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Newcastlewest Sand and Gravel Aquifer Summary of Initial Characterisation

GW3D Project Report TR2023/59
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Geological Survey Ireland is a division of the Department of the Environment, Climate and Communications

Newcastlewest Sand and Gravel Aquifer Description March 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

Newcastlewest Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystems	Area (km^2)
24 - Shannon Estuary South Limerick County Council	**Rivers:** River Deel, Lios an Uisce River **Streams:** Grange Lower Stream, Ballyfraley Stream, several unnamed, minor streams **Lakes:** None	None	2.46 km^2

Topography	The Newcastlewest sand and gravel deposit includes a localised area of hummocky sands and gravels forming terraces alongside the River Deel and some tributary watercourses, to the east of Newcastlewest. The deposit occurs at elevations between approx. 45 m and 75 m AOD. The sands and gravels are surrounded by till deposits, which occur at higher elevations, where many streams rise and then flow into and through the sand and gravel body. These eventually merge with the River Deel, which flows northwards through the body's central portion.	
Geology and Aquifers	**Aquifer categories**	Depth to bedrock is greater than 10 m, and saturated thicknesses are greater than 5 m. The saturated thickness satisfies the criteria of a **Locally Important Sand and Gravel Aquifer (Lg)** (DELG/EPA/GSI, 1999; GSI, 2017).
	Main aquifer lithologies	Glaciofluvial sands and gravels derived chiefly from limestones (GLs, GSI, 2023a).
	Key structures	There is one borehole record from desk study (GSI, 2023b) at Grange Bridge, which is 12 m deep and which describe the entire sequence in the bore as silty sandy GRAVEL.
	Key properties	There are six water level data points from borehole records (GSI, 2023b), and from data recorded during fieldwork within this aquifer body, that have allowed inferences to be made on water levels throughout it's area. The majority of the recorded water levels are at depths greater than 10m below ground level, excepting the Public Water Supply borehole at Arddrine where the water table is much closer to the surface. Using the data, it has been inferred that approx. 37% of the area of the aquifer has a depth of saturated sands and gravels greater than 5 m. In general, sand and gravel aquifers consist of unconsolidated coarse-grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000).
	Thickness	From desk study borehole data (GSI, 2023b), the sands and gravels have depths varying from 7 m to 27 m, with the deepest of these recorded in Arddrine Townland.
Overlying Strata	**Lithologies**	Approximately 10% of the area of the aquifer is overlain with alluvium, with sand and gravel assumed beneath.
	Thickness	The alluvial deposits, where present, are inferred to be less than 3 m thick.
	% area aquifer near surface	Approximately 90% of the sand and gravel aquifer is at the surface, with the remainder beneath the alluvial deposits.
	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 10% of the area of the aquifer body. These extremely vulnerable areas are therefore mostly focused adjacent to the River Deel which incises deeply into the aquifer body. In all other areas where the water table is at a depths > 3 m, the vulnerability is classed as 'High' (90% of the aquifer, Figure 3).
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs by the infiltration of rainfall through the unsaturated sands and gravels. Due to the high permeability of sand and gravel material, a high proportion of the available recharge will percolate down to the water table. Where alluvium overlies the sands and gravels, the proportion of rainfall that recharges the water table will be significantly less. It is also assumed that rejected recharge from the surrounding, slightly higher till ridges also contributes to the available groundwater resource at Newcastlewest.

