--
Sodium[4]	1	mg/L	7.32-30.2	8.32-16.6	7.89-13.8	--

Notes:
[1] AA = annual average; MAC = maximum allowable concentration.
[2] Reported in 2014, 2016, and 2021
[3] LOD in 2016 and 2017 = 0.135 mg/L
[4] Reported in 2016-2022.
[5] Trivalent chromium

Of the metals, only cadmium and mercury have EQSs stipulated in the most current Surface Water (Amendment) Regulations, specifically S.I. No. 77 of 2019. In these regulations, the EQSs are presented as "*priority hazardous substances to apply for the purpose of assigning chemical status*", which EPA uses in the process of assigning WFD water body statis. Respective EQSs are 0.15 µg/L for cadmium (an AA-EQS for a Class 5 water, where total hardness >200 mg/L as $CaCO_3$, which is indicated by the EPA WFD data from the Cushaling River) and 0.07 µg/L for mercury (a MAC-EQS). One cadmium sample exceeded the AA-EQS threshold (as a single sample, not an annual average). None of the other sample results exceeded the cadmium or mercury threshold values.

Table 10 of Schedule 5 of the Surface Water Regulations of 2009 (S.I. No. 279 of 2009) contain EQSs for "*specific pollutants*", which for metals cover arsenic, copper, zinc, and trivalent and hexavalent chromium. None of the data in Table 8-9 above exceed respective threshold values.

8.4.17 VOCs, SVOCs and Pesticides

VOCs, SVOCs and pesticides have been analysed in samples collected annually from SW6, SW5 and SW4 since 2014. The annual environmental monitoring reports are presented in Appendix 8-3. The reported results are below LODs for all parameters at all sampling locations.

8.4.18 Summary of Key Surface Water Quality Observations

Observations from the available surface water quality data are summarised as follows:

- Discharges from the existing WMF, represented by sample SW6, comply with existing IED license conditions.
- The existing attenuation lagoons and ICW south of the WMF serve to attenuate ammonia effectively.
- As illustrated in Figure 8-43, the total ammonia concentrations at SW6 are mainly below the AA-EQS of 0.065 mg/L, except during the winter season, when plant uptake in the ICW is reduced. As described in Section 8.4.14.1, the annual average concentrations of total ammonia in the outflow from the ICW (SW6) have remained below the AA-EQS of 0.065 mg/L since the existing ICW was commissioned in 2016.

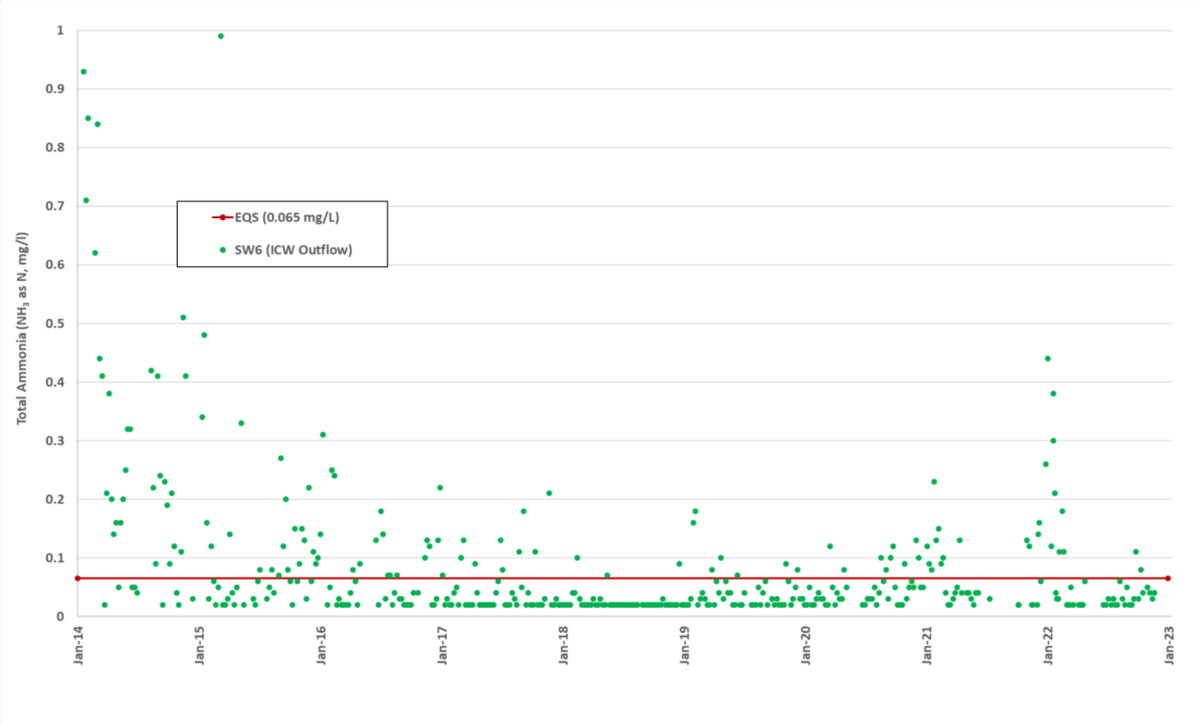

Figure 8-43 Total Ammonia Concentrations in SW6 , 2014-2022

- In contrast, the annual average concentrations of total ammonia at monitoring station SW5 exceed the AA-EQS of 0.065 mg/L in all years and at SW4 in some years (Section 8.4.14). Further attenuation of ammonia takes place in the downstream direction.
- The principal contributor of ammonia loading to the Cushaling River is from the drainage network within TSB.
- Loads from TSB are one to two orders of magnitude higher than loads from the existing ICW.
- The recorded concentrations of total ammonia in the Cushaling River represent both unionized ammonia (NH_3, or 'free ammonia') and the ammonia ion (NH_4^+, or ammonium). At the pH and temperature ranges which characterise surface waters at the site, and Cushaling River, the dominant form of ammonia in water is NH_4^+ and not NH_3 (toxic to fish).
- Based on the available data, calculated concentrations of unionized ammonia (NH_3) in the river at location SW4 just downstream of TSB are significantly lower than the 0.02 mg/L threshold that is stipulated in the Quality of Salmonid Water Regulations.
- 'Spikes' of suspended solids concentrations in the Cushaling River are caused by episodic sediment mobilisation and transport from the drainage network within TSB, and principally from the bog. Discharges from the existing WMF are compliant with IED licence conditions.

8.4.19 Proposed Surface Water Quality Monitoring

During all phases of works, surface water quality will be measured in the field and monitored via sampling and laboratory analyses.

The field monitoring will be undertaken to check for potential effects of construction works. The sampling and laboratory analysis will be conducted to check for potential shifts in baseline water quality conditions. Because construction and operations of new landfill phases take place in parallel, both field measurements and sampling activity will be ongoing throughout the lifespan of the expanded landfill.

8.4.19.1 Proposed Monitoring During All Construction Phases

To monitor construction-related activity, it is proposed that field measurements be taken at key locations as follows:

- Existing station SW5 which measures the outflow to the Cushaling River
- A new station SW10 which will measure the outflow to Mulgeeth Stream
- Existing station SW6 which measures the discharge from the existing ICW at the WMF
- A new station SW9 which will measure the discharge from the new ICW associated with the landfill expansion.

The construction-related monitoring of discharges and water courses will consist of

- Daily visual checks
- Daily measurements of key parameters, namely temperature, pH, SEC, total alkalinity, turbidity, and total colour.

Field measurements will be taken using calibrated, hand-held water quality instruments ('multi-parameter probes'). The field measurement campaign will begin one month prior to Stage 1 construction and will cease up to one month after construction of the last waste cell (phase) is completed, unless observations dictate that measurements should continue.

Regular visual inspections of all installed drainage features will be undertaken, especially after heavy rainfall. The intent is to avoid build-up of standing water where it is not intended. If visible impact during construction occurs, works will be suspended at the discretion of the supervising engineer, in which case the problem will be identified and corrective action taken before recommencing works.

8.4.19.2 Proposed Monitoring of Expanded Landfill Operations

During the expanded landfill operations, it is proposed that monitoring be carried out at the following locations:

- Outlets from attenuation lagoons at both the existing WMF and proposed expanded landfill.
- Outflows from ICWs at both the existing WMF and proposed expanded landfill (*i.e.,* at existing station SW6 and new station SW9).
- On the Cushaling River (existing stations SW4 and SW5).

The proposed monitoring regime is summarised in Table 8-12 and is guided by the requirements for the WMF under existing IE licence W0201-03.

The proposed monitoring assures:

- The detection of potential pollution events, which triggers the need for more detailed sampling of discharge waters.
- The continued long-term monitoring of water quality of the Cushaling River. This monitoring will help to identify any potential shifts in baseline conditions.

Each sampling event is also accompanied by field measurements of water temperature, pH, SEC, total alkalinity and total colour.

8.4.20 Proposed Discharge Rate Monitoring

It is proposed to measure discharge rates from the new ICW. This will be accomplished by means of a flowmeter installation by station SW9 which will record discharges continuously.

Table 8-12 Proposed Surface Water Quality Monitoring Regime

All Construction Phases	SW5, SW6, SW9, SW10			
	Daily	Weekly	Quarterly	Annually
Field Measurements				
Visual	x			
Temperature	x			
pH	x			
Specific Electrical Conductivity	x			
Total Alkalinity as $CaCO_3$	x			
Turbidity	x			
Total Colour	x			
Expanded Landfill Operations	Attenuation Lagoons (Outlets)			
	Daily	Weekly	Quarterly	Annually
Visual inspection/odour	x			
Water levels	x			
Dissolved oxygen	x			
SEC	x			
Expanded Landfill Operations	SW4, SW5, SW6, SW9			
	Daily	Weekly	Quarterly	Annually
Laboratory Analysis				
Total Ammonia as N		x		
Total Suspended Solids		x		
pH		x		
Chloride		x		
Biological Oxygen Demand (5-day)			x	
Chemical Oxygen Demand			x	
Metals/non-metals				x
List I/II Organic Substances				x
Mercury				x
Sulphate (as SO_4)				x
Nitrate as N				x
Orthophosphate as P				x
Total Phosphorus as P				x
Faecal Coliforms				x
Total Coliforms				x

Note: [1]During each sampling event

In the new settlement lagoons and ICW system (for the expanded landfill), baseline monitoring will commence immediately upon their commissioning.

