Preliminary Report on Source Protection

Doobally Group Water Scheme

County Cavan

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Executive Summary

Source protection is the protection of raw water quality through measures that limit or eliminate the risk of water contamination. It is an increasingly important strategy for the protection and maintenance of drinking water sources, emphasising prevention rather than cure in relation to raw water quality. The National Source Protection Pilot Project (2005-2009) overseen by the National Centre for Freshwater Studies (now the Centre for Freshwater and Environmental Studies) at Dundalk Institute of Technology represents a model for best practice for the implementation of source protection in Ireland and was designed for replication by group water schemes around the country.

This report provides a physical site description of the Doobally Group Water Scheme (GWS) catchment and explains the relevance to water quality (Section 4), discusses the potential impact of land use on raw water quality (Section 5), evaluates available relevant water quality data (Section 6) and provides recommendations to best manage concerns relating to source protection (Section 7).

Doobally Group Water Scheme is located approximately 6 km north of the town of Dowra in County Cavan, within the Boleybrack Mountain Special Area of Conservation. The scheme abstracts its water from Naweleian Lough located close to the Leitrim/Cavan county border at an elevation of approximately 390 m. The lake has a surface area of approximately 5 ha.

Two geological formations make up the bedrock which underlies the Doobally GWS catchment. The grey silty sideritic shales of the Gowlaun Formation are present in the western region of the catchment and underlie Naweleian Lough. Cyclothermic sandstone, siltstone and coal are present in the eastern part of the catchment in the Lackagh Sandstone Formation.

The aquifers of the catchment are Poor and generally unproductive, although the bedrock of the eastern region of the catchment may be productive in local zones. Subsoils and soils are dominated by Blanket Peat and are subsequently acidic and poorly draining. Groundwater Vulnerability is high throughout the catchment. Due to its remote upland location, there are no dwellings or industry located within the Doobally GWS catchment, and agricultural pressures (namely grazing by sheep) are relatively low.

Given the remote upland location of Naweleian Lough, it is unsurprising that pH levels in the raw water are low (acidic) as they reflect the peatland environment of the catchment. Subsequently there are few source protection measures that can mitigate low pH levels and therefore caustic dosing (or similar treatment) of the raw water is likely needed to ensure the pH of the treated water is kept within the parametric range of the Drinking Water Regulations (2007 and 2014).

True Colour values exceeded the Surface Water Regulations (1989) parametric value for Class A1 waters on 97 % of sampling occasions, with the average value for the sampling period being six times the Surface Water Regulations (1989) parametric value. The very high True Colour values and high Total Organic Carbon (TOC) values observed in the raw are indicative of the peaty environment of the Doobally GWS catchment. The fact that the Drinking Water Regulations (2007 and 2014) parametric value for THMs has not been exceeded may be due to either the success of the Dissolved Air Flotation treatment process undertaken, or that the THM sampling frequency may not be sufficient to identify when THM values are at their highest.

Raw water Iron concentrations were frequently high, exceeded the Surface Water Regulations (1989) on 43 % of occasions. Iron levels can be naturally high, especially within poorly draining, peaty soils such as those present within the Doobally GWS catchment. Subsequently there are few source protections measures that can be undertaken to reduce naturally high iron levels within the raw water.

Total Phosphorus has not been monitored within the raw water supply, however Total Oxidised Nitrogen values within the Naweleian Lough are surprisingly high given that the lake is located within an upland peatland environment where nutrient levels are usually low. Ammonia values frequently spike to high levels and Naweleian Lough is subsequently outside of the Surface Water Regulations (2009) classification for good quality for ammonia levels.

The frequent occurrence of algal blooms is also unexpected and also suggests that there are suitable levels of both nitrogen and phosphorus available within the lake to support the sometimes excessive algal growth. One potential source of the nitrogen is atmospheric deposition. Upland lakes may be particularly sensitive to the addition of nitrogen through atmospheric deposition, resulting in increased algal production and changes in nutrient balances, nutrient cycles and associated ecology.

Levels of Total Coliforms, *E. coli* and *Clostridia perfringens* within the raw water supply are of concern and have frequently exceeded the Surface Water Regulations (1989). However, following the treatment process, there have been no occasions when microbial contaminants have been found to be present in the treated water supply. The microbial contamination of the raw water supply is surprising given the low agricultural pressures and the lack of dwellings and subsequent on-site wastewater treatment systems within the catchment.

Given the physical site and water quality assessments undertaken through this report, the following recommendations are made in order to improve source protection and maintain high quality raw water supplies:

1. Put Source Protection on the agenda

Including source protection issues on the agenda of committee meetings increases the profile and awareness of source protection issues within the Doobally catchment, and brings into focus the recommendations made within this report. Developing a protocol for dealing with potential pollution incidences would be a good first step for the committee to address.

2. Consider initiating a short-term Trihalomethane monitoring programme

Although Trihalomethane (THM) concentrations have not exceeded the Drinking Water Regulations (2007 and 2014), it is recommended that a one year monitoring programme is instigated, with sampling frequency focussed on the period between late summer and early winter when the possibility of THM formation is likely to be greatest as a result of high True Colour and organic content within the raw water supply.

3. Investigate the position of the intake pipe at the point of abstraction

The frequently high levels of microbial contamination in the raw water supply are surprising given the remote location of Naweleian Lough and the low livestock pressures within the catchment. The microbial contamination levels suggest the possibility of sediment entering the intake pipe. Therefore Doobally GWS should check the height of the intake pipe from the lake bed and if necessary raise the intake pipe from the sediment whilst ensuring that there will be sufficient water depth to continue abstraction at that location.

4. Consider fencing around Naweleian Lough

If the intake pipe is found to be located at a suitable height from the lake bed, the direct access of livestock to the lake is likely to be the source of microbial contamination of the raw water supply. The fencing off of the whole lake would restrict livestock access and reduce the potential for future microbial contamination whilst also potentially reducing some treatment costs into the future.

5. Consider undertaking additional nutrient and algae monitoring

Total Phosphorus, Total Oxidised Nitrogen, Total Ammonia and algal levels may be monitored at a number of additional locations, for example at the lake source, the minor inflow stream to the lake as identified by Doobally GWS as a possible source of nutrients, as well as at one or two locations along the pipeline before a final sample at the treatment plant prior to the treatment process. The number of locations and the timeframes of sampling will be determined by available budget, but sampling should be undertaken at a minimum of a monthly basis from spring through to autumn.

1.0 Introduction

Source protection is the protection of raw water quality through measures that limit or eliminate the risk of water contamination. It is an increasingly important strategy for the protection and maintenance of drinking water sources. Source protection should be the first barrier in a multi-barrier approach to providing safe drinking water. In its simplest form, source protection emphasises prevention rather than cure in relation to water quality. A clean water source will help in the long-term provision of safe and cheap potable water. This approach involves managing any pollution in the raw water catchment area.

In Ireland, a limited number of studies have investigated the potential of source protection to improve water quality. The National Source Protection Pilot Project (NSPPP) at Churchill and Oram Group Water Scheme, County Monaghan (2005-2009) was established by the National Rural Water Monitoring Committee and was overseen by the National Centre for Freshwater Studies (now the Centre for Freshwater and Environmental Studies, CFES) at Dundalk Institute of Technology. The objectives of the pilot project were to assess water quality within the Milltown Lake catchment, identify sources of contamination and implement remediation measures to protect and enhance water quality in the lake. The project represents a model for best practice for the implementation of source protection in Ireland and was designed for replication by other group water schemes around the country. It is in the interest of privately-source group water schemes to carry out assessments to determine the potential for nutrient enrichment and biological contamination (e.g. *Enterococcus* species, *Escherichia coli, Cryptosporidium* species) of their water supplies, and to meet application conditions for a Water Services Licence under the Water Services Act (2007).

This report provides a physical site description of the Doobally Group Water Scheme (GWS) catchment and explains how this is relevant to water quality. The potential impact of land use is discussed and available raw water quality data is evaluated. Finally, major concerns relating to source protection are highlighted and recommendations are made as how best to manage these concerns in the future.

2.0 Methods

2.1 Catchment delineation and description

The outline of the catchment was defined using the available contours on the Map Genie ArcGIS basemaps available from Ordinance Survey Ireland and provided under license by the Geological Survey of Ireland. A number of national digital Geographical Information System Layers (GIS) were available from a various sources (Table 1), and were clipped to the catchment area of Doobally GWS. This allowed detailed descriptions of, for example, CORINE land cover, soils and geology, as well as illustrating the stream and water body network within the catchment.

Table 1: National GIS datasets used to describe the catchment

Dataset	Source	Description
Streams/Lakes/Rivers	EPA Ireland	Location of streams, lakes and rivers
CORINE	EPA Ireland	Image of land cover based on satellite imagery
Bedrock Geology	Geological Survey of Ireland (GSI)	Map (1:100,000 scale) of Irish bedrock geology)
Aquifer Bedrock	GSI	Information on the quality of groundwater aquifers
Aquifer Vulnerability	GSI	Information on the connectivity between contaminants and aquifers
Soils	GSI and Teagasc	Information on soil type
Subsoils	GSI and Teagasc	Information on subsoil type

2.2 Water Quality Data

Raw water quality data were collected by EPS, the service provider for Doobally GWS, and provided through the National Federation of Group Water Schemes in the form of Monthly Status Reports.

Parameters relevant to source protection were taken from the data set, analysed temporally and interpreted to highlight potential water quality issues in the Doobally GWS catchment and their potential causes and impacts.

3.0 Overview of the Doobally GWS catchment and the Water Framework Directive

Under the Water Framework Directive, the island of Ireland is divided into eight River Basin Districts (RBDs), two of which are international with boundaries shared by the Republic of Ireland and Northern Ireland. The Doobally GWS catchment lies within the Shannon International River Basin District. Each RBD is subdivided into Water Management Units, and Naweleian Lough and its catchment are included within the Upper Shannon Water Management Unit. An action plan for the Water Management Unit is available from http://www.shannonrbd.com/draftmanagementplan.htm.

This action plan presents an overview of water quality, information relating to potential causes of pollution and actions required to improve water quality to 'good' status (the overarching objective of the WFD is to achieve 'good' status for all water bodies)within the Upper Shannon Water Management Unit.

Of the 98 river water bodies monitored, the Upper Shannon WMU Action Plan classifies two rivers as having high status, 49 as good status, 18 moderate, 27 poor and two as bad status. Of the 39 lakes present within the WMU, two were classified as high status, 13 as good, 21 as moderate, two as poor and one as bad status, with one lake having no status assigned.

The Upper Shannon WMU Action Plan attributes 92 % of Total Phosphorus (TP) as being from diffuse sources, with agriculture contributing 73 % of TP. Unsewered properties, forestry and wastewater treatment plants contribute to 8 %, 7 % and 5 % of TP respectfully.

Naweleian Lough is not actively monitored through the Water Framework Directive Lakes Monitoring Programme, and the Upper Shannon WMU Action Plan attributes high ecological status to the lake through the extrapolation of regional data.

4.0 Physical Site Description

4.1 Catchment location and outline

Doobally Group Water Scheme is located approximately 6 km north of the town of Dowra in County Cavan. The scheme extracts its water from Naweleian Lough (Figure 1), located close to the Leitrim/Cavan county border at an elevation of approximately 390 m. The lake has a surface area of approximately 5 ha.

There are no inflow streams feeding Naweleian Lough. A single outflow stream flows south-easterly from the lake, eventually joining the Owennayle River approximately 3 km downstream of the Doobally GWS abstraction point. The catchment or Lough Naweleian is small, covering an area of approximately 0.4 km^2.

Naweleian Lough is situated within Boleybrack Mountain Special Area of Conservation which comprises an extensive upland plateau dominated by blanket bog and wet heath, with a number of oligotrophic and dystrophic lakes present. The area is protected as a result of the presence of five habitats listed in Annex I of the EU Habitats Directive (92/43/EEC) (NPWS, 2013). The site is lightly grazed by sheep and locally affected by burning and turbary. Much of the site is bounded by mature coniferous plantations, with recent plantings on blanket bog having caused significant local damage.

4.2 Bedrock geology

The bedrock underlying the Doobally GWS catchment consists of two geological formations (Figure 2). The Gowlaun Shale Formation, made up of dark grey silty sideritic shale (shale rich in iron carbonate), is present in the western half of the catchment and underlies Lough Naweleian. The Lackagh Sandstone Formation, consisting of cyclothermic, sandstone, siltstone and coal, is present in the eastern half of the catchment.

