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Loughros Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/11
January 2023

Loughros More 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



Loughros More Sand Aquifer Description January 2023

Loughros More Sand Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
38 – Gweebarra - Sheephaven Donegal County Council		Rivers: Duvoge River Streams: Several unnamed streams Lakes: Sheskinmore Lough	West Of Ardara/Maas Road SAC / pNHA Sheskinmore Lough SPA	1.47
Topography	The Loughros More sand deposit is located 4 km northwest of Ardara, and this beach, raised beach and windblown dune sand deposit is situated in a low-lying coastal area (Figure 1). The topography is dominated by sand dunes which reach up to 30 m in height. The aquifer is bounded by bedrock outcrop and peat deposits to the north, and the coastline to the south. The Duvoge River which runs along the eastern boundary of the aquifer drains Sheskinmore Lough, at the north of the body. Dune slacks occur between fixed dunes throughout the western area of the aquifer (Ryle <i>et al.</i> , 2009), and suggest that the water table at a shallow depth here.			
Geology and Aquifers	Aquifer categories	The Loughros More 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 deposit is classified as either beach or raised beach sands (GSI, 2023), the majority of which have been reworked into windblown sand dunes.		
	Key structures	The deposit is dominated by dune morphology. Exposures indicate that the sands in the deposit are relatively homogenous. The underlying bedrock is of Precambrian Quartzites, Gneisses & Schists (GSI, 2020) which is classed as a Poor Bedrock Aquifer (GSI, 2023).		
	Key properties	There are no available groundwater level measurements from within this body, but dune slack elevations and river levels within the aquifer can be used as proxies. The dune slacks are sustained by groundwater (Ryle <i>et al.</i> , 2009) and therefore give a good indication of the elevation of the water table. This level is ~10 m AOD along the eastern boundary of the aquifer. Due to the permeable nature of the aquifer the slope of the water table is expected to be subdued, sloping gently towards the coastline. Though permeability testing data are limited, exposure logging indicates that coarse material predominates and that permeability and storativity are high. The bedrock aquifer cannot accept much of the available recharge, and the retention of recharge in the basal layers of the sand causes the water table to be at a relatively shallow depth below ground level.		
	Thickness	There are no data available regarding the thickness of the sand aquifer, but the thickness of the deposit may be estimated using the height of the dunes, and estimating the depth to bedrock in interpreted using cross sections. The sand is likely to be greater than 10 m in thickness over much of the area of the body (Figure 2).		
Overlying Strata	Lithologies	There are no sediments overlying any portion of the Loughros More Sand Aquifer.		
	Thickness	N/A		
	% area aquifer near surface	100%		
	Vulnerability	The vulnerability delineation of this aquifer is based on the assumption that the water table is found at effectively the same elevation as that of the dune slacks. Most of the aquifer is at the surface and vulnerable; consequently pollutants can easily infiltrate the aquifer. 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. 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 aquifer vulnerability is mapped as ‘High’.		

Loughros More Sand Aquifer Description January 2023

Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> rainfall infiltrating 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 (DoELG/EPA/GSI, 1999). Typically, the proportion of recharge that infiltrates to groundwater in sand and gravel is around 85% (Hunter Williams <i>et al.</i> , 2011). Rejected recharge from the surrounding hills at the north and northeast increases the amount of available recharge to the aquifer body.
	Est. recharge rates	The rainfall in the area of the Loughros More sands is 1,330 mm (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 726 mm/yr. The minimum groundwater throughput in the aquifer is estimated to be 1,137 m ³ /d, with a significant portion of this volume coming from rejected recharge from the hills to the north and northeast.
Discharge	Large springs and large known abstractions (m ³ /d)	There are no known large spring or abstractions from this aquifer body.
	Main discharge mechanisms	The groundwater is expected to discharge to the dune slacks within the aquifer. There is also likely to be discharge to streams and seepages from the sand body onto and under the flanking strands at lower elevations.
	Hydrochemical Signature	There are no data readily available to assess the hydrochemistry of this aquifer but given the surrounding bedrock and subsoils geology the groundwater is likely to have a magnesium bicarbonate signature.
Groundwater Flow Paths		Flow paths are short due to the restricted lateral extent of the aquifer.
Groundwater & Surface water interactions		The degree of hydraulic connectivity between the groundwater in the aquifer and surrounding surface water is expected to be high. Water is expected to move easily in and out of the aquifer depending on the relative water level in the surface water bodies. The relatively shallow water table is important for supporting ecologically important areas within the West Of Ardara/Maas Road SAC, and the Sheskinmore Lough SPA. The groundwater is assumed to interact with ocean water along the coast, but the extent of the mixing zone is unknown.
Conceptual model		• The Loughros More Sand Aquifer consists of beach, raised beach and windblown sand deposits along the coast along the northeastern flank of Loughros More Bay. • The topography is dominated by sand dunes which range in elevation from 10 m AOD to 30 m AOD. • The boundaries of the aquifer are delimited by the saturated extent of the deposit, and the coastline at the southwest, with the eastern boundary of the aquifer defined by the River Duvoige. • Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sand. • The water table is estimated using the water elevations of dune slacks within the aquifer. • The aquifer is unconfined. • Due to the shallow depth of groundwater flow in this aquifer the groundwater and surface waters are considered to be closely linked. • Groundwater discharges to the numerous small pools within the aquifer, and presumably to seeps along the coastline. • The minimum groundwater throughput in the aquifer is estimated to be 1,137 m³/d, with a significant portion of this volume coming from rejected recharge from the hills to the north and northeast.

