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Killarney Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/19
February 2023

Geological Survey Ireland is a division of the Department of the Environment, Climate and Communications

Killarney Sand and Gravel Aquifer Description February 2023

This sand and gravel report forms part of a series representing the output of a body of work undertaken to re-evaluate previously mapped sand and gravel aquifers and to identify new sand and gravel aquifers. This study resulted in the refinement of existing sand and gravel aquifer mapped extents, the modification of some sand and gravel aquifer categories, and the removal of some previously mapped sand and gravel aquifers, as well as identification of new aquifers. In addition to mapping the extent and depths of the sand and gravel aquifers, the investigations consider the hydraulic properties.

The study, undertaken as part of the GW3D project (2015-2019), comprised three parts:

1) Desk study and fieldwork preparation

Sand and gravel bodies above a minimum size criterion were extracted from the GSI Quaternary Sediments 1:50,000 map. Where it was known that the surface expression of the sands and gravels was only a small portion of the subsurface body, such areas were retained. This process left several hundred sand and gravel bodies remaining as a starting point for field work.

2) Fieldwork including mapping and data collection

Field work included a visit to each of the areas which had the potential to be (at least) a Locally Important Sand and Gravel Aquifer owing to its area. In such areas, gravel pits and sand pits were visited and depth and type of sediment recorded, other exposures into the subsurface were visited and logged, wells (whether Public Supply, Group Scheme or private farm or domestic) were dipped and any information on depths recorded, and data was collected where geological and hydrogeological data existed for the area.

3) Data collation, analysis and reporting.

All field data, and information from earlier reports and studies, were compiled and analysed. Where a sand and gravel body had qualifying aquifer properties (either 10 m depth sand and gravel, or 5 m depth saturated sediments), these areas were digitised in a GIS. The aquifer area was then ascertained and drawn up. Such areas formed the basic building blocks for the sand and gravel aquifer map, which included details on the aquifer name, area, aquifer resource value (Rg or Lg), confidence level, county, and any important aspects to note for each body.

The updated mapped sand and gravel aquifers are found on the Geological Survey Ireland site https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx#Aquifers

The GW3D Mapping Team involved in the current revision of delineated sand and gravel aquifers were:

Geological Survey Ireland staff:

- Dr. Sophie O'Connor, Groundwater Programme / Land Mapping Unit
- Dr. Sarah Blake, Groundwater Programme

Consultant support:

- Dr. Robbie Meehan, Talamh Ireland
- Coran Kelly, Tobin Consulting Engineers
- Damien Doherty, independent Consultant Geologist/ Tobin Consulting Engineers
- Natalie Duncan, independent Consultant Geologist
- Sara Raymond, independent Consultant Geologist
- James McAteer, Gavin and Doherty Geosolutions

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Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
22 – Laune - Maine - Dingle Bay Kerry County Council	**Rivers:** Deenagh River, River Flesk, Teernaboul River, Woodford River, Farranaspig Stream, Folies Stream **Streams:** Several unnamed streams **Lakes:** Lough Leane	Killarney National Park, MacGillycuddy's Reeks and Caragh River Catchment SAC and pNHA, Killarney National Park SPA	15.7

