Grace Kilbane
Ryan Hanley Engineering and Environmental Consultants
Unit 1 Galway Business Park
Dangan
Galway
H91 A3EF

27 February 2020

Re: Lifford Flood Relief Scheme – Constraints Study Public Consultation

Your Ref: N/A
Our Ref: 20/52

Geological Survey Ireland is the national earth science agency and has datasets on Bedrock Geology, Quaternary Geology, Geological Heritage Sites, Mineral deposits, Groundwater Resources and the Irish Seabed. These comprise maps, reports and extensive databases that include mineral occurrences, bedrock/mineral exploration groundwater/site investigation boreholes, karst features, wells and springs. Please see our website for data availability and we recommend using these various data sets, when undergoing the EIAR, planning and scoping processes. Geological Survey Ireland should be referenced to as such and should any data or geological maps be used, they should be attributed correctly to Geological Survey Ireland.

Dear Grace,

Thank you for your email received by Monica Lee (GSI) on 13/02/2020, and invitation to comment on the proposed Lifford Flood Relief Scheme constraints study. Geological Survey Ireland (a division of Department of Communications, Climate Action and Environment) would like to make the following comments:

Groundwater

The primary issue that we would like to highlight is that the River Foyle and part of Lifford town (including the proposed hard defences) is underlain by an alluvial deposit. In this vicinity, the alluvium is thought to be coarse-grained and permeable throughout most of its depth. It is therefore possible that the deposit is hydraulically connected to the River Foyle and allows water to move laterally through it. This should be considered as part of any flood mitigation works as the deposit may enable water to bypass the proposed hard defences. The extent of the deposit within Ireland can be viewed on our web viewer (turn on the 'quaternary sediments' layer) - https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228. In Northern Ireland, Geological Survey Northern Ireland (GSNI) map this as an area of sand and gravel overlain by estuarine deposits (https://mapapps2.bgs.ac.uk/GSNI_Geoindex/home.html, map layer Geology 10K Superficial Geology). Flooding via underground movement of water through linked superficial deposits is known to occur in the UK, and the British Geological Survey provide a case study here - https://www.bgs.ac.uk/research/groundwater/flooding/oxford.html. Please find attached a draft report on the River Swilly sand and gravel aquifer. You might find it useful for characterising the Lifford deposit.

The impact of the deposit should also be considered when interpreting the results of the CFRAM study. The alluvium deposit does not seem to be mentioned in the Hydrology, Hydraulics or Preliminary Options Reports for the North Western Neagh Bann Unit of Management. As such, the flood extents and proposed solution may be based on an incomplete conceptual model of how water moves through the River Foyle.

Geoheritage

Geological Survey Ireland (GSI) is in partnership with the National Parks and Wildlife Service (NPWS, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs) to identify and select important geological and

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geomorphological sites throughout the country for designation as geological NHAs (Natural Heritage Areas). This is addressed by the Irish Geoheritage Programme (IGH) of GSI, under 16 different geological themes, in which the minimum number of scientifically significant sites that best represent the theme are rigorously selected by a panel of theme experts.

County Geological Sites (CGS), as adopted under the National Heritage Plan are now included in County Development Plans and in the GIS of planning departments, to ensure the recognition and appropriate protection of geological heritage within the planning system. CGSs can be viewed online under the Geological Heritage tab on the online Map Viewer. The audit for Co. Donegal was carried out in 2019. The full report details have not been published on our website yet but can be provided upon request. **Our records show that there are no CGSs in the vicinity of the proposed flood relief scheme.**

Therefore, with the current plan, there are no envisaged impacts on the integrity of current CGSs by the proposed development. However, if the proposed development plan is altered, please contact Clare Glanville (Clare.Glanville@gsi.ie) for further information and possible mitigation measures if applicable.

