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Geological Survey
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Carrickart Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/07
January 2023

Carrickart 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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Carrickart 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: Glenree River Streams: Several unnamed, minor streams Lakes: None	Sheephaven SAC Sheephaven NHA	5.3 km ²
Topography	This windblown sand deposit forms a spit which bounds the eastern side of a wide coastal embayment to the west and southwest of Carrickart (Figure 1). The landscape across the feature is generally lowlying and hummocky, with elevations varying between sea level and 40 m AOD. Areas of high elevation within the deposit are owing to dune formation. To the north and southeast, the sand body is bounded by steep slopes of bedrock-cored ridges. To the northeast and west the extent is restricted by the coastline.			
Geology and Aquifers	Aquifer categories	The Carrickart sand deposit is confirmed to be greater than 10 m in thickness and have 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 is mainly composed of windblown sand deposits (GSI, 2023).		
	Key structures	Borehole logs from within the area of this aquifer record the presence of both overlying and interbedded low permeability horizons (Geotechnical and Environmental Services, 2008). The logs record thicknesses of sand in excess of 10 m, with interbeds of clay up to 5 m thick encountered in many of the boreholes. The logs also show that the sand deposit is in direct contact with bedrock intermittently, as well as the fact that till deposits beneath the sand are discontinuous. The underlying bedrock is classed as a 'Poor' Aquifer (GSI, 2023).		
	Key properties	Borehole logging data indicate that coarse SAND material predominates and therefore permeability and storativity are expected to be high. The groundwater is considered to be generally unconfined; however where clay layers are present within and above the sand deposit, the aquifer may be confined locally. The slope of water table is expected to be relatively subdued due to the permeable nature of the aquifer and the lowlying terrain. The bedrock aquifer beneath the sand has a high degree of rejected recharge associated with it. The retention of recharge in the basal layers of the sand causes the water table to be at a relatively shallow depth, confirmed by water level records (Delaney, 2016).		
	Thickness	The thickness of the sand deposit ranges between 9.2 m to 16.2 m (Geotechnical and Environmental Services, 2008).		
Overlying Strata	Lithologies	There are no sediments overlying any portion of the Carrickart sand aquifer.		
	Thickness	N/A		
	% area aquifer near surface	100%		
	Vulnerability	Most of the aquifer is at the surface and therefore 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'. Measured water levels range from 0.08 m to 0.23 m below ground level in some of the level areas of sand at Carrickart (Geotechnical and Environmental Services, 2008).		



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Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> 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 sand material, and by the slope (DELG/EPA/GSI, 1999). Typically, the proportion of recharge that infiltrates to ground water in sand and gravel is around 85% (Hunter Williams <i>et al.</i> , 2011). The presence of less permeable layers in the deposit, even if thin, can create locally-perched water tables, and prevent recharge of the true water table.
	Est. recharge rates	The rainfall in the area of the Carrickart is estimated to be 1,195 mm (Walsh, 2012), and the estimated recharge rate to the aquifer from direct recharge is 610 mm/yr. The minimum groundwater throughput in the aquifer is estimated to be 2,024 m ³ /d.
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 considered to be seepage along the coastline to both the east and west, and discharge to small springs and watercourses in the west of the deposit. The water table is at a relatively shallow depth across much of the body, and there are arterial drains along the roadsides that run across the deposit. The arterial drains along the roads will have the effect of partially draining the aquifer, which in turn has the effect of lowering the water table.
	Hydrochemical Signature	There are limited groundwater chemistry data available for this locality. Delaney (2016) measured the conductivity and chloride levels within a well ~600 m from the salt marsh recorded along the eastern boundary of the aquifer. The electrical conductivity was found to be in the range of 533 µS/s to 565 µS/s. The chloride level was around 42.1 mg/l, and these elevated chloride levels are a consequence of proximity to the sea.
Groundwater Flow Paths		The length of flowpaths depends on the extent and geometry of the sand deposit. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths, usually no more than several hundred metres. This is expected to be the case at Carrickart, given the setting and geometry of the deposit.
Groundwater & Surface water interactions		The groundwater and surface water in this aquifer are expected to be in hydraulic connectivity. The shallow water table is important for supporting groundwater to ecologically important areas within the Sheephaven SAC <i>e.g.</i> dune slacks (Delaney, 2016). The groundwater is assumed to interact with seawater along the coast, but the extent of the mixing zone is unknown.
Conceptual model		• The locally important aquifer is a windblown sand deposit along the coast, with the sand topography dominated by dunes. • The boundaries of the aquifer are limited for the most part by the extent of the mapped windblown sands (GSI, 2023). • Areas at the edge of the body, where the windblown sands are thin and unsaturated, are excluded from the aquifer body. • The thickness of the windblown sand varies between 2 m to 16.2 m, but is thought to be at least 10 m deep over most of the aquifer. • Recharge occurs diffusely through the unsaturated zone. • This aquifer is generally unconfined. • Measured water levels show water table is shallow and often less than 1 m below ground level. • The flowpaths within the aquifer are constrained by the extent of the sand deposits. • The extent of the mixing zone with ocean water is unknown. • Groundwater is thought to discharge to springs and <i>via</i> seeps along the coastline. • The minimum groundwater throughput in the aquifer is estimated to be 2,024 m³/d.

