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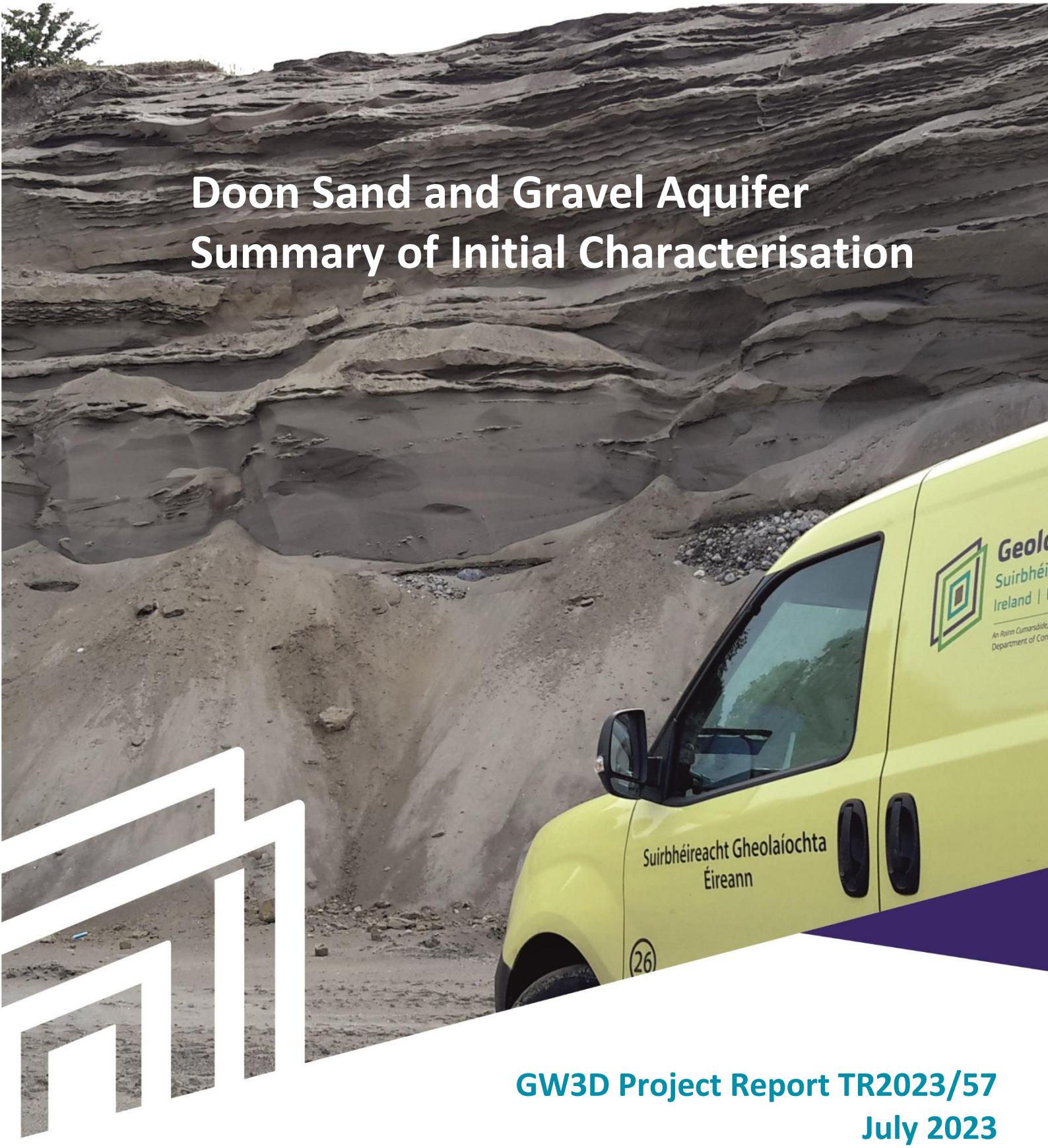

