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Kylemore Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/39
March 2023

Kylemore 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



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Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
32 – Erriff - Clew Bay Galway County Council		Rivers: Dawros River, Polladirk River Streams: Several unnamed streams Lakes: Lough Maladrolaun, Pollacappul Lough and several unnamed lakes	The Twelve Bens / Garraun Complex SAC The Twelve Bens / Garraun Complex pNHA	1.33
Topography	The Kylemore sand and gravel deposits begin just over 1 km northeast of Letterfrack village at their western end, and extend eastwards within a wide, glacially-overdeepened valley between Currywongaun and Doughruagh Mountains at the north, and Diomond Hill and Knockbrack Mountain at the south (Figure 1). Land elevations across the sands and gravels vary from 20 m to 45 m AOD. The sediments comprise eskers and hummocky sand and gravel deposits, and it is considered that the sands and gravels continue underneath the adjacent peat and alluvial sediments in some localities. The Dawros and Polladirk rivers flow through the sands and gravels, as do other small streams, some of which originate from within the sands and gravels, at the break of the mountain slopes. The sand and gravel body also contain Lough Maladrolaun and Pollacappul Lough within their area.			
Geology and Aquifers	Aquifer categories	Exposures of up to 20 m depth of sands and gravels are evident within the high ridges just south of Tullywee Bridge. Bedrock outcrops have been mapped here, within the river bed, as well as at higher elevations south of Kylemore Abbey. Given the depositional environment within the valley (Coxon and Browne, 1991; McCabe and Dardis, 1992; Thomas and Chiverrell, 2005), and known sand and gravel depths, it is considered that a large portion (c. 40%) of the delineated aquifer body has >10 m depth of sorted sands and gravels. Groundwater levels have been obtained from trial hole assessments (Reference) and from streams and small lakes that originate within the sand and gravel deposits. The majority of the delineated aquifer body has water levels close to the surface. Based on likely geometry and extent, this deposit is classified as a Locally Important Sand and Gravel Aquifer (Lg) (DELG/EPA/GSI, 1999; GSI, 2017). The subsoils overlie bedrock predominantly of Precambrian Marbles and Precambrian Quartzites, Gneisses and Schists, which are both classified as Poor Bedrock Aquifers (PI) (GSI, 2017).		
	Main aquifer lithologies	Glaciofluvial sands and gravels derived from metamorphic rocks (GMp), and eskers comprised of gravels of acidic reaction (AcEsk) (GSI, 2023b).		
	Key structures	Exposures from a pit south of Tullywee Bridge show well sorted to poorly sorted, bedded sands and gravels (see detailed descriptions of historic exposures in Thomas and Chiverrell, 2005). East of this, and close to Pollacappul Lough, there is an exposure of cobble gravels with interbedded sand lenses.		
	Key properties	There are no known data from within this aquifer on yields, permeabilities or transmissivities. Sand and gravel aquifers generally consist of unconsolidated, coarse-grained material, usually containing less than 8% fines (O’Súilleabháin, 2000). Typically, transmissivity ranges from 200 – 1500 m ² /d (Kelly et al., 2015). Specific yield is expected to be high (10%). Groundwater is considered to be unconfined within the Kylemore sand and gravel aquifer. The data are inadequate to calculate groundwater gradients, but these are expected to be relatively flat, in the order of 0.001, typical of sand and gravel aquifers.		
	Thickness	Exposures of up to 20 m depth of sands and gravels are evident within the body, south of Tullywee Bridge. Given the depositional environment within a valley, and known sand and gravel depths, it is considered that the majority of the aquifer has >10 m depth of sands and gravels, with the greatest depths in the western portion.		
Overlying Strata	Lithologies	A relatively extensive area of the sands and gravels at Kylemore are covered by blanket peat. Alluvium covers a small area of these also, along the Dawros River.		
	Thickness	Exposures within the blanket peat and alluvium show they are less than 3 m thick.		
	% area aquifer near surface	Approximately 39% of the area of the delineated sand and gravel aquifer has sands and gravels just below the land surface. Elsewhere, they are buried by blanket peat or alluvium.		



