Appendix 8.1 Desktop Hydrogeological Assessment, Proposed Coolnabacky 400-110kV GIS Substation, Co. Laois

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DESKTOP HYDROGEOLOGICAL ASSESSMENT, PROPOSED COOLNABACKY 400/110 kV GIS SUBSTATION, CO. LAOIS

Technical Report Prepared For

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EXECUTIVE SUMMARY

AWN Consulting was requested by AOS Planning to prepare an assessment of the hydrogeology at the proposed 400/110 kV substation in the town land of Coolnabacky' near Portlaoise Co. Laois.

A number of tufa deposits and springs on historical maps have been identified in the vicinity of the site. The tufa deposits identified are associated with field drains and based on field observations it appears the deposits are fed by a constant supply of calcium carbonate rich groundwater. These spring-fed watercourses are the headwaters of the Timahoe River which flows into the River Barrow and Nore Special Areas of Conservation (SAC) ca 4.5 km to the South-West. The Timahoe River is designated as part of the SAC.

The proposed works consists of a 400110 kV substation and compound area (98m x 117m). Building foundations will be at between 1-2m.

The bedrock geology underlying the site consists of the Ballyadams Formation of crinoidal wackestone/packstone limestone and is classified as a Regionally Important Aquifer (RKd). Gravel deposits are also present in the area which will also act as an aquifer when sufficiently thick, permeable, saturated and extensive. The site is located on the boundary of a defined Locally Important sand and gravel aquifer. The aquifers beneath the proposed Coolnabacky substation are classified by the Geological Survey of Ireland as having a moderate vulnerability, indicating the presence of 5-10m of clayey subsoil beneath the site. The vulnerability rating was confirmed locally by investigations on the site.

Site investigations show that Sand and Gravel deposits were encountered to between 0.9m to 1.9m bgl. Clay deposits were encountered from 0.9m bgl and proved to a maximum depth of 8.5m bgl. Where groundwater was encountered, the strikes were recorded at depths of between 0.8m bgl and 5.2m bgl. Groundwater was encountered in the Sand and Gravel deposits at one borehole location only, indicating that the Sand and Gravel is not saturated.

The water environment receptors include groundwater beneath the site, tufa deposits, field drains and watercourses and the Timahoe River. The potential impact from any short term dewatering required during construction is expected to be limited. This is because the site investigation results indicate that the Sand and Gravel deposits are not saturated and groundwater inflow is not significant. Any minor dewatering will therefore be confined to the area immediately surrounding the excavation and will not impact on the tufa deposits or springs. Additionally, the sand and gravel deposits at the site are not expected to be in hydraulic continuity with the bedrock aquifer due to the presence of low permeability clay.

Mitigation measures recommended include isolating any groundwater in the more permeable Sand and Gravel deposits during dewatering if necessary, provision of a 25m buffer zone around the tufa deposits and ensuring that mitigation measures from the final environmental report are implemented.

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CONTENTS

1.0 INTRODUCTION

AWN Consulting was requested by AOS Planning to prepare an assessment of the underlying hydrogeology at the proposed 400/110 kV GIS substation in the townland of Coolnabacky' near Portlaoise Co. Laois.

The following list of maps and publications, together with databases, were reviewed as part of the assessment:

- Geological Survey of Ireland (GSI)/Teagasc Soils Map, Online Map Database[1]
- GSI, Geology of Kildare-Wicklow, Sheet 16[2]
- Karst Database, GSI[1]
- Quaternary (Subsoils) Database, GSI[1]
- Groundwater Well Database, GSI[1]
- Draft Ground Investigation Report, Coolnabacky 400kV Substation[3]
- GSI, Bagnelstown Groundwater Body Characterisation[4].

1.1 Site Description

The proposed Coolnabacky substation is situated approximately 2.5km north of Timahoe, Co. Laois. The site consists of a large roughly rectangular field where the proposed substation is planned and another field through which the proposed site access route is planned. The site area is level and is presently being used as agricultural land. The access route rises towards the south west over its length by circa 15m.

The field where the substation is planned was short grass while the proposed access route was through a newly ploughed arable field. The fields were separated by deep ditches containing water and mature trees. A number of tufa deposits and springs on historical maps have been identified in the vicinity of the site. The tufa deposits identified are associated with field drains.

Based on field observations it appears that the watercourses and field drains surrounding the Coolnabacky substation site are fed by a constant supply of calcium carbonate rich groundwater. These spring-fed watercourses are the headwaters of the Timahoe River which flows into the River Barrow and Nore SAC ca 4.5 km to the South-West. The Timahoe River is designated as part of the SAC.

1.2 Surrounding Land Uses

The site is bordered by a disused quarry to the south and agricultural land in all other directions.

1.3 Proposed Works

The proposed works consists of a 400kV substation and compound area (98m x 117m). Building foundations will be at between 1-2m. The footprint size of the proposed buildings will be:

- 400 kV Building - 15.5m x 63.5m
- 110 kV Building - 11.3m x 50m
- Trafo bunds - 10.7m x 79m

The proposed development will also seek modifications to the existing access road approximately (1.2km), connection to 400 kV line via overhead line to gantry in compound to double circuit end mast and connection of 110 kV lines via cable from the 110 kV building in compound to the line/cable interface masts.

1.4 Disclaimer

The findings and opinions expressed in this report are based on the information available at the time the report was prepared and interpretation is based on design details available such as foundation depths. If additional information becomes available, which might alter AWN's conclusions, we reserve the right to review such information, reassess potential concerns and modify our opinions, if warranted. Please note that where we refer to information in reports from others, it must be recognised that AWN has no responsibility for the accuracy of the information contained therein.

This report has been prepared by AWN for AOS Planning on behalf of ESBi. Any third party using this Report does so entirely at their own risk. AWN makes no warranty or representation whatsoever, express or implied, with respect to the use by a third party of any information contained in this Report or its suitability for any purpose. AWN assumes no responsibility for any costs, claims, damages or expenses (including any consequential damages) resulting from the use of this Report or any information contained in this Report by a third party.

2.0 RECEIVING ENVIRONMENT

A summary of the receiving environment is provided in the following sections.

2.1 Soils

The soil and subsoil underneath the proposed substation consists of undifferentiated alluvium (see Figures 2.1 and 2.2).