Doon Sand and Gravel Aquifer
Summary of Initial Characterisation

GW3D Project Report TR2023/57
July 2023

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

Doon Sand and Gravel Aquifer Description July 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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Doon Sand and Gravel Aquifer: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystems	Area (km^2)
25 - Lower Shannon Limerick County Council		**Rivers:** Bilboa River, Doon River, Bottle Hill River, Lisgaugh River **Streams:** Several unnamed streams **Lakes:** Loughaneigha, several unnamed lakes and ponds	Lower River Shannon SAC Bilboa and Gortnageragh River Valleys pNHA	3.35 km^2
Topography	The Doon sand and gravel body comprises hummocky sands and gravels which onlap onto the southwestern foothills of the Slieve Felim Mountains, as a wide, lowlying terrace as the entrance to the Bilboa and Gortnageragh Valleys, and which rests above lowlying peat and alluvial flats to their southwest. The deposit occurs at elevations between 70 m and 100 m AOD. The sands and gravels are bounded by shallow till deposits abd bedrock close to surface at higher elevations, further up the mountain slopes.			
Geology and Aquifers	**Aquifer categories**	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 Devonian sandstones (GDSs).		
	Key structures	In general, exposure is poor within this sand and gravel body, and no good exposures showing sand and gravel structures, or deep sections, were noted during fieldwork.		
	Key properties	In general, sand and gravel aquifers consist of unconsolidated coarse-grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000). There is one water level datum from a borehole within the sand and gravel body, and some springs at the edge of it where groundwater issues as the sand and gravel meets peat. There are also a number of ponds near Doon in marked hollows, which may represent the groundwater table in these localities. Most trial pits excavated for Site Assessments for On-site Waste Water Treatment Systems to the north of Cooga Spring encountered water levels at depths between 2 m and 3 m. An exposure into the sand and gravel was noted south of Doon and is described as 2 m depth of gravelly SAND with frequent cobbles (Dillon and Kelly, 2010). Using these data and other data noted above, it has been inferred that approx. 21% of the area of the aquifer has a depth of saturated sands and gravels greater than 5 m. Sand and gravel sediments are shallow north of Bilboa Bridge, at the base of Slieve Felim (Dillon and Kelly, 2010); thus this locality has not been included in the sand and gravel aquifer. Additionally, the areas of peat to the south of the aquifer have not shown any evidence of sand and gravel beneath.		
	Thickness	In general across the area of the aquifer body, the sands and gravels are expected to be greater than 10 m deep. Although there are poor data to confirm a reliable area with Qualifying Aquifer Properties, these sands and gravels were deposited adjacent to the Murroe Sand and Gravel Aquifer a few hundred metres to the northwest, at the edge of the same glacial lake (Finch and Ryan, 1966), and it is expected that 5 m depth saturation pervades through the area of the sands and gravels.		
Overlying Strata	**Lithologies**	Approximately 6% of the area of the aquifer is overlain with lake sediment and/or alluvium, with deep sands and gravels assumed beneath.		
	Thickness	The alluvium and/or lake sediment is inferred to be less than 3m deep.		
	% area aquifer near surface	Approximately 94% of the sand and gravel aquifer is at the surface, with the remainder beneath the alluvium and/or lake sediments.		
	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 4% of the area of the aquifer. In all other areas where the water table is at a depth > 3 m, the vulnerability is classed as 'High' (96% 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, a high proportion of the available recharge will percolate down to the water table. Where alluvium and/or lake sediment overlies the sands and gravels, the proportion of rainfall that recharges the water table will be significantly less. It is assumed there is significant rejected recharge from the high sandstone ridge to the northeast of the aquifer contributing to the groundwater resource.
	Est. recharge rates	The annual average rainfall for the aquifer is 1,060 mm (Walsh, 2012), thus providing an estimated diffuse groundwater recharge of 535 mm/year. The minimum direct groundwater throughput in the aquifer is consequently estimated to be 1,046 m^3/day, which increases to a minimum potential of 2,053 m^3/day when rejected recharge is included.
Discharge	**Large springs and large known abstractions (m^3/d)**	A spring at edge of the aquifer, at a break in slope where the sands and gravels meets the peat, provides to the Doon Public Water Supply. Here, 'Cooga Spring' supplies a moderate yield of approximately 180 m^3/day to Doon Village. Cooga Spring supplies approximately 40% of the water supply for Doon Village, and two boreholes at Carrigmore, outside the area of sands and gravels, supply the balance of water. Groundwater flow to the spring is primarily considered to be from the sands and gravels (Dillon and Kelly, 2010). A number of groundwater rises also occur in drainage ditches to both the west and east of Cooga Spring, suggesting the diffuse nature of groundwater discharge along the boundary between the sand and gravels and peat.
	Main discharge mechanisms	The groundwater flow direction is assumed to follow topography, and radiate from the upland areas and discharge locally at the break in slope between the sands and gravels deposits and peat. In the vicinity of the Cooga Spring source, groundwater flow is assumed to follow topography and flow south-southeastwards (Dillon and Kelly, 2010), in line with this conceptual model.
	Hydrochemical Signature	Data form the EPA Groundwater Monitoring Network between 1995 and 2009 (Dillon and Kelly, 2010) were available to assess hydrochemistry and water quality. Thirty five sample analyses from Cooga Spring were available. The water quality is hard (138 to 486 mg/l $CaCo_3$). The pH ranges between 7.3 and 8.6, which is alkaline groundwater. Electrical conductivity ranges from 448 to 543 uS/cm. The hydrochemical signature of the groundwater at Cooga Spring is calcium bicarbonate ($CaHCO_3$). The concentration of nitrate (as NO_3) ranges from 12.9 to 43.6 mg/l, with of a mean of 22.8mg/l, therefore below the threshold value of 37.5 mg/l NO_3 (Groundwater Regulations S.I. No. 9 of 2010). Chloride concentrations range from 14.9 mg/l to 29.9 mg/l, with a mean of 20.4 mg/l, which is considered to be above the mean natural background level of 18 mg/l, but still below the threshold value. The concentration of sulphate, potassium, iron, manganese, magnesium and calcium are within normal ranges. (Dillon and Kelly, 2010)
Groundwater Flow Paths		Water enters the aquifer as diffuse recharge from rainfall, and discharges at springs and rises, and along ditches and to streams. The principal groundwater flow direction is thought to be southwestwards, although there will be localised deviations to this, where streams dissect the body.
Groundwater & Surface water interactions		Groundwater is believed to discharge into the streams flowing through the body, and allied with the dense network of springs that issue from the aquifer, connectivity between the groundwater and surface water is expected to be high.

