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New Inn Sand and Gravel Aquifer Summary of Initial Characterisation



GW3D Project Report TR2023/40
March 2023

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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
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- Sara Raymond, independent Consultant Geologist
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Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
29 – Galway Bay South East Galway County Council		Rivers: None Streams: Several unnamed streams Lakes: None	None	0.6
Geology and Aquifers	Topography	The sand and gravel deposits at New Inn comprise a long and narrow, sinuous esker, as well as some associated, flanking sands and gravels (Coxon and Browne, 1991), just north of the village of New Inn, County Galway (Figure 1). The topography of the sand and gravel body is generally flat to undulating and the deposits are situated in a gently sloping, east-west oriented area at elevations between 55 m and 100 m AOD. For the most part, the sand and gravel body is overlain and surrounded by till deposits. Several streams transect the area of the body and flow westwards. Bedrock is less than 10 m from the surface throughout the extent of the sands and gravels. Several pits within the deposits have extracted sand and gravel in the past, but these are now disused; one pit has since been used as landfill, and another pit located east of New Inn is now covered by a housing estate.		
	Aquifer categories	This aquifer, comprising glaciofluvial and esker sands and gravels covered with various areas and depths of glacial and post-glacial sediments, covers approximately 0.6 km ² . The aquifer generally slopes gently from east to west, from 100 m AOD to 80 m AOD, where it is bounded by stream tributaries of the Raftord River. It is uncertain whether the aquifer body extends beyond this river and more investigations would be required in order to determine this, given that much of the sands and gravels are overlain by other subsoil types. The depth of the sand and gravel aquifer itself varies between 2 m to 8 m (Tynan, 2018), and is overlain by tills derived from limestones, and/or lacustrine sediments, some of these up to 6 m thick in some localities. Water levels obtained from hydrogeological investigations at New Inn, suggest that the aquifer is confined locally, and perhaps seasonally (Ball, 1999, 2005; Tynan, 2018). There is one drinking water supply at New Inn Group Water Scheme (GWS), which currently abstracts from three source wells. The scheme has had issues over the years, with insufficient yields and poor water quality, and has had to change its supply well configuration. Based on likely geometry and extent, and the water supply data, this deposit is classified as Locally Important Sand and Gravel Aquifer (Lg) (GSI, 2017).		
	Main aquifer lithologies	Glaciofluvial sands and gravels derived chiefly from limestones (GLs, GSI, 2023b), and eskers comprised of gravels of basic reaction (BasEsk). Much of the delineated aquifer body is also overlain by till derived chiefly from limestones (TLs), lacustrine silts and clays (L), cutover peat (Cut) or Made Ground (Made). The subsoils overlie Dinantian Upper Impure Limestones, which is a locally important bedrock aquifer (LI) (GSI, 2017).		
	Key structures	There are no data available from pit exposures of geophysical profiles to distinguish key structures within the sand and gravel deposits.		
	Key properties	Hydrogeological data for the sands and gravels at New Inn derive from collated abstraction data for the New Inn GWS. The three operational wells abstract 307 m ³ /day (Tynan, 2018). Sand and gravel aquifers generally consist of unconsolidated, coarse-grained material, usually containing less than 8% fines (Ó'Súilleabháin, 2000). Typically, transmissivity ranges from 200 – 1500 m ² /d. Specific yield is expected to be high (10%). Groundwater is considered to be locally confined within the sand and gravel aquifer at New Inn, where thick, low permeability subsoils overlie the sand and gravel deposits. The data are inadequate to calculate groundwater gradients, but these are expected to be relatively flat, in the order of 0.001, and typical of sand and gravel aquifers (Kelly et al., 2015).		
	Thickness	Bedrock was encountered at depths between 5 m and 9 m below ground level in the vicinity of the New Inn GWS source wells. The aquifer has overlying sediments throughout much of its' area, with thicknesses of the sand and gravel deposits varying between 2 m and 8 m. Groundwater levels have been recorded as being within the overlying till and lacustrine clay deposits (Tynan, 2018); therefore, the sand and gravel deposits are considered to be saturated throughout their depth.		