Topography	The Killarney sand and gravel aquifer is a long, quasi-linear belt of sand and gravel that stretches for 12 km along an east-west orientation, and passing through Killarney Town centre, in south central County Kerry (Figure 1). The western end of the aquifer is situated along the northern shoreline of Lough Leane, and the aquifer topography is characterised as 'flat alluvial-glaciofluvial plain' (GSI, 2023a), though the majority of the deposit comprises elevated terraces and marked ridges and hummocks. The body is found at elevations between 20 m and 148 m AOD, with the highest elevations are on the eastern side of the body (Wright, 1927). The surrounding landscape to the north is characterised as bedrock streamlined ridges and plateaux which rise to between 120 and 240 m AOD. The landscape to the south is characterised as rolling to gently undulating glacial sediments which often rise to approx. 100 m AOD. The local landscape within the aquifer body has been altered significantly, especially on the eastern margins, where a number of active sand and gravel pits are present.	
Geology and Aquifers	**Aquifer categories**	There are 32 geotechnical data points available from within the sand and gravel body. The aquifer is considered to be unconfined, and it is proven to extend beneath the (urban) 'Made' ground in Killarney (GSI, 2023b). The aquifer exceeds the groundwater throughput threshold of 1,000 m^3/d, with rejected recharge from higher slopes to the north and northeast contributing significantly to this throughput. Based on its areal extent, inferred thickness, inferred saturated thickness, groundwater throughput and position in the landscape the deposit is classified as a **Regionally Important Sand and Gravel Aquifer (Rg)** (DELG/EPA/GSI, 1999; GSI, 2017).
	Main aquifer lithologies	Flat to gently undulating to hummocky, glaciofluvial sands and gravels derived chiefly from Devonian sandstones (GDSs).
	Key structures	Exposure is relatively extensive within this sand and gravel body, especially on the eastern side, and the key depositional structures noted were thickly bedded sheets of sands and gravels, with varying percentages of fines.
	Key properties	There are 21 desk study data points which have groundwater level data within, with five records indicating at least 10 m depth of saturated sand and gravel (GSI, 2023b); these are found across the aquifer extent. Using these data, along with water level data from the streams and rivers, it has been inferred that approx. 56% of the aquifer area has a depth of saturated sand and gravel greater than 5 m. Particle size distribution analyses are available for 17 boreholes logs from within the aquifer, and the average fines content is 9 % which decreases to 6.7%, when two 'outlier' analyses on the edge of the aquifer are excluded (GSI, 2023b). In general, sand and gravel aquifers consist of unconsolidated coarse grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000).
	Thickness	Proven depth to bedrock data points range from 7.5 m to 75 m below ground level (GSI, 2023b), in Avenue and Ardaneanig Townlands respectively. Borehole records at 11 localities have a subsoil thickness of at least 10 m; these are found across the entirety of the aquifer. Using the 28 desk study data points and inferences between them, the thicknesses of the subsoils are expected to be at least 10 m throughout the aquifer area, with large areas likely to have a thickness greater than 20 m (Philcox, 2002).
Overlying Strata	**Lithologies**	Approximately 31% of the aquifer is overlain with alluvium, lacustrine sediments and/or (urban) 'Made' ground, with sand and gravel proven as beneath.
	Thickness	Based on desk study data, the thickness of lacustrine sediments is between 0.3 m and 0.6 m, and the thickness of (urban) 'Made' ground is between 0.2 m and 0.5 m (GSI, 2023b). The alluvium is assumed to be less than 3 m in depth.