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	Vulnerability	The groundwater vulnerability of the sand and gravel aquifer is 'Extreme' wherever the water table is <3 m from the surface, whereas in all other areas where the water table is at depths >3 m from surface, the vulnerability is classed as 'High'. Extreme vulnerability occurs over approximately 67% of the delineated aquifer area.
Recharge	Main recharge mechanisms	Diffuse recharge occurs <i>via</i> rainfall percolating 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 sands and gravels are at surface. Where alluvium and/or blanket peat overlies the sands and gravels, the rates of recharge will be significantly less. Rejected recharge also enters the aquifer from the mountains to the south <i>i.e.</i> from Diomond Hill and Knockbrack, and potentially from the north also.
	Est. recharge rates	Recharge to the aquifer is estimated at 854 mm/yr, based on an average annual rainfall of 1,842 mm/yr (Walsh, 2012). This means a minimum direct groundwater throughput of 642 m ³ /d which rises to a potential 1,083 m ³ /d when rejected recharge from the surrounding mountain slopes is included. It must be noted that there is likely to be an element of seasonal variability associated with this.
Discharge	Large springs and large known abstractions (m³/d)	There are no known large springs or abstractions from this aquifer body.
	Main discharge mechanisms	Groundwater is expected to discharge <i>via</i> some small lowlying springs as seen on OSI 6 inch raster map (1830s – 1930s) in Addergoole Townland. Groundwater is also assumed to discharge, <i>via</i> seeps, to the Dawros and Polladirk Rivers, Lough Maladrolaun and Pollacappul Lough, as well as to several other unnamed streams and lakes within the aquifer body.
	Hydrochemical Signature	There are not enough data to determine the hydrochemical signature of the aquifer; however, given the geological setting, the groundwater is expected to have a calcium magnesium bicarbonate signature (CaMgHCO ₃).
Groundwater Flow Paths		The length of flow paths depend on the size of the sand and gravel deposit. In general, locally important sand and gravel aquifers are expected to have relatively short flow paths, <i>i.e.</i> , up to several hundred metres. This also seems to be the case at Kylemore, given the topography of the body and the stream pattern within.
Groundwater & Surface water interactions		Groundwater is expected to discharge to the rivers, streams, lakes and springs, as specified above. Hydraulic connection between the groundwater in the aquifer, and the adjacent streams and lakes, is expected to be high.
Conceptual model	- The Kylemore sand and gravel aquifer consists of glaciofluvial sands and gravels derived chiefly from metamorphic rocks (GMP) and eskers comprised of gravels of acidic reaction (AcEsk). - The deposits are situated in a generally lowlying, hummocky area, at the base of the wide, glacial valley between Diomond Hill and Knockbrack Mountain at the south, and Currywongaun and Doughruagh Mountains at the north. - The surface of the glaciofluvial deposits lie at elevations between 20 m and 45 m AOD. - A large portion of the aquifer is covered by blanket peat, and alluvium also covers a small portion adjacent to the Dawros River; in total c. 61% of the sand and gravel body is covered by these overlying strata. - The subsoils overlie bedrock predominantly of Precambrian Marbles and Precambrian Quartzites, Gneisses and Schists, which are both classified as Poor Bedrock Aquifers (PI). - The aquifer is inferred to be greater than 10 m thick over much of its extent, with c. 20% of the aquifer estimated as having ≥5 m depth saturated sands and gravels. - Across approximately 67% of the aquifer area, groundwater levels are mapped as <3 m below ground level. - The length of groundwater flow paths is expected to be in the order of several hundred metres. - Groundwater discharges <i>via</i> seeps to springs, to the Dawros and Polladirk Rivers, to Lough Maladrolaun and Pollacappul Lough, and to several other unnamed small streams and lakes.	