Loughros More Sand Aquifer Description January 2023

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	- Burningham, H. (1999). Morphodynamics of West Donegal Estuaries. Unpub. D.Phil. Thesis, University of Ulster, 281pp. - Burningham, H. (2002). Meso-scale morphological changes in the Loughros More estuary. In: Littoral 2002, The Changing Coast. EUROCOAST / EUCC, Porto – Portugal Ed. EUROCOAST – Portugal, pp. 265-270. - Burningham, H. (2008). Contrasting geomorphic response to structural control: The Loughros estuaries, northwest Ireland. Geomorphology, 97(3-4), pp. 300-320. - Burningham, H. (2017). The coastal dunes of west Donegal. In: O’Carroll, E. and McClure, M. (eds.) South- West Donegal, IQUA Field Guide 34, Irish Quaternary Association, Dublin, 35-43. - Burningham, H., Cooper, J.A.G. (2004). Morphology and historical evolution of north-east Atlantic coastal deposits: The west Donegal estuaries, north-west Ireland. Journal of Coastal Research SI41, 148-159. - 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/ - 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 web viewer. http://webgis.npws.ie/npwsviewer/ - Ryle, T., Murray, A., Connolly, C. and Swann, M. (2009). Coastal Monitoring Project 2004-2006, Unpublished Report to the National Parks & Wildlife Service. - 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. - 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.	