	% area aquifer near surface	Approximately 69% of the sand and gravel aquifer is at the surface, with the remainder beneath the overlying strata.
	Vulnerability	The groundwater vulnerability of the sand and gravel is 'Extreme' where the water table is inferred to be < 3 m from the surface, this accounts for 19% of the aquifer area. In all other areas where the water table is at a depth > 3 m, the vulnerability is classed as 'High' (81% of the aquifer area, Figure 3).
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs *via* rainfall percolating through the unsaturated sands and gravels. Due to the high permeability of sand and gravel, a high proportion of the available recharge will percolate down to the water table. A significant proportion of the sand and gravel in this area has iron pans developed at the base of the topsoil (Philcox, 2002; Warren 1978, 1979); in these zones a lower proportion of the available recharge will percolate downwards. Similarly, in the areas of the aquifer that are covered by overlying strata a much lower proportion of the available recharge will also percolate downwards. Rejected recharge from the surrounding Locally Important Bedrock Aquifer **(Ll)**, at the north and northeast, has also been included.
	Est. recharge rates	The annual average rainfall for the aquifer is 1,496 mm (Walsh, 2012), thus providing an estimated diffuse groundwater recharge of 730 mm/yr. The minimum direct groundwater throughput in the aquifer is estimated to be 17,666 m^3/d, which increases to a minimum potential 24,369 m^3/d when rejected recharge is included.
Discharge	**Large springs and large known abstractions (m^3/d)**	There are 12 springs or 'rises' mapped on the OSI 6 inch raster map (1830s – 1930s), but the discharge volumes from these are unknown. These springs are located in Lackabane, Gortroe, Ballydowney, Coollegrean and Dromhale Townlands, as well as a number of other townlands along the River Flesk. There are no known large abstraction points from within this aquifer body.
	Main discharge mechanisms	Groundwater is inferred to discharge *via* rises as well as directly into the streams and rivers which flow through the aquifer. Some of the groundwater is also expected to discharge into Lough Leane - where the lake is adjacent to the aquifer body.
	Hydrochemical Signature	Four groundwater samples taken from EPA borehole 'FBH1' in 2016 and 2017 show that the water is moderately hard, with total hardness values of 175–195 mg/l (equivalent $CaCO_3$), and electrical conductivity (EC) values of 438–473 µS/cm (average 447 µS/cm), indicating that the groundwater has a magnesium bicarbonate ($Mg(HCO_3)_2$ hydrochemical signature. Alkalinity ranges from 180–225 mg/l $CaCO_3$ (EPA, 2018).
Groundwater Flow Paths		The length of flow paths depend on the extent of the sand and gravel deposit. In general, regionally important sand and gravel aquifers are expected to have relatively long flow paths *i.e.*, perhaps up to several kilometres. The geomorphology of this sand and gravel aquifer and the pattern of streams within it, however, would suggest that groundwater flow paths are unlikely to exceed 1 km.
Groundwater & Surface water interactions		Groundwater is expected to discharge *via* lowlying springs and rises on the OSI 6 inch raster map (1830s – 1930s) at Gortroe and Ballycasheen Townlands, as well as a number of other townlands along the River Flesk, and adjacent to Lough Leane.
Conceptual model		• The aquifer topography is characterised as a 'flat alluvial-glaciofluvial plain' GSI, (2023a), though much of the body's area is comprised of terraces or marked ridges and hummocks, at elevations between 20 m and 148 m AOD. The higher elevations are on the eastern side of the aquifer. • Using data from 28 desk study data points and inferences between them, the minimum thickness of the subsoils are expected to be 10 m throughout the aquifer. • There are 21 desk study data points which have groundwater level data, and five records indicate at least 10 m depth of saturated sand and gravel. • Using these data along with other desk study data, it is inferred that approx. 56% of the aquifer area has a depth of saturated sand and gravel greater than 5 m. • Approximately 31% of the aquifer area is overlain with alluvium or lacustrine sediments, or (urban) 'Made' ground, with sand and gravel proven as beneath all of these (GSI, 2023b).

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	• Rejected recharge from the surrounding Locally Important Bedrock Aquifer **(Ll)** at the north and northeast contributes groundwater into the sand and gravel aquifer body. • The minimum direct groundwater throughput in the aquifer is estimated to be 17,666 m^3/d, which increases to a minimum potential 24,369 m^3/d when rejected recharge is included.	
Attachments	Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability	
Instrumentation	**Hydrometric gauges:** **National Water Monitoring Stations;** **River:** **Groundwater:**	22031 (Killarney S.W.) RS22D010200 (Deenagh Bridge) RS22D010230 (Deenagh – Mill) RS22D010200 (Deenagh Bridge) RS22D010230 (Deenagh - Mill Bridge) RS22F100080 (Folies Stream) RS22F020275 (Flesk Bridge) RS22F100080 (Folies) GWIE_SW_G_0413000002 (FBH1 – Flesk River study) GWIE_SW_G_0413000004 (FBH2 – Flesk River study)
Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey Ireland. • EPA (2018). Groundwater Monitoring Data to End 2017. • EPA map viewer. https://gis.epa.ie/EPAMaps/ • GSI (2017). A description of Irish aquifer categories. 3 pp. Available from: https://www.gsi.ie/documents/GSI%20Aquifer%20Category%20Descriptions.pdf • GSI (2023a). Geological Survey Ireland, Spatial Resources Viewer: Quaternary Geomorphology Map. https://www.gsi.ie/en-ie/data-and-maps/Pages • GSI (2023b). Geological Survey Ireland, Internal geotechnical borehole databases. • NPWS viewer. http://webgis.npws.ie/npwsviewer/ • Ó'Súilleabháin, 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. • Philcox, M.E. (2002). The gravel terraces east of Killarney. In: Harrison, S. and Mighall, T. (Eds.) The Quaternary of South West Ireland. Field Guide, Quaternary Research Association, UK., pp. 105-112. • Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin. • Warren, W.P. (1978). The glacial history of the Macgillycuddy's Reeks and the adjoining area. PhD Thesis, National University of Ireland, Dublin. • Warren, W.P. (1979). Moraines on the northern slopes and foothills of the Macgillycuddy's Reeks, south-west Ireland. In: Schluchter, C. (Ed) Moraines and Varves, Balkema, Rotterdam, pp. 223-236. • Wright, W.B. (1927). The geology of Killarney and Kenmare. Memoirs of the Geological Survey of Ireland.	
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.	