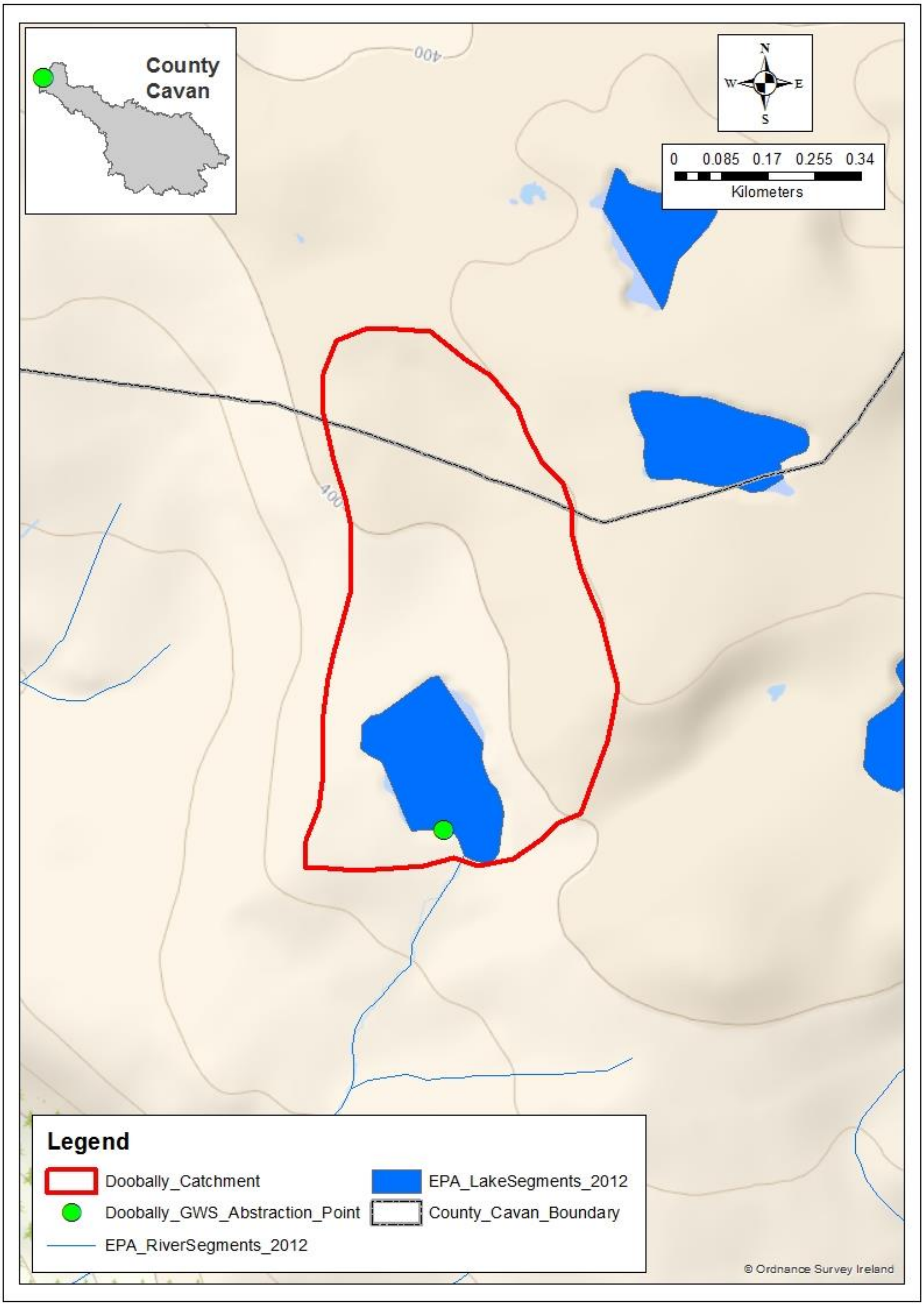

Figure 1: Surface water catchment area for the Doobally GWS.

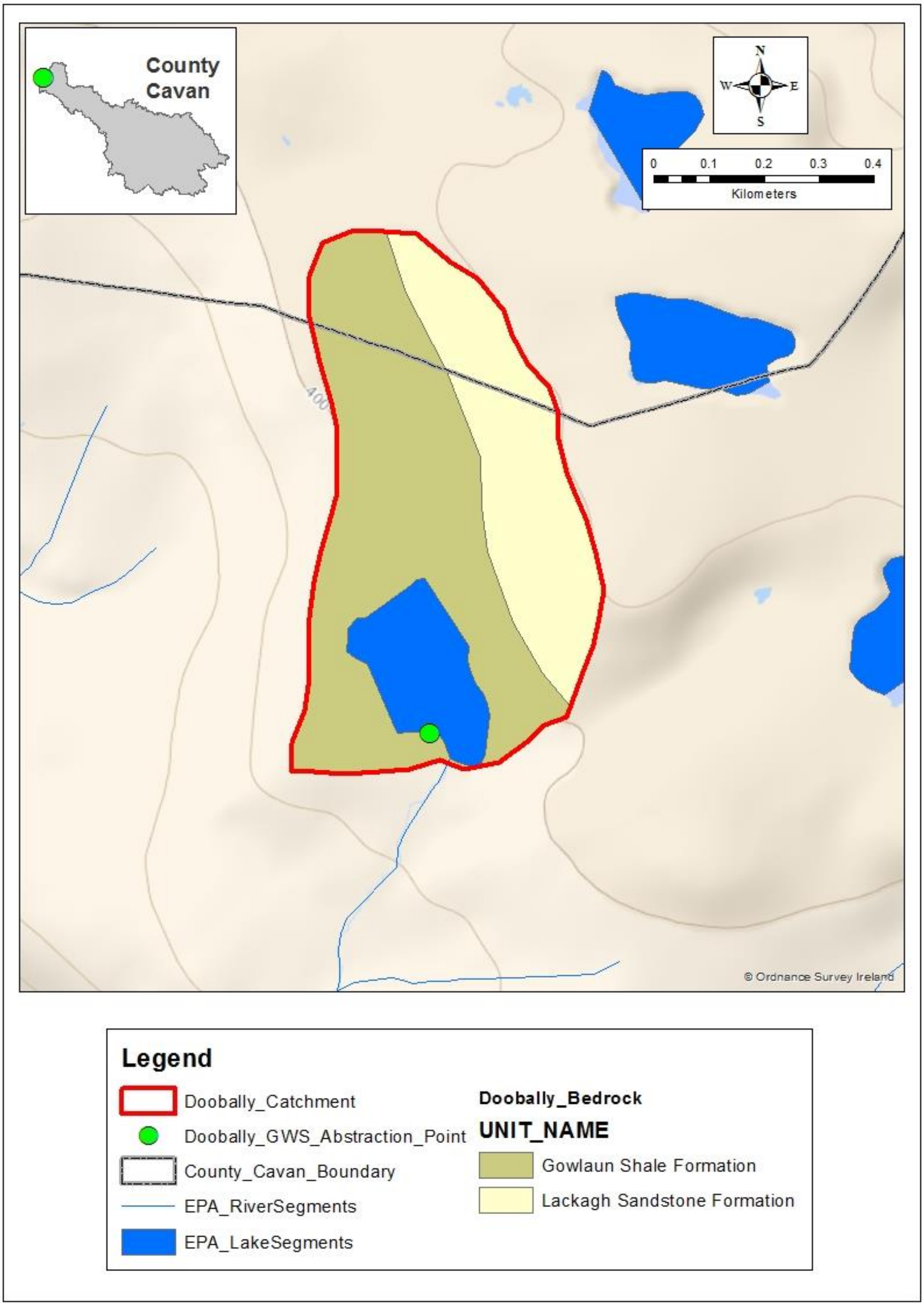

Figure 2: Bedrock geology within the Doobally GWS catchment.

4.3 Bedrock aquifers

An aquifer is an underground body of permeable rock or sand/gravel that yields water in sufficient quantities for use

The aquifers underlying the Doobally GWS catchment are Poor aquifers (Figure 3). The western aquifer, associated with the Gowlaun Shale Formation, is a Poor aquifer, the bedrock of which is generally unproductive. The eastern aquifer, associated with the Lackagh Sandstone Formation, is also a Poor aquifer, but the bedrock is generally unproductive except for local zones. Such aquifers are generally considered as unproductive (i.e. groundwater wells produce low yields), yet are mapped as covering approximately two-thirds of the total land area of Ireland. They are not regarded as important sources of water for public water supply, yet are believed to be important with regard to delivering water (and associated pollutants) to rivers and lakes via shallow groundwater pathways (EPA, 2010).

4.4 Groundwater vulnerability

Groundwater vulnerability refers to the likelihood of surface water contaminants reaching the groundwater store. The vulnerability of groundwater is dependent on three components: 1). the time of travel of infiltrating water (and contaminants); 2). the relative quantity of contaminants that can reach the groundwater; and 3). the contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate.

The whole of the Doobally catchment is classified as being of High groundwater vulnerability (Figure 4).

The vulnerability of groundwater is affected by the permeability of the overlying subsoils and soils and the interactions with surface water and groundwater.

4.5 Subsoils

Subsoils lie between the bedrock and soils and are the most important feature in influencing the groundwater vulnerability to pollution as they act as a protective filtering layer, the effectiveness of which depends on their type, permeability and thickness.

The Doobally GWS catchment subsoils are dominated by a single classification: Blanket peat (Figure 5), reflecting the upland environment of the catchment.

4.6 Soils

As for the subsoils, the soils of the Doobally GWS catchment are dominated by a single classification: Blanket peat (Figure 6). Water flowing from peaty environments such as the Doobally GWS catchment is typically low in pH (acidic), high in colour and high in Total Organic Carbon content.

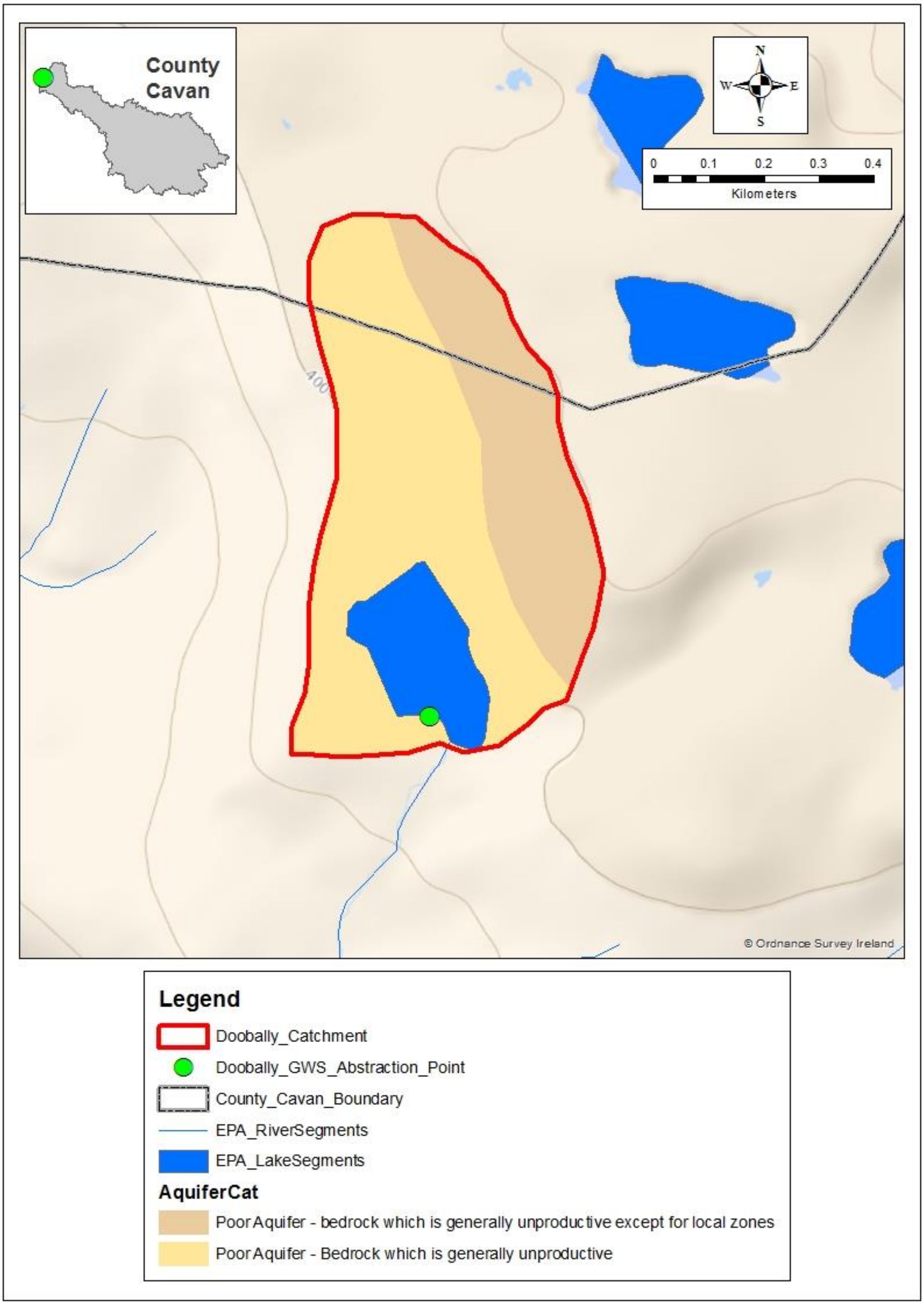

Figure 3: Aquifer types present within the Doobally GWS catchment.

