Lanesborough GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface features	Associated terrestrial ecosystem(s)	Area (km^2)
26 – Inny/Lough Ree Longford Co. Co.	**Loughs**: Ree, Derrymacar.	(001821) Cordara Turlough; (000448) Fortwilliam Turlough; (000440) Lough Ree; (000449) Lough Bannow; (001819) Lough Bawn; (002103) Royal Canal; (001444) Derry Lough; (001448) Forthill Bog; (001443) Lough Slawn.	132

Topography		This GWB is relatively low-lying and can be divided into two basic topographical areas. The eastern side of the body is extensively covered by peat land (raised bogs currently being harvested for fuel on a large scale). The land is flat with ground elevations of just 40-50 mAOD. This bog-dominated area is separated from Lough Ree by an area of higher ground on the western side of the body with ground elevations ranging from 50-80 mAOD. This western area is covered mainly by till with frequent areas of outcrop and shallow rock and consists of a series of gentle ridges and depressions running north northwest – south southeast. There is a lack of surface water drainage in this western area. The centre of the body is intersected from the east by a spur of Dinantian (early) Sandstones, Shales and Limestones, part of the Inny GWB, which corresponds to a very slight increase in elevation. Small streams flow northwest and southeast from this intersecting GWB, eventually flowing into the River Shannon in the north and Lough Ree in the south.
Geology and Aquifers	**Aquifer categories**	**Rk^c:** Regionally important karstified aquifer dominated by conduit flow.
	Main aquifer lithologies	This GWB is composed of Dinantian Pure Bedded Limestones with a small area mapped as Dinantian Dolomitised Limestones. Dolomitisation has also been observed in boreholes in the Dinantian Pure Bedded Limestones south of Lanesborough Town. The dolomitised limestones are a brown in colour and a highly weathered.
	Key structures	Few faults are mapped in this area; this may reflect the poor exposure in some areas and the lack of major variation in the rock lithology. The dips over the GWB area are generally less than 10^o. Dominant joint direction observed in rock outcrops at Lisrevagh, south of Lanesborough was north northwest – south southeast, with a minor set at right angles to this (i.e. west southwest – east northeast) (Cullen, K.T. & Co., 1991). The body is intersected from the east by the Dinantian (early) Sandstones, Shales and Limestones of the Keel Inlier, which is part of the Inny GWB. This inlier is bounded to the southeast by a zone of normal step faults, downthrowing to the southeast.
	Key properties	The pure limestone bedrock of this GWB is karstified and dolomitised which significantly improves fissure permeability. Dolomitisation can also result in an increase in the porosity of the rock. Permeability and transmissivity in such aquifers is highly variable however as karstification and dolomitisation can be unevenly distributed. Transmissivity in karstified aquifers with conduit flow can range up to a few thousand m^2/d. As part of an EIS for Ballingard Spring public supply in the neighbouring Funshinagh GWB to the west, which is similarly composed karstified pure bedded limestone, individual pumping tests were undertaken on five boreholes between June and September 1994. The estimated transmissivity from the individual pumping tests ranged from 60 m^2/d in the lower permeability rock to 180 m^2/d in the high permeability zones (Lee, M. and Kelly, C. (2003). Test pumping in dolomitised Waulsortian Limestone in the Lisheen mine and Galmoy mine area showed transmissivity in the ranges of 20 – 1366 m^2/d and 100-2500 m^2/d respectively (Dolomite Aquifer Chapter). Pumping tests carried out on three trial wells in this GWB at Carrowroe and Rathcline south of Lanesborough indicate that the three wells have a specific capacity in the range of 75-85 m3/d per metre of drawdown. The wells intersect a zone of very weathered, broken and fissured brown dolomite. Rapid groundwater flow velocities have been recorded in karstified limestone. Tracer tests carried out in the neighbouring Funshinagh GWB recorded minimum velocities of 24 m/hr in the Ballinagard tracer test (Roscommon County Council, 1991) and 70 m/hr recorded in the Lough Funshinagh to Atteagh Corn Mill Spring tracer test (Drew, D. and Burke, M., 1996). Rapid velocities recorded for groundwater in these areas imply flow through relatively sizeable conduits. Groundwater gradients calculated in the vicinity of Ballingard Spring source (Funshinagh GWB) were low ranging from 0.002-0.007 (Lee, M. and Kelly, C., 2003). In karstified pure bedded limestone such as that found in this GWB, enlargement of the fracture network by solution and dolomitisation, and the generally well-connected and widespread fracture systems result in a highly permeable aquifer with rapid groundwater flow. *(data sources: Rock Unit Group Aquifer Chapters, Roscommon GWPS and Source Reports, see references)*
	Thickness	The Dinantian Pure Bedded Limestones are generally well over 100 m thick. Most groundwater flows in an epikarstic layer a couple of metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits that extends approximately 30 m below this. Deeper inflows can occur in areas associated with faults or dolomitisation. During the drilling of trial wells south of Lanesborough, County Longford, significant inflows of groundwater were encountered below 50 m associated with zones of dolomitised limestone bedrock (Cullen, K.T. & Co., 1991).