8.4.21 Drainage Management

The Proposed Development includes drainage management, and there are three main components that are directly relevant for the assessment of likely significant effects, as follows:

- The modified drainage network within TSB, which is defined by the TSB Decommissioning and Rehabilitation Plan (Appendix 2-2 of this EIAR) and accommodates the footprint of the expanded landfill.
- The stormwater management system of the expanded landfill (Chapter 2 of the EIAR).

- The new attenuation lagoons and ICW system, through which all water collected from the expanded landfill will be passed and discharged under a future IE discharge license (Chapter 2 of the EIAR).

Until the stormwater management and attenuation lagoons/ICW systems for the expanded landfill are established under Stage 1 construction of the Proposed Development (Chapter 2 of the EIAR), any water that is collected during construction activity will be directed/pumped to the existing perimeter swale and attenuation lagoons that are associated with the WMF. Once the new stormwater management and attenuation lagoons/ICW systems are constructed for the expanded landfill, all subsequent water collected in the expanded landfill area will be directed to the new attenuation lagoons for licensed discharge via the new ICW. License to discharge from the new ICW will be in place before construction commences.

Managed construction waters from active works areas will be diverted to ensure they pass through attenuation lagoon and ICW systems prior to discharge from the site. This will be achieved using a combination of existing infrastructure and new infrastructure, as described in assessment sections below.

8.5 LIKELY SIGNFICANT EFFECTS OF THE PROPOSED DEVELOPMENT

8.5.1 Do Nothing Scenario

In the Do Nothing scenario, the Proposed Development does not occur. However, implementation of the Timahoe Bog Decommissioning and Rehabilitation Plan (Appendix 2-2 of this EIAR) proceeds as planned by BnM under the broader Peatlands Climate Action Scheme (PCAS).[12] As well, the ongoing waste activities at the existing WMF continue through year 2028 subject to void space capacity (end-date of the operational period for the WMF), with post-closure activity commencing thereafter. In the post-closure phase, facility operations cease, but leachate management and environmental monitoring both continue under the existing IED license conditions.

The main anticipated change to the current (baseline) state of the surface water environment will be related to the implementation of the Timahoe Bog Decommissioning and Rehabilitation Plan. Targeted outcomes of the plan are "*environmental stabilisation, re-wetting and setting the bog on a trajectory towards development of naturally functioning peatland and wetland habitats. Rehabilitation will be integrated with current and potential future land-uses*" (BnM, 2022).

The plan content will serve to:

- Raise water levels within the bog, thereby reducing the leaching potential of ammonia (and metals such as arsenic).
- Stabilise hydrological conditions within the bog, partly through re-wetting and re-vegetation of the peat, thereby reducing the potential for sediment mobilisation and transport.

Planned efforts to re-wet deep peat will be augmented by efforts to create wetlands (BnM, 2022).

The expected environmental effect of the plan that is relevant to Cushaling River is reduced chemical and sediment loading to the river. Combined with stabilised hydrological conditions,

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[12] Bord na Móna Peatlands Climate Action Scheme (bnmpcas.ie)

this translates into an expected improvement of water quality and aquatic habitat in the river. This is considered a net positive effect. The expectation is consistent with emerging experiences from other, ongoing bog rehabilitation activities elsewhere, for example the Longfordpass and Corlea bogs, where ammonia and suspended sediment concentrations in outflowing streams are decreasing in response to rehabilitation, as indicated in Figure 8-44 from Longfordpass below. The net positive effect will emerge over time (a few years) as the conditions within the bog change/improve. The Longfordpass example shows a downward trend in ammonia concentrations over a 4+ year period. Not every bog will respond the same, but the example provided is illustrative, based on real-world data.

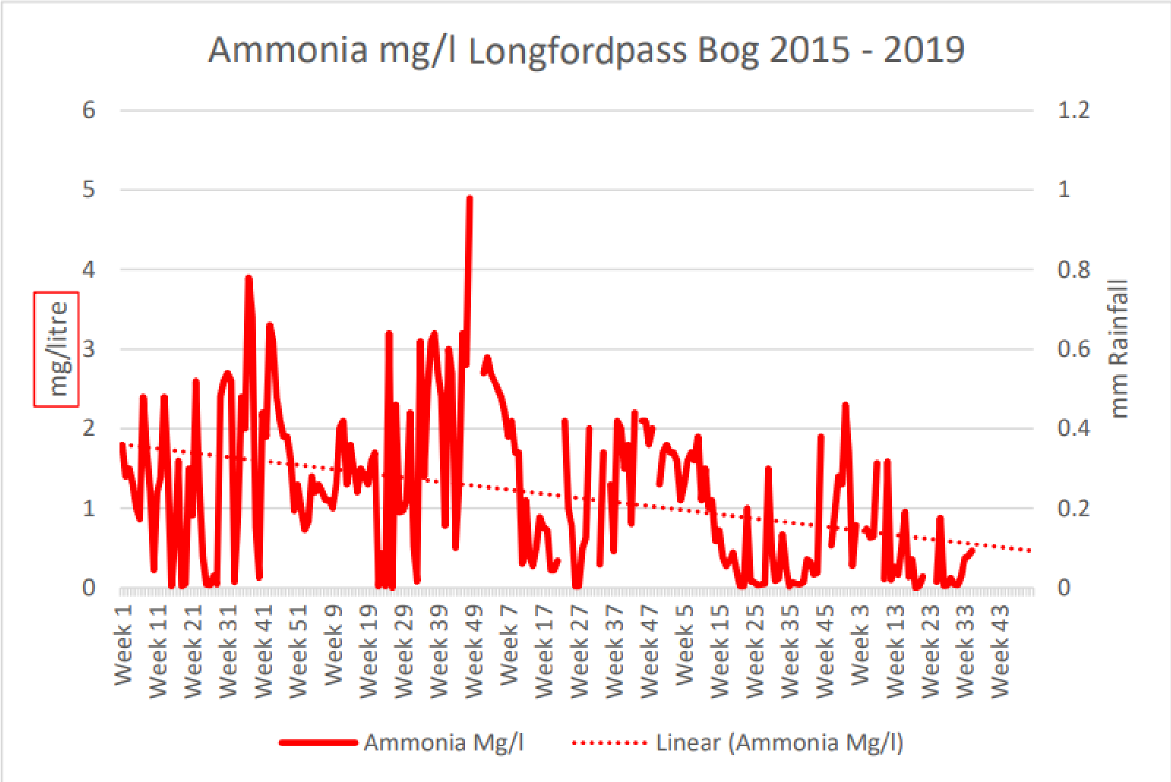

Figure 8-44 Decreasing Ammonia Concentrations, Longfordpass Bog (Source: BnM, 2022)

In the Do Nothing scenario, environmental monitoring continues per existing license conditions. The proposed monitoring stations (see Section 8.4.19), notably SW4 and SW5 on the Cushaling River, are well suited to identify and track any trends that may arise from implementation of the TSB Decommissioning and Rehabilitation Plan.

8.5.2 Construction Phase

As described in Chapter 2 of this EIAR, the expanded landfill will be constructed in a staged manner over a total period of approximately 25 years. When completed, the expanded landfill will consist of 12 no. additional waste cells or 'phases' which are numbered from 16 through 27. The sequential numbering begins at 16, since Phase 15 is the last phase constructed and operated at the existing WMF.

The first stage of construction (Stage 1) is the most comprehensive in terms of scope, comprising these components:

- MSW Processing and Composting Building.
- Maintenance Building.
- Soil, Stones and C&D Rubble Processing Building.

- Contractor's yard.
- Surface water management infrastructure, including perimeter swales, berms and embankments, and the new attenuation lagoons and ICW system.
- Phase 16 of the expanded landfill
- Under-cell drainage system beneath Phase 16.

An overview of the sequence of activities related to Stage 1 construction, upon commencement of works, was provided in Chapter 2 of this EIAR.

The duration of Stage 1 construction is approximately 18 months. Subsequent stages involve the sequential development of phases along with expanded stormwater and underdrain management. The development of subsequent phases is planned such that a new phase is constructed to be ready at least six months prior to the previous phase reaching its void space capacity.

The construction of additional phases, starting with Phase 17, will require approximately 1.5 years each, and will be undertaken sequentially every 2 to 2.5 years. As such, construction of a new phase will commence c. 2 years after the previous phase. As defined in Chapter 2, the last phase (Phase 27) will be capped by 2050.

The construction period for each phase allows for pre-construction surveys, vegetation clearance, peat stripping and placement, subsoil excavation and placement, and construction of the engineered liner along with drainage management (e.g. the under-cell drainage system).

Likely significant effects of the Proposed Development on the receiving surface water environment and proposed mitigation measures during the construction phase are described below. The principal objectives of proposed mitigation measures are:

- To control water discharges.
- To limit chemical and sediment loading to receiving surface water bodies.
- To prevent accidental spill and leaks from occurring.

For this reason, and throughout the period of works, the Contractor(s) will be required to follow contractually-defined methods and procedures which are consistent with:

- CIRIA C532: Control of water pollution from construction sites: guidance for consultants and contractors.
- CIRIA C648: Control of water pollution from linear construction projects.
- CIRIA SP156: Control of water pollution from construction sites – guide to good practice.
- Inland Fisheries Ireland: Guidelines on protection of fisheries during construction works in and adjacent to waters (2016).

8.5.2.1 Vegetation Removal and Clear-brushing

A total area of approximately 63.5 hectares (ha) will undergo vegetation removal and clear-brushing in order to accommodate the expanded landfill construction. The activity will occur in stages as the landfill phasing is progressed.

Removal of vegetation/brush is carried out in advance of peat stripping and subsoil excavation. The activity in each phase will last for approximately 2-3 months.

The uprooting of vegetation/brush will disturb residual peat and subsoils. The disturbance results from vehicle tracking and skidding, and vegetation/brush extraction, and placing vegetation/brush in stacking areas.