	Est. recharge rates	The annual average rainfall for the aquifer is 1,054 mm (Walsh, 2012), thus providing an estimated diffuse groundwater recharge of 521 mm/year. The minimum direct groundwater throughput in the aquifer is consequently estimated to be 1,276 m^3/d, but with rejected recharge the throughput increases to a minimum potential 3,483 m^3/d.
Discharge	**Large springs and large known abstractions (m^3/d)**	There is a public water supply borehole at Arddrine abstracting over 3,000 m^3/d (EPA, 2017), which is 7 m deep, and which has a water level at 0. 2m below ground level, confirming a saturated thickness in the southern portion of the body greater than 5 m (GSI, 2023b). Given the topography of the locality and the water level depths recorded elsewhere in the body, this 5 m saturated depth is considered to maintain across the majority of the area underlain by sands and gravels.
	Main discharge mechanisms	Groundwater in the area will generally flow downslope, towards the River Deel and the lowermost land elevations within the body. There is also likely to be groundwater seepage from the extremities of the sand and gravel body at relatively lower elevations at the east, which may appear as rises in baseflow to watercourses there.
	Hydrochemical Signature	The hydro chemical signature groundwater is unknown in this aquifer, but given that the sands and gravels are derived chiefly from limestone, this is expected to be of calcium bicarbonate ($CaHCO_3$).
Groundwater Flow Paths		The length of flow paths depends on the extent of the sand and gravel deposit. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths *i.e*. up to several hundred metres. Based on the geomorphology of the aquifer, and the patterns of streams and the River Deel within it, it is considered that flow paths will be no more than a few hundred meters length within this body.
Groundwater & Surface water interactions		Groundwater is believed to discharge into the River Deel that flows through the aquifer, as well as to it's tributary streams. There are 'rises' at the heads of streams marked on the Ordnance survey 6 inch historical map, both in Arddrine and Grange Upper Townlands.
Conceptual model		• The sand and gravel body at Newcastlewest consists of hummocky, glaciofluvial sands and gravels which comprise a set of intersecting terraces on either side of the River Deel. • The deposits rest at elevations between 45 m and 75 m AOD. The highest elevations, around 75 AOD, are in the northeast, with the land sloping down westwards from here towards the channel of the River Deel, which dissects the aquifer. • Depth to bedrock varies throughout the aquifer area; depths generally seem to be in the order of >10 m, with the maximum depth to bedrock value of 27 m recorded at Arddrine. • The water table within sand and gravel aquifers is usually flat, and therefore the depth to water will depend on the exact topography and setting of the locality concerned. • Approximately 37% of the aquifer is inferred to have greater than 5 m depth of saturated sands and gravels, with the remainder inferred to have a saturated thickness less than this. • Groundwater is expected to discharge *via* springs and seeps along the lowest boundary of the body, and also along river courses. There may also be discharge to rivers as baseflow where the water table lies above the river stage. • Diffuse recharge occurs *via* rainfall percolating through the unsaturated sand and gravel, with reduced recharge in the areas that are covered by alluvium. • Rejected recharge from the areas of higher elevation flanking the aquifer body, and underlain by till, also contribute to the groundwater resource in the sand and gravel aquifer at Newcastlewest. • The minimum direct groundwater throughput in the aquifer is consequently estimated to be 1,276 m^3/d, but with rejected recharge the throughput increases to a minimum potential 3,483 m^3/d.

Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater vulnerability	
Instrumentation	**Hydrometric gauges:** **National Water Monitoring Stations;** **River:** **Groundwater:**	24012 (Grange Bridge) RS24D020800 (Grange Bridge, D46) None present
Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey Ireland. • EPA map viewer. https://gis.epa.ie/EPAMaps/ • EPA (2017). Newcastlewest PWS Drinking Water Audit Report. 8 pp. https://www.epa.ie/publications/compliance--enforcement/drinking-water/audit-reports/limerick-county/Newcastlewest-300317.pdf • 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 Map Viewer, Quaternary Sediments Map. • GSI (2023b). Geological Survey Ireland, Internal groundwater databases. • Hunter-Williams, N.H., Misstear, B.D.R., Daly, D. and Lee, M. (2011). Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology, 46(4):493-506. • NPWS Mapviewer: 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. • Walsh S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.	
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae. Figures 1, 2 and 3 are used for illustrative purposes only.	