Overlying Strata	**Lithologies**	The eastern side of this GWB is covered by extensive areas of peat, which are being harvested on a large scale. The peat areas are generally underlain by lacustrine clay and marl. Small areas of limestone till also occur in the east of the body. The western half of the body is covered by limestone till with frequent areas of rock outcrop and rock close to the surface. There are also some areas of cut peat in the south of the body near the shores of Lough Ree. *Subsoil Types identified in body by Teagasc Parent Material Mapping: Cut Peat (Cut); Limestone Till (TLs) Lower Paleozoic Devonian Sandstone Till; Karstified Limestone outcrop & Karstified Limestone close to surface (KaRck), Alluvium (A),* *[Information to be added at a later date]*
	Thickness	There are few areas of rock outcrop or shallow rock in the east of the body. Most of the eastern area is expected to have >3 m of subsoil. In the west of the body there are frequent areas of rock outcrop or shallow rock. A large proportion of the western half of the body will have <3 m subsoil. Elsewhere in the west of the body subsoil thickness of 3-10 m is expected. Isolated points where subsoil is >10 m may be encountered as a result of large in filled cavities in the limestone. A trial well (TW2) drilled in Carrowroe, County Longford encountered thick subsoil down to a depth of 52 m when bedrock was observed at the surface some 40 m away (Cullen, K.T. & Co., 1991)
	% area aquifer near surface	[Information to be added at a later date]
	Vulnerability	Areas of Extreme vulnerability will be common in the western half of the body where subsoil thickness is frequently < 3 m and karst features such as turloughs and swallow holes have been recorded. The large areas of cut peat in the east of the body are expected to have Moderate or Low vulnerability due to the peat cover and the underlying lacustrine clay and marl that are generally found beneath large areas of peat in this region, however the vulnerability rating will be dependant on the thickness of the subsoil. Areas of High and Extreme vulnerability may occur in the east of the body where subsoil cover is thin. A Groundwater Vulnerability Map is not currently available for County Longford. [Information to be added at a later date]
Recharge	**Main recharge mechanisms**	Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. Given the karstified nature of the limestone bedrock, swallow holes and collapse features may occur, providing routes for point recharge. Swallow holes and collapse features may be more common in the west of the body where subsoil cover is thinner. The lack of surface drainage in the west of the GWB indicates that potential recharge readily percolates into the groundwater system. Groundwater in karstified limestones where subsoil is thin or absent generally shows a rapid response to recharge. In a highly permeable aquifer such as karstified pure bedded limestone, a proportion of the effective rainfall can also be rejected in low-lying areas with a high water table due to lack of storage space in the aquifer. Percolation of recharge will be somewhat restricted in the east of the body due to the extensive covering of peat and the typically associated underlying lacustrine clay or clayey till. Subsoil permeability has not currently been mapped in detail in County Longford but the sub peat subsoil in the east of the body would be expected to be of 'low' permeability. Despite the presence of peat and low permeability till however, point recharge to the underlying aquifer can still occur in areas underlain by karstified limestone by means of swallow holes and collapse features/dolines. Dolines have been recorded in the Carrick on Shannon GWB,County Roscommon, even in areas with thick peat deposits. (Hickey et al, 2002). *Note: Subsoil permeability has not currently been mapped in detail in County Longford.*
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	**Springs and large known abstractions (m^3/d)**	Lanesborough RWSS - Production Well Testing at Lisrevagh/Carrowroe 1989/1990 indicated that 1000-1500 m^3/d could be abstracted from the site (Cullen, K.T. & Co., 1991). Laneborough RWSS – Public Supply Well adjacent to Lanesborough ESB PowerStation – Yield >400 m^3/d. Lanesborough ESB PowerStation Well – Yield > 400 m^3/d. *[This information is not complete –data need to be updated from County Council records]*
	Main discharge mechanisms	The main discharges are to Lough Ree and the River Shannon in the west and to some springs and streams crossing the body. In winter groundwater will discharge to the turloughs found in the area. There may be some groundwater discharge in 'lagg zones' at the margins of the raised bogs or at flushes within the bogs where the underlying 'low' permeability subsoils are thin or absent. .