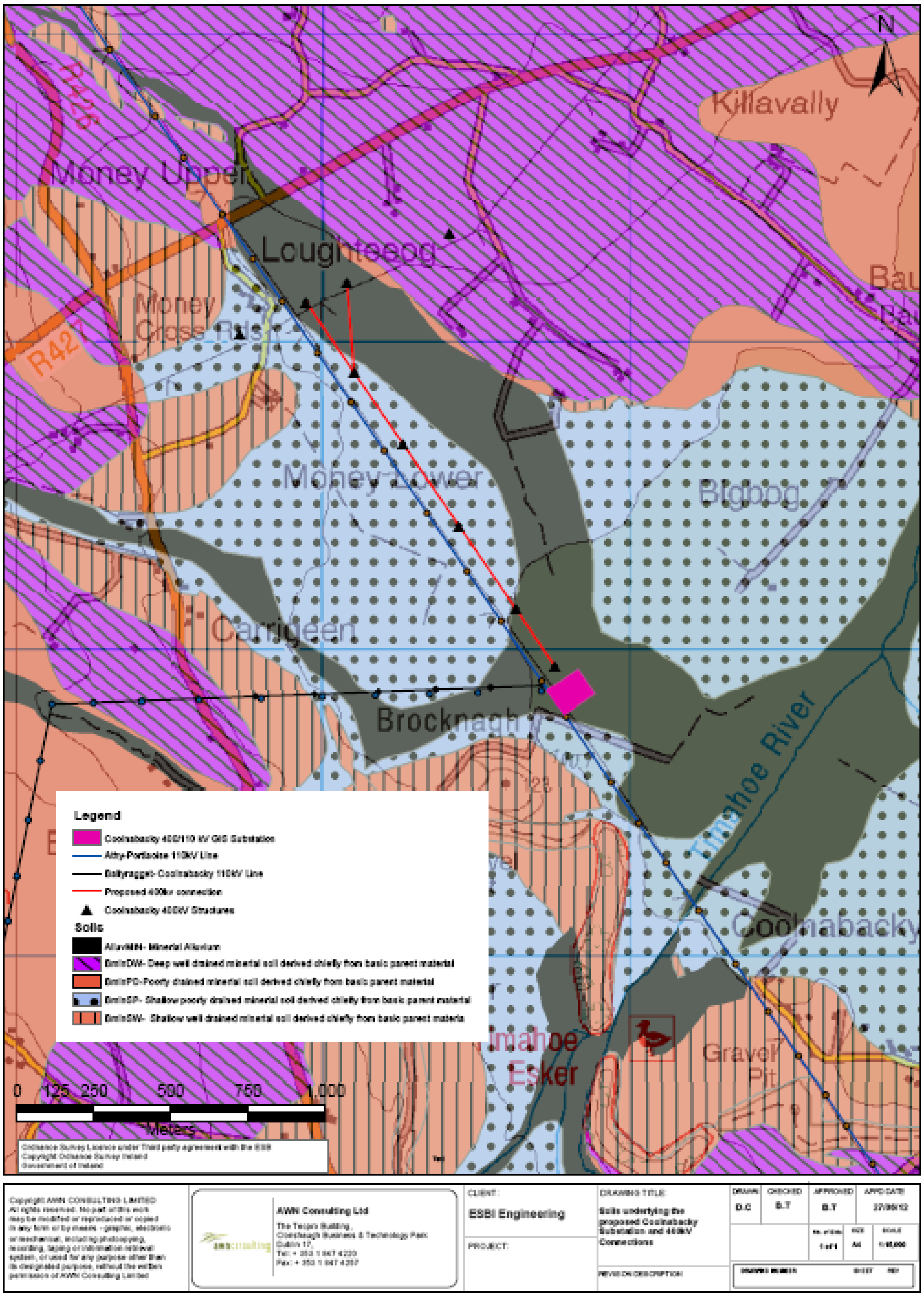


Figure 2.1 *Soils underlying the proposed Coolnabacky Substation*

Alluvial subsoil consists of gravel, sand, silt or clay in a variety of mixes and usually consists of a fairly high percentage of organic carbon (10%-30%). Alluvium is mapped only on modern day river floodplains. The alluvial deposits are usually bedded, consisting of many complex strata of waterlain material left both by the flooding of rivers over their floodplains and the meandering of rivers across their valleys.