Conceptual model	• The aquifer consists of a hummocky sand and gravel deposit, which occurs as a lowlying terrace at the southwestern footslopes of the Slieve Felim Mountains. • The deposits stand above the surrounding landscape at elevations between 70 m and 100 m AOD. The highest elevations, around 100m AOD, are in the northwest, with the land sloping generally down towards the southeast. • Diffuse recharge occurs *via* rainfall percolating through the unsaturated sands and gravels, with reduced recharge in the areas that are covered with lake sediment and/or alluvium. • The water table within gravel aquifers is usually flat and therefore the depth to water table will depend on the exact topography of the locality concerned. • Approximately 29% 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 to the lowlying, flat peatlands and alluvium at the southwest of the sand and gravel body, as well as into lowlying pockets of till also. Groundwater discharge will also occur *via* springs and seeps along the lowest boundary of the body ,and also along stream courses. There may also be discharge to rivers as baseflow where the water table lies above the river stage. • The minimum direct groundwater throughput in the aquifer is consequently estimated to be 1,046 m^3/day, which increases to a minimum potential of 2,053 m^3/day when rejected recharge is included.	
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 RS25B030080 (Br u/s Blackboy Br - Bilboa b) RS25D030460 (WDLE 15, u/s Trib of Dead River Doon Stream STP) GWIE_SH_G_21336000008 (Doon)
Information Sources	• DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the • Environment and Local Government, Environmental Protection Agency and Geological • Survey Ireland. • Dillon, J. and Kelly, C. (2010). Establishment of Groundwater Source Protection Zones: Doon Water Supply Scheme, Cooga Spring. Tobin Consulting Engineers report to EPA, with contributions from Drs. Robert Meehan and Jenny Deakin. • EPA map viewer. https://gis.epa.ie/EPAMaps/ • Finch T. F. and Ryan P. (1966). Soils of County Limerick. An Foras Talúntais: National Soil Survey of Ireland. • 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, Geomorphology Map. • GSI (2023b). Geological Survey Ireland Map Viewer, Quaternary Sediments Map. • GSI (2023c). Geological Survey Ireland, Internal groundwater databases. • Hunter-Williams, N.H., Misstear, B.D.R., Daly, D. and Lee, M. (2011). (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	

Information Sources (contd.)	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.