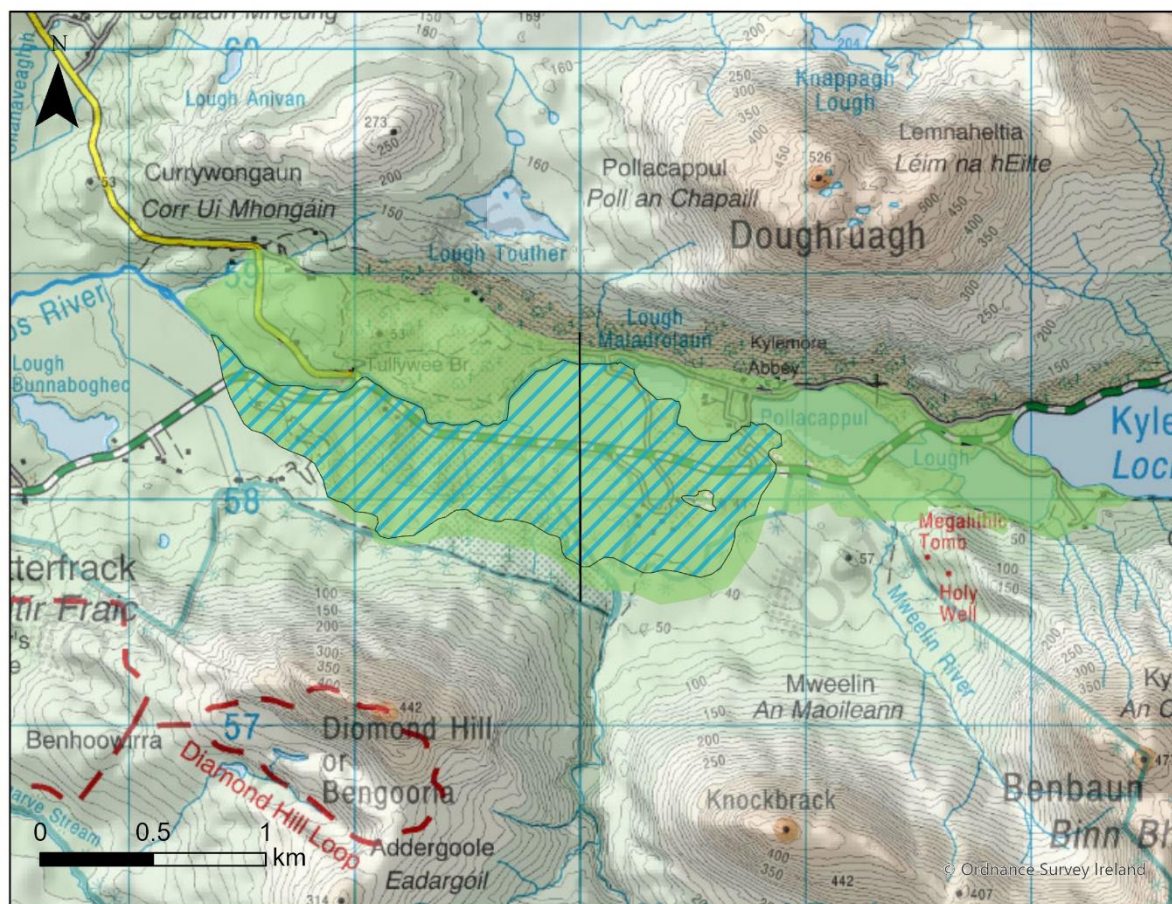


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	- Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels, with lower recharge rates occurring where the sand and gravel is overlain by blanket peat and/or alluvium. - Recharge to the aquifer is estimated as a total of 854 mm/yr, which means a minimum direct groundwater throughput of 642 m³/d, which rises to a potential 1,083 m³/d when rejected recharge from the surrounding mountain slopes is included.
Attachments	Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability
Instrumentation	Hydrometric gauges: None present National Water Monitoring Stations; River: RS32D010060 Dawros – Br d/s Pollacappul Lough RS32D010080 Dawros – d/s L. Maladrolaun RS32D010100 Tullywee Bridge Lake: LS320013300400010 – M_3;_Shore Groundwater: None present
Information Sources	- Coxon, P. and Browne, P. (1991). Glacial deposits and landforms of central and western Ireland. In: Ehlers, J., Gibbard, P. and Rose, J. (Eds.) <i>Glacial Deposits in Great Britain and Ireland</i>. A.A. Balkema, Rotterdam, pp. 355-365. - DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland. - EPA (2023). Environmental Protection Agency Map Viewer. https://gis.epa.ie/EPAMaps. - 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 internal groundwater database. - GSI (2023b). Geological Survey Ireland Map Viewer. https://www.gsi.ie/en-ie/data-and-maps - Kelly, C., Hunter Williams, T., Misstear, B.M. and Motherway, K. (2015). Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency. 110 pp. - McCabe, A.M. and Dardis, G. (1992). Tullywee Delta. In: McCabe, A.M., Dardis, G.F. and Hanvey, P.M. (Eds.) <i>Glacial Sedimentology in northern and western Ireland</i>. Pre- and post-Symposium Field Excursion Guide Book, University of Ulster, pp. 191-194. - NPWS (2023). National Parks and Wildlife Service Map Viewer. http://webgis.npws.ie/npwsvviewer - 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. - Thomas, G. and Chiverrell, R. (2005). Ice marginal subaqueous depositional environments during retreat stages from the LGM in western Connemara. In: Coxon, P. (Ed.) <i>The Quaternary of Central Western Ireland</i>. Field Guide, Quaternary Research Association, London. pp. 164-171. - Walsh, S. (2012). A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Dublin.
Disclaimer	Note that all calculations 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.