Loughros More Sand Aquifer

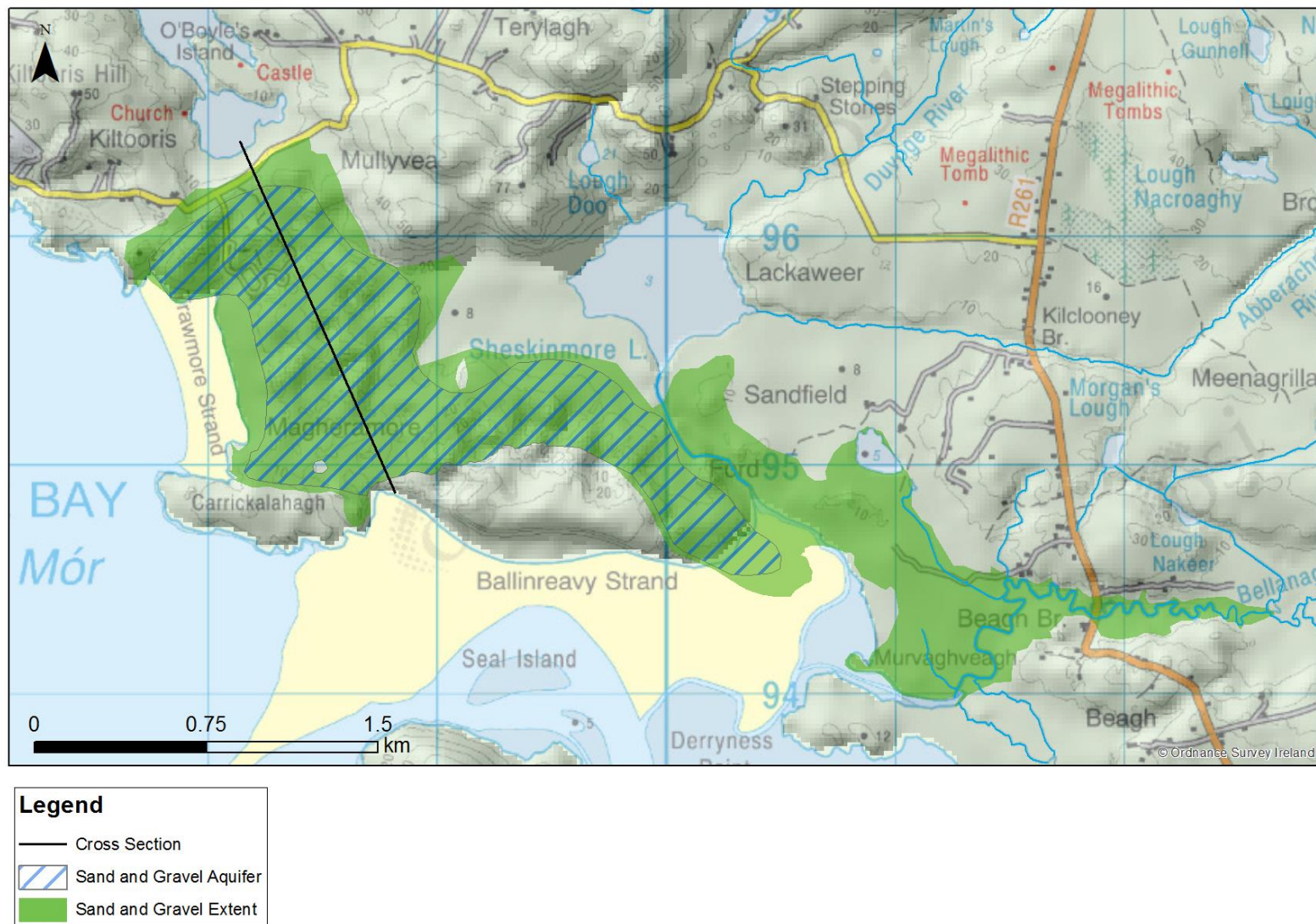
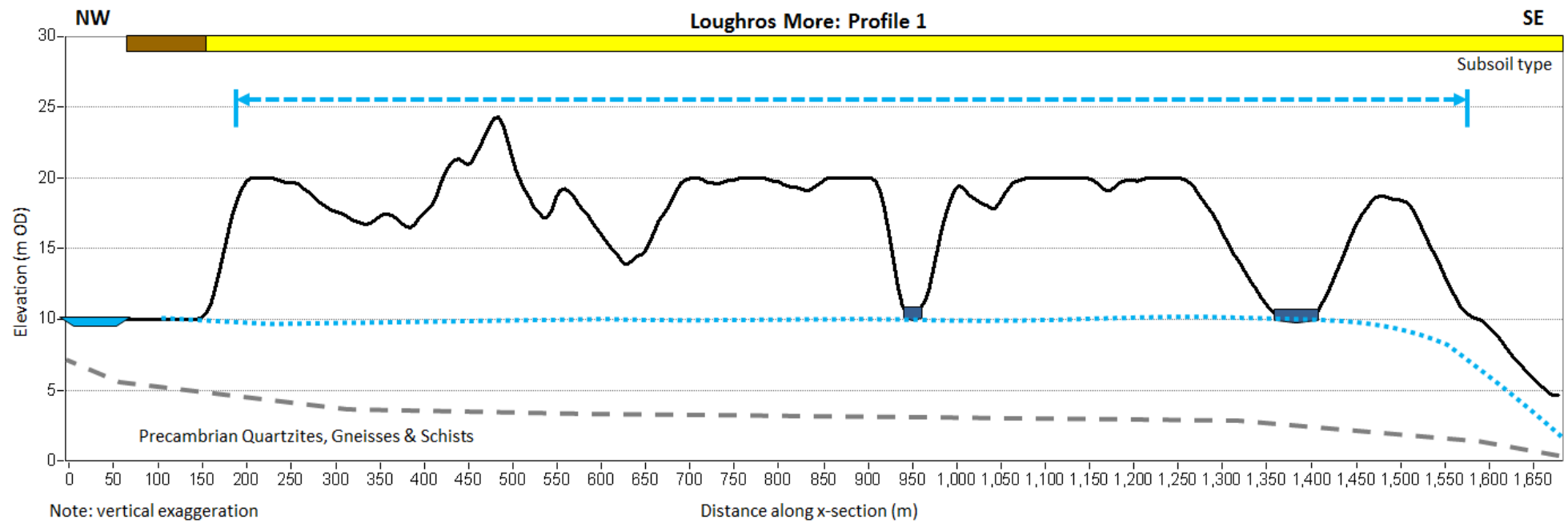


Figure 1. Loughros More Sand Aquifer extent with cross section location.