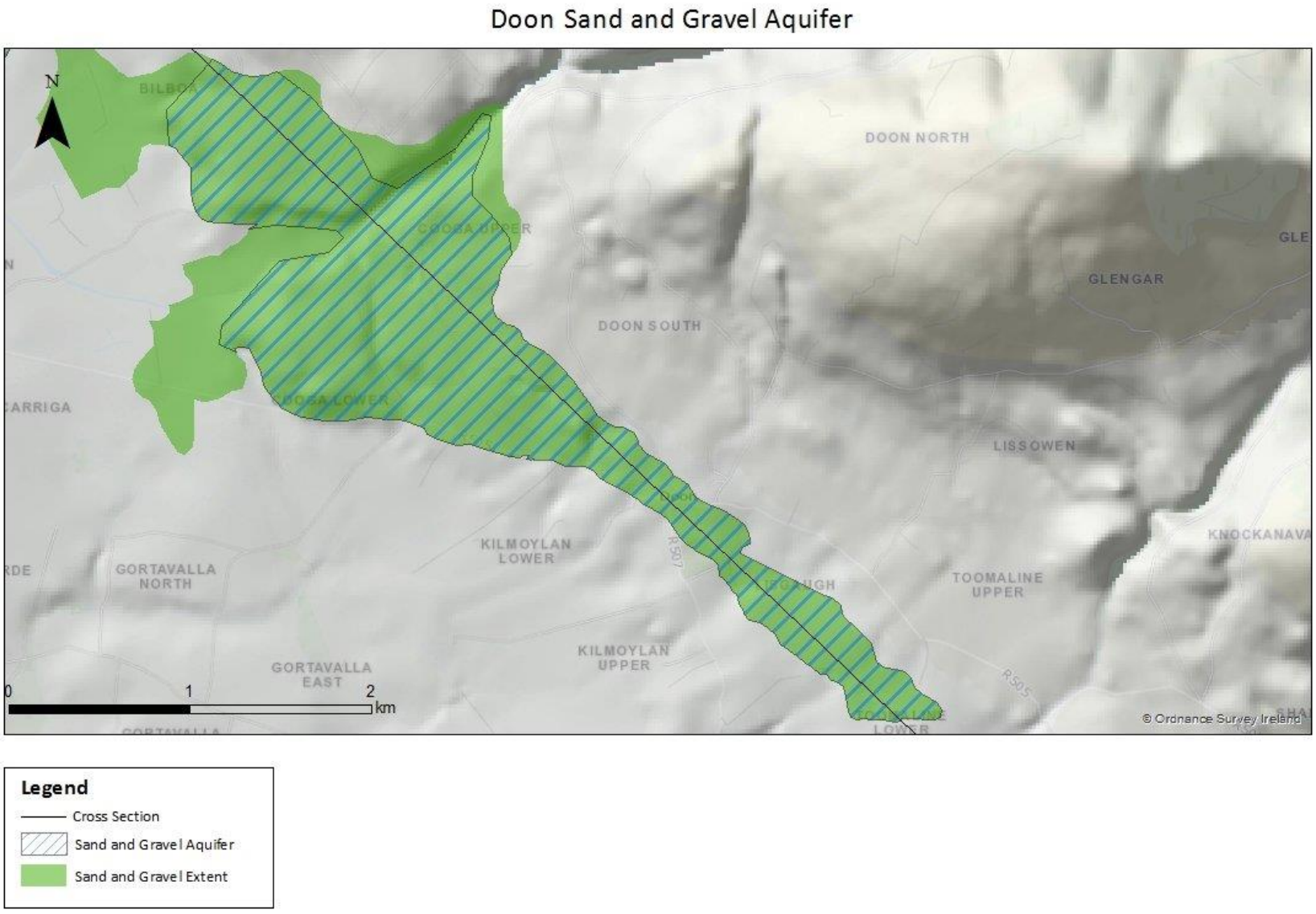

Figure 1: Doon Sand and Gravel Aquifer extent with cross section location.