Geotechnical Database Resources

Geological Survey Ireland continues to populate and develop our national geotechnical database and viewer with site investigation data submitted voluntarily by industry. The current database holding is over 7500 reports with 134,000 boreholes; 31,000 of which are digitised whish can be accessed through downloads from our Geotechnical Map Viewer. We would strongly recommend that this database be consulted as part of any baseline geological assessment of the proposed development as it can provide invaluable baseline data for the region or vicinity of the proposed development area. This information may be beneficial and cost saving for any site specific investigations that may be designed as part of the development.

Other Comments

Should development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. The data would be added to GSI's national database of site investigation boreholes, implemented to provide a better service to the civil engineering sector. Data can be sent to Beatriz Mozo, Geological Mapping Unit, at Beatriz.Mozo@gsi.ie, 01-678 2795.

I hope that these comments are of assistance, and if we can be of any further help, please do not hesitate to contact me (Clare.Glanville@dccae.ie), or my colleague Ted McCormack of the Groundwater and Flood Mapping Programme (Ted.McCormack@gsi.ie).

Yours Sincerely,

Dr. Clare Glanville
Geoheritage & Planning Programmes
Geological Survey Ireland

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Swilly Sand and Gravel Aquifer

Summary of Initial Characterisation

December 2018

3rd Draft Swilly Sand and Gravel Aquifer Description September 2018

Swilly Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
39 – Lough Swilly Donegal Co. Co.	**Rivers:** River Swilly, Farnoge Burn, Coravaddy Burn, Corranagh Burn, Fergaug Burn **Streams:** Several unnamed streams **Lakes:** None	Lough Swilly SAC Lough Swilly SPA	4.9

Topography		This sand and gravel deposit is located along the River Swilly, which flows from WSW to ENE, south of Letterkenny. The aquifer body covers an area of 4.9 km^2 (Figure 1). The sand and gravel comprises glaciofluvial outwash sands and gravels overlain by alluvium of varying grain size, and is bounded by till and bedrock. The sediments are deposited within the river valley, surrounded by ridges to the north and south. The elevation across the aquifer area ranges from sea level to 10 m AOD. The River Swilly, which flows westwards into Lough Swilly, is tidal as far west as Sallaghagrane, 4.5 km inland (Lee and Fitzsimons, 2004).
Geology and Aquifers	**Aquifer categories**	The sand and gravel deposit is confirmed to be greater than 10 m deep, and has a saturated thickness greater than 5 m. The thickness, saturated thickness and areal extent satisfy the criteria of a **Locally Important Sand and Gravel Aquifer (Lg)** (DELG/EPA/GSI (1999).
	Main aquifer lithologies	"Alluvial deposits along river floodplains are thought to comprise sands and gravel at depth, overlain by finer material (silts and clays) (Meehan, 2006). Ground investigations 2.5 km WSW of Letterkenny show that sand and gravel layers are not uniform throughout the deposit; generally they are > 5 m thick and overlain by 10 m to 15 m of silt or clay (Minerex Environmental Ltd, 2001). In some areas, there are only thin (0.5 m to 2 m) gravel layers. In general, the sand and gravels thicken towards the centre of the deposit, where they are >10 m (GSI, 2005).
	Key structures	There are a number of borehole logs from within this aquifer which provide some insight into the structure of the body, and which record the variability within the sediments. The aquifer is overlain by silt and clay of varying thicknesses. Clay and silt layers are also interbedded with the sand and gravel throughout the deposit. The sand and gravel is generally deposited directly on bedrock for the most part; however, discontinuous till deposits may also be found separating the gravel and the bedrock. The sand and gravel deposit sits mainly upon a 'Poor' bedrock aquifer which has a high degree of rejected recharge associated with it. This has the effect of retaining the water within the basal layers of the sand and gravel aquifer.
	Key properties	Productivity and yield data indicate that the gravel layers are transmissive and capable of providing yields in excess of 400 m^3/d (Lee and Fitzsimons, 2004). In gravel layers, transmissivity will probably be >200 m^2/d. In areas where the aquifer is fine-grained, transmissivity will be lower. Storativity is expected to be high (10-20%) (GSI, 2005).The groundwater is considered to be generally confined due to the presence of overlying silt and clay layers. There are eight records of well yields in the aquifer ranging from 200 m^3/day to 1,091 m^3/day. Five of the eight wells have 'Excellent' yields. The aquifer is close to the coast and is therefore vulnerable to sea water intrusion; yet there is no evidence of saltwater intrusion into this aquifer. The tidal range along the river reaches Port Bridge (Minerex, 2001) which invades the north-eastern boundary of the aquifer.
	Thickness	Borehole logs within the aquifer area indicate depth to bedrock varies between 6 m bgl to 22 m bgl. The thickest sequence of gravel recorded is 18 m, however most logs record interbedded sand and gravel with clay and silt. Generally gravel layers vary between 1.5 m to 6 m in thickness (Minerex, 2001).
Overlying Strata	**Lithologies**	Alluvial clay and silt layers overlie the sand and gravel deposit in places.
	Thickness	The overlying alluvial clay and silt layers vary in thickness from 4 m to 14 m, but are generally in the range of 5 m to 7 m.
	% area aquifer near surface	Unknown