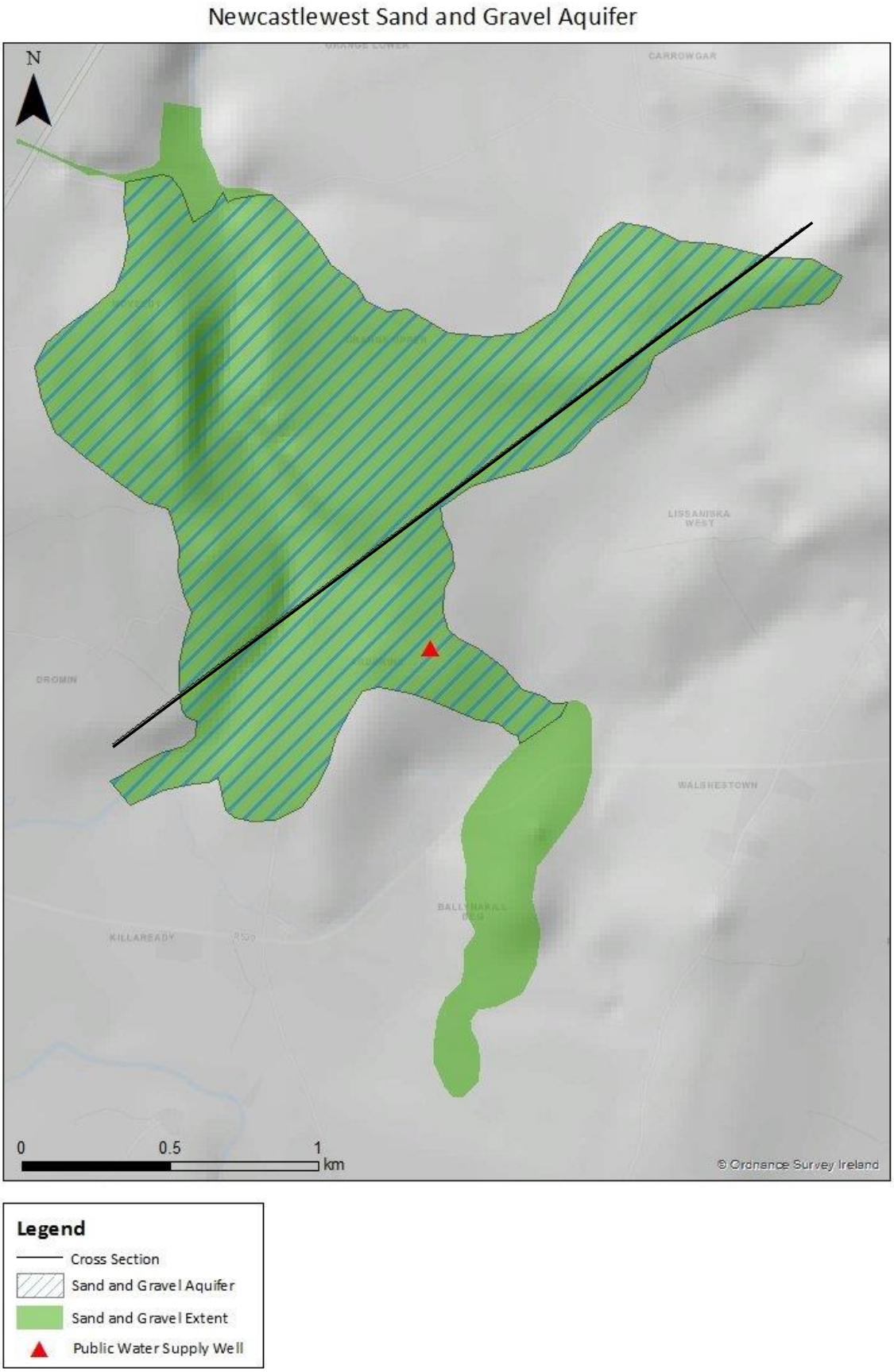

Figure 1: Newcastlewest Sand and Gravel Aquifer extent with cross section location.