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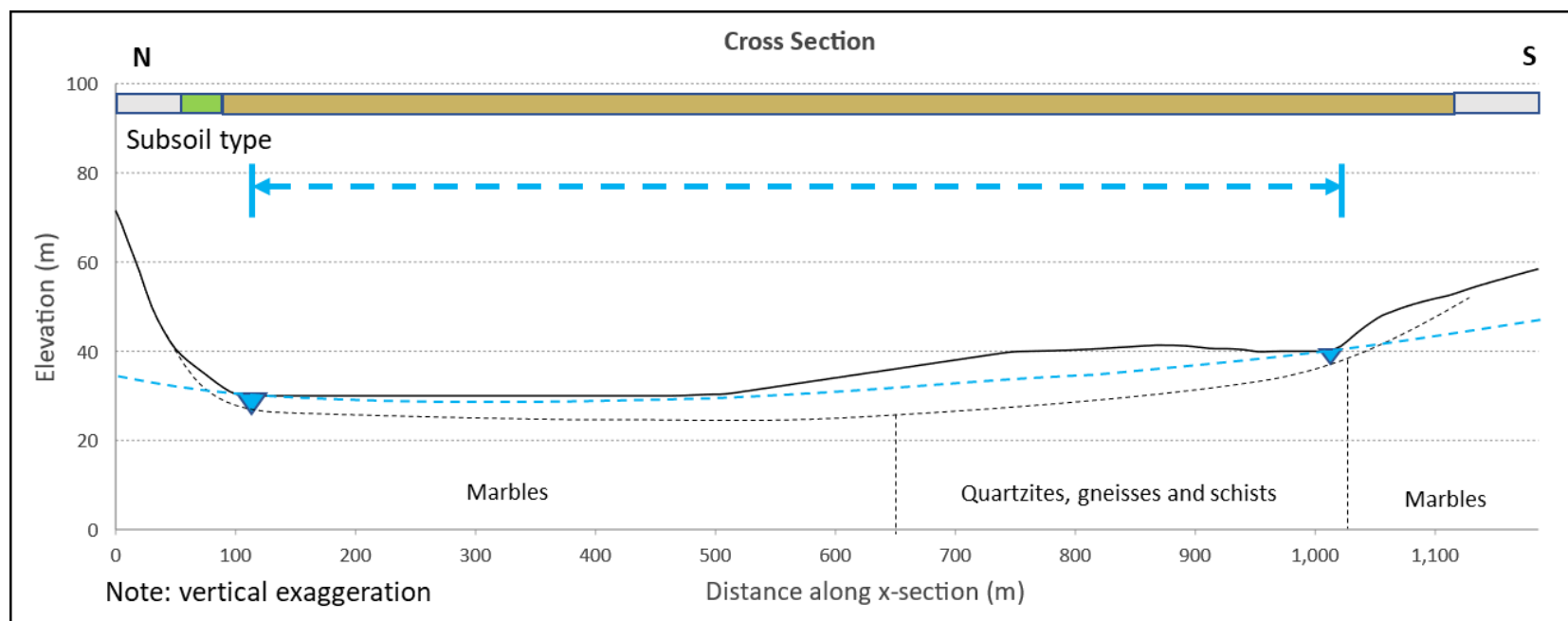


Legend

- Cross Section
- Sand and Gravel Aquifer
- Sand and Gravel Extent

Figure 1: Kylemore Sand and Gravel Aquifer extent with cross section locations.

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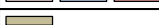
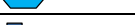
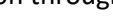
LEGEND			
Feature		Subsoil Type	
Topography		Sands and gravels	
Groundwater level		Esker	
Top of bedrock		Windblown sands	
Borehole/Trial Pit		Till	
Dug well		Peat	
S&G exposure		Rock outcrop	
Active quarry		Alluvium	
Freshwater lake		Lake sediments	
GW Ponding		Top of S&G	
River		Top of till	
Stream/drainage channel		Karst Feature	
Spring		Spring	
Aquifer envelope		Turlough	

Figure 1: Cross section through the Kylemore Sand and Gravel Aquifer body.

Kylemore Sand and Gravel Aquifer Vulnerability