	Vulnerability	It is thought that much of the sand and gravel is overlain by low permeability sediments which provide some protection to the underlying gravel aquifer. However this thickness and the areal of extent of these low permeability deposits vary and are not mapped in any detail. Sand and gravel aquifers are categorised as having either 'High or 'Extreme' vulnerability (DELG/EPA/GSI, 1999), with the vulnerability classification determined by the depth to the water table from ground level. Measured water levels range from 1 m to 5 m below ground level in the Swilly aquifer. In areas where the water table is less than three metres below ground level the aquifer vulnerability is 'Extreme' and where it is greater than three metres below ground level the aquifer vulnerability is 'High'
Recharge	**Main recharge mechanisms**	The aquifer receives both direct and indirect recharge. Diffuse recharge occurs *via* infiltration of rainfall through the unsaturated sand and gravel. This may be inhibited slightly across some of the aquifer body by the presence of overlying silt and clay deposits. "*Most of the recharge is likely to be at the top of the valley at the top of the glaciofluvial gravels, with smaller amounts seeping through the silts above them throughout the valley area. It is likely that there is more recharge through the silts to the sides of the valley as they are thinner. Similarly through the alluvial sediments up valley as these are more porous. The groundwater is probably moving down the valley 'seaward' through the glaciofluvial sediments*"(Minerex, 2001). Typically the proportion of recharge that infiltrates to ground water in sand and gravel is around 85% (Hunter Williams *et al*., 2011). Rejected recharge from the surrounding hills will increase the amount of available recharge to the aquifer. Depending on the relationship between the water table and river stage the rivers may recharge the aquifer in some localities.
	Est. recharge rates	The rainfall in the area of the Swilly sands and gravels is 1350 mm (Walsh, 2012), and the average recharge rate from diffuse recharge across the aquifer extent is estimated to be 270 mm/yr.
Discharge	**Large springs and large known abstractions (m^3/d)**	There are a number of wells within the Letterkenny Water Supply Scheme (WSS) that have 'Excellent' yields (Minerex, 2001).
	Main discharge mechanisms	Groundwater discharges to the river and stream tributaries at low elevations, as well as along the coast to Lough Swilly.
	Hydrochemical Signature	There are no data available to assess the hydrochemistry of this aquifer.
Groundwater Flow Paths		Generally, the surface water and groundwater flow directions coincide. The principal groundwater flow direction is to the ENE (GSI, 2005). The length of groundwater flow paths depend on the extent of the sand and gravel deposit, and also upon the spacing of internal groundwater divides and the distance between streams. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths *i.e*. up to several hundred metres. The variability in the composition of this aquifer disrupts flow, shortening groundwater flow paths.
Groundwater & Surface water interactions		Hydraulic connection between the groundwater and surface water is expected to be high.