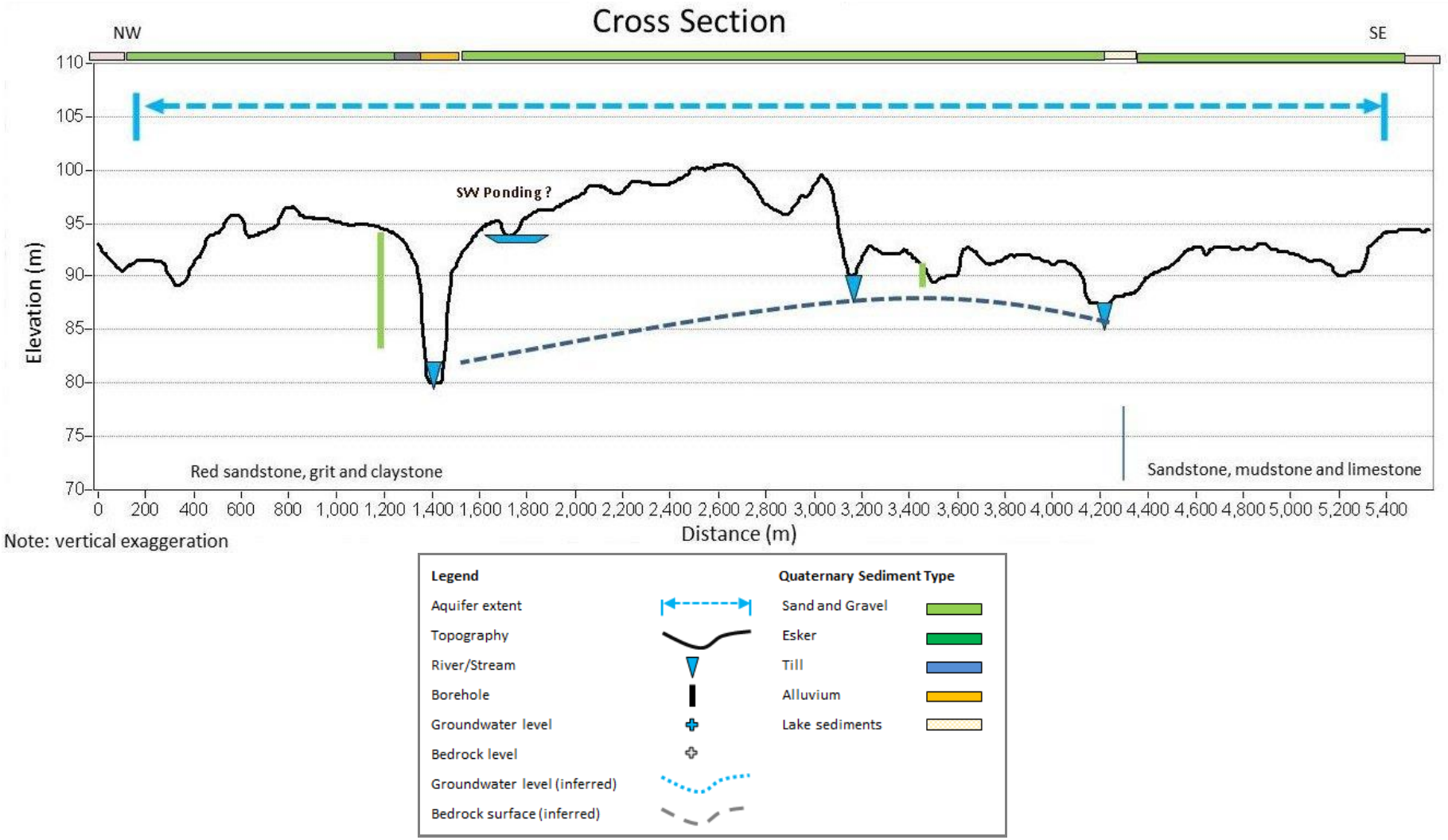

Figure 2: Cross section through the Doon Sand and Gravel Aquifer body.