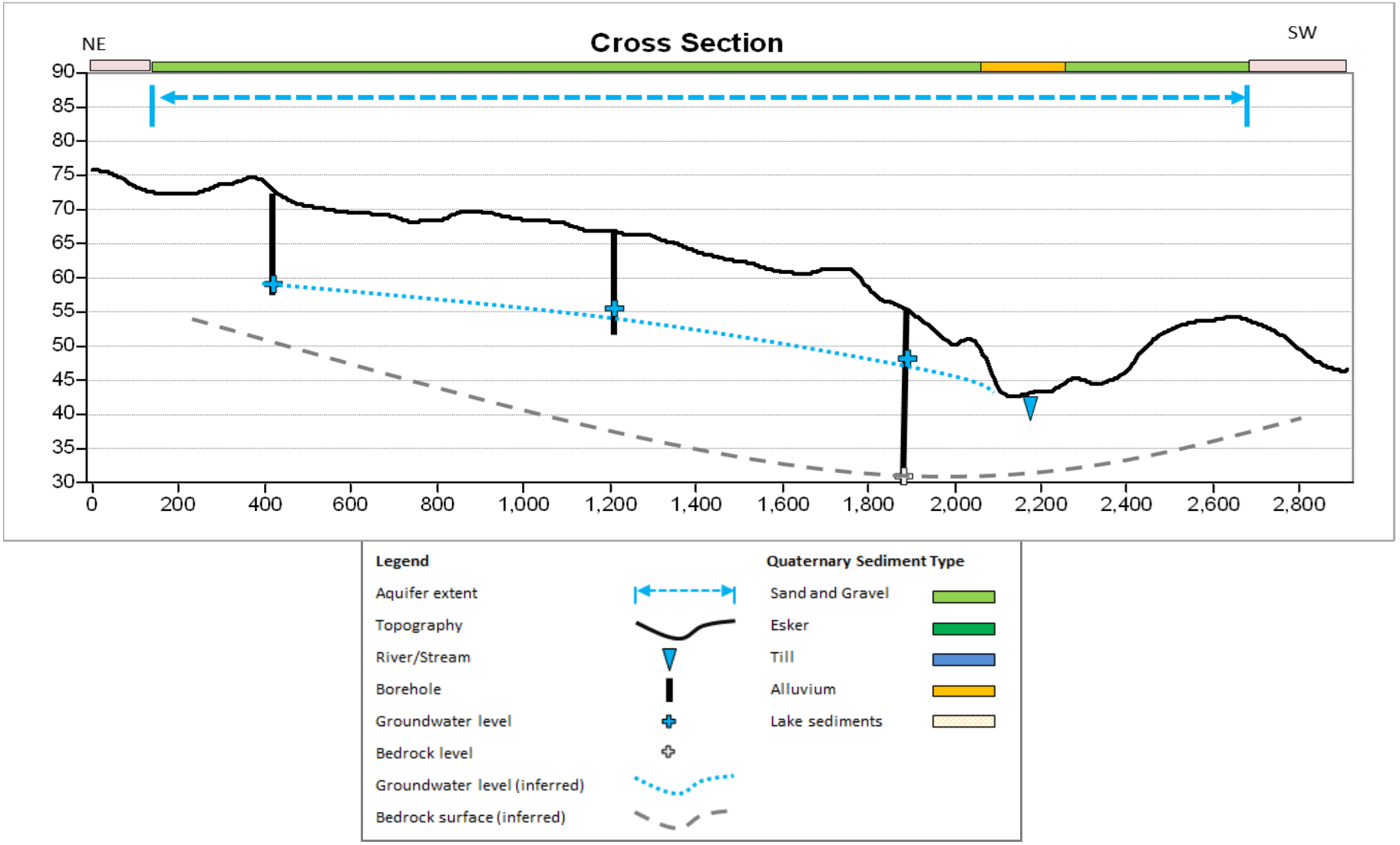

Figure 2: Cross section through the Newcastlewest Sand and Gravel Aquifer body.