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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	• Delaney, A. (2016). Investigation into the relationships between the plant and invertebrate communities of dune slacks, and how they are influenced by environmental factors including groundwater. Unpublished PhD. Thesis, Trinity College Dublin. • DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. • Geotechnical and Environmental Services (2008). Preliminary ground investigation factual report No. 014/ROI/08. • 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 http://gis.epa.ie/Envision/ • 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). County Donegal Groundwater Protection Scheme Volume I: Main Report. Geological Survey of Ireland. • 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.	
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.	



Carrickart Sand Aquifer

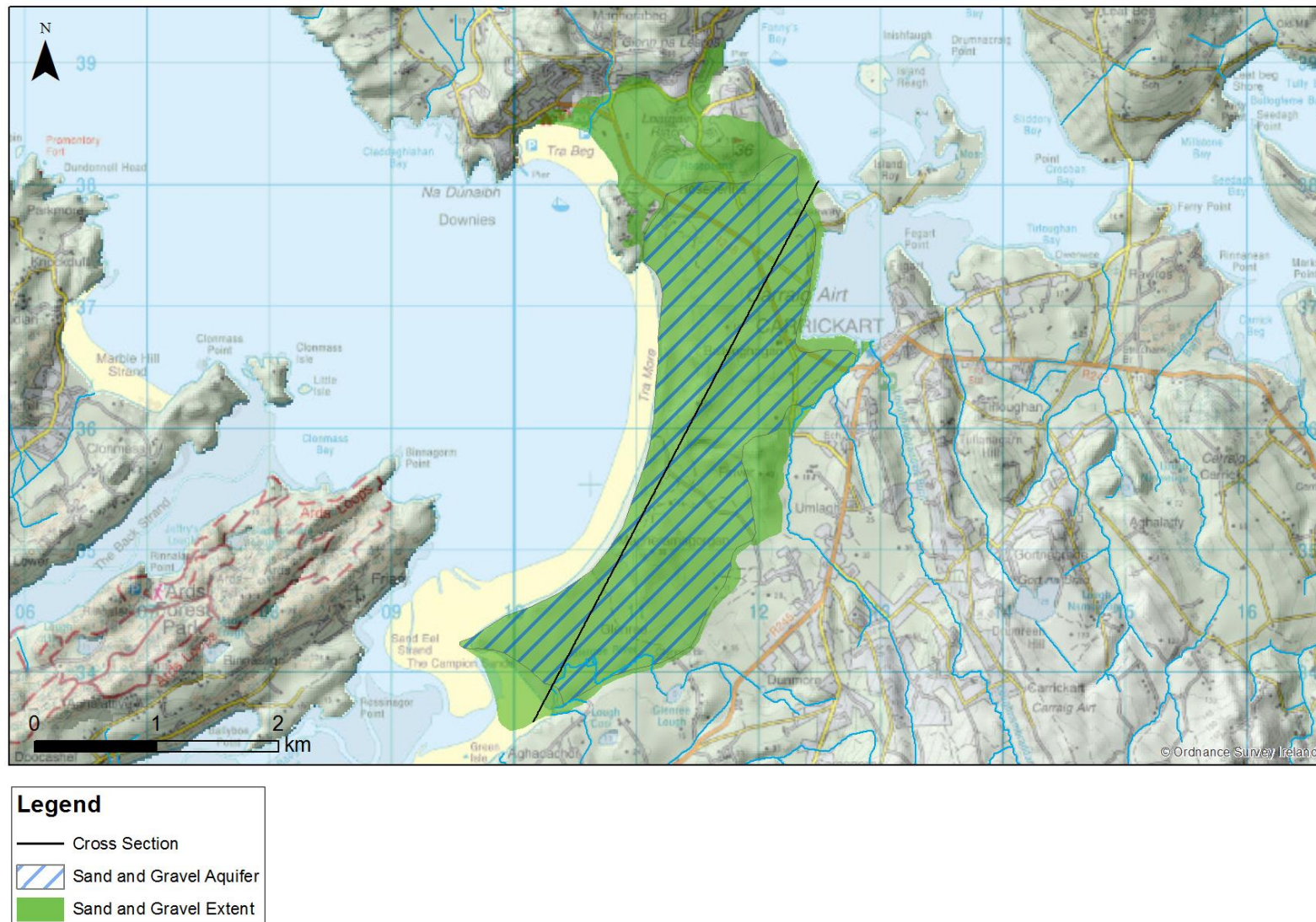
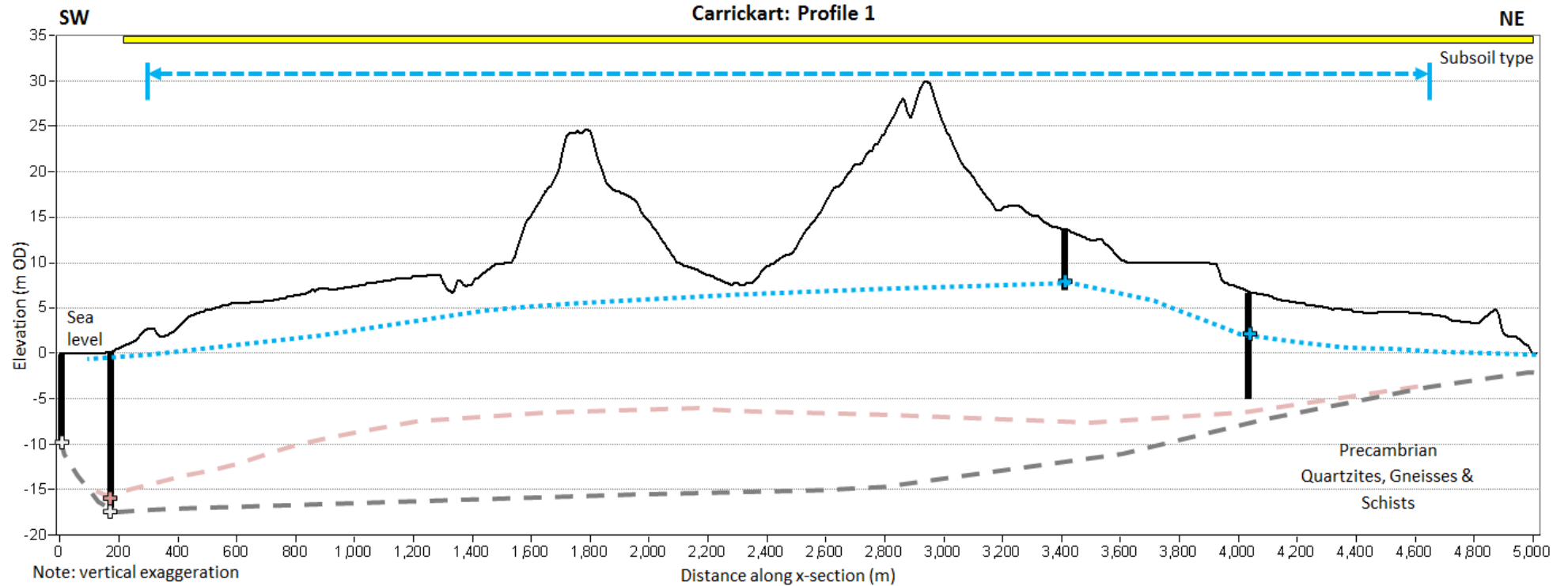


Figure 1. Carrickart Sand Aquifer extent with cross section location.