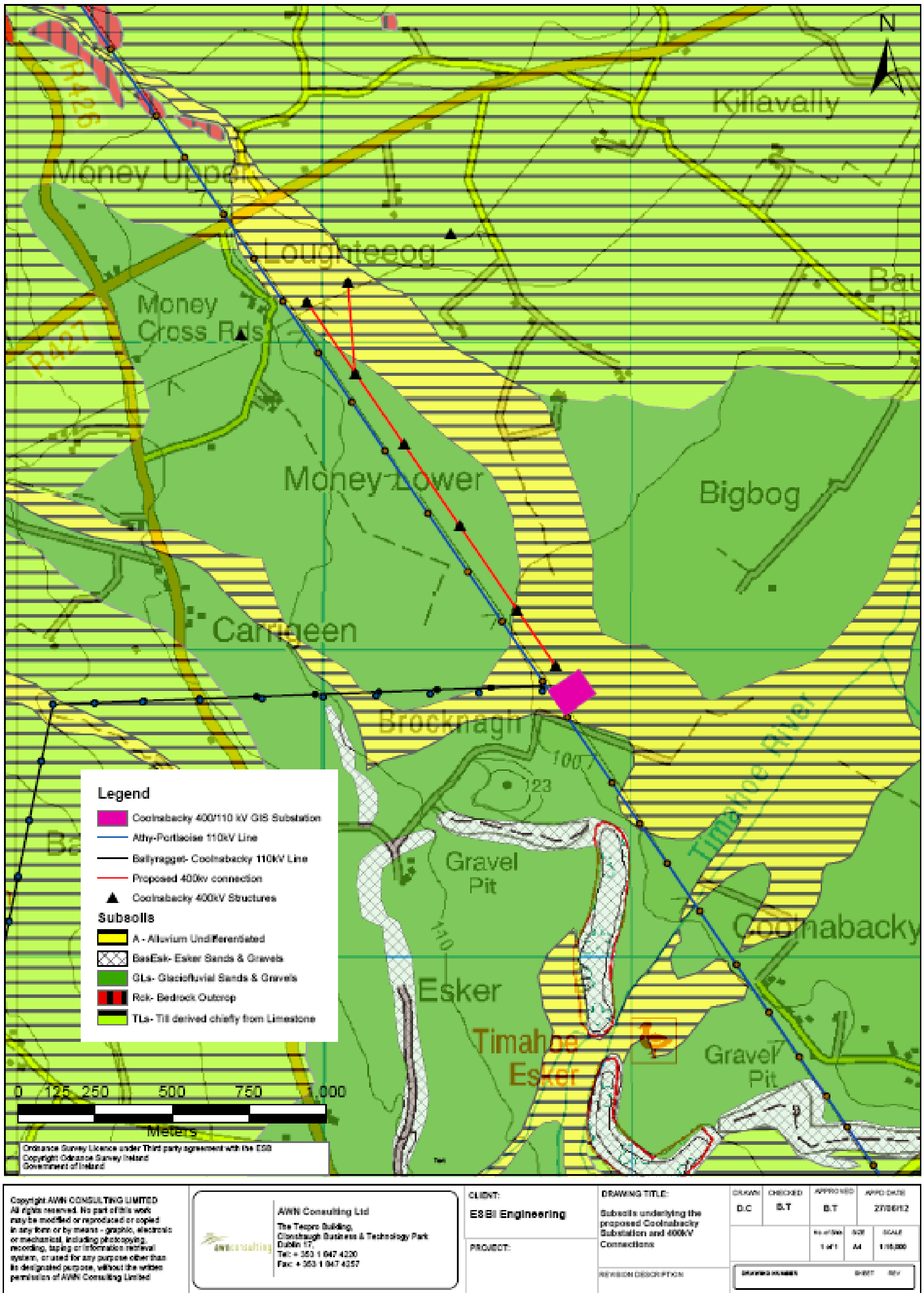


Figure 2.2 *Subsoils underlying the proposed Coolnabacky Substation*

2.2 Bedrock Geology

The bedrock geology underlying the site consists of the Ballyadams Formation of crinoidal wackestone/packstone limestone (see Figure 2.3).

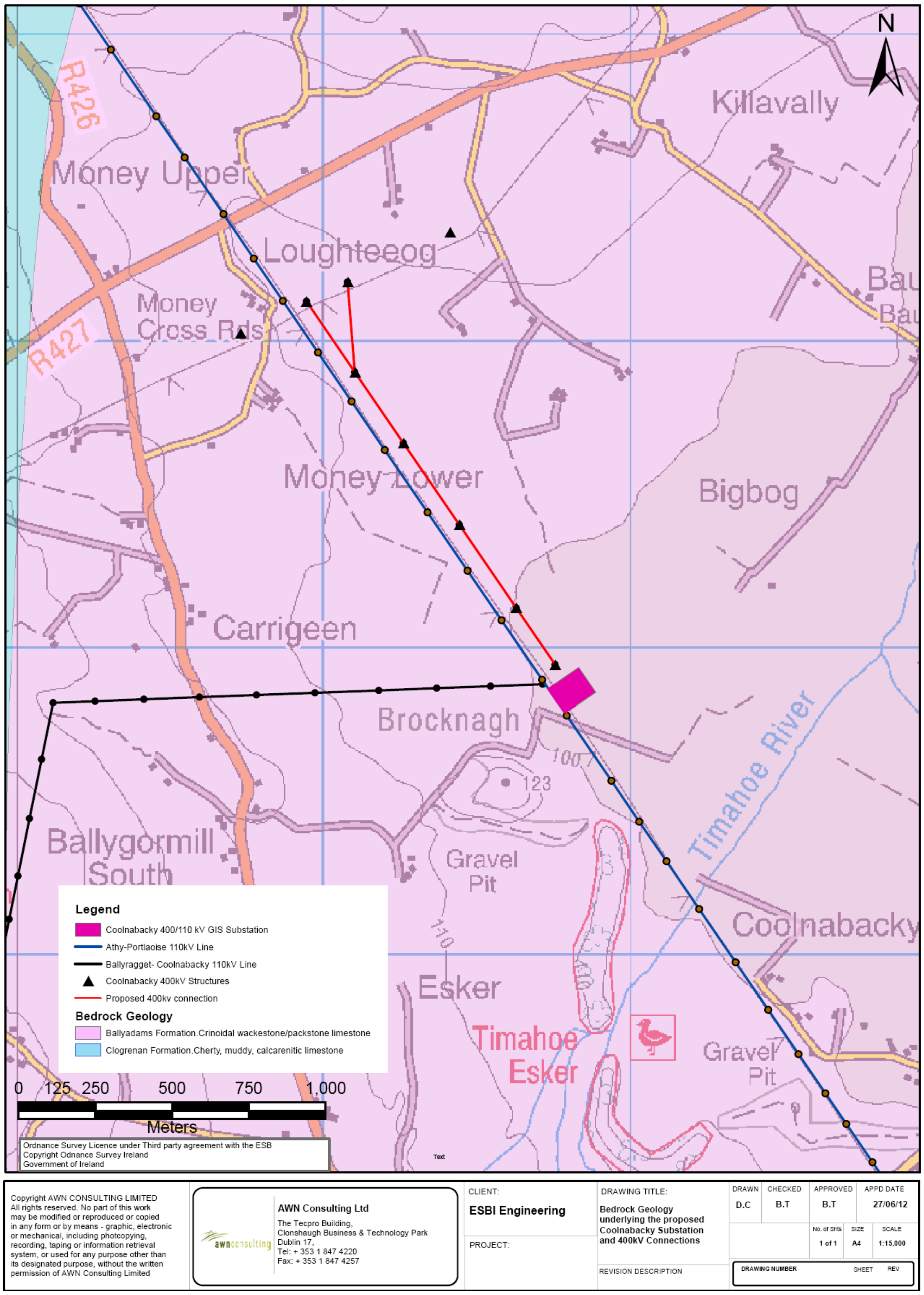


Figure 2.3 *Bedrock Geology underlying the proposed Coolnabacky Substation*

The Ballyadams Formation consists of pale-grey thick-bedded pure fossiliferous limestone. It comprises water-bearing units of pure limestone and dolomitised limestone and Calp. The dolomitisation is not complete and therefore there may be areas of undolomitized limestone that act as aquitards.

2.3 GSI Boreholes

The closest GSI boreholes are approximately 1.5km and 1.8km north east of the site. The wells are both shallow (5.5m bgl and 7m bgl) and the yield is classified as poor.

2.4 Aquifer Classification

The bedrock aquifer is classified as a Regionally Important Aquifer (RKd), referring to the Ballyadams Formation (see Figure 2.4).