Pre-Mitigation Potential Effects: Without mitigation, the activity can release sediments and organic matter into adjacent drains. In flowing drains, suspended sediments and organic matter can then be transported to the Cushaling River via the main channel and old settlement ponds near the western BnM landholding boundary (see Section 8.4.3). Sedimentation of suspended /organic matter along the river can contribute to clogging of river bed substrate (a river morphological effect). Risks of effects arise during the construction of each new landfill phase.

Based on Tables 8.1 and 8.3, the pre-mitigation potential effects are:

- Negative – *i.e.,* effects can reduce the quality of the receiving water and associated habitats.
- Slight –effects will not change the character or sensitivity of the Cushaling River.
- Likely – effects will likely occur.
- Temporary – effects will last for the duration of activity (2 weeks each phase)
- Repeated – risks and effects are repeated with each landfill expansion phase.

Because effects are related to sediment mobilisation and transport, it is anticipated that effects will be similar to those documented in Section 8.4.14, whereby an increased suspended solid load was recorded at sampling stations SW5 (old settlement ponds) and SW4 (Cushaling River downstream of BnM boundary) in the winter season 2021-2022. The elevated suspended solids was due to bog drain cleaning, drain diversion and de0silting of the bog lagoon, noting also that elevated suspended solids were not experienced during the construction of Phases 1 through 15 of the existing WMF.

Proposed Mitigation Measures: Mitigation measures and routine best practice methods are incorporated in the CEMP (Appendix 2-5), consistent with:

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh.
- Coillte (2009): Forest Operations and Water Protection Guidelines.
- Coillte (2009): Methodology for Clear Felling Harvesting Operations (Draft) ; Forest Service.
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

Mitigation by Avoidance: Vegetation stripping and clear-brushing will be avoided during the birds nesting season (per the Wildlife Act: March 1st - August 31st) and during significant rainfall events.

Mitigation by Design: Machine combinations (*i.e.* handheld or mechanical) will be chosen which are most suitable for ground conditions in order to minimise the disturbance of peat/soils. Mechanical machinery will have wide tracks suitable for the soft bog/soil environment. BnM has considerable experience in the operation of plant and machinery in peat environments and will ensure that these initial development works are only carried out by experienced operators with suitable machinery.

Vehicles will use road infrastructure and designated drain culverts/crossing points in all works areas. Tracking of vehicles across/through/along watercourses will not occur. Checks and maintenance of roads and culverts will be ongoing throughout the activity periods.

Silt fences/traps will be placed downgradient of work areas near and along drains. The purpose is to allow the settling of silt and limiting sediment transport into and via drains. Any accumulated sediments will be excavated based on visual inspection.

Bog mats will be used to support vehicles on soft ground, thereby mitigating rutting and reducing soil erosion. Bog mats replacement will be enforced when they become heavily used and worn. Loose sediments will be compacted or removed from tracks during wet periods and dust suppression will be employed during dry spells. Vehicles leaving works areas and going onto the access or public roads will pass through a wheel wash. Controlled, accumulated sediments will be carefully disposed in dedicated disposal areas away from drains.

Drains and silt fences/traps will be maintained throughout the activity periods, and will be kept clear of sediment build-up.

Brush materials, including roots, will be stacked in dedicated dry areas. Straw bales will be emplaced on the downgradient side of such areas. Branches, logs or debris will not be allowed to build up in aquatic zones.

Inspection and Maintenance: Prior to activity, operational rules will be communicated with the contractor/operator. Activities will be supervised on a full-time basis. Equipment, machinery, access roads and culverts will be inspected daily.

Following activity, all drains will be inspected to ensure that they are functioning as intended, including those which are part of the TSB Decommissioning and Rehabilitation Plan (BnM, 2022). Any accumulated silts will be removed. Removed materials will be deposited in dedicated disposal areas, away and separated from drains. Disposal will not result in sediment mobilisation towards any stream leaving the landholding.

Surface Water Quality Monitoring: During the construction phases, monitoring campaigns will be undertaken as presented in Section 8.4.19.

Post-Mitigation Residual Effects: Based on Tables 8.1 and 8.3, post-mitigation residual effects are considered to be:

- Neutral – effects will be imperceptible and will not affect the character or quality of the receiving water.
- Not significant – any effects will be episodic and without significant consequences on the receiving water.
- Likely – effects are likely, but effects will be temporary, are mitigated against, and can be managed/addressed.
- Reversible – effects can be undone through remediation (including source and pathways controls, see Section 8.5.2.2).

Significance of Effects: For the reasons outlined above, no likely significant effects on Cushaling River will occur and the magnitude of effects is not significant.

8.5.2.2 Earthworks

Earthworks involve stripping, excavation, movement, and staging of both peat and/or subsoil materials. The estimated total areas and volumes involved are (from Chapter 2 of the EIAR):

	Area (ha)	Volume (m^3)
Peat:	49.4	506,058
Subsoils:	35.75	747,855

Peat stripping and excavations will commence in the south-western corner of the Proposed Development to allow for construction of the new attenuation lagoons and ICW system. Peat stripping and excavation will also commence in the footprint of Phase 16 so that the related infrastructure (e.g., liners, under cell drainage system) can be completed.

Both stripped/excavated peat and subsoil will be reused to support environmental screening berms and landscaping. Subsoils may also be used for capping purposes, pending testing for suitability. No peat will be removed off-site. All stripped peat will be utilised within the Proposed Development area. A Peat and Spoil Management Plan is included in Appendix 2-5.

Earthwork activity will take place during the entire 24-year construction period. The scope of work is considerably greater during Stage 1 construction since this involves a much larger footprint of activity, approximately 22% of the total.

Like vegetation removal/clear-brushing, risks of effects to surface water arise during each landfill expansion phase.

Pre-Mitigation Potential Effects: Without mitigation, earthworks can result in mobilisation and transport of suspended sediments and both suspended and dissolved organic matter (from the disturbed peat) to local water courses, including the Cushaling River via the same pathways that were described in Section 8.5.2.1.

Effects will be manifested in the same manner as described in Section 8.5.2.1. The release of humic and dissolved organic matter from peat can also affect water colour and other properties such as pH and water clarity. Deterioration of water quality and clogging of river bed substrate can both contribute to loss of (quality of) aquatic habitat.

Based on Tables 8.1 and 8.3, pre-mitigation potential effects are:

- Negative – effects will reduce the quality of the Cushaling River as an aquatic habitat.
- Moderate – effects will shift baseline conditions and alter the character of the river.
- Long-term – because construction activity extends across a 24 year total period, potential effects are considered long-term (15-60 years, per Table 8-1). Without mitigation or rehabilitation measures, sedimentation effects on river morphology could even be permanent.

Mitigation by Avoidance: Risks and effects of earthworks are made greater during storm events. Hence, earthworks will not be carried out during significant storm events. Decisions to potentially suspend works will be made from visual observation and weather forecasting of storm events. The checking and communication of weather forecasts are part of the CEMP. The following forecasting systems are available:

- General Forecasts: Available on a national, regional and county level from Met Eireann. These provide general information on weather patterns including rainfall, but do not provide any quantitative rainfall estimates.
- MeteoAlarm: This service alerts to the possible occurrence of severe weather for the next 2 days at provincial scale.
- 3-hour Rainfall Maps: These forecast quantitative rainfall amounts for the next 3 hours but do not account for possible high-intensity localised events.
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and provide a picture of current rainfall extent and intensity. Images show a quantitative measure of recent

rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive.

- Consultancy Service: Met Eireann provide a 24-hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Prior to suspending works for climatic reasons, the following control measures will be completed:

- Open excavations will be secured.
- Temporary or emergency drainage will be provided to prevent back-up of surface runoff in work areas.
- Working for up to 24 hours after heavy rainfall events will be avoided to ensure drainage systems are not overloaded. Decisions are subject to visual inspection and judgement by the resident (supervising) engineer. The intent and objective is to control erosion, avoid collapses of embankments, and limit the mobilisation and transport of sediments.

Mitigation by Design: Proposed mitigation measures fall into three basic categories:

- Source controls, involving the use of swales, silt fences, straw bales, flume pipes, sand bags, oyster bags (e.g. filled with gravel), and filter fabrics. Flexibility to adapt methods will be required based on location-specific conditions, as judged by supervising engineers.
- In-Line controls, involving the use of silt fences, straw bales, check/silt dams and flume pipes.
- Treatment systems, involve the use sediment traps and attenuation lagoons.

Swales will surround the works and staging areas. Runoff and drainage water collected in the swales will initially be directed to the existing perimeter swale that surrounds the WMF. From here, the collected water will be routed to the existing attenuation ponds and ICW system south of the WMF. Directing the water to in this manner will require pumping from collector sumps which will be placed at suitable locations in active works and staging areas. The water pumped from the sumps will be led to the perimeter swale using temporary pipes.

In addition to the source and in-line control measures, the water will be treated through the existing attenuation lagoons and ICW system. Once the proposed, new attenuation lagoons and ICW system are constructed, the water will pass through this system, reducing the distance of the sump pumping involved.

Trapped sediments in source, in-line and treatment controls, including swales and drains will be periodically removed based on regular inspection. Drains will also be maintained so as not to overflow during the construction stages. Outflows from blocked drains (see Section 8.5.2.3) will be controlled by 8-inch pipes at the downstream ends of each blocked drain.

Monitoring: Monitoring will be performed according to the Section 8.5.2.1. In addition, regular (min. daily) inspections of drainage systems will be undertaken, especially during rainfall events, to check for damage and blockages, and ensure there is no escape or build-up of standing water in parts of the systems where it is not intended. Any excess build-up of sediment in the drainage system will be removed in a controlled and supervised manner using excavators, as outlined in the CEMP.

Post-Mitigation Residual Effects: Based on Tables 8.1 and 8.3, post-mitigation residual effects are considered to be:

- Not significant – residual effects will not affect the character or quality of the receiving water, and do not carry significant consequences.
- Likely – brief effects may occur, but are mitigated against and can be managed (addressed).
- Long-term – the duration of the applicability of mitigation measures covers the duration of construction of all phases of the expanded landfill.
- Reversible – *i.e.,* effects can be undone through remediation (source, pathway, and treatment measures).