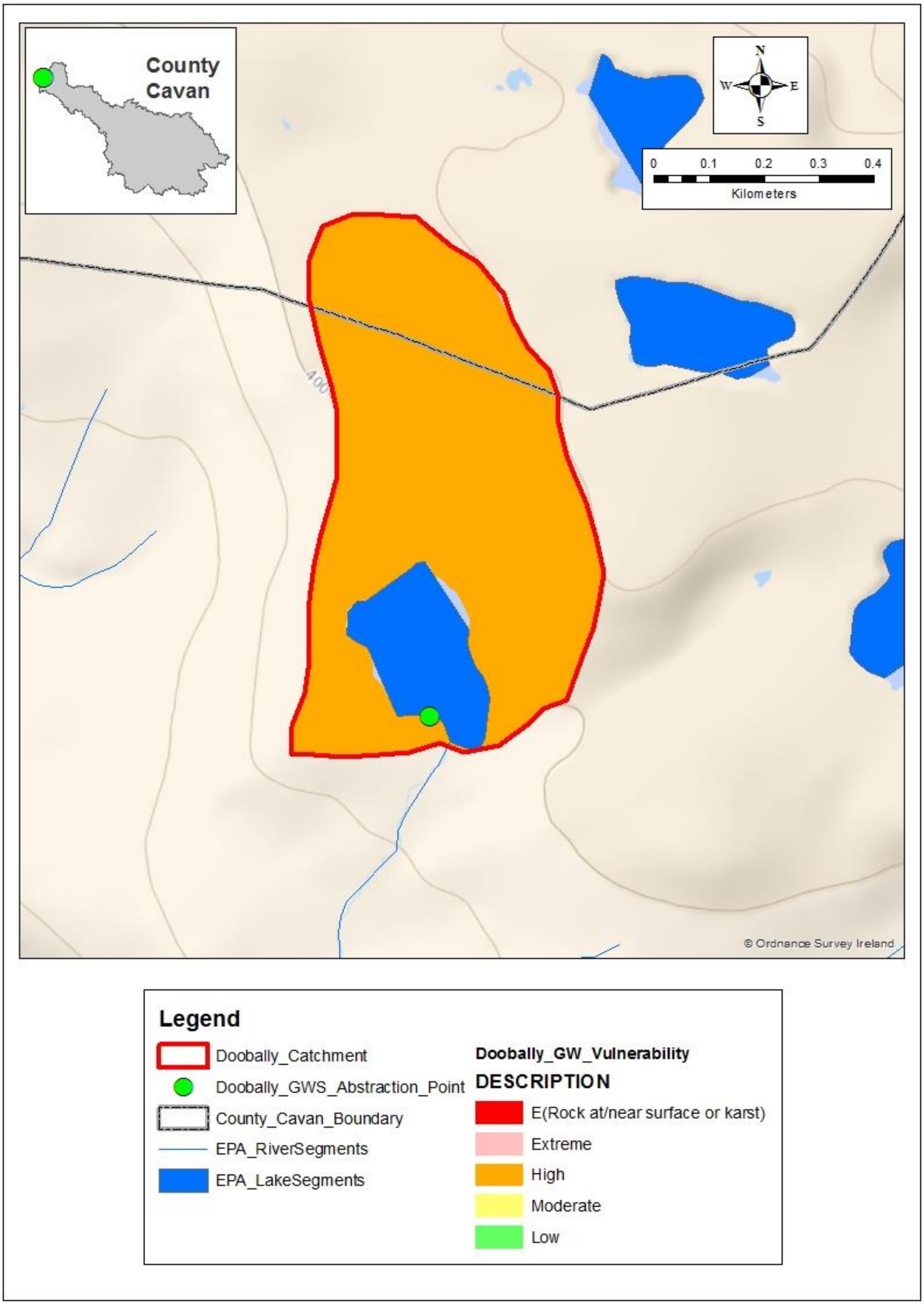

Figure 4: Groundwater vulnerability within the Doobally GWS catchment.

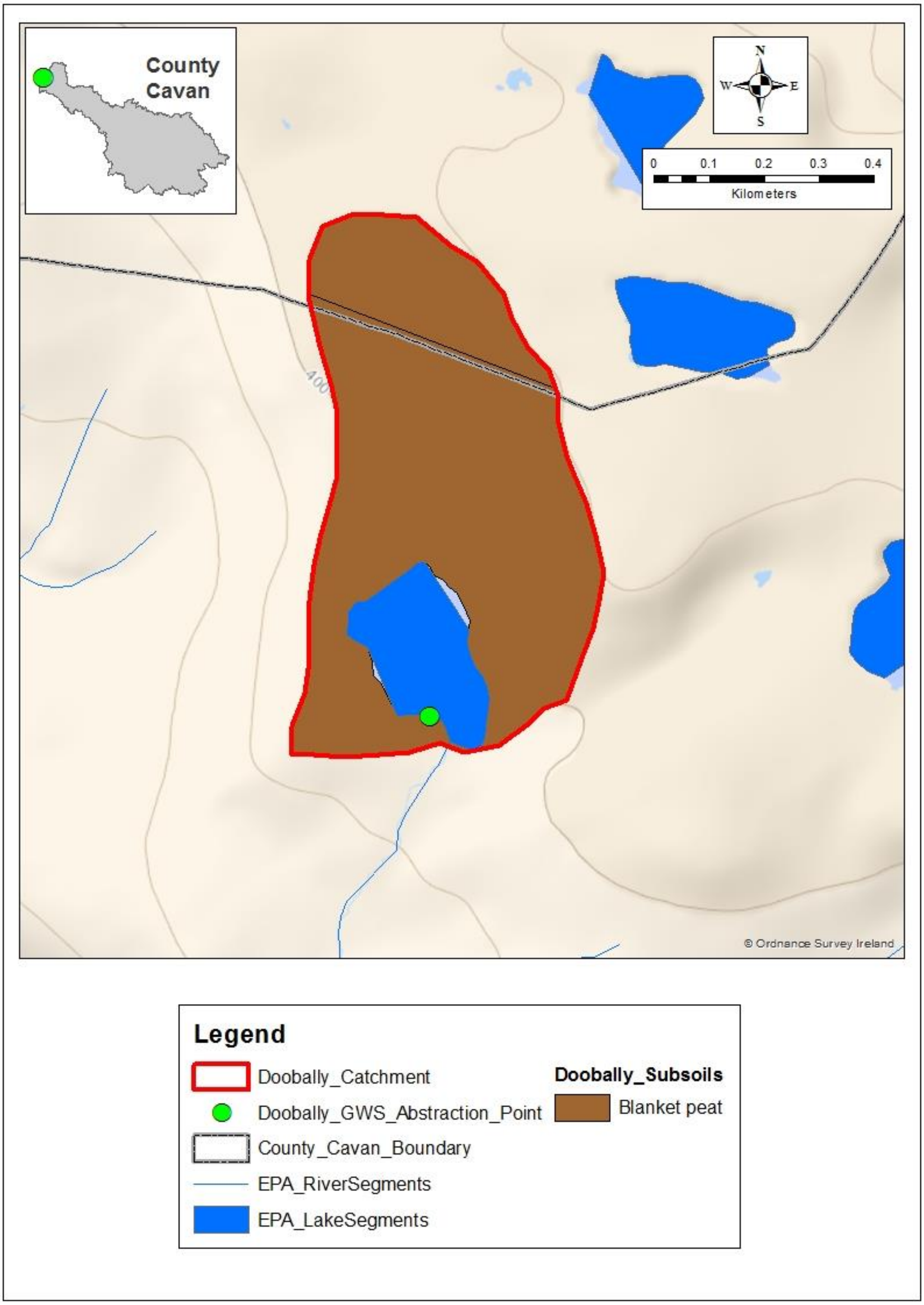

Figure 5: Subsoil deposits within the Doobally GWS catchment.

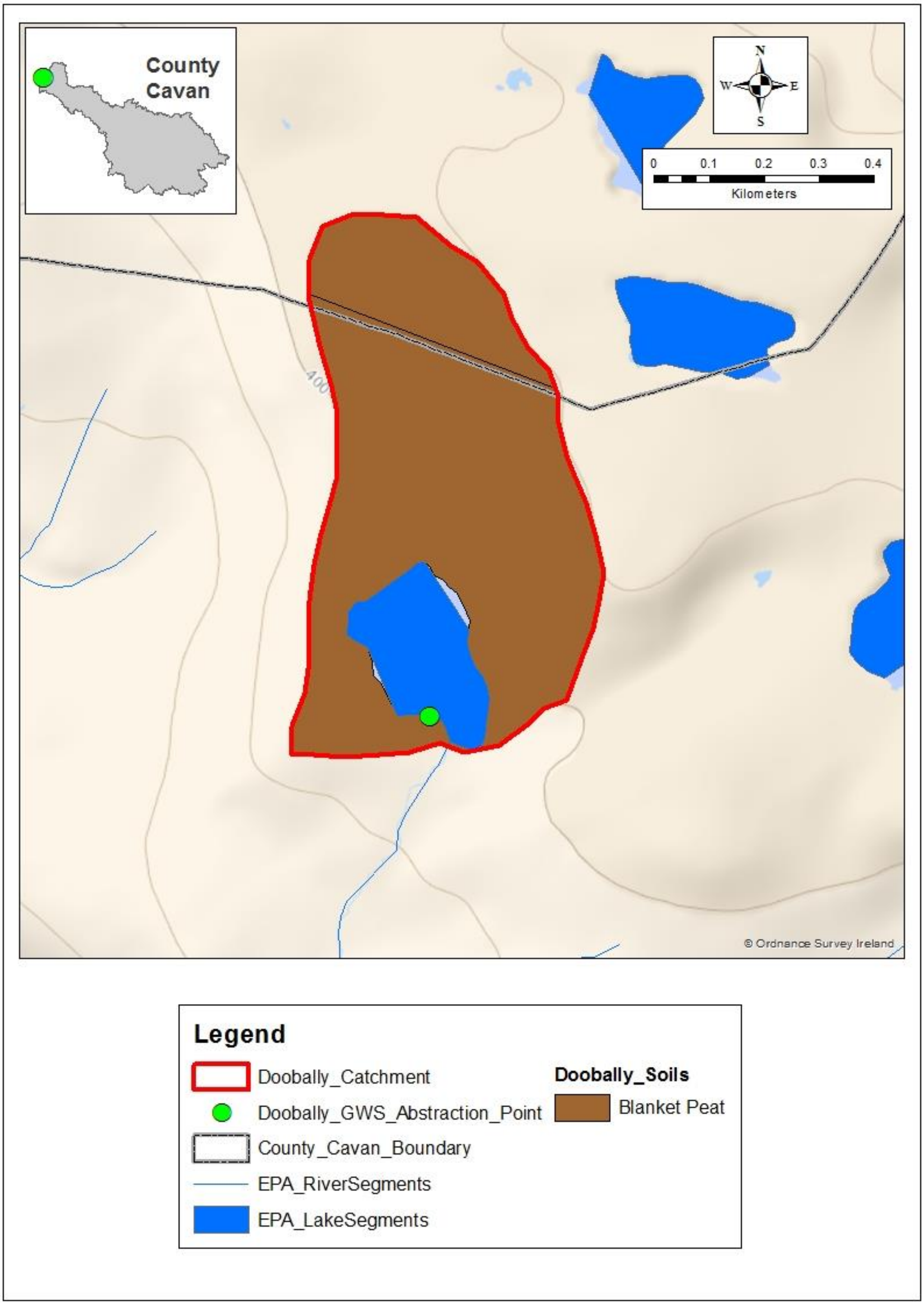

Figure 6: Soil types present within the Doobally GWS.

4.7 Slope and run-off

The slope of the land leading to a water body is an important determinant of the rate at which water and pollutants move into the lake by overland and groundwater flows. Slope can affect the quantity of contaminants entering a water body and thus can influence the quality of the water body. Steep slopes are vulnerable to surface water run-off, particularly if combined with poor draining soils. Soil erosion can also be a problem if vegetation cover is sparse, particularly as a result of overgrazing.

Although the region in which Naweleian Lough is situated is mountainous, the Doobally GWS catchment is relatively flat, with only small rises surrounding the lake. Naweleian Lough is situated at an elevation of approximately 390 m, and elevation is greatest at the north of the catchment at approximately 415 m.

5.0 Land use within the catchment

5.1 CORINE Land Cover

CORINE land cover is a map of the European environmental landscape based on the interpretation of satellite images (remote sensing). CORINE stands for 'Coordination of Information on the Environment' and the project has resulted in a Europe wide cataloguing of land cover into 44 standard classes. Importantly, land cover is defined as the observed physical cover, as seen from the ground or through remote sensing, including natural or planted vegetation and human constructions (e.g. roads, buildings) which cover the land surface. Therefore water, rock and ice are also included as land cover. Land cover is therefore distinct from land use which is based upon function: the purpose for which the land is being used. CORINE land cover does not include an assessment of land use.

There are two land cover classifications present within the Doobally GWS catchment (Figure 7). The catchment land cover is dominated by Peat bogs, with small areas of Moors and heath present in the east and north of the catchment.

The management of the risks associated with this land cover classification will form the basis of this source protection report.