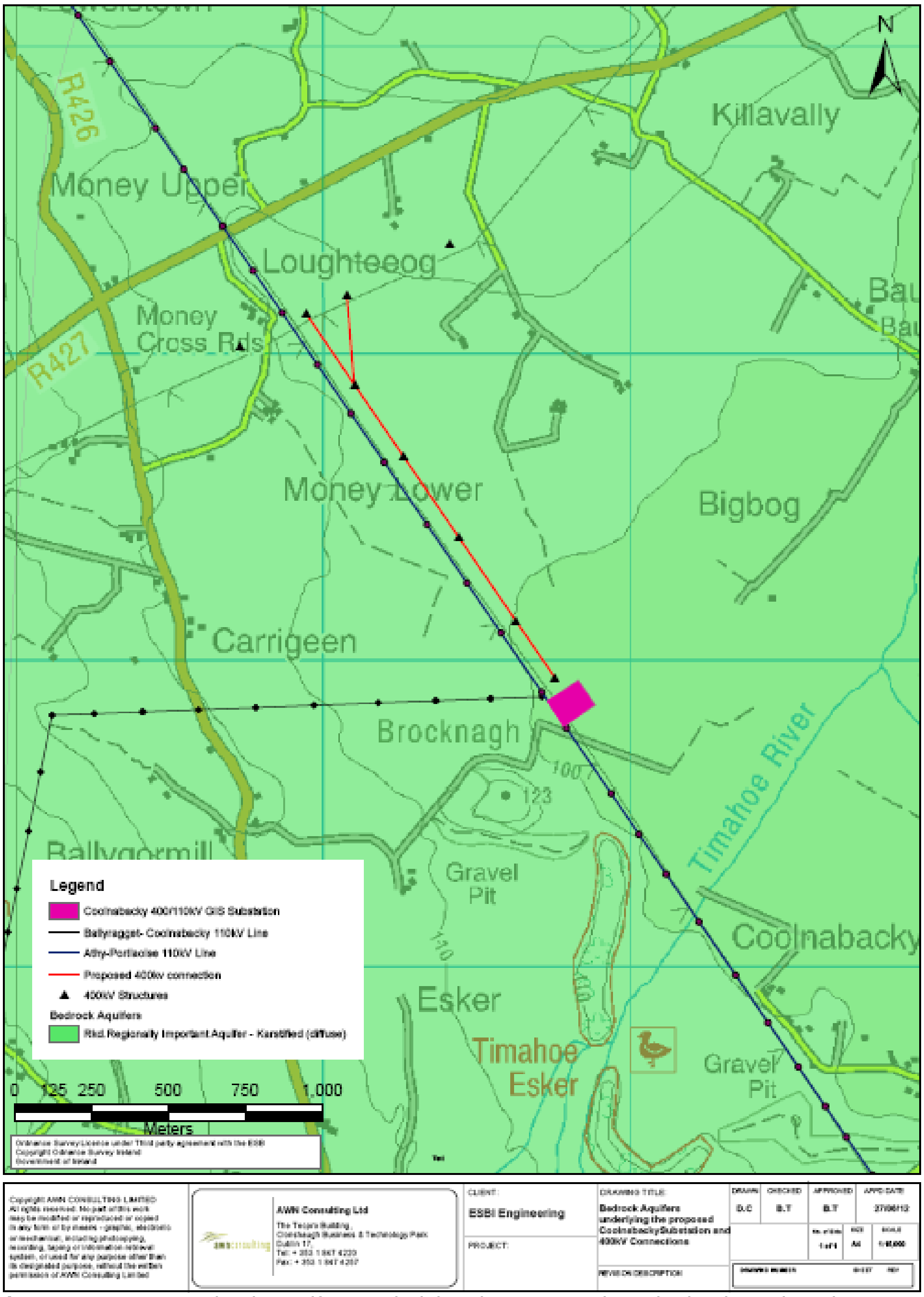


Figure 2.4 *Bedrock Aquifers underlying the proposed Coolnabacky Substation*

Gravel deposits are also present in the area which will also act as an aquifer when sufficiently thick, permeable, saturated and extensive. The proposed Coolnabacky substation is located on the boundary of a defined Locally Important sand and gravel aquifer (see Figure 2.5). The tufa deposits to the east of the substation are also on the boundary of the gravel aquifer. The gravel aquifer is shown to extend to the south west of the site, where eskers and gravel pits are noted.