Conceptual model	• The Swilly sand and gravel aquifer is a Locally Important aquifer, located near Letterkenny along the valley of the River Swilly. • The deposit is formed of alluvium and underlying glaciofluvial sand and gravel. • The boundaries of the aquifer are for the most part delimited by the extent of the mapped alluvial deposit (GSI, 2018), however areas where the sands and gravels are thought to extend under 'Made' ground are also included. • The aquifer is generally confined due to the presence of overlying low permeability layers and, for the most part, is deposited directly on top of the bedrock. The bedrock itself is classified as a Poor Bedrock Aquifer' (GSI Aquifer Map) and the retention of recharge in the basal layers of the sand and gravel causes the water table to be at a relatively shallow depth. • There is therefore a considerable saturated thickness within the body where thick gravel layers are present. • Borehole logs within the deposit show the heterogeneity of the aquifer material which makes the behaviour of the groundwater difficult to predict, and as a result the permeability of the deposit is expected to vary considerably throughout the aquifer extent. • It is thought that the variability in the recorded yields from numerous boreholes is a reflection in the variability in composition of the materials. • Although there are a number of 'Excellent yields, 'Good' yields are also recorded. Recharge to the aquifer occurs diffusely through the unsaturated zone. • Water enters the aquifer as diffuse recharge from rainfall, and discharges at ditches, to the river and at the estuary.
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability
Instrumentation	**Hydrometric gauges:** 39061 Port Bridge **National Water Monitoring Stations:** RS39S020600 Thorn Quay; RS39S020500 Torn Quay; TW06007073LS1002 Blackwoods Burn; TW06007073LS1001 LS010 - Port Bridge; RS39S020370 Sprack Burn N Drumnahough; RS39S110800 Swilly R.; RS39S110700 Bridge u/s Swilly R.; RS39S020350 Sprack Burn near Church; RS39S020310 Old Town STW; RS39S020300 Old Town Letterkenny; RS39S110600 Br on N13 NW of Port B; RS39S020190 75m u/s Br at Newmills; RS39S020200 Bridge at Newmills

Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • GSI (2005). Swilly Gravel Groundwater Body Description. 8pp. • Hunter Williams, N., Misstear, B., Daly, G., Johnston, P., Lee, M., Cooney, P., Hickey, C., (2011) National Groundwater Recharge Map for Ireland. Geological Survey Ireland and Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • Lee, M. and Fitzsimons, V. (2004) County Donegal Groundwater Protection Scheme. Volume 1 Main Report, Draft, July 2004. 58 pp. Geological Survey of Ireland • Meehan, R.T., (2006). Subsoils Map for County Donegal. Map produced as part of EPA Soil and Subsoil Mapping Project (formerly FIPS-IFS). Teagasc, Kinsealy. • Minerex Environmental Ltd (2001). Letterkenny Water Supply – No. 2 Augmentation Scheme. Groundwater resource development in Glen Swilly. Data Review, Geophysics, Core Logging, Replacement Well Drilling, Pumping Tests & Reporting. Fieldwork July – November 2000. MEL Report Ref:- 1009-828 (Final).doc. • O'Suilleabháin, C., (2000). Assessing the boundary between high and moderately permeable subsoils. Unpublished MSc., University of Dublin. Department of Civil, Structural and Environmental Engineering, Trinity College Dublin. • Walsh S., (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin. • Wright, G.R., Aldwell, C.R., Daly, D. and Daly, E.P. (1982). Groundwater resources in the Republic of Ireland, vol 6. In: European community's Atlas of groundwater resources, SDG, Hannover, Germany. • GSI, 2018. Geological Survey Ireland Spatial Resources Viewer. https://www.gsi.ie/en-ie/data-and-maps/Pages
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations and assumptions based on the information sources described above and established hydrogeological formulae. Figures 1, 2 and 3 are used for illustrative purposes only.