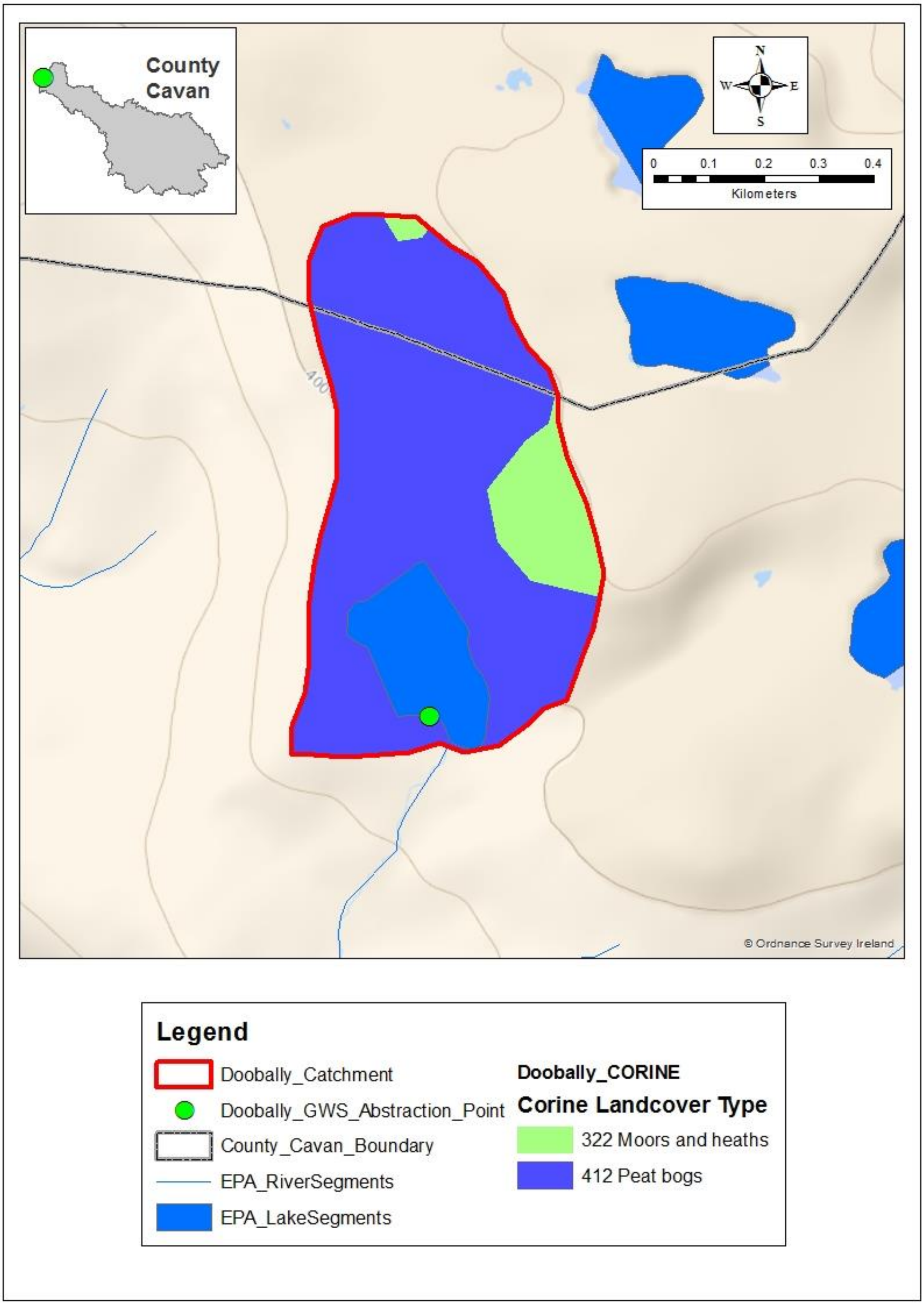

Figure 7: CORINE Land Cover classification within the Doobally GWS catchment.

5.2 Forestry

Forestry plantations may present threats to the quality of water bodies during the planting and early growing phase of a forest as well as during felling. Water quality can be affected by activities such as ground preparation, fertilisation, thinning, felling and construction of forestry roads. The application of fertilisers to young standing stock to enhance growth can lead to excessive phosphorus availability with the potential to increase phosphorus (P) volumes in the run off from planted land. During felling, sediment loss, siltation and nutrient release can also occur. In addition, the exposure of unvegetated soil can lead to the run off of P in soil suspension. The construction of forestry roads causes disturbance, erosion and compaction of the soil surface, resulting in sedimentation and nutrient run-off.

There are no commercial conifer forest plantations within the Doobally GWS catchment, although a large plantation is located approximately 800 m downstream of the abstraction point, through which the Naweleian Lough outflow stream flows.

5.3 EPA licensed facilities – Integrated Pollution Prevention Control (IPPC)

There are no IPPC licenced facilities present within the Doobally GWS catchment.

5.4 Rural housing and on-site wastewater treatment plants

On-site wastewater treatment systems, including septic tanks, can add nutrients, chemicals and pathogenic organisms to water bodies. These risks are particularly elevated when systems are installed in areas of high groundwater vulnerability (i.e. where there is good hydrological linkage between surface water and groundwater) and where soil drainage is poor.

There are no dwellings located within the Doobally GWS catchment.

In association with the Geological Survey of Ireland, the EPA have undertaken an assessment of domestic wastewater risk, giving a relative ranking that nutrients and bacteria from domestic wastewater treatment systems will contaminate surface waters via either surface water or groundwater pathways (EPA, 2013a and b). As a result of the low dwelling density, the Doobally GWS catchment is classified as Low Risk in a Non-Sensitive Area. The relationship between this classification and the classification of the greater area is best viewed online via the EPA's geoportal: http://gis.epa.ie/Envision.

5.5 Overall interpretation of catchment land use

Doobally Group Water Scheme is located approximately 6 km north of the town of Dowra in County Cavan, within the Bolebrack Mountain Special Area of Conservation. The scheme abstracts its water from Naweleian Lough (Figure 1), located close to the Leitrim/Cavan county border at an elevation of approximately 390 m. The lake has a surface area of approximately 5 ha.

There are no inflow streams feeding Naweleian Lough. A single outflow stream flows south-easterly from the lake, eventually joining the Owennayle River approximately 3 km downstream of the Doobally GWS abstraction point. The catchment or Lough Naweleian is small, covering an area of approximately 0.4 km^2.

Two geological formations make up the bedrock which underlies the Doobally GWS catchment. The grey silty sideritic shales of the Gowlaun Formation are present in the western region of the catchment and underlie Naweleian Lough. Cyclothermic sandstone, siltstone and coal are present in the eastern part of the catchment in the Lackagh Sandstone Formation.

The aquifers of the catchment are Poor and generally unproductive, although the bedrock of the eastern region of the catchment may be productive in local zones. Subsoils and soils are dominated by Blanket Peat and are subsequently acidic and poorly draining. Groundwater Vulnerability is high throughout the catchment. Due to its remote upland location, there are no dwellings or industry located within the Doobally GWS catchment, and agricultural pressures (namely grazing by sheep) are relatively low.

The Upper Shannon Water Management Unit Action Plan classifies Naweleian Lough as being of high ecological status, although this is based on extrapolation of regional data rather than through specific monitoring. Subsequently water quality should be relatively good, although the peaty environment may result in raw water of low (acidic) pH, high colour and high Total Organic Content.

An assessment of water quality parameters is provided in Section 6.0.

6.0 Raw Water Quality

Raw water quality data were collected by EPS, the service provider for Doobally GWS, and provided through the National Federation of Group Water Schemes in the form of Monthly Status Reports. Data were available from August 2002 to September 2014.

Parameters relevant to source protection were taken from the data set, analysed temporally and interpreted to highlight potential water quality issues in the Doobally GWS catchment and their potential causes and impacts.

6.1 Raw Water Quality

6.1.1 Colour and Trihalomethanes

Natural colour reflects the presence of organic molecules originating from humic matter such as peat, leaves and branches. A coloured water supply does not pose high health risks in itself but can react with chlorine in the treatment plant to produce trihalomethanes (THMs) which can be carcinogenic and their removal from drinking water can add significantly to the cost of treatment. The formation potential of THMs can also be correlated with the amount of Total Organic Carbon (TOC) in the raw water supply. For these reasons, high levels of colour should be avoided where possible; however colour can vary greatly as a parameter, depending on quantities of precipitation and run off, leading to spikes in results. Results of colour analyses can be presented as apparent colour (from an unfiltered sample) or true colour (from a filtered sample). Irvine *et al*. (2001) reported that colour in Irish lakes ranged between 5 mg/L mg PtCo L^{-1} to 134 mg/L mg PtCo L^{-1}. The Surface Water Regulations (1989) recommend a value of 20 mg/L mg PtCo L^{-1}/Hazen (True Colour) for A1 waters. The Drinking Water Regulations (2007 and 2014) recommend a parametric value of 100 µg/L for total trihalomethanes.

True Colour data were available from August 2002 until September 2014, although no data was provided between August 2002 and December 2005 (Figure 8). Values ranged from a minimum of 5 Hazen in July 2006, to a maximum of 540 Hazen in September 2013, with an average value of 120 Hazen recorded for the sampling period. True Colour values were typically very high, exceeding the Surface Water Regulations (1989) parametric value on 97 out of 100 sampling occasions (97 % of occasions). The very high True Colour value in the raw water supply in September 2013 was accompanied by formal consumer complaints regarding the colour of the treated water.

Trihalomethane data were provided for five annual sampling occasions between November 2009 and March 2014, although no data was provided from 2010 (Figure 9). Values ranged from a minimum of 19 µg/L recorded in March 2014, to a maximum of 65 µg/L recorded in July 2012, with an average value of 33 µg/L recorded for the sampling period. The Drinking Water Regulations (2007 and 2014) were not exceeded on any occasion, however, sampling for THMs has frequently not been undertaken when the True Colour values are at their highest (typically in August and September each year: Figure 8) and therefore the data may not represent the highest THM values that may be present each year. Recommendations regarding THM sampling are given in Section 7.0.

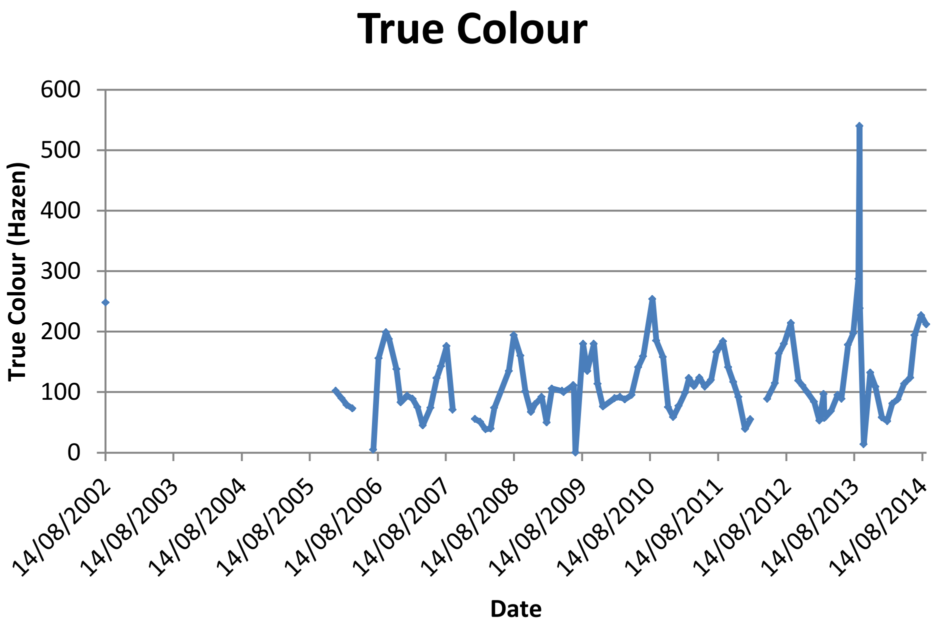

Figure 8: Raw water True Colour from August 2002 until September 2014.

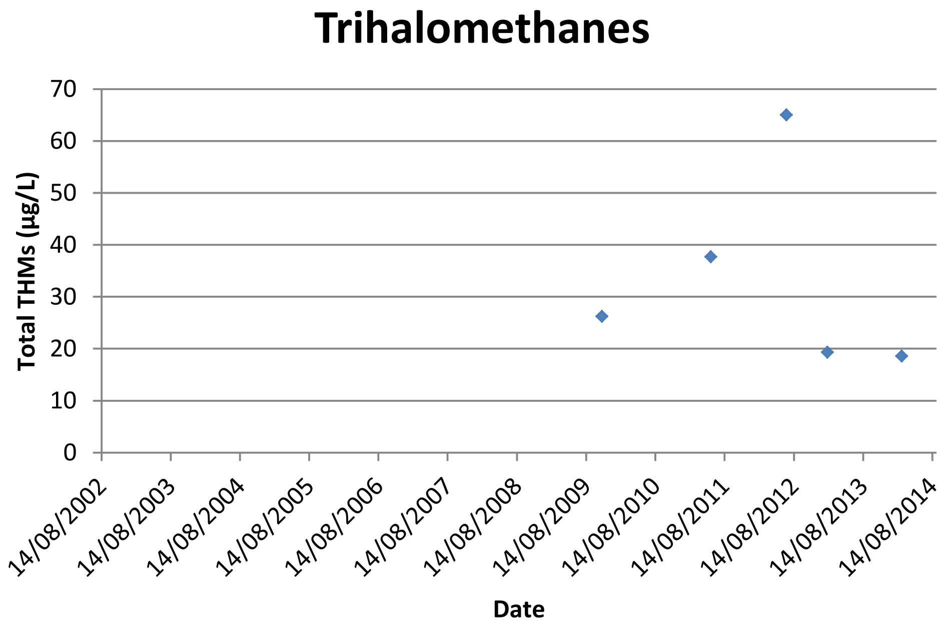

Figure 9: Total Trihalomethane concentrations within the treated water from November 2009 until March 2014.

6.1.2 Total Organic Carbon

Natural Organic Matter (NOM) is the complex of organic material that is found within natural waters which is typically derived from decayed vegetation or microbial decomposition processes. The chlorination of raw water can lead to the production of disinfection bi-products such as Trihalomethanes as a result of the reaction of chlorine compounds with the NOM content of the raw water. Total Organic Carbon (TOC) provides an estimate of the NOM present in a water source and can be used as an assessment of water quality during the treatment process for drinking water. TOC levels within raw water samples from 12 Irish water treatment works were found to range between 3.5 – 14.0 mg/L (Chua, 1996).