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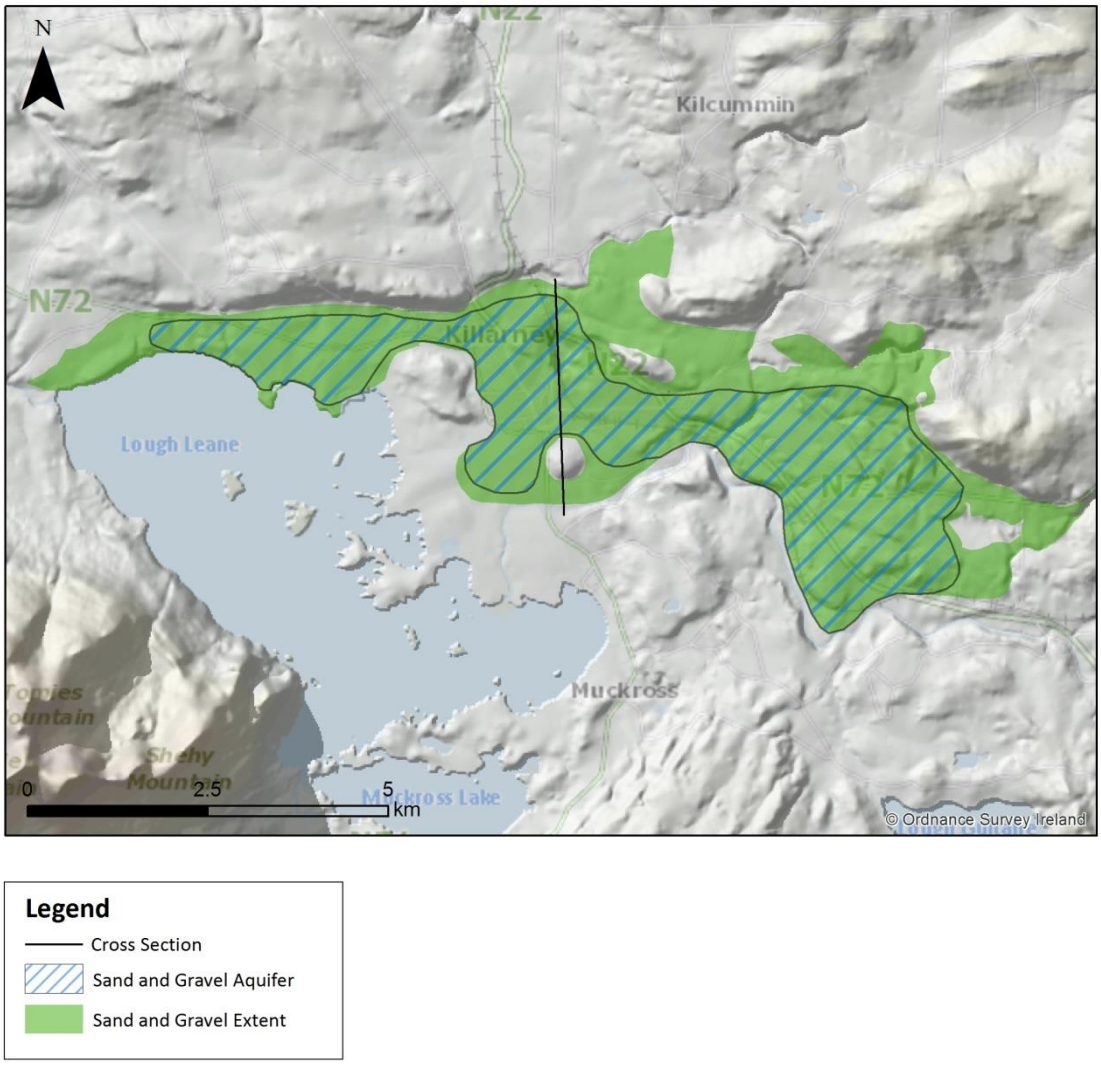

Figure 1: Killarney Sand and Gravel Aquifer extent with cross section location.