Newcastlewest Sand and Gravel Aquifer Vulnerability

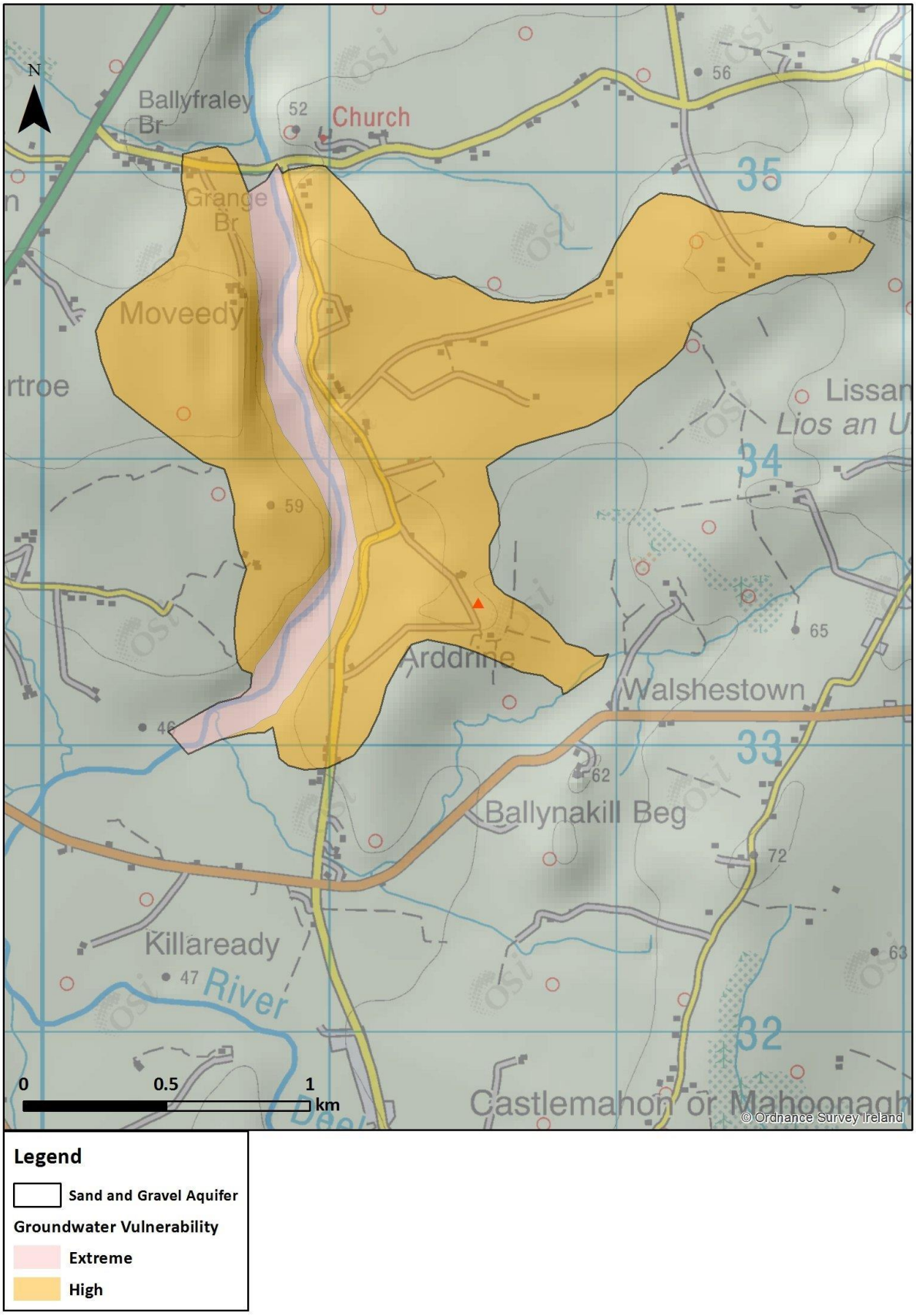

Figure 3: Groundwater vulnerability across the Newcastlewest Sand and Gravel Aquifer.