TOC was monitored in the raw water on two occasions between August 2002 and September. Values of 30 mg/L and 20.25 mg/L were recorded in August 2002 and September 2013 respectively. These values are high and, depending on a number of factors such the treatment process and residence time in the GWS reservoir, are likely to contribute to the formation of THMs in the treated water.

6.1.3 pH

The pH value of water is generally only of concern if it is extremely low or extremely high indicating acid or alkaline waters respectively. High or low pH values may have consequences for odour or taste, lead to corrosion in distribution systems and affect fish survival. The pH of water generally ranges from 6.5-8.0 and the Surface Water Regulations (1989) recommend a pH range of 5.5-8.5 for Class A1 waters. The Drinking Water Regulations (2007 and 2014) recommend a pH range of 6.5-9.5 for treated water.

pH data were provided from between August 2002 and September 2014, although no data were available between August 2002 and December 2005 (Figure 10). Values ranged from a minimum of pH 3.6 recorded in August 2002 and December 2005, to a maximum of pH 10.0 recorded in October 2006, with an average of pH 5.3 recorded for the sampling period. Values were below the minimum range value of the Surface Water Regulations (1989) on 70 out of 103 sampling occasions (68 % of occasions). Values were above the maximum parametric range value of the Surface Water Regulations (1989) on one occasion.

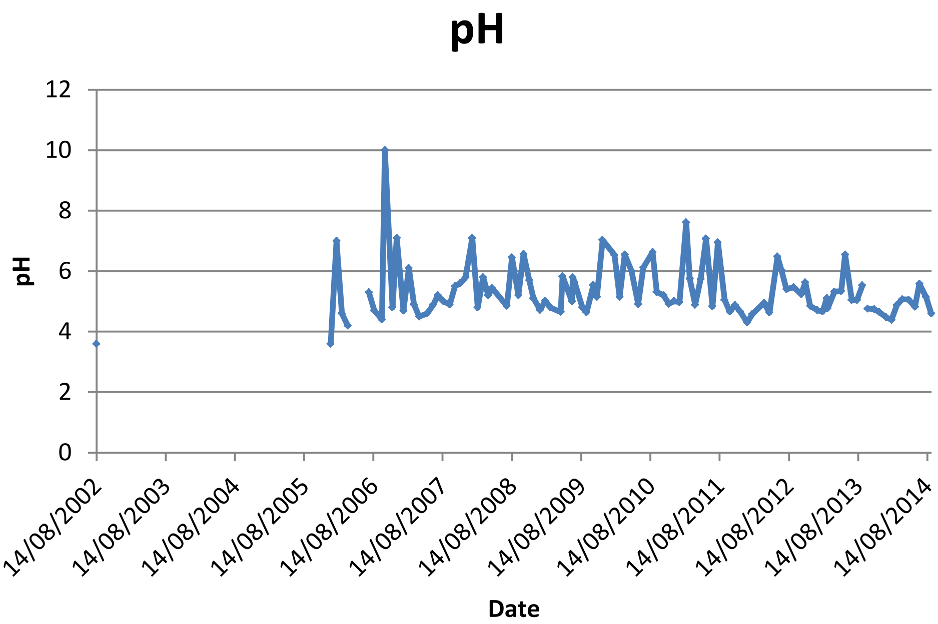

Figure 10: Raw water pH from August 2002 until September 2014..

6.1.4 Turbidity

Turbidity in water consists of very finely divided particles that are too small to be removed through filtration. Their origin may include clay particles, algae, silt, sewage solids and organic or biological sludges. High levels of turbidity in the raw water supply can interfere with the ability of the treatment plant to provide safe drinking water. Turbidity can be represented using the following units: Jackson Turbidity Units (JTU); Formazin Turbidity Units (FTU); and Nephalometric Turbidity Units (NTU). Each of these units can be interpreted to mean the same thing.

Raw water turbidity data were provided from August 2002 until September 2014, although no data was available between August 2002 and December 2005 (Figure 11). Values ranged from a minimum of 0.66 NTU in June 2013, to a maximum of 32 NTU recorded in August 2002, with an average of 3.5 NTU for the sampling period.

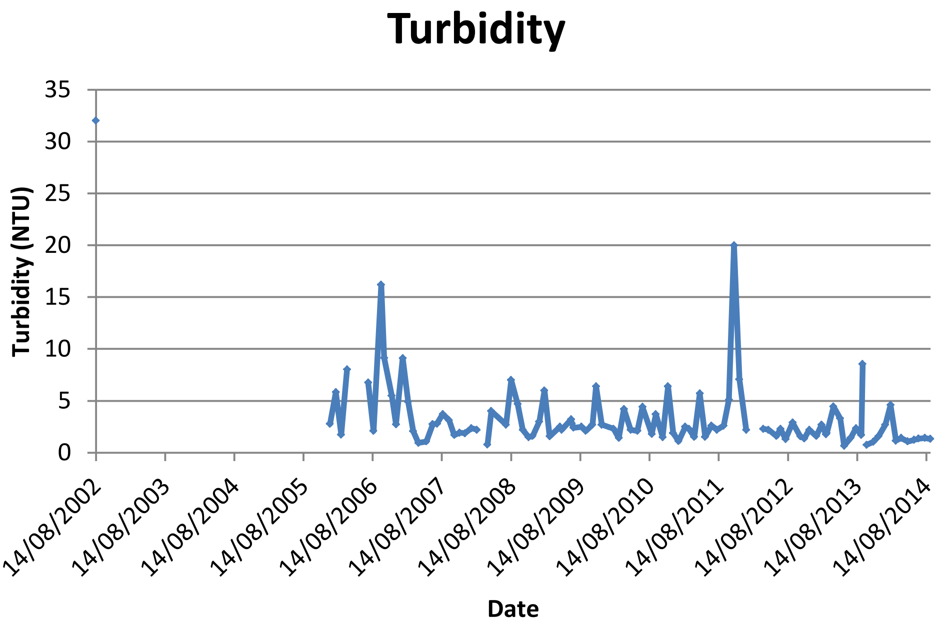

Figure 11: Raw water turbidity from August 2002 until September 2014.

6.1.5 Sulphates and Chlorides

Drinking water that contains high levels of sulphates has been reported to have the potential to cause diarrhoea. Issues with taste and odour may occur where sulphate levels exceed 250 mg/L. The Drinking Water Regulations (2007 and 2014) state a parametric value of 250 mg/L sulphate whilst the Surface Water Regulations (1989) (the quality of surface waters intended for the abstraction of drinking water) recommend a parametric value of 200 mg/L sulphate for all water categories (Class A1, A2 and A3 waters). Group Water Schemes should aim to achieve the parametric values identified for Class A1 Waters (surface waters that only require simple physical treatment and disinfection to become drinking water).

High concentrations of chlorides in freshwater systems can be indicative of pollution by sewage and industrial wastes or the intrusion of saline water. High chloride content can also have a deleterious effect on metallic pipes and structures. The Surface Water Regulations (1989) recommend a parametric value of 250 mg/L chloride for all water categories (Class A1, A2 and A3 waters). The same parametric value is stated in the Drinking Water Regulations (2014).

Sulphates and Chlorides have not been monitored in the Doobally GWS raw water supply.

6.1.6 Iron

Iron (Fe) is present in rocks and soil in an insoluble form but can become soluble when water passes through ground formations containing iron. Large amounts of iron in water are not usually harmful to consumers, but can be aesthetically unpleasing as a result of causing changes in colour or turbidity. This can lead to staining of laundry, discoloration of vegetables following cooking and taste problems. The Surface Water Regulations (1989) parametric value for iron in Class A1 waters is 200 µg/L.

Raw water iron data were provided from August 2002 until September 2014, although no data were available from August 2002 until December 2005 (Figure 12). Values ranged from a minimum of 9 µg/L recorded in July 2014, to a maximum of 588 µg/L recorded in May 2011. An average value of 245 µg/L was recorded for the sampling period. The Surface Water Regulations (1989) parametric value of 200 µg/L iron in Class A1 waters was equalled or exceeded on 43 out of 100 sampling occasions (43 % of occasions).

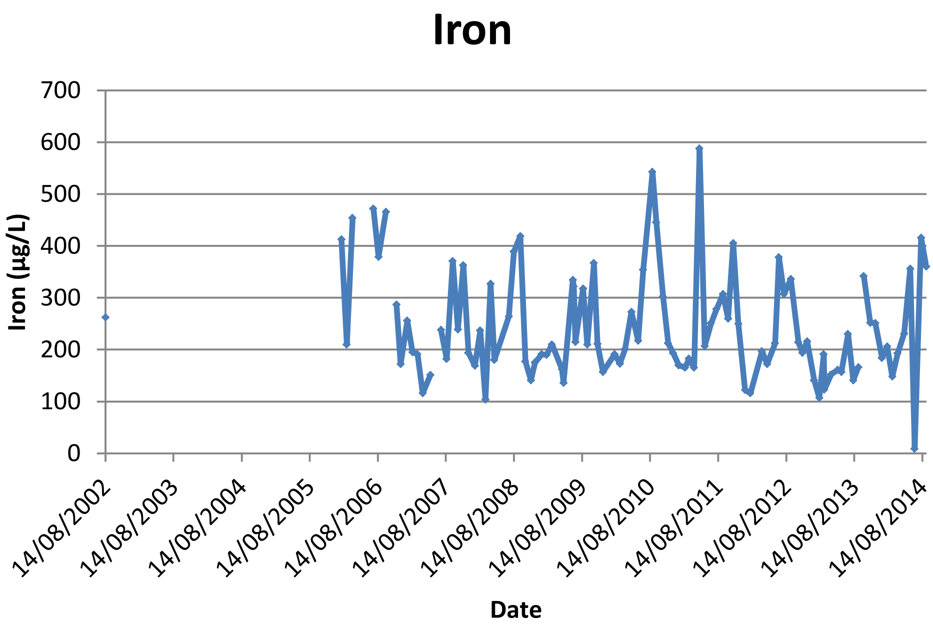

Figure 12: Raw water iron concentrations from July 1999 until June 2013.

6.1.7 Manganese

Manganese is found in soils and groundwaters and is generally not considered harmful to humans. However it can cause more severe staining problems than iron and can adversely affect taste and potentially block pipes in large volumes. The Surface Water Regulations (1989) parametric value for concentrations of manganese in Class A1 waters is 50 µg/L.

Raw water manganese data was provided from August 2002 until September 2014, although no data were available between August 2002 and January 2006 (Figure 13). In October 2008, November 2009 and July 2011, values were recorded as being below the limit of detection ("<5 µg/L) and these are represented in Figure 13 as zero values. When recorded above the limit of detection, values ranged from a minimum of 3 µg/L recorded in August 2007 to a maximum of 184 µg/L recorded in November 2012. An average value of 13.8 µg/L was recorded for the sampling period. The Surface Water Regulations (1989) parametric value of 50 µg/L manganese in Class A1 waters was exceeded on two out of 100 sampling occasions (2 % of occasions).

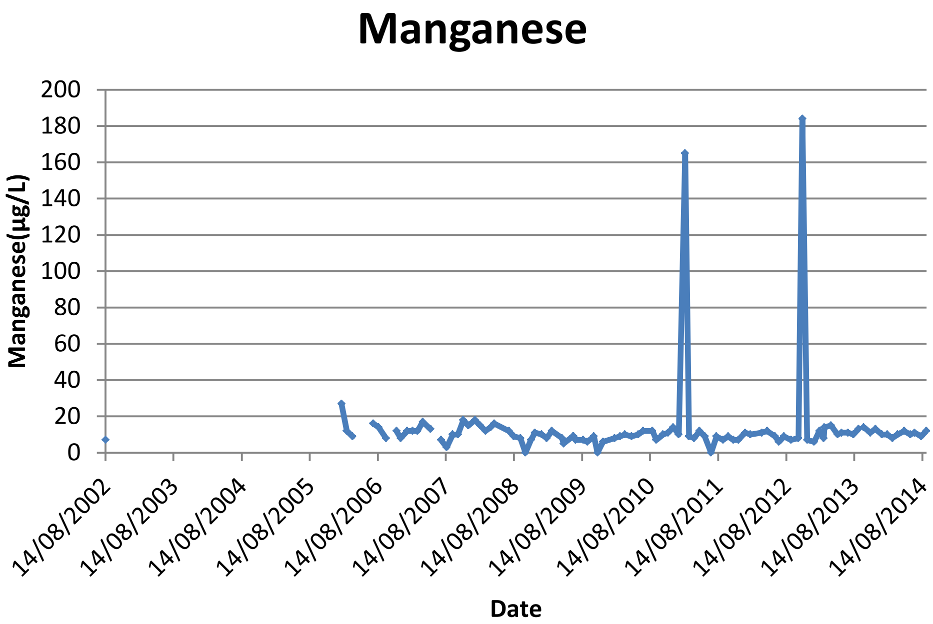

Figure 13: Raw water manganese from August 2002 until December 2014.

6.1.8 Alkalinity

Alkalinity is a measure of a water's capacity to neutralise acids, with high alkalinity providing a buffering capacity against pH change. The alkalinity of water is typically associated with bicarbonates in catchment soils. There is little known sanitary significance to alkalinity; however increased levels can be indicative of eutrophication and photosynthesis.

Alkalinity has not been monitored in the Doobally GWS raw water supply.