	Hydrochemical Signature	The hydrochemistry of the carbonate rocks, especially pure limestones, is dominated by calcium and bicarbonate ions. Hardness can vary from slightly hard to very hard (typically ranging between 380–450 mg/l). Spring waters tend to be softer, as throughput is often quicker with less time for the dissolution of minerals into the groundwater. Groundwater alkalinity is variable, but can be high. Alkalinity is generally less than hardness indicating that ion exchange (where calcium or magnesium are replaced by sodium) is not a significant process. Lime-scale can be problematic. Like hardness and alkalinity, electrical conductivities (EC) can vary greatly. Typical limestone groundwater conductivities are of the order 500–700 µS/cm. Lower values suggest that groundwater residence times are very short. Hydrochemical analyses carried out on a number of trial wells at Carrowroe, County Longford in 1985 (Cullen, K.T. & Co., 1991) showed hardness ranging from 318-359 mg/l, alkalinity from 257-318 mg/l and EC from 580-620 µ/cm. Groundwater in karstic aquifers is highly vulnerable to bacteriological and chemical pollution from point sources such as septic tank systems, farmyards, waste disposal sites, land spreading of organic waste and from polluted streams flowing underground. High levels of suspended solids can also be a problem in heavily weathered and fissured limestone. The hydrochemical signature of groundwater from Newtowncashel WS is demonstrated in an expanded Durov plot in Figure 2 below.
Groundwater Flow Paths		Groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones these openings are enlarged by karstification which significantly enhances the permeability of the rock. Pure bedded limestones are generally devoid of intergranular permeability however dolomitisation can result in an increase in the porosity and permeability of the rock. Karstification can be accentuated along structural features such as fold axes and faults. Groundwater flow through karst areas is extremely complex and difficult to predict. As flow pathways are often determined by discrete conduits, actual flow directions will not necessarily be perpendicular to the assumed water table contours, as shown by several tracing studies (Drew and Daly, 1993). Flow velocities can be rapid and variable, both spatially and temporally. In pure bedded limestones fracture systems are generally well-connected and widespread and support regional-scale flow systems. Flow path lengths can be up to a several kilometres in length. Overall groundwater flow will be towards Lough Ree, but the highly karstified nature of the bedrock means that locally groundwater flow directions can be highly variable. The intersecting spur of lower permeability rocks of the Inny GWB will isolate groundwater flow in the south of the Lanesborough GWB from that in the north of the body. The northern boundary of this body is formed by the Inny/Lough Ree-Camlin/Rinn surface water catchment boundary. The topography is quite subdued at this point and given the karstified nature of the bedrock it is possible that this surface water catchment boundary does not coincide with a groundwater divide. There may be some groundwater flow between the Lanesborough GWB and the Newtown Forbes GWB. Groundwater is generally unconfined in the western side of this GWB but may become partially confined in the east and south beneath the extensive areas of peat and underlying low permeability subsoil. Water levels in karstified limestone generally show rapid response to rainfall. Water level data for a well within this GWB are shown in Figure 1 attached.