Significance of Effects: For the reasons outlined above, no likely significant effects on the Cushaling River and Mulgeeth Stream will occur. The magnitude of effects will be not significant.

8.5.2.3 Modification to Drainage Network in TSB

As part of the TSB Decommissioning and Rehabilitation Plan, a new south-to-north oriented main drain will be constructed to the east of the landfill expansion footprint. In the context of the Proposed Development, this new drain will:

- Receive runoff from the peat berm that is designed along the eastern margin of the proposed landfill expansion (see Chapter 2).
- Receive overflows from drains that presently run through the landfill expansion footprint and that will be blocked off to prevent flow into the landfill excavations.

The layout of the modified drainage network is depicted in Figure 8-45. The existing drains that presently run through the landfill expansion footprint will be blocked off sequentially in line with the sequencing of construction of new landfill phases. Locally sourced subsoil materials will be used for this purposes. The blocking will cause water levels in the affected drains to rise. Overflow pipes will be installed to direct the water into actively flowing drains, whereby:

- Overflows and runoff east of the landfill expansion will be directed north to the Mulgeeth Stream via the new south-to-north oriented drain.
- Overflows and runoff to the south of the landfill expansion will be directed to Cushaling River via existing, active drains.

The partial re-direction of drainage to the north is necessary and constrained by the bog's topography to the east of the landfill expansion footprint. By re-directing a proportion of drainage to Mulgeeth Stream, the Proposed Development becomes indirectly connected to the Boyne River catchment, which is described below and assessed further in Sections 8.5.2.8 through 8.5.2.10.

The resulting, modified subcatchment areas of the Cushaling River and Mulgeeth Stream are also shown in Figure 8-45**.** Specifically, the modified drainage that results from the TSB Decommissioning and Rehabilitation Plan will:

- Reduce the subcatchment area within TSB that drains to Cushaling River from approximately 445 to 413 hectares (*i.e.,* a 7% decrease of the original subcatchment area).
- Increase the subcatchment area within TSB that drains to Mulgeeth Stream from approximately 154 to 186 hectares.

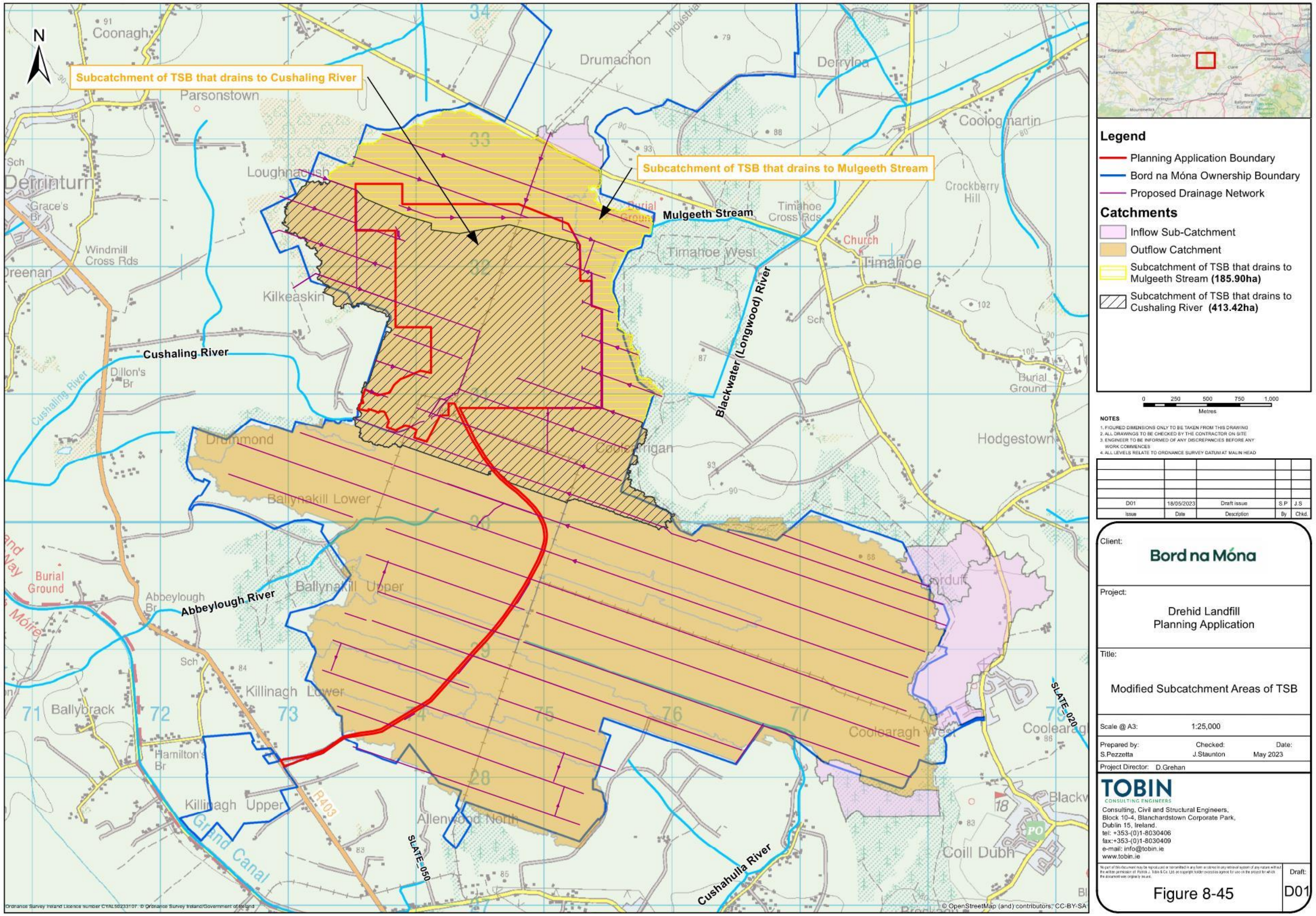

Figure 8-45 Modified Drainage Network and Relevant Subcatchment Areas in TSB

The changes mean that fractionally less of the bog's drainage will flow to Cushaling River and fractionally more will flow to the Mulgeeth Stream. Pro-rated to subcatchment areas, the mean flow to the Cushaling River will be reduced by 0.0021 m^3/s, or 2.1 l/s (*i.e.,* 7% of the estimated mean flow of 0.03 m^3/s as defined in Sections 8.5.8 and 8.4.9.

In practice, this is an imperceptible change and within the margin of error of flow estimates. Moreover, the reduced flow to Cushaling River will be partially compensated by a) the stormwater runoff from the expanded landfill which is captured by the perimeter swale and directed to Cushaling River, and b) the discharge from the new ICW which includes shallow groundwater captured by the under-cell drainage system.

The under-cell drainage is an operational matter (Section 8.5.2.3) but will occur in parallel with sequential construction phases. Both stormwater and shallow groundwater will be actively captured and discharged (under license) during the 24-year construction phase.

The corresponding increase in mean flow of Mulgeeth Stream is similarly minor. Based on EPA's Qube model, the modelled mean flow of the Blackwater (Longwood) River at a location approximately 2.5 km east (and downstream) of the exit point of Mulgeeth Stream from TSB is 0.28 m^3/s.[13] This includes the drainage contribution from TNB. The additional mean flow contribution of Mulgeeth Stream represents <1% of the Qube modelled flow of the Blackwater (Longwood) River at this location.

Pre-Mitigation Potential Effects: Without the modified drainage network, including the drain blocks, the Proposed Development cannot proceed. The drainage layout of the TSB Decommissioning and Rehabilitation Plan is necessary to accommodate the landfill expansion. With regard to the Proposed Development alone, a fraction of stormwater runoff from the peat berm east of the landfill expansion footprint will be directed to Mulgeeth Stream via the new south-to-oriented drain. This re-directed runoff will contribute flow and potential, added chemical load to Mulgeeth Stream, and the main constituents of concern from the peat berm area are ammonia and dissolved organic carbon.

The potential effects on water quality cannot be predicted with certainty, as the changes in flow (and load) are small and within normal variations in both streams. Nevertheless, an illustrative calculation is presented below which:

- Defines the annual average runoff from the peat berm area (see below).
- Estimates an annual average ammonia runoff load which is guided by the annual average ammonia concentration of 0.16 mg/L (NH_3-N) at sampling station SW5 for the period 2014-2022 (per Table 8-5), which is the best available information in the absence of runoff sample values.

The annual average runoff from the peat berm area was calculated from the following inputs:

- Berm area: 10,350 m^2 (from Chapter 2).
- Annual average effective rainfall: Approximately 450 mm/yr, or 0.45 m/yr (from the national groundwater recharge map published by GSI (Hunter Williams et al, 2013).[14]
- Runoff coefficient (applicable to the annual average effective rainfall): 95% (conservative, high)

[13] NATQ30 flow at Qube model node RW_SEG CD 07_1636, accessible from https://gis-stg.epa.ie/EPAMaps/Water

[14] From GSI's web viewer at www.gsi.ie

Based on these inputs, the calculated annual average runoff rate from the berm area becomes 10,350 m^2 × 0.45 m/yr × 0.95 = 4,424 m^3/yr (0.00014 m^3/s).

Hence, the annual average load of ammonia from the eastern peat berm, without mitigation, becomes 4,424 m^3/yr × 0.16 mg/L = 0.71 kg/yr. This is an order of magnitude lower than the estimated annual average load from the existing ICW (Section 8.4.15). While representing a potential added load to Mulgeeth Stream, it also represents a reduced load to Cushaling River.

During storm events, average do not apply, and both the runoff and potential loading from the berm will be temporarily greater over short periods of time, as a function of both the magnitude and duration of the storm. For a 1-day duration, 1 in 100 year return period storm event, the rainfall depth is 86.8mm, or 0.087 m/d (Appendix 8-1). For this event, the calculated runoff volume from the berm becomes 10,350 m^2 × 0.087 m/d × 0.25 = 225 m^3/d (assuming a runoff coefficient of 25% for soils with a slow infiltration rate and slope between 2-6%)[15]. This equates to a 1-day duration ammonia load of approximately 0.035 kg/d.