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

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

Carrickart Sand Aquifer Vulnerability

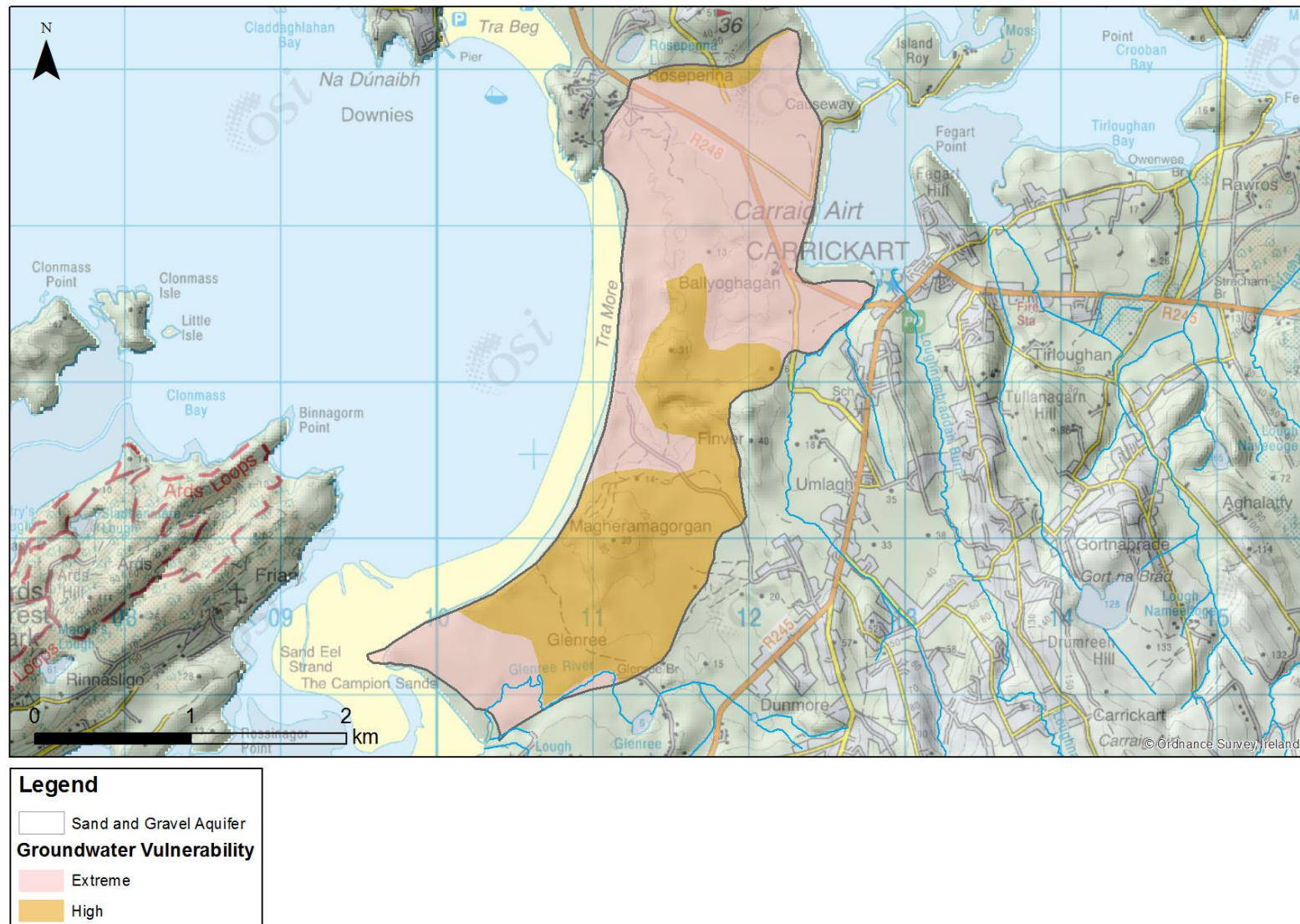


Figure 3. Groundwater vulnerability across the Carrickart Sand Aquifer.