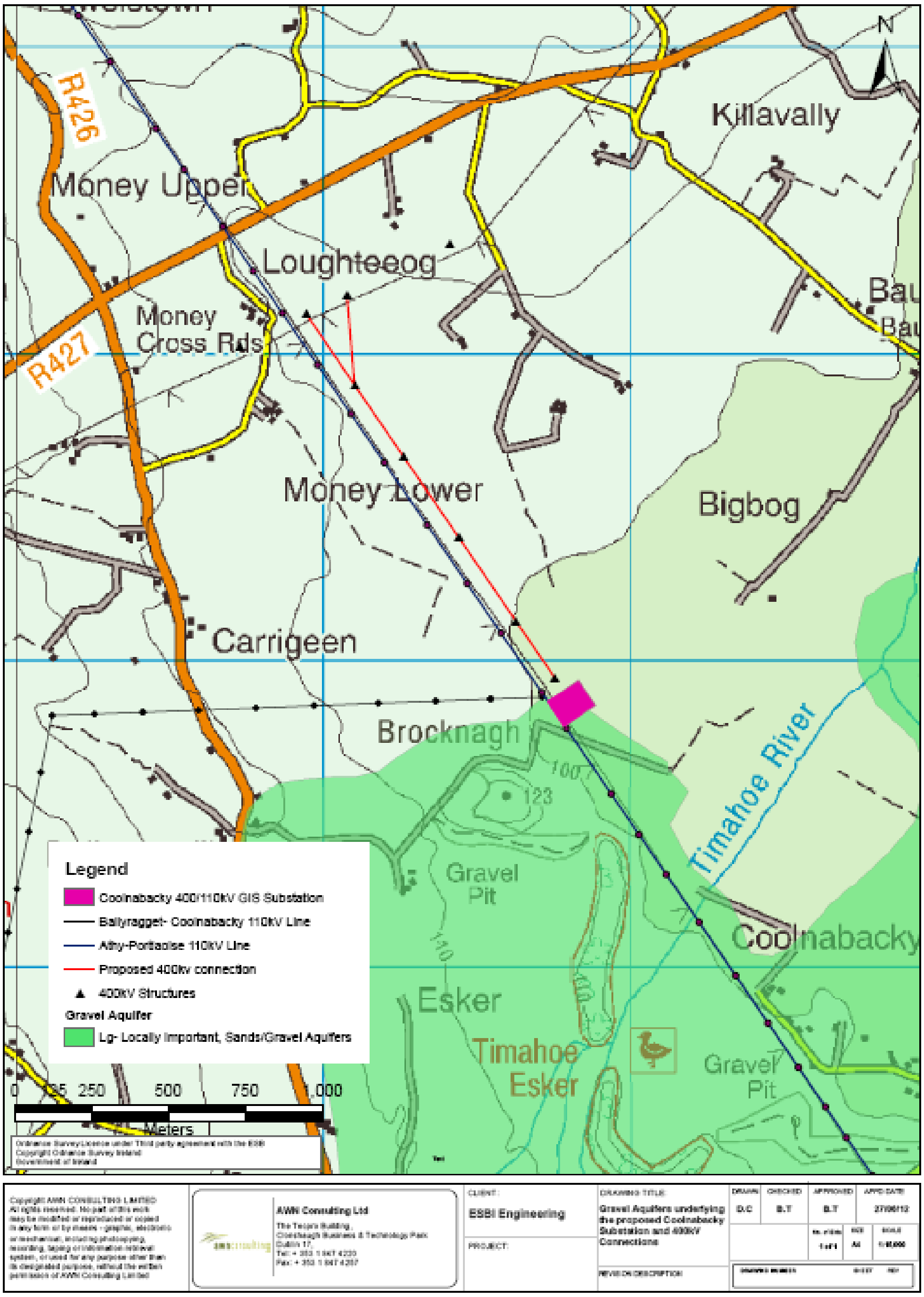


Figure 2.5 *Gravel Aquifers underlying the proposed Coolnabacky Substation*

2.5 Groundwater Vulnerability

The aquifers beneath the proposed Coolnabacky substation are classified as having a moderate vulnerability (see Figure 2.6), indicating the presence of 5-10m of clayey subsoil beneath the site, as shown in the GSI's vulnerability mapping guidelines shown in Table 2.1.

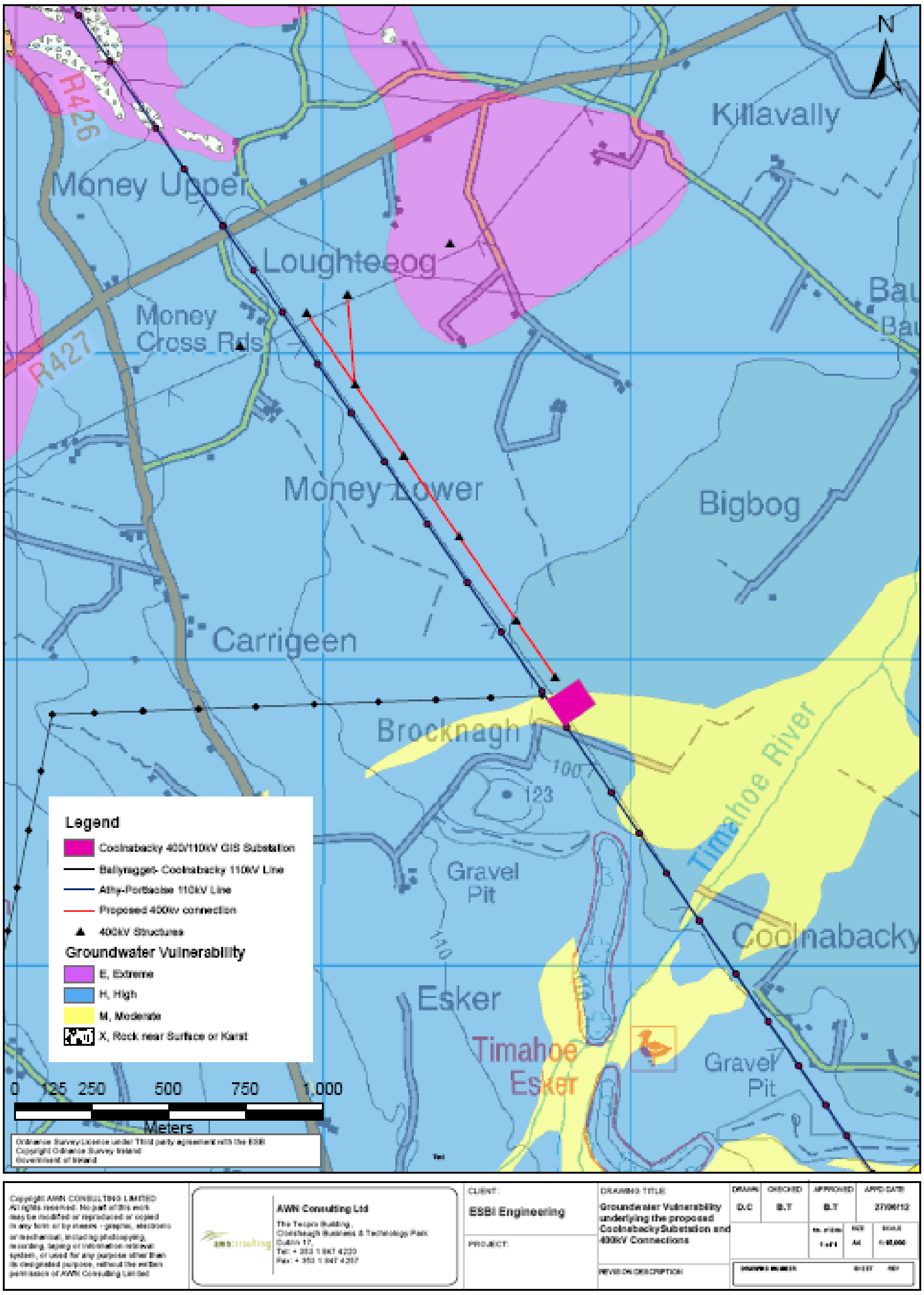


Figure 2.6 *Groundwater Vulnerability underlying the proposed Coolnabacky Substation*

The substation is surrounded by areas of high vulnerability (see Figure 2.6).

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Table 2.1 *Vulnerability Mapping Guidelines*

2.6 Groundwater Flow Direction

The nearest large river is the Timahoe river, approximately 600m to the south east of the site (see Figure 4.1). The groundwater flow direction is assumed to also be to the south east.

2.7 Groundwater Body

The site is underlain by the Bagenalstown Groundwater Body (GWB). The GSI has issued a Summary of Initial Characterisation for the Bagenalstown GWB[4].

Sands and gravels overlie significant areas of this groundwater body and are themselves discrete groundwater bodies. The sands and gravels are very coarse and poorly sorted and are similar to those seen in the Nore Basin. Clay layers often separate individual layers of the sands and gravels. In other areas, Till derived from limestone is the dominant overlying material.

