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Finner Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/09
January 2023

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

Finner Sand Aquifer Description January 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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Finner Sand Aquifer Description January 2023

Finner Sand Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
36 – Erne Donegal County Council	**Rivers:** River Erne **Streams:** Several unnamed, minor streams **Lakes:** None	Erne Estuary/Finner Dunes pNHA	1.7

Topo-graphy	The Finner sand aquifer is located approximately 1 km west of Ballyshannon Town, on the southern extreme of Donegal Bay (Figure 1). The western side of the deposit dominated by windblown sand dunes which reach up to 60 m in height. Eastwards the topography becomes flatter as the thickness of the sand deposit decreases. Dune slacks are also present within the central area of the aquifer (Ryle *et al*., 2009).	
Geology and Aquifers	**Aquifer categories**	The Finner sand 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; GSI, 2017).
	Main aquifer lithologies	This aquifer comprises windblown sands and raised beach/beach sand deposits (GSI, 2023).
	Key structures	The deposit is dominated by sand dunes. Borehole logs record the presence of low permeability sediments beneath the aquifer sands; these are most probably glacial tills. The underlying bedrock is classed as a Locally Important Bedrock Aquifer (GSI, 2023).
	Key properties	The groundwater is considered to be generally unconfined in the Finner Sand Aquifer. There are no yield or productivity data available for this body. Particle size analyses show that the deposit comprises 95% sand grade particles (Lee and Fitzsimons, 2004), which suggests a highly permeable material. This, combined with the saturated thickness and extent, suggests that the aquifer should be able to sustain relatively high yields (Lee and Fitzsimons, 2004). Water levels in the east of the deposit are recorded at 0.5 m below ground level (5.7 m AOD). The presence of the shallow water table is corroborated by the presence of dune slacks within the central portion of the aquifer (Ryle *et al*., 2009).
	Thickness	This sand deposit is interpreted to be 60 m deep, at its thickest. The western portion of the deposit has an average thickness of 10 m to 20 m, however the aquifer thins considerably to the east. Trial pit records indicate that the sand remains greater than 5 m thick even near the eastern aquifer boundary (Glover Site Investigations, 2001).
Overlying Strata	**Lithologies**	There are no sediments overlying any portion of the Finner Sand Aquifer.
	Thickness	N/A
	% area aquifer near surface	100%
	Vulnerability	All of the aquifer is at the surface and therefore vulnerable; consequently pollutants can easily infiltrate the aquifer body. Sand 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 surface. In areas where the water table is less than 3 m below ground level the aquifer vulnerability is mapped as 'Extreme' and where it is greater than 3 m below ground level the vulnerability is mapped as 'High'. Measured water levels in the eastern area of the sand range from 0.4 m to 0.5 m below ground level; to the west the depth is assumed to be deeper based on topographical analysis.
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs *via* infiltration of rainfall through the unsaturated sand. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope (DELG/EPA/GSI, 1999). Typically the proportion of recharge that infiltrates to groundwater in sand and gravel is around 85% (Hunter Williams *et al*., 2011). Rejected recharge from the surrounding, low hills to the south will increase the amount of available recharge to this aquifer body.

Finner Sand Aquifer Description January 2023

	Est. recharge rates	The rainfall in the area of the Finner Sands is 1,245 mm (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 650 mm/yr. The minimum groundwater throughput in the aquifer is estimated to be 2,318 m^3/d, with a significant portion of this volume interpreted as coming from rejected recharge from the low hills to the south.
Discharge	**Large springs and large known abstractions (m^3/d)**	There are no known large springs or abstractions from this aquifer body.
	Main discharge mechanisms	The main discharge mechanisms are seepages at the extremities of the body, discharge along the coast to the west, and to the River Erne in the north.
	Hydrochemical Signature	There are no data available as to the hydrochemical signature of the groundwater within the Finner Sand Aquifer, but the groundwater is likely to have a calcium bicarbonate signature. The saltmarsh present to the east of the aquifer (Ryle *et al*., 2009) is excluded from the aquifer body as the groundwater is not potable here.
Groundwater Flow Paths		Groundwater flow path length depends on the extent of the sand 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. This is also expected to be the case at Finner, given the setting and geometry of the deposit.
Groundwater & Surface water interactions		Hydraulic connection between the groundwater in the aquifer and the surface water features is expected to be high. Dune slacks are present with this aquifer and are sustained by groundwater (Ryle *et al*., 2009). The groundwater is also assumed to interact with ocean water along the coast, but the extent of the mixing zone is unknown.
Conceptual model	• The locally important aquifer is located on the southern side of the River Erne Estuary. • The aquifer is primarily comprised of windblown sand deposits. • The deposit is dominated by dunes at the west and flat, low-lying land to the east. • The boundaries of the aquifer are delimited for the most part by the extent of the mapped sand deposit (GSI, 2023) to the point at which they are presumed to be unsaturated. • The saltmarsh present to the east of the aquifer (Ryle *et al*., 2009) is excluded from the aquifer body as the groundwater is not potable here. • Recharge occurs diffusely *via* rainfall percolating through the unsaturated sand. • The aquifer is interpreted as unconfined. • Due to the geometry of the deposits, groundwater flow paths are likely to be relatively short, and groundwater gradients are likely to be 0.01 or less. • Groundwater flows in general towards the coastline. • The aquifer is thought to discharge *via* groundwater seepage from the extremities of the sand body at the lower elevations. • The minimum groundwater throughput in the aquifer is estimated to be 2,318 m^3/d, with a significant portion of this volume interpreted as coming from rejected recharge from the hills to the south.	
Attachments	Figure 1: Location and extent Figure 2: Cross sections Figure 3: Groundwater Vulnerability	
Instrumentation	**Hydrometric gauges:** **National Water Monitoring Stations;** **River:** **Groundwater:**	None present None present None present

Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • EPA map viewers. https://gis.epa.ie/EPAMaps/ and http://gis.epa.ie/Envision/ • Glover Site Investigations (2001). Ballyshannon Sewerage Scheme Site Investigation Contract Factual Report - Vol.1. • GSI (2017). A description of Irish aquifer categories. 3 pp. Available from: https://www.gsi.ie/documents/GSI%20Aquifer%20Category%20Descriptions.pdf • GSI (2023). Geological Survey Ireland Spatial Resources Viewer. https://www.gsi.ie/en-ie/data-and-maps/Pages • Hunter Williams, N., Misstear, B., Daly, G., Johnston, P., Lee, M., Cooney, P. and 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). Donegal Groundwater Protection scheme Volume 1: Main report. • 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. • Ryle, T., Murray, A., Connolly, C. and Swann, M. (2009). Coastal Monitoring Project 2004-2006, Unpublished Report to the National Parks & Wildlife Service. • 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.
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.

Finner Sand Aquifer

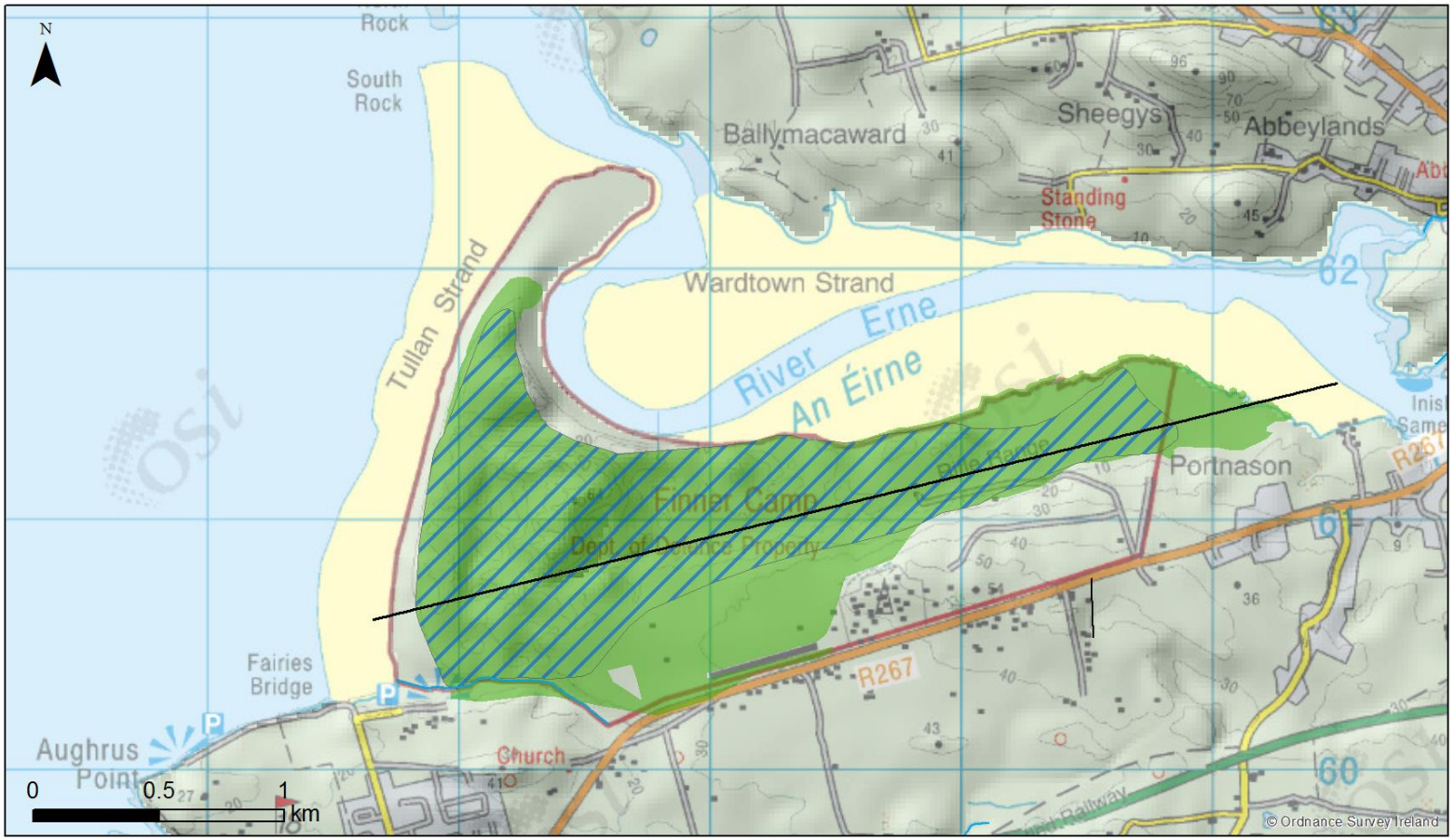
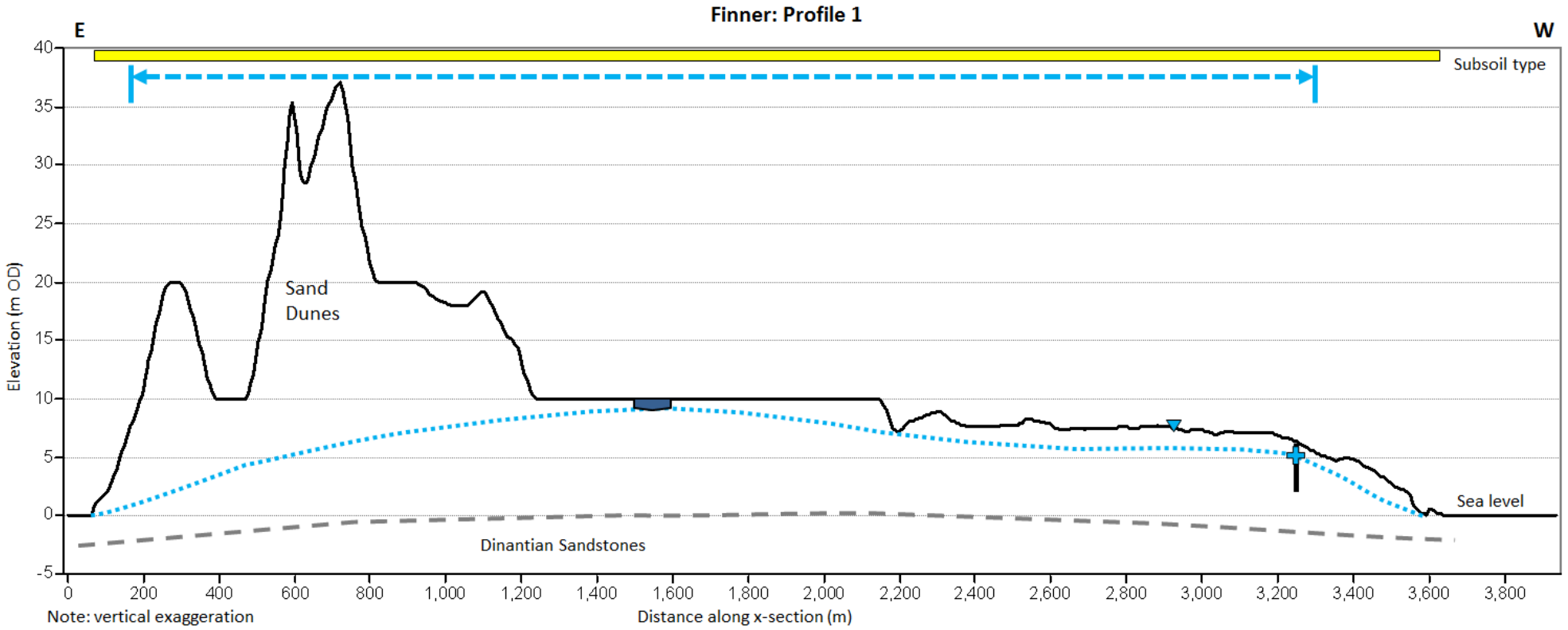


Figure 1. Finner Sand Aquifer extent with cross section location.