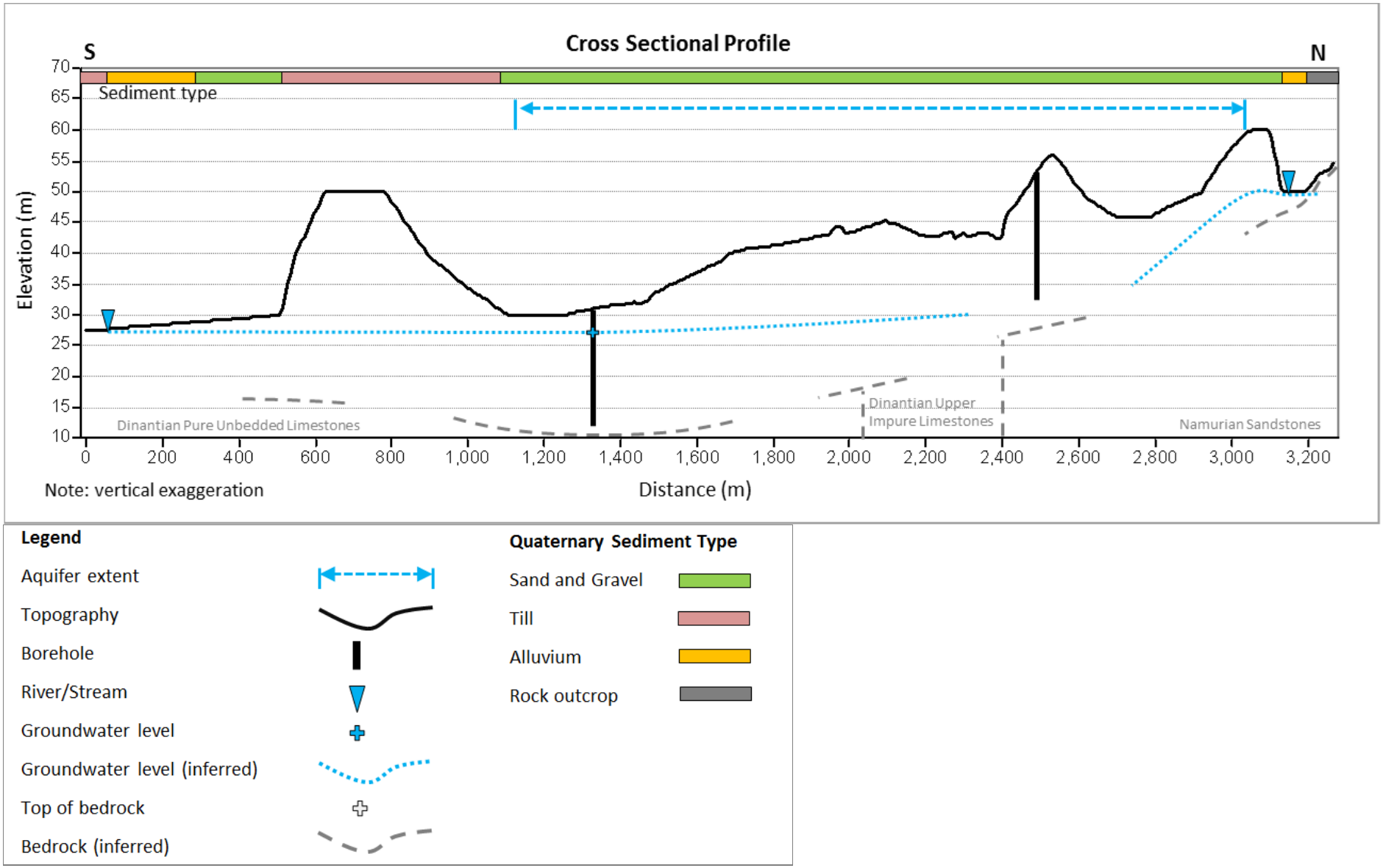

Figure 2: Cross section through the Killarney Sand and Gravel Aquifer body.