Eutrophication and Trophic Status (Note)

Eutrophic means well-nourished and eutrophication is the process where water bodies become more eutrophic through the addition of nutrients, primarily nitrogen and phosphorus (N and P). These additional nutrients, often in combination with low flow or still conditions and increased water temperatures, trigger a series of events causing excessive plant and algal growth. The process may culminate in oxygen depletion in waters, fish kills and problems with the treatment of the water for drinking. Water bodies suffer different degrees of eutrophication, termed trophic status. Lakes are often characterised by their trophic status using the following scale: Oligotrophic (low in nutrients and algal growth); Mesotrophic (moderately productive, less clean than oligotrophic bodies); and Eutrophic (high levels of nutrients and algal growth combined with poor water quality). Lakes suffering from excessive eutrophication can be classed as hypertrophic. Trophic status is typically determined by algal abundance (using Chlorophyll *a* assessments as an indicator of abundance) or total phosphorus concentration (the most important nutrient in the eutrophication process).

6.1.9 Total Phosphorus

Phosphorus occurs widely in nature but much of the phosphorus found in surface waters occurs as a result of anthropogenic activities. Human and animal wastes contain large amounts of phosphorus and therefore agriculture and wastewater treatment plants are large sources of phosphorus and often provide pathways for phosphorus to enter the aquatic environment. Artificial fertilisers used in agriculture and forestry are also primary sources of phosphorus. Phosphorus and, to a lesser extent, nitrogen are the two key drivers of eutrophication events in the freshwater aquatic environment (see Eutrophication and Trophic Status Note, above, for details on eutrophication) as they are the primary nutrients required by the algae and plants that can flourish during eutrophication events. Eutrophication can lead to a loss of biological diversity (particularly of sensitive and/or desirable species), increased plant growth, the development of algal scums and a general deterioration in water quality. Eutrophication is the largest threat to Irish water quality and is of great importance to drinking water sources. Increased algal abundance can create problems in treatment plants and decomposing algae can release toxins into the water and cause taste and odour problems. The management of phosphorus levels entering the aquatic environment is central to the long-term viability of many drinking water sources.

Total Phosphorus has not been monitored within the Doobally GWS raw water supply.

6.1.10 Chlorophyll and Algae

Chlorophyll is used as an indicator of overall algal abundance within a water source. High levels of chlorophyll can indicate high algal abundance which can have negative implications for the treatment process and lead to taste and odour problems in treated water. Chlorophyll values are typically greatest in the summer when the water temperatures are warmer, and light availability is high. It is monitored as chlorophyll *a*, the most abundant form of chlorophyll in lake algae.

Chlorophyll has not been monitored within the Doobally GWS raw water supply, however algal counts have been undertaken on a monthly basis between August 2006 and September 2014 (Figure 14). Values ranged from a minimum of zero cells/ml recorded on seven occasions to a maximum of 33,372 cells/ml recorded in July 2009.

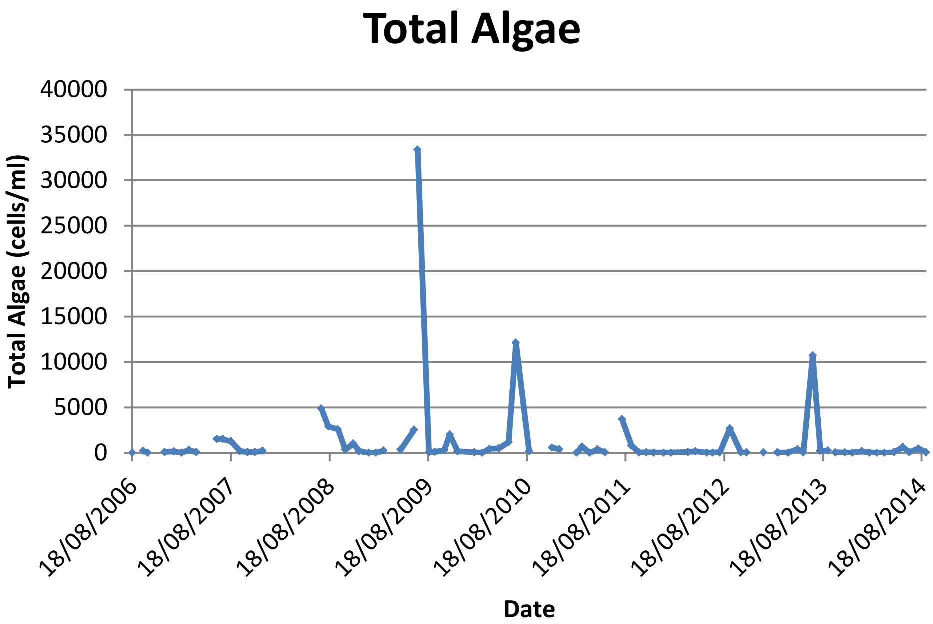

Figure 14: Raw water Total Algae data from August 2006 to September 2014.

6.1.11 Transparency

Transparency can give an indication of the presence of suspended matter within a water body and is measured using a Secchi disk (a coloured disk). The disk is lowered through the water until it can no longer be seen by the naked eye and the distance lowered recorded: the greater the distance, the greater the transparency. The transparency of the water can be used as an overall indicator of quality as algae, coloured TOC compounds, and/or sediment can reduce transparency. Low transparency levels can effect light penetration and also potentially affect the ability of fish to find prey.

Transparency has not been monitored in the Doobally GWS raw water supply.

6.1.12 Nitrogen

Nitrogen, together with phosphorus, is central to the development of eutrophication as nitrogen is a key nutrient for plant and algal growth. Although approximately 78% of the earth's atmosphere is made up of nitrogen gas, this form of nitrogen is not available as a nutrient to plants. Instead it is converted to different forms such as ammonium, nitrite and nitrate through the nitrogen cycle. Nitrate is the most common form of nitrogen that exists in aquatic environments and typically originates from human and animal wastes as well as from the application of artificial fertilisers to agricultural lands. The Surface Water Regulations (1989) recommend a parametric value of 50 mg/L NO_3 for Class A1 waters. Nitrite is an intermediate form between ammonium and nitrate and typically only represents a small proportion of nitrogen in water. Nitrite and nitrate are often presented together as Total Oxidised Nitrogen (TON). As well as having environmental implications with regards to nutrient enrichment, high levels of nitrate in drinking water can have important health implications. Large amounts of nitrate in drinking water can cause methemoglobinemia in pregnant women and infant children, with those under 6 months particularly vulnerable.

Methemoglobinemia, also known as 'blue baby syndrome' reduces the ability of the red blood cells to carry oxygen as a result of nitrate in the drinking water being converted into nitrite by stomach bacteria. This nitrite is absorbed into the blood and results in the conversion of haemoglobin to methemoglobin which does not efficiently carry oxygen. Severe cases can lead to brain damage and death. Importantly, *nitrates and nitrites cannot be removed from raw water during the standard treatment process*. The Drinking Water Regulations (2014) stipulate maximum acceptable values of 50 mg/L for nitrate and 0.5 mg/L for nitrite. The Surface Water Regulations (1989) parametric value for nitrate is also 50 mg/L NO_3 for Class A1 waters.

The source of ammonia in the aquatic environment is most likely from human and animal waste and high concentrations of ammonia can indicate pollution from these sources. Ammonia also arises from peat drainage. In aquatic environments, ammonia (NH_3) is frequently ionised to ammonium (NH_4^+) and equally ammonium can be converted back into ammonia. The pH of the water is the major factor than influences the ionisation of ammonia to ammonium and at the typical pH of most Irish freshwaters; it is ammonium that is the most common form. Although naturally present in small amounts in aquatic environments, values of over 0.1 mg/L N is interpreted as an indication of human waste pollution or industrial contamination. With regards to lake quality classes based on total ammonia levels (NH_4^+ plus NH_3), the Surface Water Regulations (2009) state that bodies must have ≤0.040 mg N/L as a mean for high status (or ≤0.090 95%ile) and ≤0.065 mg N/L as a mean for good status (≤0.140 95%ile). Following treatment, the Drinking Water Regulations (2014) parametric value for ammonium is 0.3 mg/L.

Total Oxidised Nitrogen (TON)

TON data was provided from August 2002 to September 2014, although no data were available between August 2002 and December 2005 (Figure 15). An exceptionally high value of 84.39 mg/L was recorded in August 2011 and this value reduces the clarity of the remaining available data. Therefore Figure 16 presents the data with the August 2011 value removed for clarity, and shows that TON values have typically been low since 2008. Of the 101 sampling events, TON concentrations were below limits of detection on 64 occasions and these are represented in Figure 15 as zero values. When TON values were recorded above limits of detection, values ranged from a minimum of 0.03 mg/L N recorded on 16 occasions, to a maximum of 84.39 mg/L N recorded in August 2011. The average value for the sampling period was 0.22 mg/L N. The Surface Water Regulations (1989) parametric value for nitrate was exceeded on one occasion.

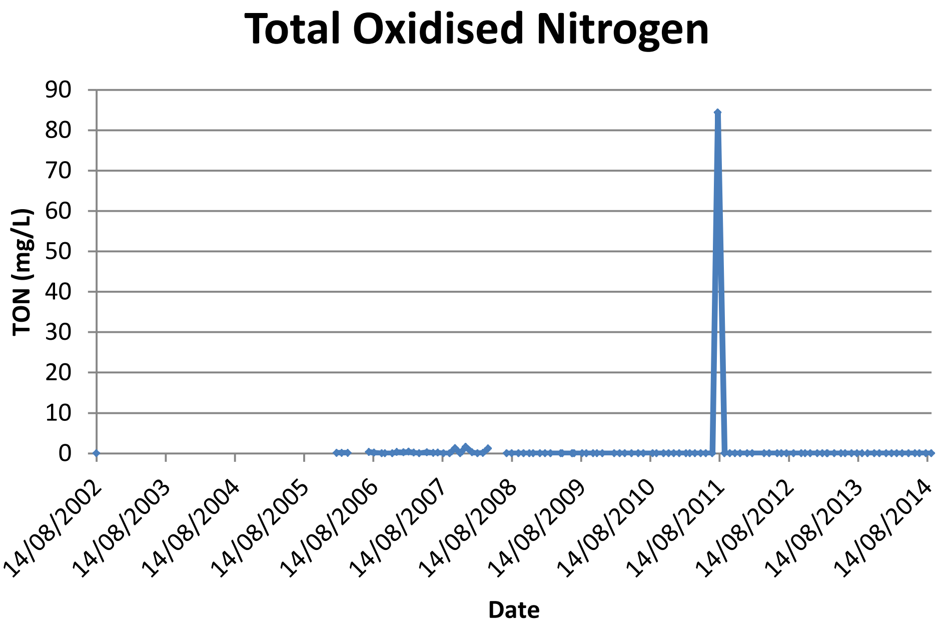

Figure 15: Raw water Total Oxidised Nitrogen values from August 2002 until September 2014.

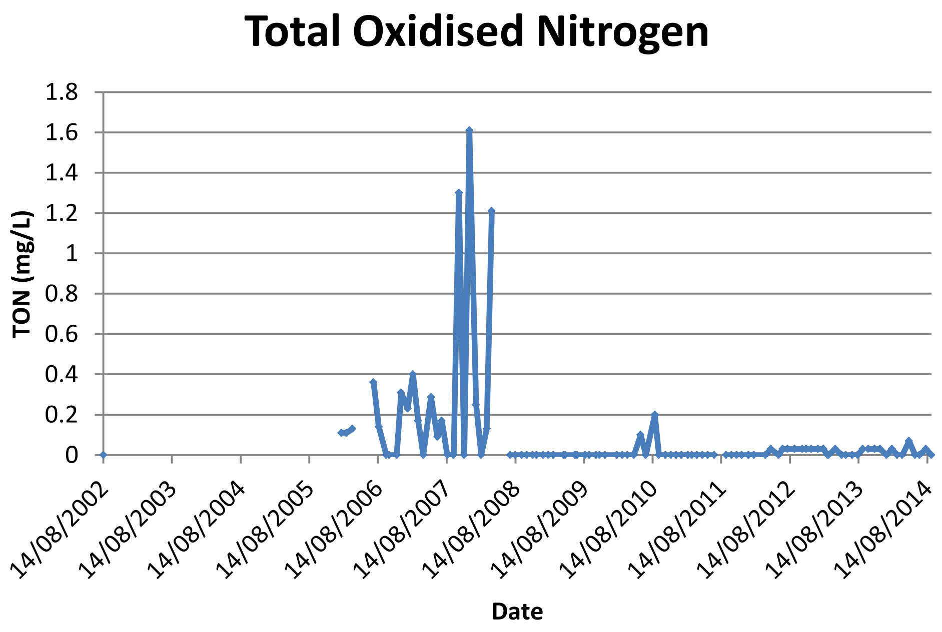

Figure 16: Raw water Total Oxidised Nitrogen values from August 2002 until September 2014 with the large value recorded in August 2011 removed for clarity.

Ammonia

Raw water Total Ammonia data was provided from August 2002 to September 2014, although no data was available from August 2002 until January 2006 (Figure 17). Values ranged from a minimum of 0.03 mg N/L recorded in April 2012 to a maximum of 0.54 mg N/L recorded in May 2012, with an average of 0.13 mg N/L recorded for the sampling period. This average value places Naweleian Lough outside of the Surface Water Regulations (2009) good quality class for Total Ammonia.