The dolomite aquifer is presumed to be of "replacement" origin and hence may contain some primary permeability. The dominant secondary permeability of the dolomite results from the development of fissures by the solution of bedding planes and joints. In the undolomitised pure limestones only secondary permeability exists. The transmissivity of the dolomites can range from 20-200m^2/d, with a specific yield less than 2% (storage coefficient 10^{-4}).

There is hydraulic continuity between the Barrow Valley sands and gravels and the underlying aquifer. Under natural non-pumping conditions the flow regime in the aquifer is severely restricted, as there is no natural discharge down-dip. Hence the aquifer will be full of water and circulation will be limited to the near surface zone. Under pumping conditions leakage will occur from the sands and gravels into the aquifer.

3.0 SITE INVESTIGATIONS

Site investigations carried out at the site include a series of boreholes (BH1 – BH8) located at the substation compound area[3].

The following ground conditions were encountered:

3.1 Topsoil

Topsoil was encountered from ground level to a maximum depth of 0.3m below ground level (bgl). Topsoil was encountered at all locations.

3.2 Sand and Gravel Deposits

Sand and Gravel deposits were encountered beneath the topsoil to between 0.9m to 1.9m bgl. The sand and gravel deposits are typically described as brown to orange brown with sub rounded cobbles of limestone. Sand and Gravel deposits were encountered at all locations.

3.3 Clay Deposits

Clay deposits were encountered from 0.9m bgl and proved to a maximum depth of 8.5m bgl (BH2). Between 2.7m to 6.8m of clay was proved in the boreholes. The clay consisted of grey to brown grey firm to stiff clay with sub rounded gravel and cobbles of limestone. The clay became very stiff in some locations with depth. Clay deposits were encountered at all locations.

Bedrock was not encountered at the site.

3.4 Groundwater

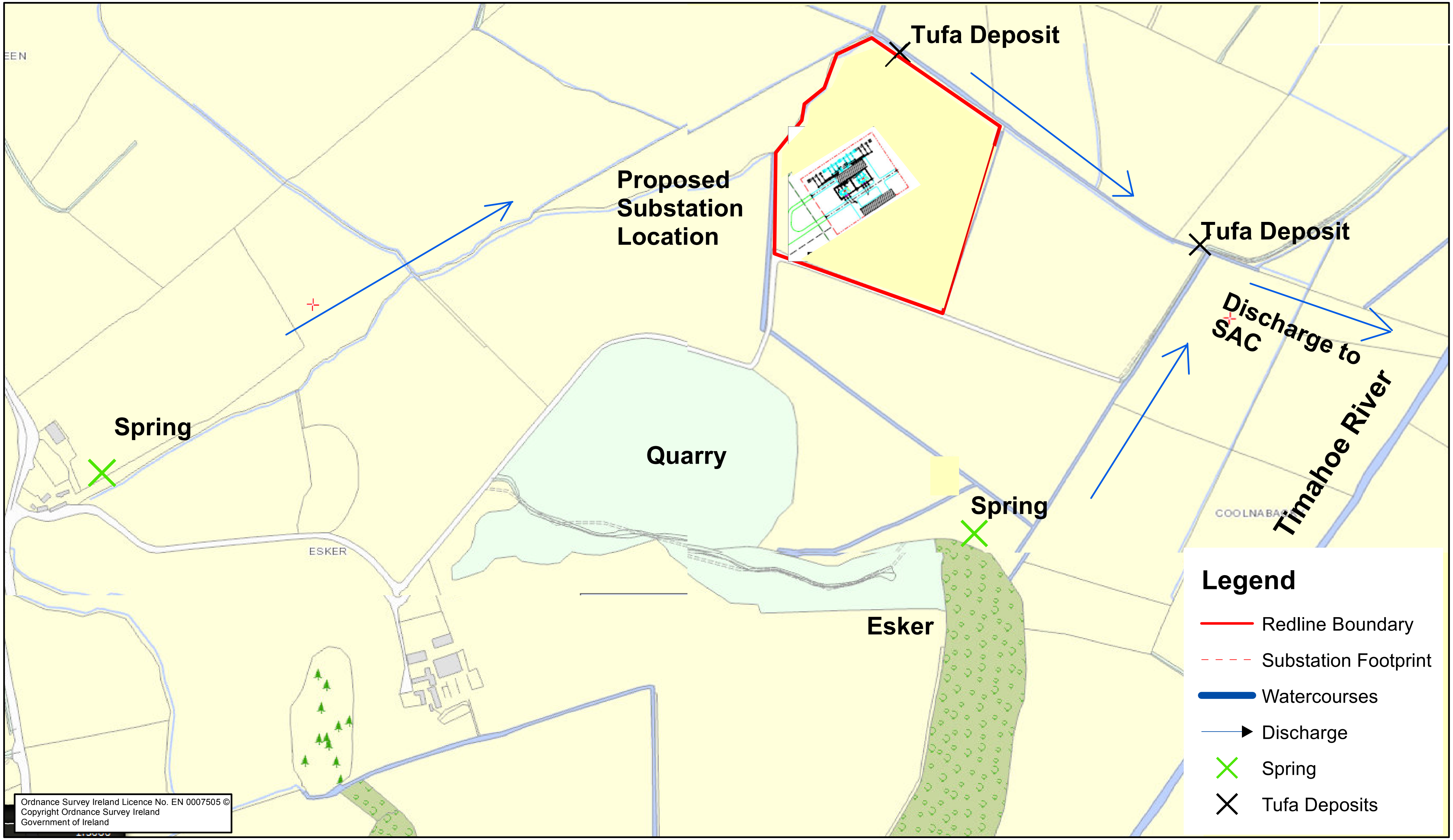
Groundwater strikes were encountered in all boreholes other than BH1 and BH10. The groundwater strikes were encountered in both the Sand and Gravel and Clay deposits. Where groundwater was encountered, the strikes were recorded at depths of between 0.8m bgl (BH3) and 5.2m bgl (BH7). No groundwater inflows were noted in BH2, BH3 and BH5.

It is noted that groundwater was encountered in the Sand and Gravel deposits at boreholes BH3 only, indicating that the Sand and Gravel is not saturated.

4.0 IDENTIFICATION OF WATER ENVIRONMENT RECEPTORS

The following Water Environment receptors have been identified in the vicinity of the site, and are shown in Figures 4.1 and 4.2. The Water Environment receptors are:

- Groundwater in the shallow gravel aquifer beneath the site;
- Groundwater in the underlying bedrock aquifer beneath the site;
- Tufa deposits along northern boundary of site;
- Tufa deposits to the north east of the site;
- Field drains along the site boundary which are part of the main headwaters of the Timahoe River;
- Timahoe River to the south east of the site;
- Spring associated with an esker to the south of the site;
- Spring at the head of the watercourse to west of site, and;
- Spring on head of watercourse to south of site.