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Overlying Strata	Lithologies	Till derived from limestones, cutover peat, 'Made' ground and/or lacustrine sediments overlie much of the area (65%) of the mapped sand and gravel body.
	Thickness	Hydrogeological investigations in the area show that where tills, cutover peat and/or lacustrine sediments exist, these overlying sediments are between 1 m and 6 m thick.
	% area aquifer near surface	Only 35% of the area of the delineated sand and gravel aquifer body is just below ground surface; across the majority of the area, relatively deep overlying materials are in evidence.
	Vulnerability	The groundwater vulnerability of the sand and gravel aquifer is 'Extreme' wherever the water table is at depths <3 m from the ground 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 c. 60% of the delineated aquifer area at New Inn.
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. Based on topography, subsoil type and the underlying bedrock aquifer type, it is expected that a significant amount of rejected recharge will enter the aquifer from higher ground to the east and southeast.
	Est. recharge rates	Recharge to the aquifer is estimated at 350 mm/yr, based on an average annual rainfall of 1,135 mm/yr (Walsh, 2012). This means a minimum direct throughput of the aquifer of approximately 147 m ³ /d, which rises to a maximum potential 1,738 m ³ /d when rejected recharge from the flanking higher ground to the east and southeast is included.
Discharge	Large springs and large known abstractions (m³/d)	New Inn GWS has an abstraction rate of 307 m ³ /d (Tynan, 2018), from the combined rate of the three boreholes currently in use there (BH2, BH3 and BH 6).
	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) at, for example, Castlebin North and Castlebin South Townlands. Groundwater discharges <i>via</i> seeps to the streams that flow through the sand and gravel deposits, as well as to springs which rise among these materials.
	Hydrochemical Signature	The groundwater from the aquifer has a calcium bicarbonate (Ca-HCO ₃) signature (Tynan, 2018). Hydrochemical analyses of raw water samples from New Inn GWS (Well No. 1), from 1995 to 2017, are included in Table 1 of this report (after Tynan, 2018). Levels of ammonium and chloride in the raw water have exceeded the legislative limits on occasion, as have the number of faecal coliforms. This illustrates the dominance of extreme vulnerability to pollution throughout the delineated aquifer body. Iron and Manganese concentrations have also exceeded the legislative limits on occasion.
Groundwater Flow Paths		The length of flow paths depends on the extent 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 is also expected to be the case across the sand and gravel aquifer body at New Inn, given the setting and geometry of the deposit.
Groundwater & Surface water interactions		Groundwater is expected to discharge to the streams and springs within the area of the aquifer body. Hydraulic connection between the groundwater in the aquifer and the adjacent streams is therefore expected to be high.
Conceptual model	- The New Inn sand and gravel aquifer consists of glaciofluvial sand and gravels derived from limestones (GLs) and esker gravels of basic reaction (BasEsk). - The deposits are located in a relatively low-lying, gently sloping area, situated at elevations between 80 m and 100 m AOD. - A number of stream tributaries of the Ráford River flow through or emerge from the aquifer body. - The aquifer is overlain by till derived from limestonesm cutover peat and/or lacustrine sediments over the majority of its' area, and these overlying deposits are between 1 m to 6 m thick. - The subsoils overlie bedrock of Dinantian Upper Impure Limestones, which is a locally important bedrock aquifer (LI).	



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	- The sand and gravel aquifer body is up to 8 m thick over much of its extent, with c 25% of the aquifer estimated as having ≥ 5 m depthsaturation. - The aquifer is locally, and potentially seasonally, confined by the overlying till, cutover peat and lacustrine sediments materials. - Across c. 60% of the aquifer, groundwater levels are at depth < 3 m below ground level. - Diffuse recharge occurs <i>via</i> rainfall percolating through the unsaturated sands and gravels, as well as through the overlying sediments where present. - Recharge to the aquifer is estimated at an average of 350 mm/yr across the area of delineated aquifer body. - Rejected recharge also enters the aquifer from the higher ground at the east and southeast. - There is a minimum direct throughput of the aquifer body itself of approximately only 147 m³/d, which rises to a maximum potential 1,738 m³/d when rejected recharge from the flanking higher ground to the east and southeast is included. - The length of the flow paths is expected to be in the order of (maximum) several hundred metres. - Groundwater discharges to springs and to the stream tributaries of the Rford River. - One important drinking water supply, New Inn GWS, currently abstracts groundwater from three boreholes and abstracts 307 m³/d (Tynan, 2018).
Attachments	Table 1: Raw water analysis of pumped water from New Inn Well No. 1, 1995-2017 Figure 1: Location and extent Figure 2: Cross section Figure 3: Groundwater vulnerability
Instrumentation	Hydrometric gauges: None present National Water Monitoring Stations; River: None present Groundwater: GWIE_WE_G_010012000018 New Inn No. 1
Information Sources	- Ball, David M. (1999). New Inn Group Water Scheme summary technical assessment. - Ball, David M. (2005). New Inn Group Water Scheme supplementary production borehole drilling and testing – summary report. - 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 (2023a). Environmental Protection Agency Map Viewer. https://gis.epa.ie/EPAMaps. - EPA (2023b). Groundwater Monitoring Data to End 2017. - EPA/WRBD/Galway County Council (2011). Water Framework Directive Groundwater Monitoring Programme (New Inn). - 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. - NPWS (2023). National Parks and Wildlife Service Map 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.

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Information Sources (contd.)	- Tynan, S. (2018). Establishment of Groundwater Zones of Contribution, New Inn Group Water Scheme, Co. Galway. - 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 are used for illustrative purposes only.