Elevation		Stream		Aquifer	
Groundwater level		Presumed Groundwater Level		Windblown sands	
Top of bedrock		Presumed Top of Bedrock			
GW Ponding		Borehole/Trial Pit			

Figure 2. Cross section through the Finner Sand Aquifer body.

Finner Sand Aquifer Vulnerability

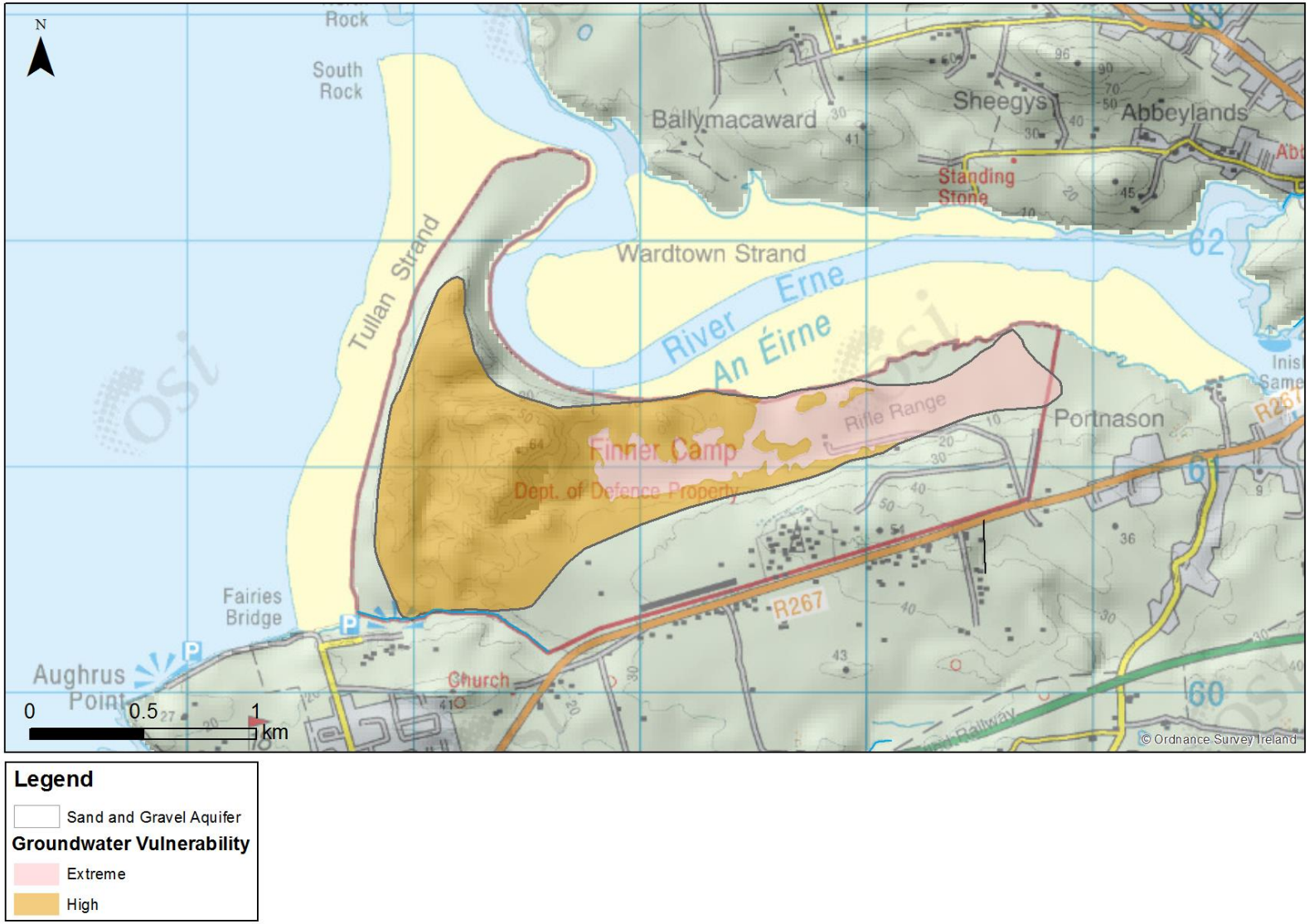


Figure 3. Groundwater vulnerability across the Finner Sand Aquifer.