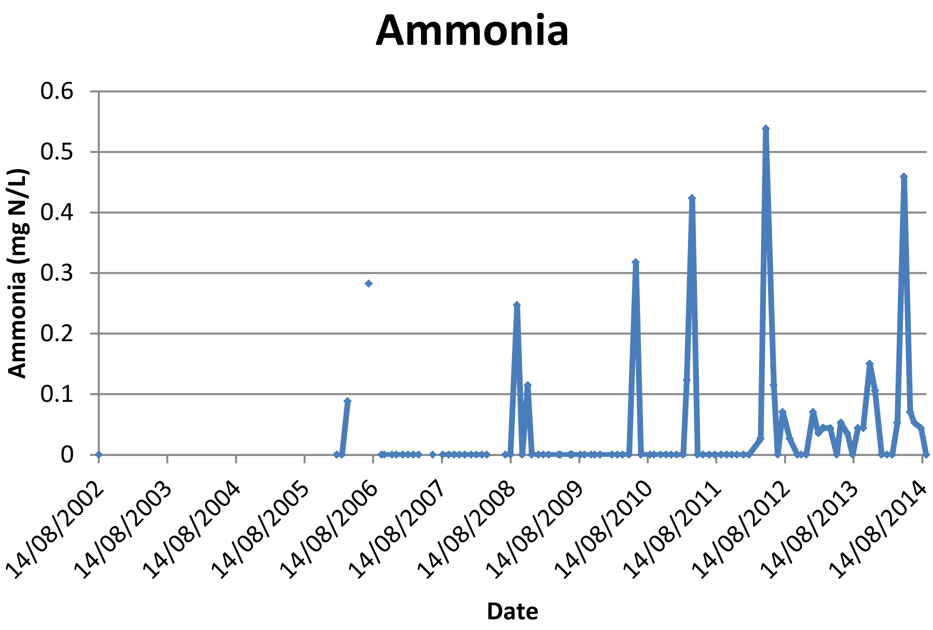

Figure 17: Raw water Total Ammonia values from August 2002 until September 2014.

6.1.13 Conductivity

The ability of water to conduct an electrical current is quantified as the conductivity of water and is an indication of the mineral salt content of the water body. Conductivity itself has no direct health or sanitary significance in freshwater environments, and the Surface Water Regulations (1989) specify a limit of 1000 µS/cm at 20°C for Class A1 waters.

Raw water Conductivity data was provided from August 2002 until September 2014, although no data was available from August 2002 until January 2006 (Figure 18). Values ranged from a minimum of 19 µS/cm recorded in November 2011, to a maximum of 345 µS/cm recorded in November 2009, with an average value of 52 µS/cm recorded for the sampling period. On no occasions was the Surface Water Regulations (1989) parametric value of 1000 µS/cm for Class A1 waters exceeded.

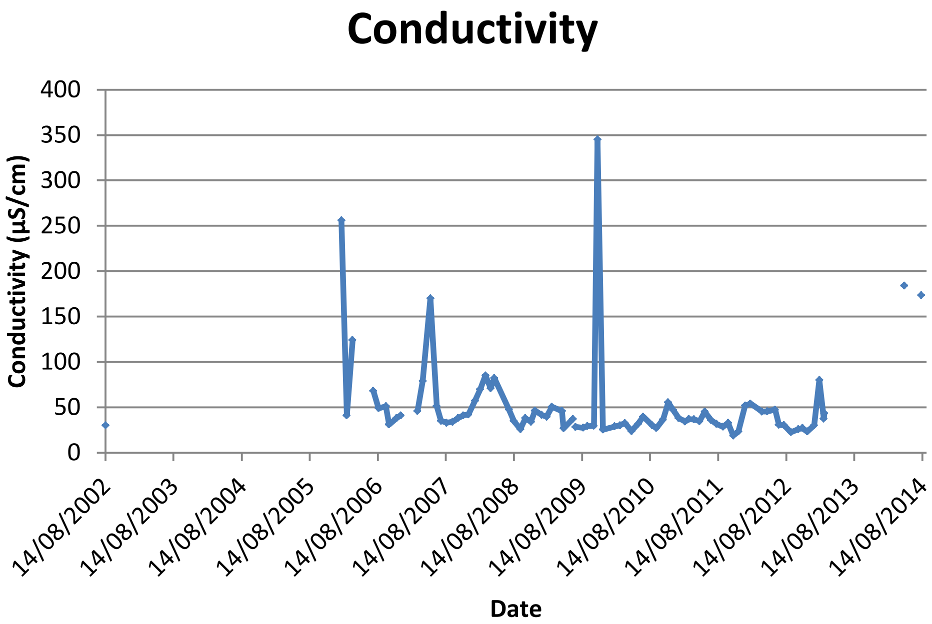

Figure 18: Raw water Conductivity values from August 2002 until September 2014.

6.1.14 Dissolved Oxygen (DO)

The amount of oxygen dissolved within a water body is important for fish survival. If a water body is suitable for fish survival then it generally meets the quality requirements for most other forms of water consumption.

Dissolved oxygen saturation is dependent on water temperature: warmer waters typically contain less dissolved oxygen then colder waters. Summer temperatures resulting in lower DO levels, in combination with low water levels can leave aquatic environments particularly vulnerable to organic pollution. DO saturation and concentration can also be affected by photosynthesis, with increased eutrophication and photosynthesis leading to high oxygen concentrations during daylight hours, and these high oxygen concentrations can be depleted at night when respiration takes over from photosynthesis.

Dissolved Oxygen has not been monitored within the Doobally GWS raw water supply.

6.1.15 Biological Oxygen Demand (BOD)

Unpolluted water is typically saturated with dissolved oxygen, but when organic pollution enters a water body, bacteria break it down through a process that uses available oxygen, thus reducing DO levels. The Biological Oxygen Demand (BOD) is a measure of the oxygen demand required to break down organic waste. BOD is the amount of dissolved oxygen taken up by bacteria degrading organic material in the dark at 20 °C over five days. The Surface Water Regulations (1989) recommend the value for BOD in Class A1 Waters to be 5 mg/L O_2.

Biological Oxygen Demand has not been monitored within the Doobally GWS raw water supply.

6.1.16 Coliforms

Faecal coliforms such as *Escherichia coli* (*E. coli*) originate in animal or human wastes. A typical measurement of coliforms is Total Coliforms which include faecal and soil-born coliforms. Total coliforms is used as an indicator or pathogenic organisms within a water body and the Surface Water Regulations (1989) recommend that Class A1 waters should not exceed 5,000 total coliforms per 100ml, or 1,000 faecal coliforms per 100ml. The Drinking Water Regulations (2007 and 2014) state that Total Coliform values above 0 numbers per 100ml in treated water is unacceptable.

Escherichia coli

Escherichia coli (*E. coli*) *bacteria* are present in high numbers in human and animal faeces and are rarely found in waters in the absence of faecal pollution.

E. coli have been monitored between March 2006 and September 2014 (Figure 19). Values ranged from a minimum of 0 MPN/100 ml recorded on a number of occasions, to a maximum of 1300 MPN/100 ml recorded in June 2014, with an average value for *E. coli* of 40 MPN/100 ml recorded between for the sampling period. Highest *E. coli* values were typically observed between the months of June and September, suggesting potential livestock access to the water source during these times of the year.

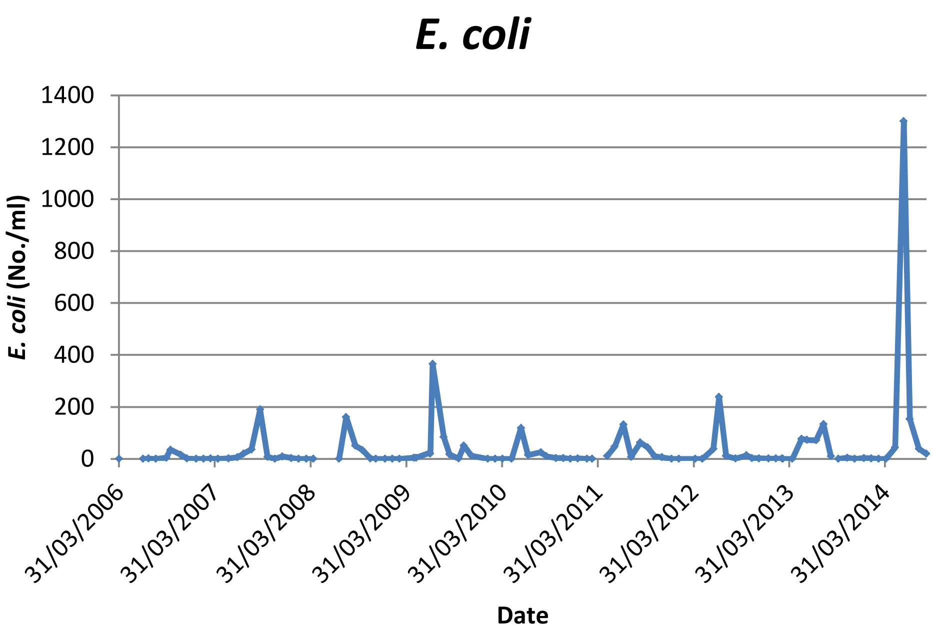

Figure 19: Raw water *E. coli* values from March 2006 until September 2014.

Clostridia

Clostridia, such as *Clostridia perfringens*, exist as part of the natural bacterial intestinal flora of humans and therefore serve as an indicator of faecal pollution.

Clostridium perfringens were monitored between March 2006 and September 2014 (Figure 20). Values ranged between a minimum of 0 cfu/100 ml recorded on a number of occasions, to a maximum of 214 cfu/100 ml recorded in November 2008. An average of 4 cfu/100 ml was recorded for the sampling period.

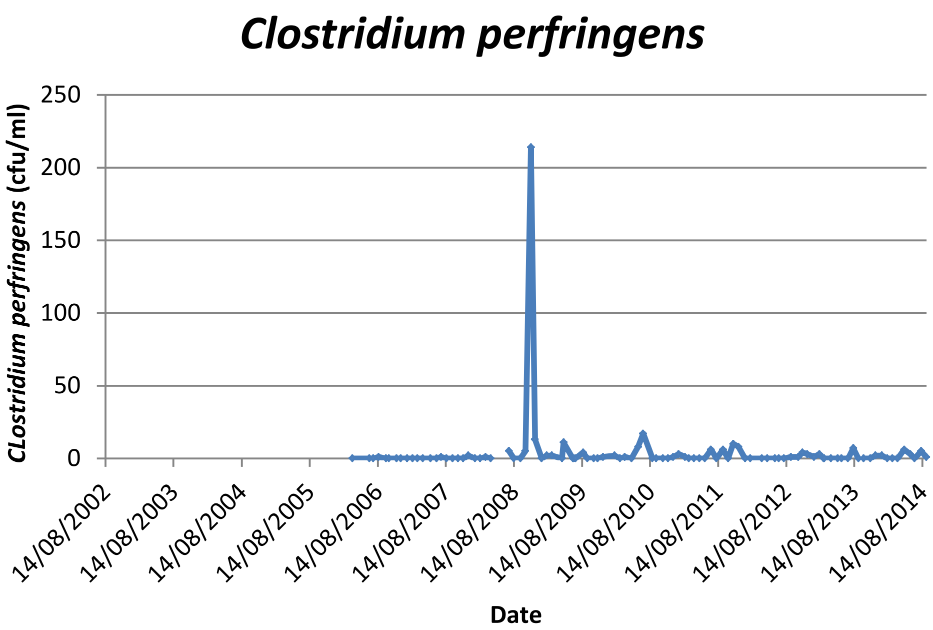

Figure 20: Raw water *Clostridium perfringens* values from March 2006 until September 2014.

Total Coliforms

Total Coliform data was provided from August 2002 until September 2014, although no data was available between August 2002 and June 2006) (Figure 19). Values ranged from a minimum of 0 counts/100 ml recorded on a number of occasions, to a maximum of 6,830 counts/100 ml recorded in June 2014. An average value of 618 counts/100 ml was recorded for the sampling period. Counts have frequently been high and have been increasing over time, with the Surface Water Regulations (1989) parametric value for Class A1 waters being exceeded on one occasion.

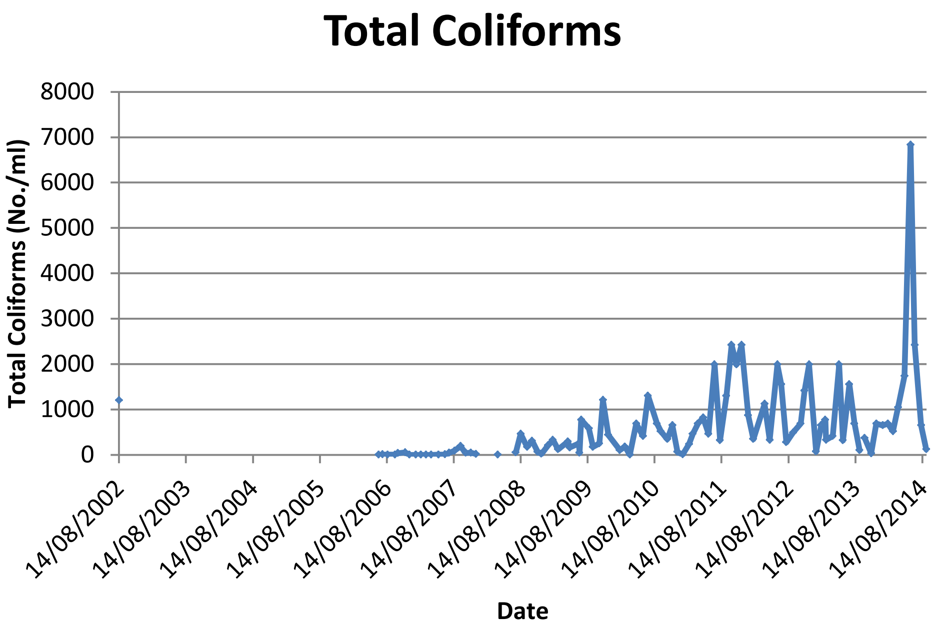

Figure 21: Raw water Total Coliforms values from August 2002 until September 2014.