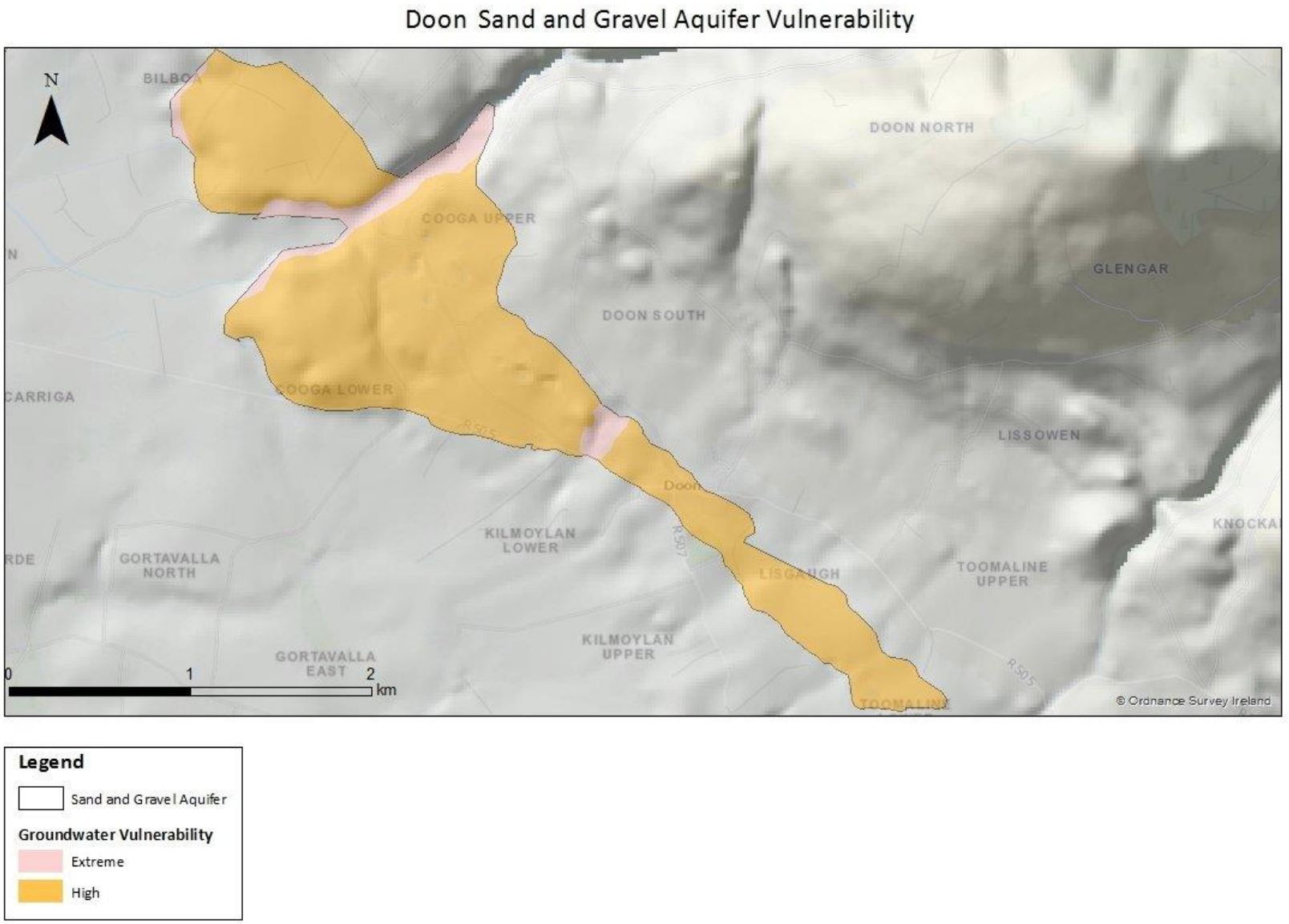

Figure 3: Groundwater vulnerability across the Doon Sand and Gravel Aquifer.