Mitigation Measures: The proposed drain blocks outside the landfill expansion footprint will contribute to raising water levels in and surrounding the blocked drains. The raising of water levels is expected to reduce the leaching potential of ammonia and mobilisation of suspended matter east of the landfill expansion footprint.

The flat areas between the peat berms and actively flowing drains (e.g., the new south-to-north drain) will be purposefully vegetated to create buffer zones, whereby the aim is to attenuate ammonia and suspended matter loads.

The drain blocks will also serve as check dams for suspended solids (including organic matter). The water in the blocked drains will undergo natural attenuation processes (including nitrification), and such processes will continue in the downstream direction within TSB, Mulgeeth Stream and along the Blackwater (Longwood) River.

Bog drainage water which passes to the Cushaling River will continue to flow through the old settlement ponds near the western BnM landholding boundary. Bog drainage water which passes to the Mulgeeth Stream will pass through a new settling pond to be built on the main drain within TSB, before the exit point of TSB, as per PCAS/TSB Decommissioning and Rehabilitation Plan.

Post-Mitigation Residual Effects: With regard to the Proposed Development, the post-mitigation residual effects are related to minor changes in flow and chemical load to Mulgeeth Stream. These are not expected to be significant and will not change the character or sensitivity of the Blackwater (Longwood) River in the downstream direction.

The corresponding changes in flow and chemical load to the Cushaling River will be imperceptible from documented baseline conditions.

The residual effects of the new drainage network during the construction phase are long-term (>15 years). They will, however, not affect the character or integrity of the attributes of the receiving waters. Hence, residual effects will not be significant.

8.5.2.4 Pumping/Dewatering of Open Excavations/Pits

As landfill phases are excavated, water will enter the excavations by direct rainfall and via groundwater seepage once the groundwater level is reached/intercepted. The water inside the

[15] TII Publication RE-CPI-07001, accessible from: https://www.tiipublications.ie/library/RE-CPI-07001-01.pdf

excavations will collect in sumps and the water will be pumped out using sump pumps. For illustration purposes, and based on construction experiences from the existing WMF, the type of pump that will be used is similar to that depicted in Photo 5.

Photo 5 Hand-Carried Sump Pump

As described in Section 8.4.21 and Section 8.5.2.2, the pumped water will be directed to swales which will lead the water to attenuation lagoon and ICW systems before draining to the Cushaling River. In Stage 1 construction, the pumped water will be led to the existing attenuation lagoons and ICW system, south of the WMF. Once the new attenuation lagoons and ICW system is constructed in Stage 1 of the Proposed Development, water from sump pumping will be led to this system. In both cases, the respective attenuation lagoon and ICW systems serve to mitigate potential effects on the Cushaling River.

The excavation-related pumping and discharge will be periodic, as-needed based on prevailing climatic (rainfall) conditions and the geology that is intersected. The geology is relevant because sand and gravel lenses or channels (Chapter 7) will release more water, faster, into pits than clays and silts.

Based on experiences from the construction of the existing WMF, the quantities that will be managed will generally be less than 5 m^3/hr (0.0013 m^3/s, or 1.3 l/s), although shorter term pumping can be higher, especially after significant rainfall events. Pumping can be flexibly adapted (expanded) to accommodate higher pumping needs.

The discharge water from sumps will carry suspended sediments and possibly organic matter, and it is anticipated that concentrations of ammonia will be elevated since the water originates from the surrounding peat and shallow groundwater environment (Section 8.4.14). The attenuation lagoon and ICW system will serve to significantly attenuate both, as described in Sections 8.4.15 and 8.4.18.

Pre-Mitigation Potential Effects: Discharges from sump pumping can affect the water quality of Cushaling River. Based on Tables 8.1 and 8.3, pre-mitigation potential effects are those that would arise if the water was not discharged to attenuation lagoon and ICW systems, which is not applicable.

Mitigation by Avoidance: Following water management procedures in the existing WMF, a perimeter drain will be dug around the phase that is under construction as a means of helping to control water levels in the excavations. This limits the quantity of water collecting in excavation floors.

Existing drains that presently cross the landfill footprint will also be blocked off. This will raise water levels in subsoils and peat along the drain trajectories, external to the landfill footprint, but will also prevent ingress of water from the drains into the excavations.

Mitigation by Design: The water pumped by sump pumps will also pass through silt bags before being discharged into swales. As the water pass through the silt bags, the majority of sediment and organic matter is retained by geotextile fabric. The silt bags will be used with natural vegetation filters or sedimats. Sediment entrapment mats, consisting of coir or jute matting, will be placed at the silt bag locations to provide further treatment of the outfalls from silt bags. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure that all water passes through this additional treatment measure. Level spreaders will be designed for each outfall. As outlined in the CEMP (Appendix 2-5), these are standard practice methods which help to reduce suspended matter loads.

Monitoring: Surface water will be monitored as described in Section 8.4.19 and 8.4.20.

Post-mitigation Residual Effects: Based on Tables 8.1 and 8.3, post-mitigation residual effects are considered to be:

- Not significant – residual effects will not affect the character or quality of the receiving water, and do not carry significant consequences.
- Likely – brief effects may occur, but is unlikely, and can mitigated and managed by rehabilitation (e.g. if/as the silt bags lose effectiveness or fail).
- Long-term – the perimeter swale and attenuation lagoon and ICW system are permanent features in place before waste cell excavations begin, hence the unlikely effects apply for the construction period, which exceeds 15 years (threshold for "long-term").
- Reversible – the unlikely effects can be undone through remediation/rehabilitation of equipment and installations (as indicate above).

Significance of Effects: For the reasons outlined above, likely significant effects on Cushaling River will not occur.

8.5.2.5 Accidental Spills and Leaks of Chemicals

Accidental spills and leaks of fuels or other chemicals to surface water represent a significant risk to surface water quality and aquatic habitats. For the Proposed Development, relevant pathways are runoff, drains and shallow groundwater. The ultimate receiving water body is the Cushaling River.

Pre-Mitigation Potential Effects: Based on Tables 8.1 and 8.3, pre-mitigation potential effects are:

- Negative – any spills or leaks will likely reduce the quality of the receiving water body (Cushaling River).
- Imperceptible to Profound – small spills/leaks may cause effects that imperceptible. Large or continuous spill/leaks can potentially damage the habitats and living organisms in the receiving water.
- Brief to Long-term – likely effects can be brief to long-term, depending on the nature and scale of the spill/leak. The construction period is 24 years in total. Hence, the risks of effects is constant over the construction period, even if effects of individual spills/leaks can be much shorter.
- Reversible – *i.e.,* potential effects can be mitigated and managed.

Mitigation Measures by Design: The prevention of, and responses to, accidental spills and leaks of fuel and other chemicals are covered by the CEMP. The following mitigation measures will be implemented:

- Onsite refuelling will be carried out at dedicated locations by trained personnel only.
- Onsite refuelling of machinery will be done by mobile double-skinned fuel bowsers.
- Drip trays and fuel absorbent mats will be available and used during all refuelling operations.
- A permit for the fuel system will be put in place.
- Fuel storage tanks will be bunded, self-contained and double-walled, conforming with EPA bunding specifications.
- The fuel-filling area will be fitted with a storm drainage system and an appropriate oil interceptor.
- The plant used during construction will be regularly inspected for leaks and fitness for purpose.
- Spill kits will be available to deal with and accidental spillages in and outside the re-fuelling area.

Post-Mitigation Residual Effects: Proven, routine, and effective measures to mitigate the risk of releases of fuels and chemicals will break the link between potential sources and receptors. Based on Tables 8.1 and 8.3, post-mitigation residual effects are considered to be:

- Not significant – residual effects will not affect the character or quality of the receiving water, and do not carry significant consequences.
- Likely – brief effects may occur, but are mitigated against and can be managed (addressed).
- Long-term – the duration of the applicability of mitigation measures does not change, and measures have to be applied for the duration of construction works.
- Reversible – *i.e.,* any effects can be undone through remediation.

8.5.2.6 Releases of Cement-Based Products

Entry of cement-based products to drains or other surface water features within the Proposed Development a represents a risk to the aquatic environment at and downstream of the release.

Concrete and other cement-based products are alkaline and can be corrosive. They generate fine, highly alkaline silt (pH 11.5) that can physically damage fish. A pH range of ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit.

Pathways are runoff and drains. The main receptor is the Cushaling River.

Pre-Mitigation Potential Effects: The washing of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution. Based on Tables 8.1 and 8.3, pre-mitigation potential effects are:

- Negative – *i.e.,* discharges will likely reduce the quality of the receiving water body (Cushaling River).
- Moderate – if unmitigated, discharges will likely cause noticeable changes in the character of the receiving water and can affect existing baseline conditions.
- Long-term – construction is carried out in 12 stages each stage will last for approximately 1.5 years. Hence, water quality effects from discharges would span more than 15 years (the criterion for medium term effects in Table 8-1). Without mitigation measures, releases of cement-based products can have effect on river morphology as well, which can be long-term or even permanent.

- Reversible – *i.e.,* risks and likely effects can be mitigated and managed.

Mitigation Measures by Avoidance: Concrete will be delivered where it is needed in sealed concrete delivery trucks. Ready-mixed supply of wet concrete products such as pre-cast elements for culverts will be installed. Concrete trucks will be directed back to their batching locations for washout. As stated in the CEMP, discharge of cement-based products to construction phase drainage systems or directly to any artificial drain or other watercourse will not be allowed. Pre-cast elements for culverts will be used.

Mitigation Measures by Design: Batching of cement will be carried out at dedicated, existing locations within the WMF. Chute cleaning water will be undertaken at lined cement washout ponds. Containment will be facilitated with straw bales. Ponds will be lined with an impermeable membrane. Ponds will also be covered when not in use to prevent rainwater collecting. Pour sites of cement will be kept free of standing water, and plastic covers will be ready in case of sudden rainfall events.