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

Figure 2. Cross section through the Loughros More Sand Aquifer body.

Loughros More Sand Aquifer Vulnerability

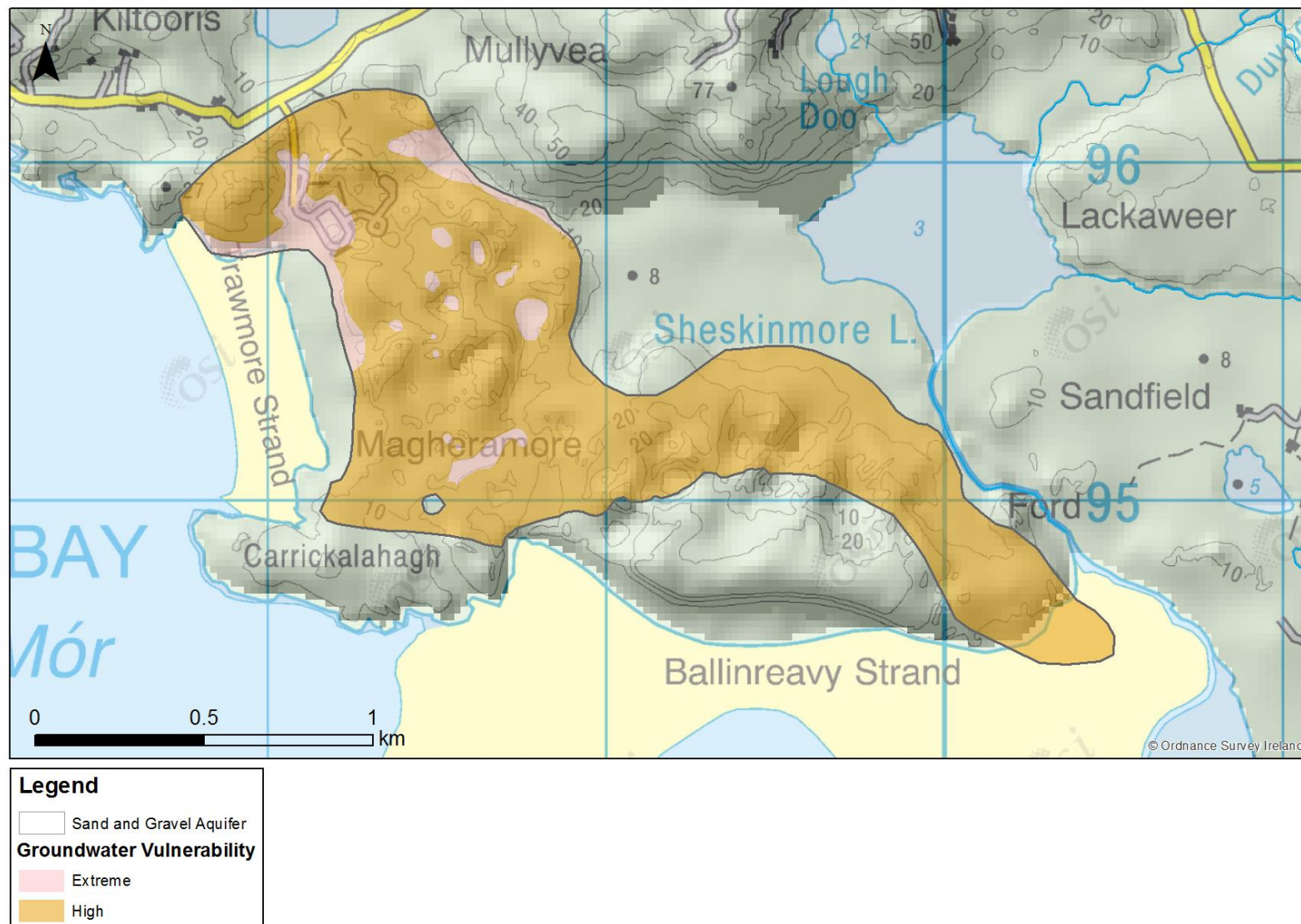


Figure 3. Groundwater vulnerability across the Loughros More Sand Aquifer.