Swilly Sand and Gravel Aquifer

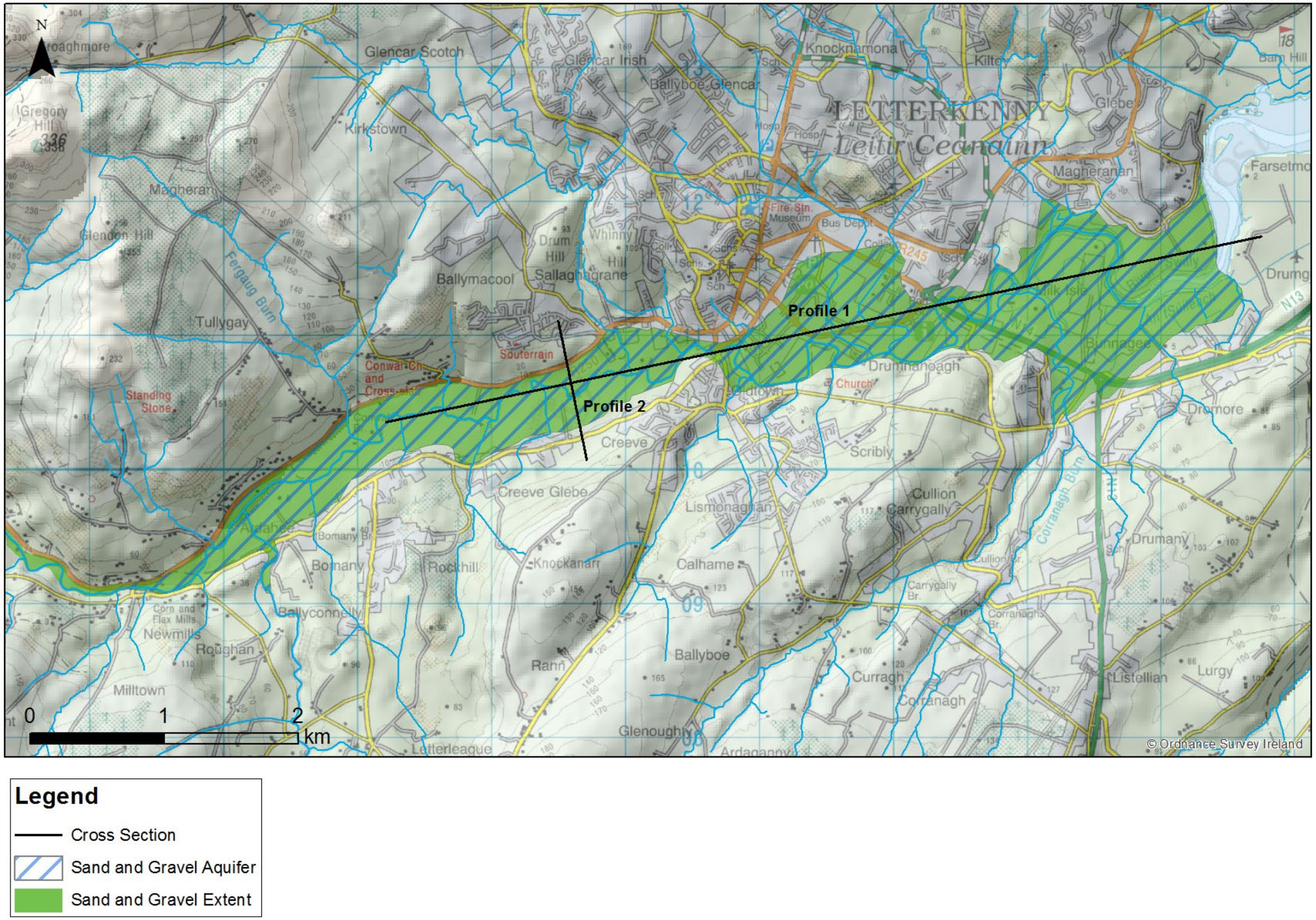

Figure 1: Swilly sand and gravel aquifer extent with cross section locations.