Risks of pollution will be further reduced as follows:

- Concrete will not be transported around the site in open trailers or dumpers so as to avoid spillage while in transport.
- All concrete used in the construction will be pumped directly into the shuttered formwork from the delivery truck. If this is not practical, the concrete will be pumped from the delivery truck into a hydraulic concrete pump or into the bucket of an excavator, which will transfer the concrete locally to the location where it is needed.
- Arrangements for concrete deliveries will be discussed with operators before work starts, confirming routes, prohibiting onsite washout and discussing emergency procedures.
- Clearly visible signage will be placed in prominent locations close to concrete pour areas specifically stating washout of concrete lorries is not permitted on the site.
- Using weather forecasting to assist in planning large concrete pours and avoiding large pours where prolonged periods of heavy rain is forecast.
- Restricting concrete pumps and machine buckets from slewing over watercourses while placing concrete.
- Ensuring that covers are available for freshly placed concrete to avoid the surface washing away in heavy rain.
- Disposing of any potential, small surplus of concrete after completion of a pour in suitable locations away from any watercourse or sensitive habitats.

Post-Mitigation Residual Effects: Proven, routine, and effective measures to mitigate the risk of releases of cement-based products are in place which will break the link between potential sources and receptors. Based on Tables 8.1 and 8.3, post-mitigation residual effects are considered to be unlikely, neutral, and imperceptible. The risk of residual effects is long-term, as the duration of the applicability of mitigation measures covers the duration of the entire construction phase. Residual effects, should they occur, can be undone through remediation.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water quality will not occur.

8.5.2.7 Wastewater Management

As described in Chapter 2 of the EIAR, the Proposed Development includes a dedicated contractor's compound where welfare facilities for staff in the form of portacabins will be established for the duration of construction works and removed by the Contractor at the end of each construction contract.

Separate welfare facilities are already in place for operational staff in the existing WMF administration building and additional welfare facilities are being constructed for operational staff in the new MSW Processing and Composting Facility as well as in the new Maintenance Building.

As such, wastewater will not be treated or disposed of within the Proposed Development areas. Associated wastewater will be collected regularly and brought offsite in fully enclosed tanks for disposal by authorised means (permitted wastewater collector) to a wastewater treatment plant.

The use of sealed storage tanks and offsite disposal breaks the link between the source and receptor. Hence, likely significant residual effects on peat and groundwater from the Proposed Development will not occur.

8.5.2.8 WFD Status of Surface Water Bodies

A WFD compliance assessment of the Proposed Development is presented in Appendix 8-4. Key aspects of the assessment are described below.

The Cushaling River, as the principal receiving water body, is part of the Figile_010 river water body. The water body is classified as being at "*Poor ecological status*" in the period 2016-2021 (see Section 8.4.6), and is associated with "*Poor invertebrate status or potential*". Impaired water quality and river morphological conditions are likely contributing to the "*Poor invertebrate status or potential*".

As documented in Section 8.4.6, Section 8.4.13, and 8.4.14, the water quality and character of the Figile_010 river water body is influenced both by the outflow from TSB and environmental pressures downstream of TSB (EPA, 2019). The latter includes wastewater discharges (especially urban wastewater discharges at Derrinturn) and agricultural land uses/activity west of TSB.

As documented in Section 8.4.14, the water quality influence from TSB relates mainly to concentrations of ammonia in the Cushaling River. The AA-EQS for total ammonia is exceeded in samples from SW5 (old settlement ponds) in all years and from SW4 (Cushaling River downstream of the BnM landholding boundary) in some years. The main contributor of ammonia load is drainage from the TSB, and not the licensed discharge from the WMF. The ammonia in water transforms to nitrate in the downstream direction by the process of nitrification (USEPA, 2002). TSB does not export a significant load of phosphorus to the Cushaling River.

A key environmental objective of WFD implementation is to prevent the deterioration of WFD status from one 6-year river basin management plan cycle to the next. During construction, which will last for 24 years, there is risk of water quality deterioration, especially with regard to chemical loading (e.g., ammonia) and sedimentation of suspended solids (a river morphology issue). Both can contribute to loss of (quality of) aquatic habitat.

Pre-Mitigation Potential Effects: Without mitigation measures, likely significant effects can result from the activities and items presented in preceding sections, especially 8.5.2.2. Because the construction period is over 24 years, pre-mitigation potential effects will be long term.

Mitigation by Design: Strict control measures will be put in place, as presented in Section 8.4.21 and Sections 8.5.2.1 through 8.5.2.7. Construction-related waters will pass through swales, sumps, check dams, attenuation lagoons and ICW systems in all stages of development. Existing data associated with the existing attenuation lagoons and ICW system at the WMF shows that ammonia and suspended solids concentrations are significantly reduced (attenuated) by the system, with discharge values that are consistently below ELVs.

Surface Water Quality Monitoring: Surface water quality monitoring serves to identify, track and respond to potential effects. The proposed surface water quality monitoring is presented in Section 8.4.19.

Post-Mitigation Residual Effects: In the context of WFD status, and based on Table 8-3, there will be no likely significant effects on the WFD status of the Figile_010 or Blackwater (Longwood)_010 river water bodies (see Appendix 8-4 for further details) from the Proposed Development. Rather, the CEMP and the attenuation lagoons and ICW system will contribute to attenuation of ammonia especially, which will be a net positive (albeit minor) effect.

While it can be said with certainty that WFD status will not deteriorate (since loads are reduced compared to the baseline), it cannot be stated with certainty that WFD status will improve. Water quality improvements have the potential to contribute to WFD status improvement, but there are several other factors outside TSB that will influence EPA's WFD status classification of respective water bodies, including the environmental pressures that are documented downstream of TSB (Section 8.4.6).

8.5.2.9 Designated Sites and Protected Areas

The locations and descriptions of designated sites and protected areas were presented in Chapter 6 of this EIAR (Biodiversity). With regard to the Cushaling River, the nearest SAC that is hydrologically linked with the Proposed Development is the River Barrow and River Nore SAC (see Section 8.4.5). The nearest protected area is a section of the River Barrow near Athy which is a designated drinking water protected area (see Section 8.4.5).

The Cushaling River is a surface water pathway between the Proposed Development and both the SAC and drinking water protected area. The Cushaling River becomes the Figile River in the downstream direction (near Ticknevin). The latter merges with River Barrow near Monasterevin, more than 30 km (straight line distance) downstream and southwest of TSB.

In the downstream direction, the Cushaling/Figile River grows in size. The mean flow of Cushaling River near the western BnM landholding boundary is approximately 0.03 m^3/s. Approximately 13 km (straight line) distance southwest, the recorded mean flow at the Clonbulloge gauging station (ID 14004 operated by OPW) on the Figile River is 3.08 m^3/s.

This represents a 100-fold increase in mean flow, which will result in downstream dilution of any pollutants in Cushaling River. The River Barrow is a larger than Figile River again, and provides for additional dilution potential at the confluence between the two rivers. Hence, the concentration of a hypothetical contaminant (e.g., nitrate) from the Proposed Development will be diluted by a factor of at least 100 between TSB and the Barrow River, all other factors along the pathway being constant.

There is, nevertheless, a risk present from the Proposed Development on both the SAC and drinking water protection area, albeit low. The risk is proportional to types of contaminant that are released, relative concentrations, and the transformation of contaminants that take place in the downstream direction.

As an illustrative example, the annual average concentration of total ammonia (NH_3 as N) of 0.16 mg/L at station SW5 (near the TSB boundary) for the period 2015-2022 will attenuate to 0.0016 mg/L at the Clonbulloge gauging station (by dilution alone), and lower still in the Barrow River.

Ammonia and other pollutants are additionally subject to other attenuation processes which will serve to reduce concentrations along flow paths further (e.g., nitrification, uptake).

For the reasons outlined above, likely significant effects on the named designated sites and protected areas are not expected to occur during construction. Risks of pre-mitigation effects are low and the proposed mitigation measures in preceding sections will reduce risks further, making any effects on the SAC or drinking water protected area imperceptible.

Based on the necessary modification to the drainage network within TSB (Section 8.5.2.3), the Proposed Development will become indirectly linked to Mulgeeth Stream, whereby runoff from the peat berm and blocked drains to the east of the expanded landfill footprint will flow to the stream via the new south-to-north oriented drain that is being constructed as part of the TSB Decommissioning and Rehabilitation Plan (Section 8.6). Mulgeeth Stream flows to the Blackwater (Longwood) River and thus indirectly connects the Proposed Development with the River Boyne catchment, including the River Boyne SAC and the Trim drinking water protected area (see Appendix 8-4). For the same reasons outlined above, likely significant effects on the named designated sites and protected areas will not occur during the construction phase.

8.5.2.10 Surface Water-Sourced Public or Private Water Supplies

As stated in Section 8.5.2.9, the segment of the River Barrow near Athy, downstream of the confluence with the Figile River, is a designated drinking water protected area, approximately 35 km (straight-line distance) south of TSB. Athy is served by the Srowland Water Treatment Plant which in 2020 abstracted approximately 3 Million litres per day.

A hypothetical chemical release from the site would travel 35 km in just under 10 hours for a river flow velocity of 1 m/s, recognising that the actual flow distance to Athy is longer than 35 km when the meandering river trajectory is factored in. Should a spill event occur (e.g., of fuel), the travel time involved allows time for BnM to alert Uisce Éireann of the spill and for responses to be put into effect.

There are no private river water abstractions intended for human consumption between TSB and the Srowland Water Treatment Plant. As such, the Athy public water supply is the main drinking water source at risk.

Prevention of contamination events of hazardous substances is a key objective of the CEMP. The CEMP also includes protocols for alerting Uisce Éireann and the Srowland Water Treatment Plant directly.

For the reasons outlined above, no likely significant effects on the Athy public water supply from construction of the Proposed Development will occur.

As described in Section 8.5.2.9, the necessary modification to the drainage network within TSB (Section 8.5.2.3) will create an indirect link between the Proposed Development and Mulgeeth Stream. The latter is a headwater stream of the Boyne River, which is an SAC and includes the Trim drinking water protected area (see Appendix 8-4). For the same reasons outlined above, no likely significant effects on the Trim public water supply will occur during the construction phase.

8.5.3 Operational Phase

Likely significant effects of the Proposed Development on the receiving water environment and proposed mitigation measures during the operational phase are described below.