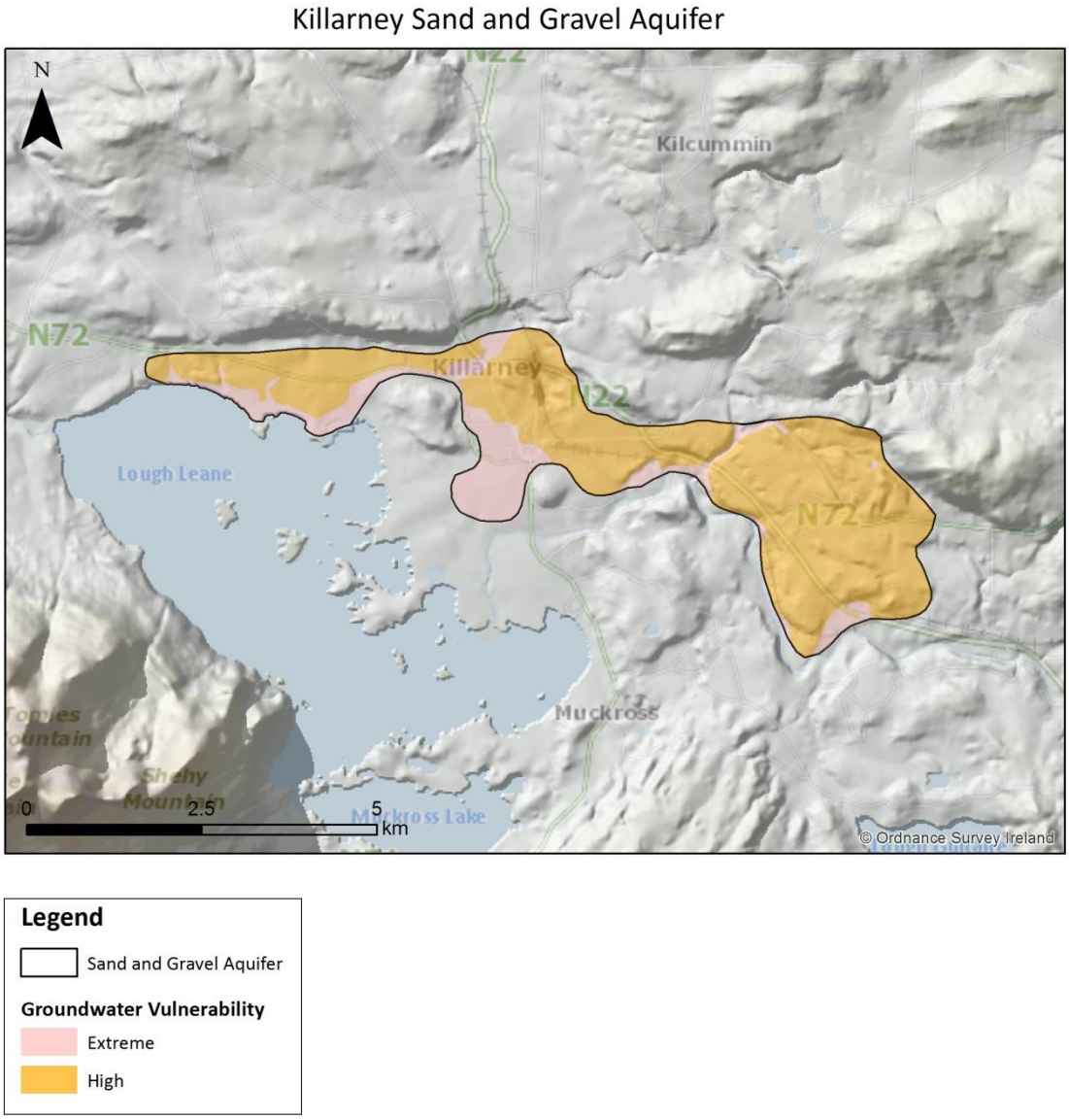

Figure 3: Groundwater vulnerability across the Killarney Sand and Gravel Aquifer.