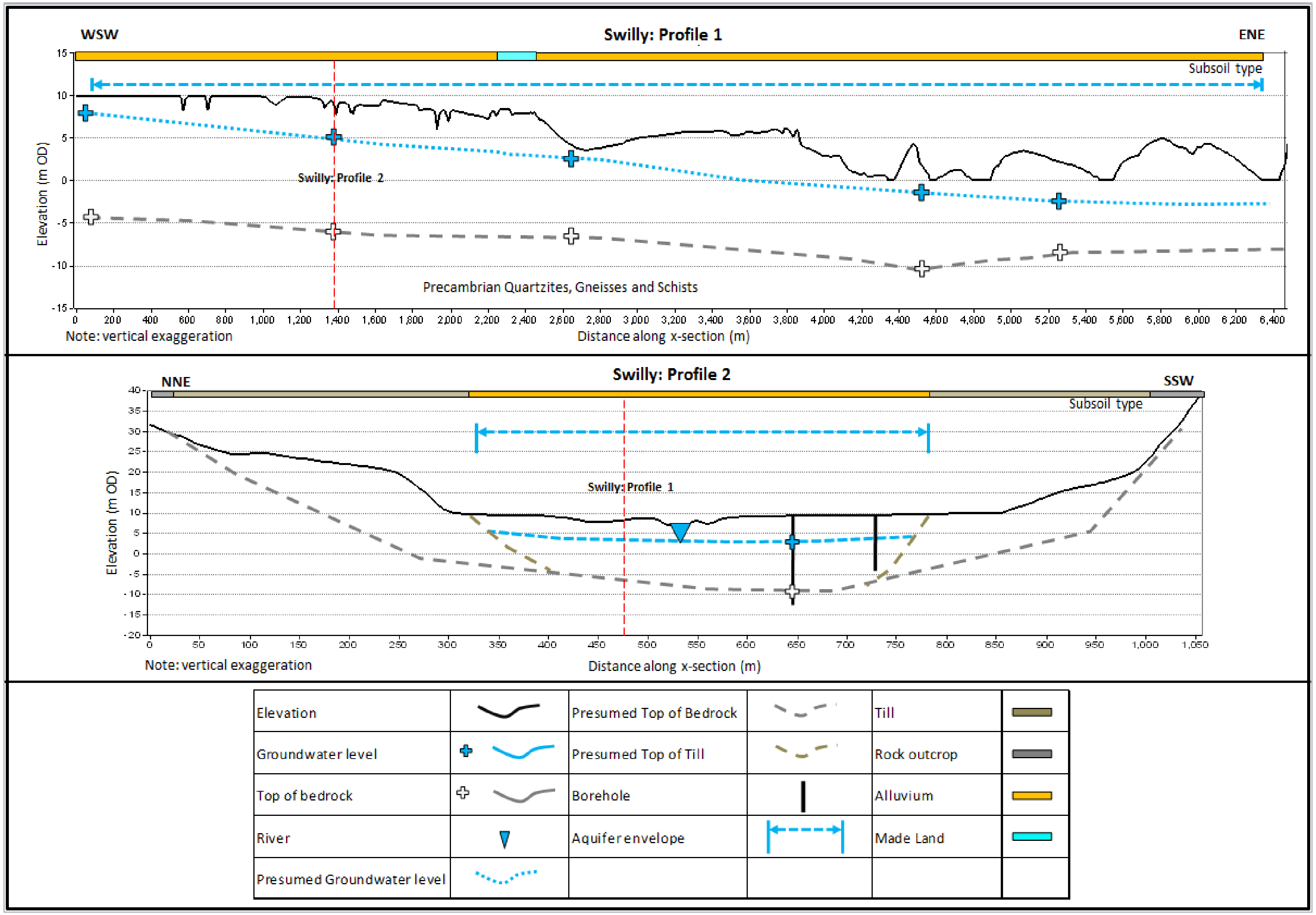

Figure 2: Cross sections through the Swilly sand and gravel aquifer body (above and below).