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CLIENT: ESBI Engineering

PROJECT:

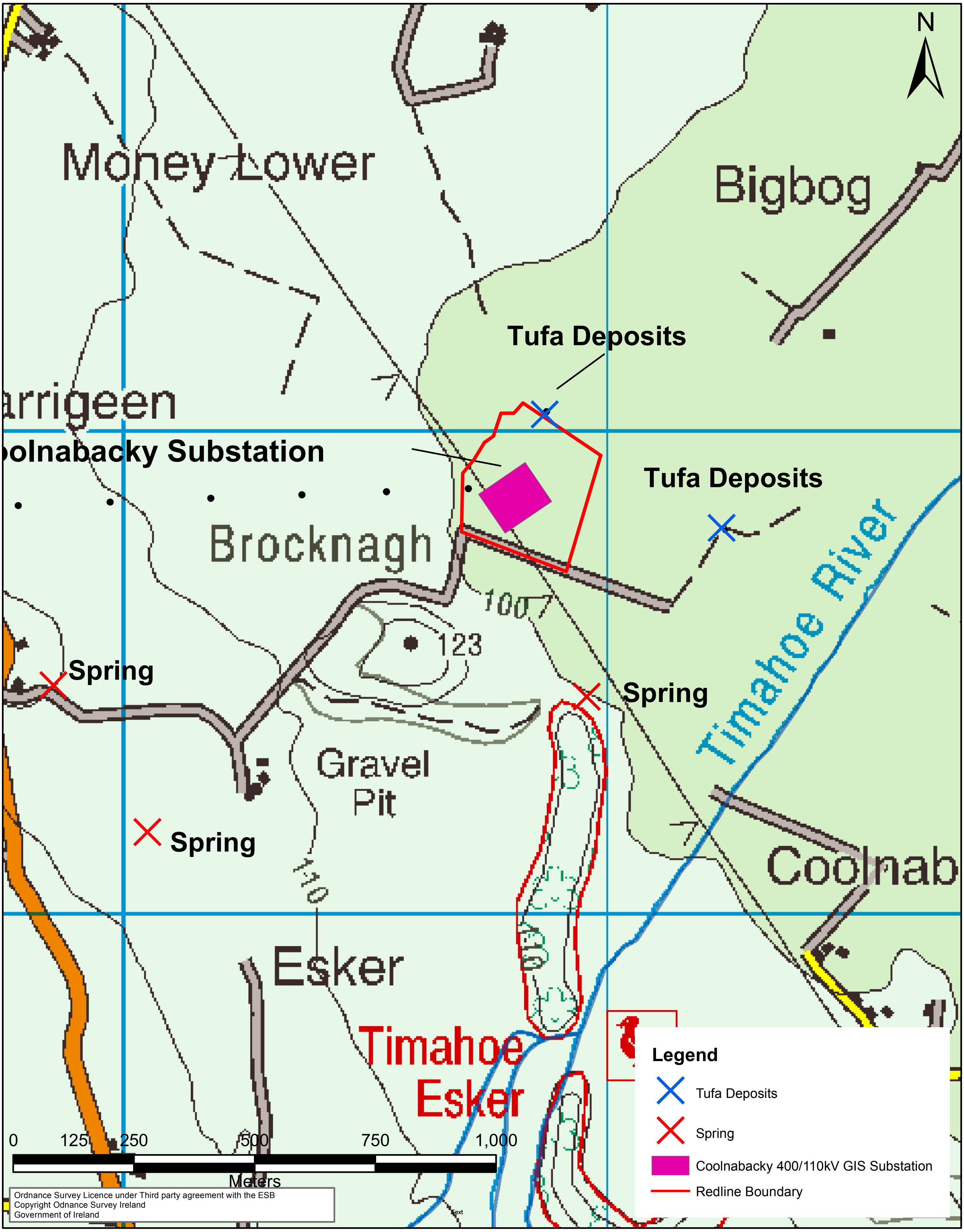
DRAWING TITLE: Receiving Environment Receptors (vicinity of site)

REVISION DESCRIPTION

DRAWN	CHECKED	APPROVED	APPD DATE
D.C	D.B	D.B	02/07/2012

	No. of Shts	SIZE	SCALE
Figure 4.1	1	A4	

DRAWING NUMBER	SHEET	REV



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CLIENT: **ESBI Engineering**

PROJECT:

DRAWING TITLE: Water Environment Receptors (Wider area)

REVISION DESCRIPTION

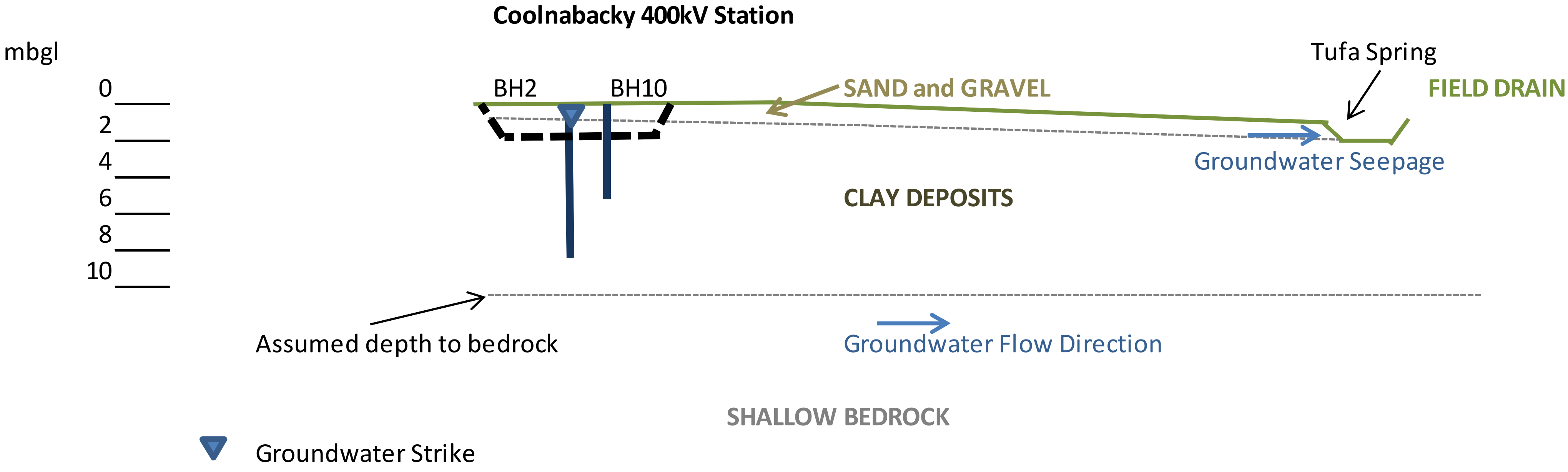
DRAWN	CHECKED	APPROVED	APPD DATE
D.C	D.B	D.B	02/07/12

	No. of Shts	SIZE	SCALE
Figure 4.2	1 of 1	A4	1:10,000

DRAWING NUMBER	SHEET	REV

4.1 Conceptual Site Model

The Conceptual Site Model (CSM) (Figure 4.3) is presented as a schematic cross section between the site of the proposed Coolnabacky 400Kv substation and the tufa deposits closest to the site shown in Figures 4.1 and 4.2.