Groundwater & Surface water interactions		There is a high degree of interconnection between groundwater and surface water in this GWB particularly in the west of the body. Karst features such as turloughs, swallow holes and sparse or intermittent streams are recorded. Turloughs (seasonal lakes which are fed by groundwater as the watertable rises in winter) occur in this body. These turloughs support sensitive ecosystems which are highly dependant on groundwater. Because of the close interaction between surface water and groundwater in karstified aquifers, surface water and groundwater quality are also closely linked. Any contamination of surface water is rapidly transported into the groundwater system, and vice versa. There are several terrestrial ecosystems within this GWB, some which are highly dependant on groundwater.

Conceptual model	• This GWB is bounded to the west by Lough Ree and the River Shannon and to the south by Lough Ree. The eastern boundary of the body is formed by the contact with the Dinantian Impure Limestones (Upper & Lower) and the Dinantian (early) Sandstones, Shales and Limestones of the Inny GWB. A spur of the Inny GWB intersects this GWB from the east separating the north-eastern and north-western parts of this body. The northern boundary of the body is formed by the Inny/Lough Ree-Camlin/Rinn surface water catchment boundary. However, the topography is quite subdued at this point and given the karstified nature of the bedrock it is possible that this surface water catchment boundary does not coincide with a groundwater divide. There may be some groundwater flow between the Lanesborough GWB and the Newtown Forbes GWB. • This GWB is relatively low-lying and consists of flat peat land (raised bog) in the east (40-50 mAOD) and slightly higher ground (50-80 mAOD) to the west between the bog areas and Lough Ree. The western side of the body consists of a series of gentle ridges and depressions covered mainly by till with frequent areas of outcrop and shallow rock. There is a lack of surface drainage in this western area. The intersecting part of the Inny GWB corresponds to a very slight increase in elevation from which small streams flow northwest and southeast. • The GWB is composed of highly permeable karstified and dolomitised limestone. Karst features such as dolines, swallow holes and turloughs are recorded in the west of the body. The intersecting spur of low permeability limestones and sandstones of the Inny GWB isolates groundwater flow in the northeast of the Lanesborough GWB from that in the southeast of the body. • Groundwater flows along interconnected fractures, joints, faults and bedding planes, many of which have been enlarged by solution. Groundwater flow can be concentrated in conduits. Rapid groundwater flow velocities have been recorded through groundwater tracing in adjoining GWBs with similar lithology. • Recharge to this GWB is both point, though swallow holes and collapse features, and diffuse via rainfall percolating through the subsoil. The lack of surface drainage in the western part of this GWB indicates that potential recharge readily percolates into the groundwater system. In the east of the body the extensive covering of peat and the typically underlying ‘low’ permeability subsoil may restrict percolation of recharge. • Groundwater is generally unconfined in the western part of this GWB but may become partially confined in the east and south beneath the extensive areas of peat and underlying low permeability subsoil. Much of the groundwater flow in karstified aquifers is concentrated in the upper epikarstic layer and in a zone of interconnected fissures, enlarged by karstification, generally extending to a depth of 30 m. In this GWB significant groundwater inflows have also been encountered at depths of > 50 m below bedrock surface associated with a zone of highly weathered dolomitised limestone. • In karstic aquifers, the degree of interconnection between fractures zones is high and they support regional scale flow systems. Flow paths can potentially be several kilometres in length. • Some areas in this GWB, particularly in the west are of extreme groundwater vulnerability due to the thin nature of the subsoil, as well as the frequency of karst features. Groundwater storage in karstified bedrock is low and the potential for contaminant attenuation in such aquifers is limited. • Groundwater will discharge to Lough Ree and the River Shannon in the west. In winter groundwater will discharge to the turloughs found in the area. There are also some discharges to some springs and small streams crossing the body. In the east and south of the body there may be some groundwater discharge in ‘lagg zones’ at the margins of the raised bogs or at flushes within the bogs where the underlying ‘low’ permeability subsoils are thin or absent. . • There is a high degree of interaction between surface water and groundwater in this GWB. Groundwater supports sensitive terrestrial ecosystems, including turloughs, which are highly dependant on groundwater.