Swilly Sand and Gravel Aquifer Vulnerability

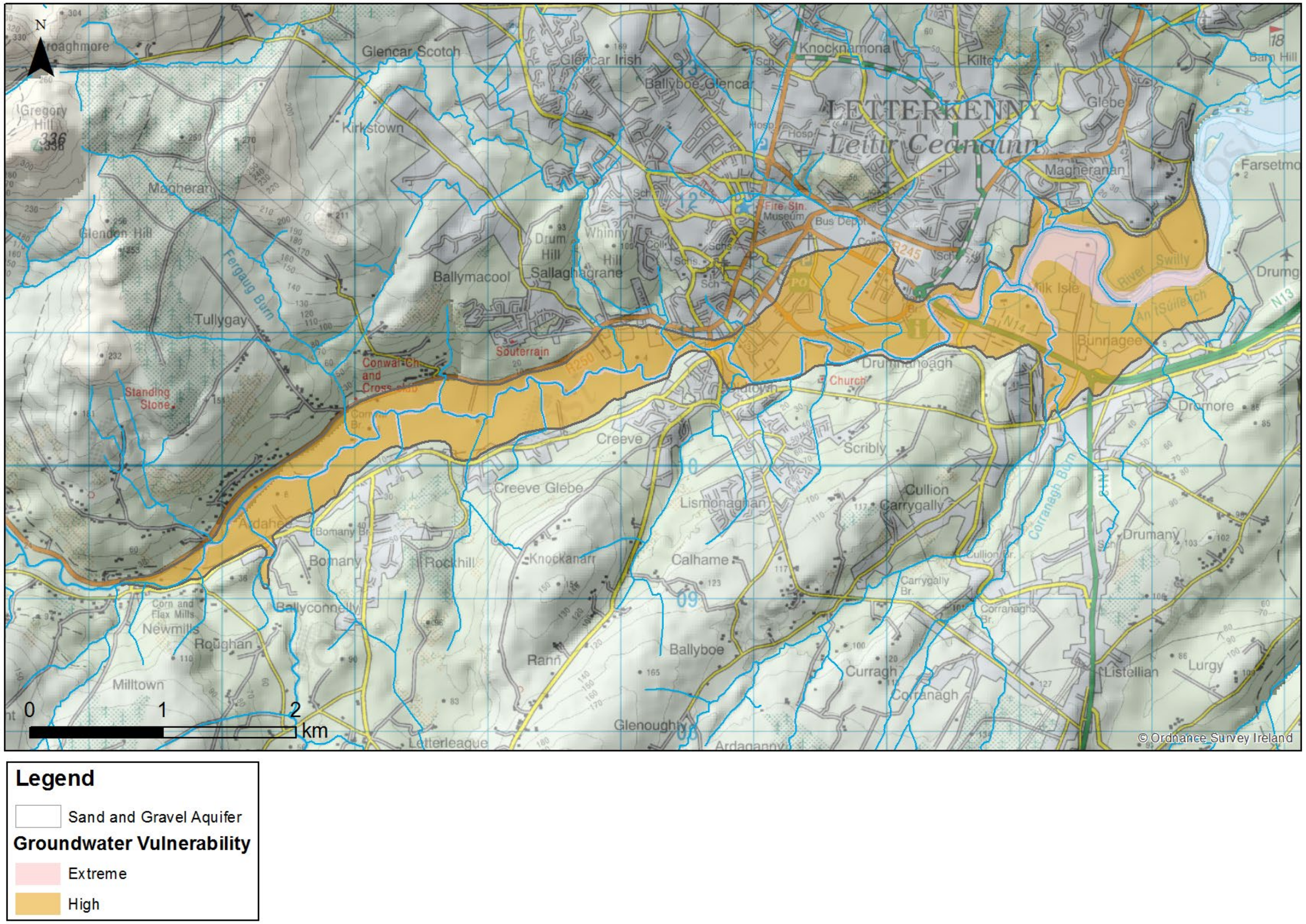

Figure 3: Groundwater vulnerability across the Swilly sand and gravel aquifer.