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CLIENT: ESBI Engineering	DRAWING TITLE: Conceptual Site Model	DRAWN: D.C	CHECKED: D.B	APPROVED: D.B	APPD DATE: 02/07/2012
PROJECT:			No. of Shts: 1	SIZE: A4	SCALE:
	REVISION DESCRIPTION	DRAWING NUMBER		SHEET	REV

The closest tufa deposit to the site is located over 100m from the boundary of the proposed excavation. Given the ground conditions at the site, the tufa deposits are expected to be fed from seepages from the gravel aquifer. The thickness of the sand and gravel deposits is variable, and across the site ranges from 0.9 to 1.9m.

The gravel aquifer is shown to extend to the south west of the site. The presence of eskers and gravel pits to the south west of the site further indicates that a greater thickness of Sand and Gravel deposits is expected in this area. Both tufa deposits are located at or near the boundary of the gravel aquifer and are thus associated with discharge zones at the gravel aquifer boundary.

However, the sand and gravel deposits at the site were not found to be saturated during the site investigation. In most cases, groundwater strikes were not recorded in the Sand and Gravel deposits. It is noted that, due to the presence of low permeability Clay deposits beneath the sand and gravel, the inflow volumes of groundwater encountered during drilling was minimal. As the sand and gravel was not saturated, this indicates that the quantities of groundwater present are not significant.

Although for the wider groundwater body hydraulic continuity exists between the Sand and Gravel deposits and the bedrock aquifer, within the localised site area any groundwater in the sand and gravel deposits is not expected to be in hydraulic continuity with the bedrock aquifer underlying the site. This is due to the presence of a proved significant thickness of low permeability Clay deposits, with between 2.7m to 6.8m of clay proved beneath the Sand and Gravel deposits. The clay encountered during the site investigations is described as stiff to very stiff at depth, and this stiff clay will impede any vertical groundwater flow.

The groundwater flow direction in the Sand and Gravel deposits is expected to be in the direction of the closest watercourse, i.e. to the south east. The CSM assumes that the tufa deposits are directly down gradient of the site.

4.2 Impact of Proposed Works on Hydrogeology

The proposed works include excavations of 1-2m bgl at the building locations. An excavation of 2m is shown on the CSM and is located over 100m from the closest tufa deposit.

The excavations will extend through the sand and gravel deposits into the underlying clay deposits. However, as discussed above the borehole logs indicate that the sand and gravel deposits are not saturated. Therefore, groundwater inflow from the sand and gravel deposits is expected to be limited.

Minimal groundwater inflows were encountered in the underlying clay deposits. As the permeability of these deposits is low, this will also impede the groundwater flow into the excavations. Due to the presence of low permeability clay at the base of the excavations, any groundwater in the more permeable Sand and Gravel deposits can be isolated during dewatering if necessary. This would minimise the impact on the local regime if unexpected additional gravel lenses were encountered during excavation.

As the groundwater flow into the excavations is expected to be limited, extensive dewatering is not anticipated during excavation and any impact on the water environment receptors is expected to be minimal. During construction should additional saturated gravel be encountered, the use of low permeability barriers to isolate and essentially keep out groundwater in the sand and gravels can be undertaken to ensure that the impact of dewatering is localised to the area immediately surrounding the excavation.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A number of water environment receptors have been identified in the vicinity of the site, including tufa deposits located at field drains on the boundary of the site and associated with the boundary of the gravel aquifer.

The proposed excavation works at the Coolnabacky substation will extend for a maximum of 2m bgl and will intercept the shallow Sand and Gravel deposits into the underlying Clay deposits.

The impact on the water environment from any dewatering required during excavation is expected to be limited due to the following:

- Site investigation results indicate that the Sand and Gravel deposits are not saturated;
- Most groundwater strikes were in the underlying low permeability clay deposits and during dewatering the inflow is expected to be limited;
- As the excavations extend into the low permeability clay, any groundwater in the more permeable Sand and Gravel deposits can be isolated during dewatering if necessary;
- Any dewatering can therefore be confined to the area immediately surrounding the excavation and will not impact on the local groundwater regime which supplies the tufa deposits or springs;
- The Sand and Gravel deposits at the site are not expected to be in hydraulic continuity with the bedrock aquifer.

5.1 Mitigation Measures

The following mitigation measures are recommended to protect water environment receptors during construction:

Isolation of Groundwater Seepages

Borehole logs indicate that the Sand and Gravel deposits are not saturated and groundwater flow into the excavation during construction is expected to be limited. However, should on-going dewatering be required during excavations it is recommended that a low-permeability barrier be installed around the excavation walls. This will ensure that any potential for drawdown that could affect the water regime including the watercourses and tufa deposits will be minimised.

Protection of Water Environment Receptors

The mitigation measures outlined in the final environmental report accompanying the planning application will ensure that no sediment contamination, contaminated runoff or untreated wastewater will enter any watercourses during the construction of the proposed line route. Given the presence of sensitive water environment receptors at the site, it is imperative that these mitigation measures are adhered to.

Provision of Buffer Zone

It is recommended that a 25m buffer zone is applied around the tufa deposits to ensure protection of the deposits. No works during construction and operation will occur within this area, including re-fuelling, batching of concrete or storage of fuels and soil stockpiles.

REFERENCES

1. Geological Survey of Ireland (2012) Databases in relation to karst, quaternary (subsoils), groundwater wells, bedrock geology – www.gsi.ie

2. B.McConnell, M.E. Philcox, (1994), Geology of Kildare-Wicklow, Sheet 16. Geological Survey of Ireland.

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4. GSI, Bagnelstown Groundwater Body – Summary of Initial Characterisation