Attachments	Groundwater hydrographs (Figure 1); Hydrochemical Signature (Figure 2)
Instrumentation	Stream gauges: 26106, 26234. EPA Water Level Monitoring boreholes: Rapareehill (LON 015). EPA Representative Monitoring points: Nixon (CAV 47), Lanesboro RWS (LON 13), Newtowncashel WS (LON 14).
Information Sources	Drew, D. and Burke, M. (1996) The Disappearance of Lough Funshinagh. Groundwater Newsletter No. 30, November 1996. Cullen, K.T. & Co., 1991. Consultant Hydrogeologist’s Reports on Carrowroe Aquifer and Aquifer Protection Plan. Lanesborough Regional Water Supply. From *Lanesborough Regional Water Supply- Preliminary Report - Appendix B*, P.H. McCarthy Son & Partners Consulting Engineers March 1991. Prepared for Longford County Council. Hickey, C., Lee, M., Drew, D., Meehan, R. and Daly D. (2002) Lowland Karst of North Roscommon and Westmeath. International Association of Hydrogeologists Irish Group. Karst Field Trip October 2002. Unpublished IAH Report. Lee, M. and Kelly, C. (2003) Roscommon Central Regional Water Supply Scheme (Ballinagard Spring and Proposed Production Boreholes) Groundwater