Operations involve:

- Waste filling and capping (upon completion of a landfill phase).
- Maintenance of landfill-related infrastructure and control features, including water management (e.g. stormwater collection).
- Discharges from the new attenuation lagoons and ICW system, under license.

As described in Chapter 2 of the EIAR, and summarised in Section 8.5.2, operations will be conducted in parallel with construction of new landfill phases, sequentially across 12 new landfill phases over an approximately 25-year period. Because the landfill phases are similar in scale and nature, risks of effects during operations are also similar in nature and scope in each phase.

8.5.3.1 Maintenance Works

The maintenance activities that carry the greater risk of affecting the Cushaling River (and Mulgeeth Stream) are a) the periodic removal of sediments from silt fences, silt traps and drains, and b) accidental spills or leaks of chemicals.

The periodic removal of sediments is necessary to maintain drains and protect water courses. The potential for causing erosion and mobilising sediment transport during the operational phase is significantly lower than during the construction phase, as drainage controls and working routines are in place and all major earthworks are completed.

The risks of accidental spills or leaks of chemicals is mainly related to machinery since storage facilities and refilling activity will not take place inside the Proposed Development area.

Relevant pathways are runoff, drains and groundwater. The principal receptors are shallow groundwater and the Cushaling River.

Pre-Mitigation Potential Effects: Without mitigation measures, there are no controls or routines in place to control, manage, or otherwise limit sedimentation, clogging of drains, discharges, and accidental spills and leaks. Accordingly, the pre-mitigation potential effects are:

- Negative – the baseline aquatic environment could be affected.
- Likely – effects are likely because risks are present on a continual basis over 25 years.
- Moderate – effects can alter the character of the receiving water in a manner that is consistent with existing baseline trends.
- Long term – the operations phase is longer than 15 years and less than 60 years (the threshold for long-term effects in Table 8-1).

Mitigation Measures by Design: Maintenance works will be subject to routines and procedures which are based on BnM's extensive operational experience (under licence) at the existing WMF.

Because operational maintenance activity is conducted in parallel with construction activity (in adjacent phases), and risks are of a similar nature, (e.g., accidental spills and leaks), the key measures that apply for maintenance works are covered by those outlined in Section 8.5.2.

Post-Mitigation Residual Effects: Based on Tables 8-1 and 8-3, post-mitigation residual effects are:

- Neutral – effects are manageable and changes will occur which are within normal bounds of variation and which is already demonstrated by the water quality monitoring data from the existing WMF (Section 8.4.134.

- Likely – based on operational experience from the existing WMF.
- Not Significant – water quality variations will occur but these will be naturally occurring and mainly driven by load contribution from the bog.
- Long term – the operations phase is longer than 15 years (the threshold for long-term effects in Table 8-1).

Significance of Effects: For the reasons outlined above, no likely significant effects on the receiving water environment will occur from maintenance activity.

8.5.3.2 Water Management and Discharges From New Attenuation Lagoons and ICW

One of the main operational aspects of the expanded landfill is the collection and combined discharge of stormwater and groundwater from the under-cell drainage system, under license, from the new attenuation lagoon and ICW system.

The stormwater represents rainfall runoff from the landfill cap and hardstanding areas, and is captured by a landfill perimeter drain. The under-cell drainage water is shallow groundwater which is captured beneath actively filled cells (see Chapter 7 of this EIAR).

The combined discharge from new attenuation lagoons to the new ICW is a passive overflow which will be proportional to water levels in the lagoons. In some periods, there will be no overflow and in other periods, time-varying discharges will occur in the same way as documented in Section 8.4.12 for the existing WMF. Based on the operational data from the existing WMF, the maximum recorded discharge rate from the existing attenuation lagoons between 2015 and 2022 was approximately 0.038 m^3/s (derived from converting monthly totaliser flow meter readings). The meter readings do not capture individual peaks on any given day, and it is considered likely that discharges will be temporarily higher in short periods of time, notably during storm events.

The discharge passes through the new ICW before discharging to the main channel which leads water to the old settlement ponds and Cushaling River. As water passes through the ICW, the plants will consume some of the water, and more so in summer/growing season than in winter.

As the water passes through the new attenuation lagoons and ICW, significant attenuation of ammonia and suspended solids will be achieved. Based on operational experiences with the existing WMF (Section 8.4.14), total ammonia and suspended solids concentrations are expected to be below EQSs for surface water and the ELVs that accompany the existing discharge license for the WMF.

As such, the main chemical and sediment loading to the Cushaling River will continue to be from the bog (see Section 8.5.3.2).

The quality of the discharge water will not be affected by landfill leachates. As described in Chapter 2 of this EIAR, the expanded landfill will be fully lined and cells are further underlain by an under cell drainage system which serves as an added level of protection. The landfill liner (see Chapter 2 of this EIAR for further information) is designed and engineered based on requirements of the EPA landfill design manual (EPA, 2000). The leachate is contained within the landfill cells, collected and transferred by tanker to licensed waste water treatment plants, including Ringsend in Dublin under legal agreement with Uisce Éireann.

In the unlikely event that pollutants are identified in the discharge water (by monitoring, see Section 8.4.19), pollutants will undergo attenuation in the subsurface (groundwater) environment and will be partially or wholly captured by the under-cell drainage system. As such, the under-cell drainage system acts as a second barrier (protection level).

The new discharge from the expanded landfill will also help to sustain river flow conditions, which is especially beneficial during prolonged dry weather conditions.

Pre-Mitigation Potential Effects: Pre-mitigation potential effects are those that would occur without the new, designed attenuation lagoons and ICW system.

In this instance, the quality of the water that will be discharged from the expanded landfill is expected to be similar to that documented from sampling station SW7 in Section 8.4.14.8. representing inflowing water from the WMF. The water at SW7 is described by elevated concentrations of ammonia and variable concentrations of parameters that otherwise reflect the stormwater influence (e.g. SEC, SS).

In this scenario, the discharge water will not have benefited from the significant attenuation that takes place across the new, designed attenuation lagoons and ICW system. Accordingly, the pre-mitigation potential effects are:

- Negative – the discharges will contribute higher chemical load, derived from stormwater and groundwater in the under-cell drainage system.
- Moderate – the chemical load will contribute to alter the character of the receiving water in a manner consistent with existing baseline trends.
- Long term – the operations phase is longer than 15 years (the threshold for long-term effects in Table 8-1).

Mitigation by Design: The proposed new, designed attenuation lagoons and ICW system is a necessary mitigation measure. As presented in Appendix 2-4, it is specifically designed to remove ammonia and suspended solids in the discharge. It will serve to reduce loads that would otherwise be higher, which will benefit the receiving water environment.

Post-Mitigation Residual Effects: Based on Table 8-1 and Table 8-3, the post-mitigation residual effects are:

- Positive – the discharges will contribute to lowering the chemical and sediment load to the Cushaling River, which translates to water quality improvement.
- Likely – the effect is likely. Based on operational experience from the existing WMF, significant attenuation will be achieved.
- Slight – the chemical load will likely cause noticeable/measurable changes to water quality (lower ammonia and suspended concentrations) compared to baseline conditions, but without changing the sensitivities of the river.
- Long term – the operations phase is longer than 15 years (the threshold for long-term effects in Table 8-1).

Significance of Effects: Based on Table 8-3, there are no likely significant negative effects. Rather, the effect is considered minor positive. The Proposed Development, specifically the new, designed attenuation lagoons and ICW system, will likely contribute to improving baseline conditions (water quality) in the Cushaling River.

8.5.3.3 WFD Status of Surface Water Bodies

A WFD compliance assessment is presented in Appendix 8-4. Key aspects of the assessment are summarised below.

Potential effects from expanded landfill operations are those referenced and addressed in Sections 8.5.3.1 and 8.5.3.2. The greater risk to WFD status classification is associated with chemical load (especially ammonia) and settling of suspended sediments affecting both water quality and biological quality elements of Cushaling River in particular as the principal receiving surface water.

WFD status is classified by EPA in 6-year cycles. The operational period covers 25 years, *i.e.,* up to 4 WFD river basin management plan cycles. Therefore, the risk of failing to achieve WFD environmental objectives has a longer-term perspective.

Pre-Mitigation Potential Effects: Without mitigation measures, which includes the new attenuation lagoons and ICW system, likely significant effects can result from maintenance activities and discharges since, in this scenario, control measures are not in place.

Mitigation by Design: Relevant mitigation measures are those referred to in Sections 8.5.3.1 and 8.5.3.2, and include the new attenuation lagoons and ICW system.

Surface Water Quality Monitoring: Surface water monitoring will proceed as described in Section 8.4.19.

Post-Mitigation Residual Effects: Based on Tables 8-1 through 8-3, the likely post-mitigation residual effects on WFD status are:

- Positive – the discharges via the new designed ICW will contribute to lowering the chemical and sediment load to the Cushaling River, which translates to water quality improvement.
- Likely – the effect is likely. Based on operational experience from the existing WMF, and as described in Section 8.4.14, significant attenuation of ammonia and suspended solids will be achieved across the new attenuation lagoons and ICW system.
- Slight - the reduced chemical load will likely cause measurable lower ammonia concentrations at stations SW5 and SW4 compared to baseline conditions, which means that calculated annual average concentrations of total ammonia will also be lower. Water quality improvements may also help to halt or reverse the apparent upward trends since 2018 that were referred to above.
- Long term – the operations phase is longer than 15 years (the threshold for long-term effects in Table 8-1).

Significance of Effects: The planned new discharge from the Proposed Development will be conducted under license in the same manner and at concentrations that are comparable to, or lower than, the discharge from the WMF. As such, the new discharge has the potential to reduce total ammonia concentrations at monitoring station SW5, hence also SW4.

While it can be stated with some confidence that the current (2016-2021) WFD status of the Figile_010 river water body will not deteriorate by implementation of the Proposed Development, this measure of confidence cannot be extended to expectation that WFD status might improve. This is because the status classification of the Figile_010 river body is also contingent on environment pressures and condition offsite and downstream of the Proposed Development (Section 8.4.6), including river morphology.