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Parameter	No. of samples	Concentration			¹ Drinking Water Limit (DWL) or ² Threshold Value (TV)
		Min	Max	Average	
pH (pH Units)	45	6.6	7.6	7.0	6.5-9.5 (DWL)
Conductivity (µS/cm)	47	465	857	694	2,500 (DWL), 800-1875 (TV)
Alkalinity (mg/l CaCO ₃)	57	206	400	332	(-)
Total Hardness (mg/l CaCO ₃)	58	194	464	362	(-)
Ammonium (mg/l N)	58	<0.008	0.23	-	0.3 (DWL), 0.065-0.175 as N (TV)
Nitrate (mg/l NO ₃)	56	4.12	26.57	11.46	50 (DWL), 37.5 (TV)
Sulphate (mg/l SO ₄)	56	3	82	22	250 (DWL), 187.5 (TV)
Chloride (mg/l)	58	19	35	25	250 (DWL), 24-187.5 (TV)
Sodium (mg/l)	57	8	22	15	200 (DWL), 150 (TV)
Potassium (mg/l)	57	1.3	5	3.3	(-)
Potassium:Sodium	57	0.13	0.38	0.23	0.4 (indicator)
Calcium (mg/l)	50	5	163	133	(-)
Magnesium (mg/l)	50	3.7	131	7.6	(-)
Iron (mg/l)	57	<2	283	-	200 (DWL)
Manganese (mg/l)	56	<1	78	-	50 (DWL)
Total Coliforms (MPN/100ml)	57	0	920	-	0 (DWL)
Faecal Coliforms (<i>E. coli</i>) (MPN/100ml)	57	0	336	-	0 (DWL)

¹S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014

²S.I. No. 9/2010 – European Communities Environmental Objectives (Groundwater) Regulations 2010

Table 1: Raw water analysis of pumped water from New Inn Well No. 1, 1995-2017 (after EPA, 2023b).

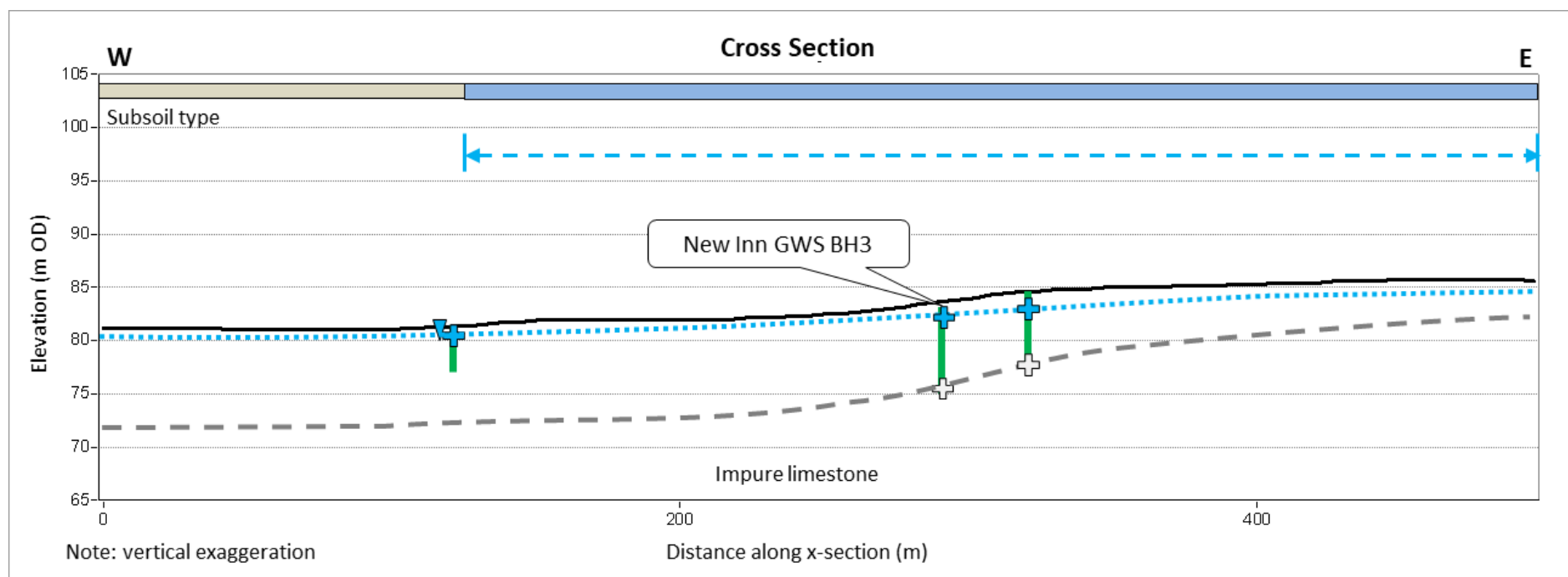


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Figure 1: New Inn Sand and Gravel Aquifer extent with cross section location.



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 2: Cross section through the New Inn Sand and Gravel Aquifer body.

New Inn Sand and Gravel Aquifer Vulnerability