Source Protection Zones. Geological Survey of Ireland Report to Roscommon Co. Co., 14 pp. McGrath R. (2001). *Microgravity on Roscommon Karst*. Unpublished GSI Report. Morris J.H., Somerville I.D. and MacDermot C.V. (2002). *Geology of Longford-Roscommon.* A Geological Description to Accompany the Bedrock Geology 1:100,000 Bedrock Series Sheet 12. With contributions by D.G. Smith, M. Geraghty, B. McConnell, K. Carlingbold, W. Cox, D. Daly. Geological Survey of Ireland, 121pp. (Publication Pending)
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Figure 1: Groundwater hydrographs
(EPA Groundwater Level Monitoring)

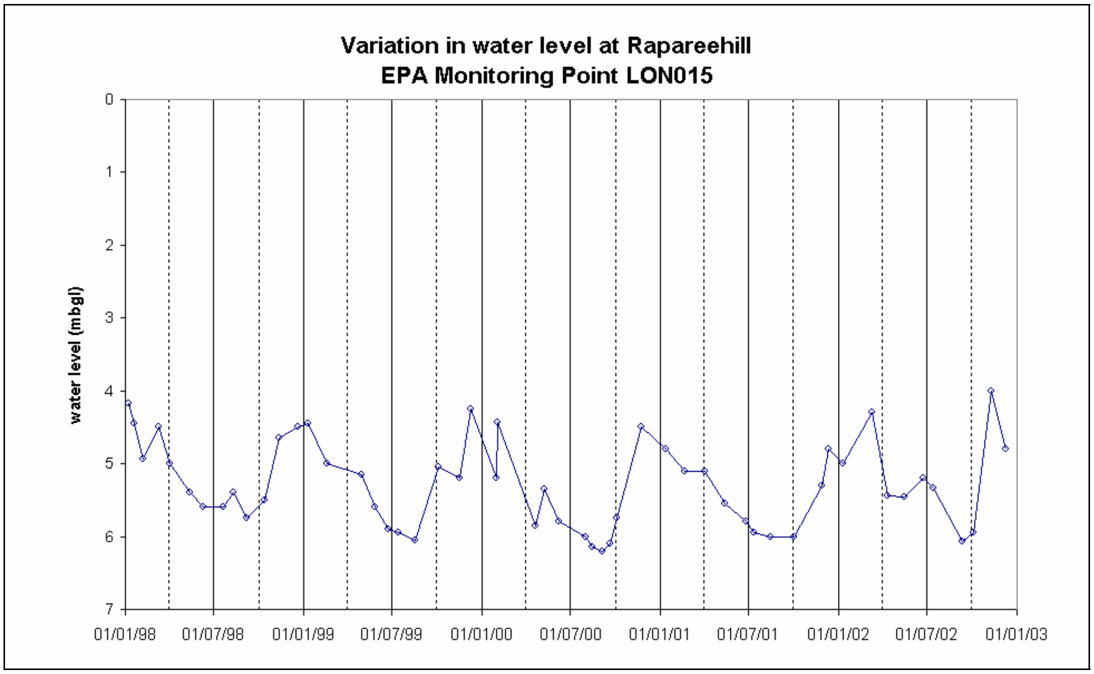
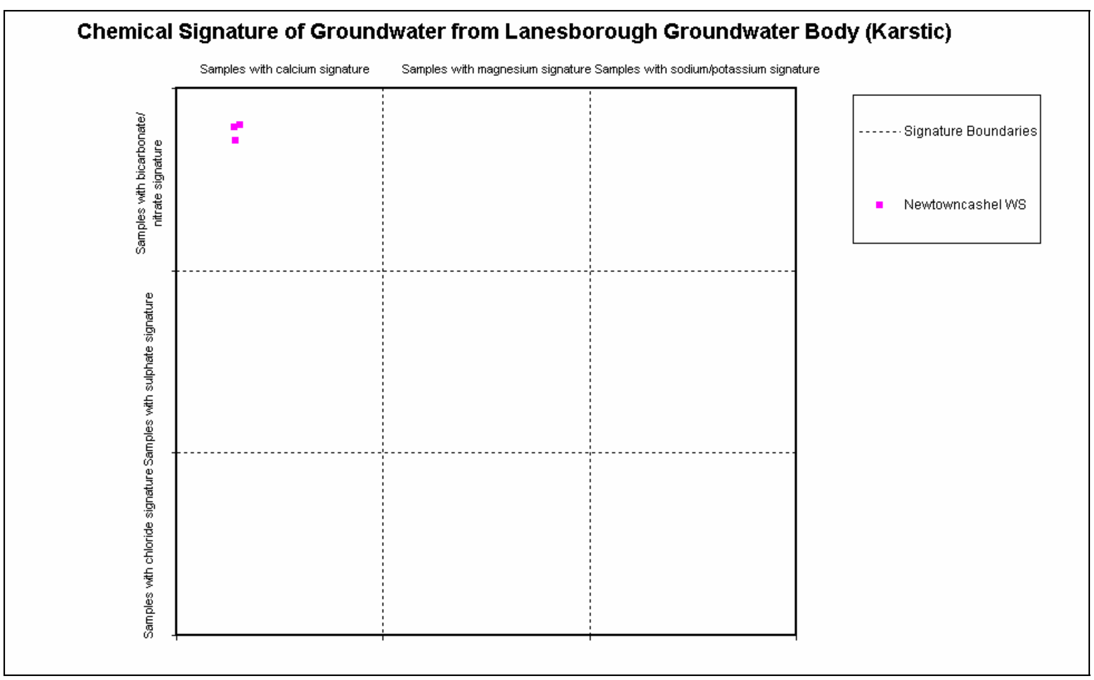
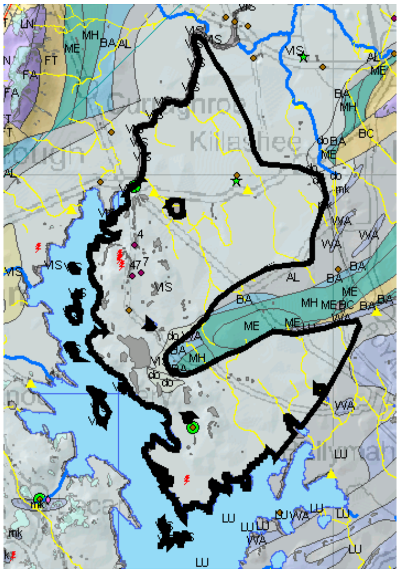


Figure 2: Hydrochemical signature
(EPA Representative Monitoring)



LANESBOROUGH GWB (For Reference)



List of Rock units in Lanesborough GWB

Rock unit name and code	Description	Rock unit group
Visean Limestones (undifferentiated) (VIS)	Undifferentiated limestone	Dinantian Pure Bedded Limestones
Dolomitised Limestone (do)		Dinantian Dolomitised Limestone