6.1.17 Biological data

Q values

Clabby *et al.* (2006) state that in the presence of pollution, characteristic and well documented changes are induced in the flora and fauna of rivers and streams. Organic pollution that impacts the aquatic macroinvertebrate communities are particularly well documented, with changes occurring due to varying sensitivities of different species to the stresses caused by pollution.

Macroinvertebrate diversity declines in the presence of pollution and sensitive species are progressively replaced by more tolerant species as pollution increases. The EPA classify benthic aquatic macroinvertebrates into five arbitrary 'indicator groups' based on sensitivity to pollution, with Group A being the most sensitive and Group E being the most tolerant. These groups, in combination with physico-chemical assessment of water quality, are used to produce Quality (Q) Values. The values range from Q1 to Q5, with Q5 waters having the greatest macroinvertebrate diversity (with sensitive species present) and good water quality; and Q1 waters having the little macroinvertebrate diversity (with communities dominated by tolerant species) and poor water quality.

Macroinvertebrates have not been monitored within the Doobally GWS catchment.

6.2 Tellus Border Soil Geochemistry and Water Chemistry

The Tellus Border Project (www.tellusborder.eu) was an Interreg IVA-funded regional mapping project collecting geo-environmental data on soils, water and rocks across the six border counties of the Republic of Ireland that ran from 2011 until December 2013. As well as using an aircraft to collect information on the physical properties of soils and rocks, the project took approximately 3,500 soil and stream water samples and analysed their chemistry. Data collected by the Tellus Border project is freely available from their website.

No Tellus Border soil geochemistry, stream water or stream sediment samples were collected from within the Doobally GWS catchment. The nearest soil geochemistry sample was collected approximately 600 m to the south-east of the Doobally GWS abstraction point. The soil from this sample was of low pH (pH 3) and had a very high Loss on Ignition value (a surrogate for carbon content), highlighting the peaty environment of the area. Iron values from this Tellus Border soil sample were relatively low in comparison to the range of values found throughout the border county sample area.

6.3 Overall Interpretation of Water Quality

A number of raw water quality parameters have been monitored within the Doobally GWS catchment allowing the interpretation of both historical and recent raw water quality and the likely impacts of catchment-level activities on that water quality.

Given the remote upland location of Naweleian Lough, it is unsurprising that pH levels in the raw water are low (acidic) as they reflect the peatland environment of the catchment. Subsequently there are few source protection measures that can mitigate low pH levels and therefore caustic dosing (or similar treatment) of the raw water is likely needed to ensure the pH of the treated water is kept within the parametric range of the Drinking Water Regulations (2007 and 2014).

True Colour values exceeded the Surface Water Regulations (1989) parametric value for Class A1 waters on 97 % of sampling occasions, with the average value for the sampling period being six times the Surface Water Regulations (1989) parametric value. As discussed in this report, high levels of colour do not represent health risks. However, upon treatment with chlorine, Trihalomethanes (THMs) can be produced when the chlorine reacts with naturally occurring organic matter in the raw water (high colour values can be an indication of high organic matter). The very high True Colour values and high Total Organic Carbon (TOC) values observed in the raw are indicative of the peaty environment of the Doobally GWS catchment. The fact that THM levels have not exceeded the Drinking Water Regulations (2007 and 2014) parametric value may be due to the Dissolved Air Floatation (DAF) treatment process undertaken on the raw water prior to chlorination. Alternatively, given the very high True Colour and high TOC values, the THM sampling frequency may not be sufficient to identify when THM values are highest. It may be prudent for Doobally GWS to undertake a specific THM monitoring programme during the period of late summer through to early winter (when True Colour and TOC values are typically highest) in order to ensure that THM values are consistently within the Drinking Water Regulations (2014). Therefore recommendations regarding THM monitoring are given in Section 7.0.

Raw water Iron concentrations were frequently high, exceeded the Surface Water Regulations (1989) on 43 % of occasions. Iron levels can be naturally high, especially within poorly draining, peaty soils such as those present within the Doobally GWS catchment. Subsequently there are few source protections measures that can be undertaken to reduce naturally high iron levels within the raw water.

Total Phosphorus has not been monitored within the raw water supply, however Total Oxidised Nitrogen values within the Naweleian Lough, are surprisingly high given that the lake is located within an upland peatland environment where nutrient levels are usually low. Ammonia values frequently spike to high levels in the Doobally GWS raw water supply and Naweleian Lough is subsequently outside of the Surface Water Regulations (2009) classification for good quality for ammonia levels.

The frequent occurrence of algal blooms is also unexpected and also suggests that there are suitable levels of both nitrogen and phosphorus available within the lake to support the occasionally excessive algal growth. Eutrophication is the over-enrichment of waters with nutrients, leading to increased algal biomass. It is the largest threat to Irish water quality and is of great importance to drinking water sources as increased algal abundance can create problems in treatment plants and decomposing algae can release toxins into the water and cause taste and odour problems.

The DAF treatment process undertaken by Doobally GWS has been designed to remove algal matter (as well as other undissolved matter) prior to the treatment process, However, the management of nutrient levels entering the aquatic environment is central to the long-term viability of many drinking water sources. The identification of the source of nutrients into Naweleian Lough will be key in outlining potential mitigation actions to reduce nutrient input into the catchment area and raw water source.

One potential source of the nitrogen is atmospheric deposition. Upland lakes may be particularly sensitive to the addition of nitrogen through atmospheric deposition, resulting in increased algal production and changes in nutrient balances, nutrient cycles and associated ecology (UK UWMN, 2010). However, the frequently high levels of microbial contamination (see below) suggest the possibility of agricultural (livestock) contamination of the raw water supply.

Levels of Total Coliforms, *E.coli* and *Clostridia perfringens* within the raw water supply are of concern and have frequently exceeded the Surface Water Regulations (1989). However, following the treatment process, there have been no occasions when microbial contaminants have been found to be present in the treated water supply. The microbial contamination of the raw water supply is surprising given the low agricultural pressures and the lack of dwellings and subsequent on-site wastewater treatment systems within the catchment. Naweleian Lough is unfenced and therefore there is potential for sheep to directly access the raw water supply close to the abstraction point. The abstraction point is also located in a relatively shallow area of the lake and therefore there is the possibility that some sediment is being transported into the intake pipe, with the microbial load of the sediment contributing to the subsequent high levels of Total Coliforms and *E. coli* in the raw water supply If such sediment uptake was occurring, the turbidity of the water would be expected to be high. The monthly data provided shows that turbidity can occasionally be high and subsequently, although this high turbidity may be a result of rainfall run off, algal matter and other organic content, there may be the possibility of occasional sediment uptake.

A number of recommendations are provided in Section 7 based on the assessment of physical properties and raw water quality data from within the catchment.

7.0 Recommendations

The assessment of geology, soils, land use and water quality data has identified a number of issues within the Doobally GWS catchment that are recommended to be addressed in order to improve source protection and maintain a high quality raw water supply.

Put source protection on the agenda

Within many group water schemes the importance of source protection is often underestimated or neglected. It is recommended that source protection be installed as an item on the agenda at all Doobally GWS meetings (AGM, Committee meetings, etc.). This will ensure that important issues within the catchment are discussed and addressed as appropriate. For example, the findings of this report should be discussed as a starting point. Issues around source protection measures and potential pollution within the catchment should also be discussed.

Reporting of potential pollution issues

The Doobally GWS should encourage committee members and people with connections to the scheme to report potential pollution issues. Members should be able to call the scheme staff to report pollution incidents in confidence. The scheme staff can then decide how to proceed with investigation, either dealing with the problem themselves or passing relevant information on to the County Council.

Develop a protocol for dealing with offenders

The committee should agree a protocol for dealing with potential pollution incidences. From the moment the staff receive knowledge, there should be a procedure in place. The protocol should reflect the seriousness of individual issues with some being dealt with by the scheme and more serious incidences being reported directly to the appropriate authority. Having a protocol in place ensures that all complaints are dealt with in an agreed and equitable manner.

Investigate the position of the intake pipe at the point of abstraction

The frequently high levels of microbial contamination in the raw water supply are surprising given the remote location of Naweleian Lough and the low livestock pressures within the catchment. The microbial contamination levels suggest the possibility of sediment entering the intake pipe. Therefore Doobally GWS should check the height of the intake pipe from the lake bed and if necessary raise the intake pipe from the sediment whilst ensuring that there will be sufficient water depth to continue abstraction at that location.

Confirm raw water collection protocols with EPS

Given the surprising levels of microbial contamination, EPS should be engaged to confirm raw water sample collection protocols in order to ensure that there is minimal possibility of cross-contamination of water samples.

Consider fencing around Naweleian Lough

If the intake pipe is found to be located at a suitable height from the lake bed, the direct access of livestock to the lake is likely to be the source of microbial contamination of the raw water supply. The fencing off of the whole lake would restrict livestock access and reduce the potential for future microbial contamination whilst also potentially reducing some treatment costs into the future.

Consider undertaking additional nutrient and algal monitoring

Total Phosphorus, Total Oxidised Nitrogen, Total Ammonia and algal levels may be monitored at a number of additional locations, for example at the lake source, the minor inflow stream to the lake as identified by Doobally GWS as a possible source of nutrients, as well as at one or two locations along the pipeline before a final sample at the treatment plant prior to the treatment process. The number of locations and the timeframes of sampling will be determined by available budget, but sampling should be undertaken at a minimum of a monthly basis from spring through to autumn.

Trihalomethane monitoring

As discussed in this report, the high levels of raw water colour that are present in the Doobally GWS raw water supply do not represent health risks. However, upon treatment with chlorine, THMs can be produced when the chlorine reacts with naturally occurring organic matter in the raw water (high true colour values can be an indication of high organic matter). These THMs have potentially significant health implications and further information on THMs and their monitoring within Ireland is provided by the Environmental Protection Agency:
http://www.epa.ie/pubs/advice/drinkingwater/DrinkingWaterGuide4_v8.pdf.

Although THM concentrations in the Doobally GWS treated water did not exceed the Drinking Water Regulations (2007) on any occasion, given the high True Colour and Total Organic Carbon values, the Trihalomethane sampling frequency may not have been sufficient to detect any occasion when the parametric value was exceeded. Trihalomethane monitoring should be undertaken during the period when True Colour values are typically highest (late summer to early winter), and therefore it may be prudent to undertake a short-term THM monitoring programme over the course of one year that concentrates on the late summer to early winter period, but also includes a minimum of two samples taken during the remainder of the year.

These monitoring timeframes will identify whether the Drinking Water Regulations (2014) parametric value for THMs is exceeded. The following mitigation methods for raw water are advised by the EPA if THM levels are found to be high in the treated water:

- Improve raw water management, including storage, intake management and monitoring and control (e.g. raw water turbidity monitors or automation of coagulant dosing based on raw water conditions);
- Install automatic shut off when water quality is poor.
- Examine the option for using an alternative raw water source.

The challenge remains between maintaining low THM levels whilst increasing chlorine treatment to remove coliform contamination. It is in this arena where source protection and the catchment-level management actions outlined in this report are important.

7.1 Further Work

1. Put Source Protection on the agenda

Including source protection issues on the agenda of committee meetings increases the profile and awareness of source protection issues within the Doobally catchment, and brings into focus the recommendations made within this report. Developing a protocol for dealing with potential pollution incidences would be a good first step for the committee to address.

2. Consider initiating a short-term Trihalomethane monitoring programme

Although Trihalomethane (THM) concentrations have not exceeded the Drinking Water Regulations (2007 and 2014), it is recommended that a one year monitoring programme is instigated, with sampling frequency focussed on the period between late summer and early winter when the possibility of THM formation is likely to be greatest as a result of high True Colour and organic content within the raw water supply.

3. Investigate the position of the intake pipe at the point of abstraction

The frequently high levels of microbial contamination in the raw water supply are surprising given the remote location of Naweleian Lough and the low livestock pressures within the catchment. The microbial contamination levels suggest the possibility of sediment entering the intake pipe. Therefore Doobally GWS should check the height of the intake pipe from the lake bed and if necessary raise the intake pipe from the sediment whilst ensuring that there will be sufficient water depth to continue abstraction at that location.

4. Consider fencing around Naweleian Lough

If the intake pipe is found to be located at a suitable height from the lake bed, the direct access of livestock to the lake is likely to be the source of microbial contamination of the raw water supply. The fencing off of the whole lake would restrict livestock access and reduce the potential for future microbial contamination whilst also potentially reducing some treatment costs into the future.

5. Consider undertaking additional nutrient and algae monitoring

Total Phosphorus, Total Oxidised Nitrogen, Total Ammonia and algal levels may be monitored at a number of additional locations, for example at the lake source, the minor inflow stream to the lake as identified by Doobally GWS as a possible source of nutrients, as well as at one or two locations along the pipeline before a final sample at the treatment plant prior to the treatment process. The number of locations and the timeframes of sampling will be determined by available budget, but sampling should be undertaken at a minimum of a monthly basis from spring through to autumn.

8.0 References

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