There is, nevertheless, potential for improvements, by virtue of the beneficial effects of the new attenuation lagoons and ICW system.

For the same reasons described in Section 8.5.2.8, likely significant effects of the Proposed Development on WFD status of receiving waters will not occur.

8.5.3.4 Designated Sites or Protected Areas

Potential effects during the operational phase are the same as those described for the construction phase in Section 8.5.2.9. No further or additional effects are likely to occur during operations.

For these reasons, likely significant effects on the designated sites or protected areas will not occur.

8.5.3.5 Surface Water-Sourced Public or Private Water Supplies

Potential effects during the operational phase are the same as those described for the construction phase in Section 8.5.2.10. No further or additional effects are likely to occur during operations.

For these reasons, likely significant effects on the designated sites or protected areas will not occur.

8.5.3.6 Flood Risk

The flood risk assessment in Appendix 8-2 concludes that fluvial flood risk from the site is minimal. Flood risk will not be made greater by the Proposed Development. This is because discharges from TSB will be managed by the modified drainage network, and the channel capacity of the Cushaling River at the western landholding boundary is considerably greater than "Index Flood Flows" from the site (Section 8.4.10).

The future discharge to the Cushaling River from TSB will have three components:

- The current licensed discharge from the existing WMF, via the existing ICW.
- The future licensed discharge from the expanded landfill, which will be discharged via the new ICW.
- The discharge from the bog, which will be influenced by the modified drainage network as part of the TSB Decommissioning and Rehabilitation Plan (Appendix 2-2).

Based on Section 8.4.12, the recorded maximum discharge to the ICW from the WMF is 0.085 m^3/s. This serves as guide for what can be expected in the expanded landfill. Moreover, and based on the Engineering Services Report (Appendix 2-3), the estimated runoff from a 1 in 100 year storm event, when the expanded landfill is at capacity, is 0.114 m^3/s. This accounts for future climate change, for a high rainfall scenario of 30% above the defined long-term annual average.

Based on the drainage planning that supports the TSB Decommissioning and Rehabilitation Plan, "Index Flood Flow" (Q_{med}) value of approximately 1.2 m^3/s has been estimated for the subcatchment of TSB that drains to Cushaling River. This flow represents a 'typical peak flood' with a 50% chance of being exceeded in any given year (*i.e.,* 1 in 2 year recurrence interval).

Based on these figures, the sum of combined maximum discharges is approximately 1.4 m^3/s for "Index Flood Flow" conditions. This is significantly lower than the estimated channel capacity of 8.5 m^3/s of the Cushaling River near the western BnM landholding boundary (TCE, 2017), and confirms the low flood risk assigned in the FRA (Appendix 8-2).

As mentioned in Section 8.4.10, fluvial flood events within the site have not been recorded and water levels fluctuate annually by approximately 0.6 m on average in the old settlement ponds. As such, flood risk is mitigated by the significant storage and buffering capacity of the bog's drainage network and redirection of a portion of drainage water within TSB to Mulgeeth Stream (see Section 8.5.2.3 and Section 8.5.6).

Additionally, the hydrology of TSB will be stabilised as part of the TSB Decommissioning and Rehabilitation Plan. The plan will increase the water retention function of TSB, and drainage management will "*serve to regulate peak runoff in winter and potentially smooth out the flows in drier periods*".

Significance of Effects: For the reasons outlined above, it is not expected that likely significant effects on flood risk from the Proposed Development will occur.

8.5.4 Post-Closure

As described in Chapter 2, a Closure, Restoration and Aftercare Management Plan (CRAMP) will be required, to be approved by EPA. A CRAMP is in place for the existing WMF, which is already agreed with EPA. Upon granting a revised Industrial Emissions Licence (IEL) for the expanded facility, the existing CRAMP will serve to guide the future CRAMP for the expand landfill. Anticipated landfill closure tasks and programmes were presented in Appendix 2-11.

The potential effects associated with post-closure are mainly associated with decommissioning of infrastructure and plant. Risks and potential effects are similar to those described in Section 8.5.2, but risks are reduced as the scale of related works are smaller.

As a result of post-closure, it will be possible to reverse or at least reduce some of the potential effects caused during construction, and to a lesser extent operation, by rehabilitating constructed areas such as hardstanding areas. This will be done by re-establishing vegetation, thereby helping to reduce runoff and sediment loads. Some roadways will be kept and maintained following landfill closure, as these may be utilised for bog management and/or amenity purposes.

Any underground electrical cabling will be removed but ducting will remain in-situ rather than excavation and removal, as this is considered to have less of a potential environmental effect in terms of soil disturbance and thus generation of suspended sediment.

Other effects such as possible contamination by leachate leaks from waste cells will remain, and this will be strictly monitored under licence (post-closure monitoring).

Mitigation measures to avoid contamination by accidental leakage of soil and groundwater by onsite plant will be implemented as per the CEMP.

With these measures, no likely significant effects on the Cushaling River will occur during the decommissioning and post-closure stages of the landfill expansion.

Upon cessation of waste deposition, the under-cell drainage system will no longer be active, and shallow groundwater will recover to conditions that are controlled by the bog drainage network within TSB. The raising of water levels will contribute to reducing the leaching of ammonia, and reducing the transport of organic matter, hence reducing the chemical load of ammonia to the Cushaling River.

8.6 CUMULATIVE EFFECTS

The Proposed Development will interact with two other planned projects within the boundaries of TSB:

- Firstly, the traversing of the planned Shannon Pipeline[16] across the northwestern 'corner' of TSB, *i.e.,* to the northwest of the existing WMF. For this purpose, a linear corridor approximately 50 m wide has been agreed between Uisce Éireann and BnM, pending decisions about the Uisce Éireann going ahead in the future.
- The TSB Decommissioning and Rehabilitation Plan (Appendix 2-2). As described in Section 8.5.1, the plan will serve to raise water levels and stabilise hydrological conditions in the bog, in areas of TSB that are outside the redline boundary.

8.6.1 Shannon Pipeline

The Shannon Pipeline is a large diameter water supply pipeline which will bring treated drinking water from the Shannon River to new storage reservoirs near Dublin. Construction (installation) involves vegetation stripping, clear-brushing, and earthworks. Risks, potential effects, and mitigation measures that will be undertaken to address risks are similar/the same as those described in Section 8.5.2. Without mitigation measures, the construction could temporarily affect the water quality of both the Cushaling River and Mulgeeth Stream, as the pipeline trajectory crosses the subcatchments of both within TSB. The duration of construction of the pipeline segment through TSB is approximately 1 year.

Because the pipeline will be below ground, carries treated drinking water from the Shannon River, and pipeline excavations will be backfilled with native subsoil materials, the pipeline will not affect water courses in TSB during water transmission operations.

Accordingly, net cumulative effects on the water environment in TSB will not be significant.

8.6.2 TSB Decommissioning and Rehabilitation Pipeline

The likely effect of the Proposed Development with the proposed mitigation measures and in combination with implementation of the TSB Decommissioning and Rehabilitation Plan are two-fold:

- The subcatchment area within TSB that drains to the Cushaling River will be reduced by approximately 7%, which based on a pro-rating of areas, translates to an estimated annual average flow reduction of 0.0021 m^3/s (Section 8.5.2.3).
- The chemical and sediment loading to the Cushaling River will also be reduced, both from the effects described in Section 8.5.1 and by the attenuation that will occur in the new attenuation lagoons and ICW system.

The combined effects are expected to result in improvements in water quality of Cushaling River, which is supported by experiences from other bogs that are part of BnM's PCAS (Section 8.5.1). Precisely how quickly the improvements will occur cannot be predicted with certainty, but documented case studies indicate that improvements will become discernible within a few (<5) years.

Improvements in water quality also translates to improvements in river morphological conditions and aquatic habitat. Accordingly, the cumulative effects to Cushaling River will be net positive, likely, and permanent.

[16] https://www.water.ie/projects/national-projects/water-supply-project-east-1/

Cumulative effects on Mulgeeth Stream involve minor changes to flow and load contribution to the Blackwater (Longwood) River downstream. However, as documented in Section 8.5.2 and 8.5.3, the effects will not affect the characteristics or sensitivity of the river.

The cumulative effects will not result in deterioration of the WFD status of the Figile_010 or Blackwater (Longwood)_010 river water bodies. Rather, the expected improvements in conditions at the outflow of Cushaling River from TSB can potentially help to improve the present (2016-2021) "*Poor*" status classification in the future. However, it is recognised that the future WFD status classification will also be determined by the environmental pressures that exist or may be caused by any new or changed activities downstream of TSB.

Implementation of the TSB Decommissioning and Rehabilitation Plan is not a subject of the current planning application for the Proposed Development. However, it has undergone an appropriate assessment and a NIS which was reviewed by NPWS. The latest draft River Basin Management Plan for Ireland, which covers the period 2022-2027, refers to the beneficial effects that bog/peatland rehabilitation is expected to have on water quality, as a means of achieving WFD objectives (DHLGH, 2021). EPA has also identified "*Water quality improvements arising from the enhanced restoration*" as a topic under their 2021 research call.

8.6.3 Other Developments Outside TSB

BnM is planning to develop the Ballydermot Wind Farm[17] in areas to the west/southwest of TSB. The development is within the subcatchment of the Cushaling/Figile River and the Abbeylough River. However, the development is offsite and downstream of TSB, including the redline boundary of the Proposed Development.[18] For this reason, the wind farm development will not interact hydrologically with or influence the Proposed Development. Rather, the Proposed Development will influence the Cushaling River as it flows into the surface water 'catchment' of the wind farm development. As stated previously, the Proposed Development, in combination with the TSB Decommissioning and Rehabilitation Plan, will have a neutral effect on flow conditions and is expected to have a net positive effect on water quality in river.

It should be pointed out that the net positive effect will occur with the Proposed Development also, since the bog will continue to dominate the current loading experienced in the Cushaling River, guided by the calculations in Section 8.4.15. The expected load from the Proposed Development, represented by the discharge from the new attenuation lagoons and ICW system, will be in the same range as the measured/calculated load from SW6 (outflow from existing ICW at the WMF), which is less than the load from the bog.

8.7 REFERENCES

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