Inny Groundwater Body: Summary of Initial Characterisation.

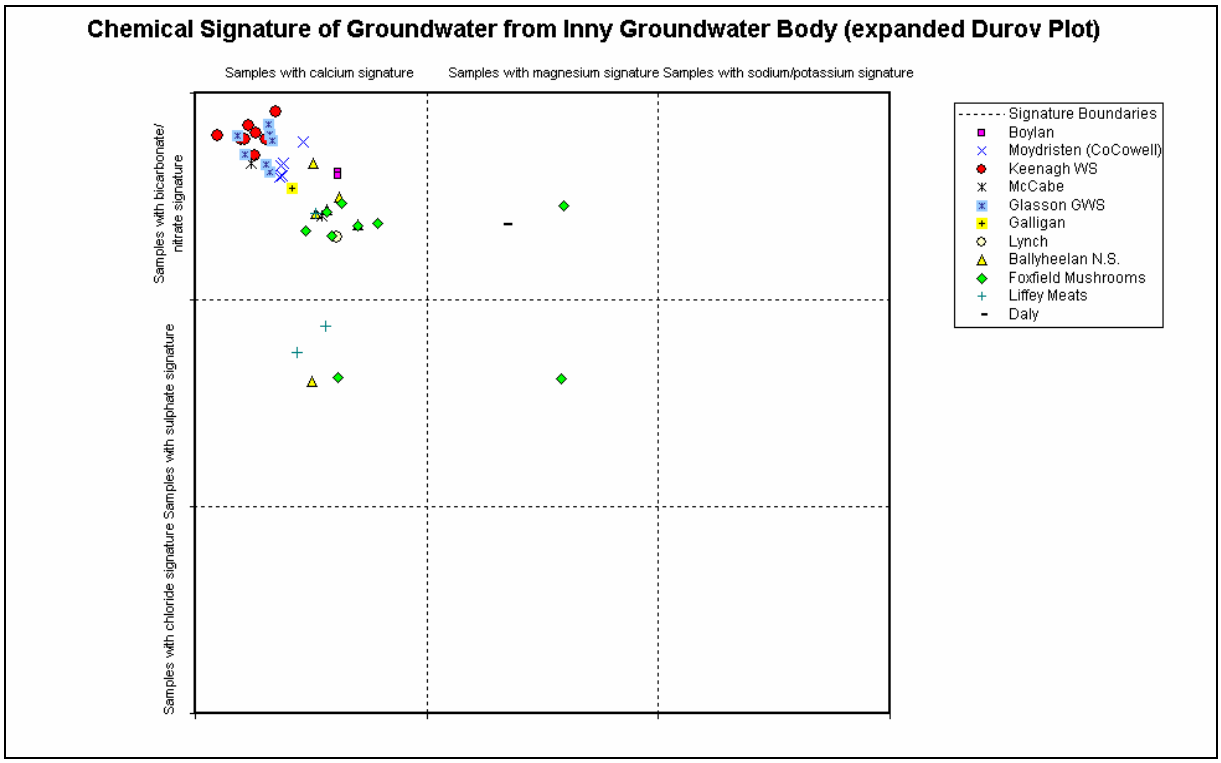
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
26 – Inny/L Ree Longford, Westmeath, Meath & Cavan Co. Co.'s.	Rivers: Inny; Tang; Rath; Irishtown; Comogue; Black; Riffay; Gaine; Yellow; Glore; Mount Nugent; Upper Inny Streams: Lemamore Loughs: Sewdy/Sunderlin; Drum; Pot; Roach; Sheever; Slevin's; Loughagar; Drin; McEvoy's; Owel; Brittas; Gar; Iron; Nagall; Poteen; Glen; Derravaragh; Ruddan; Cordaragh; Bracklagh; Kinale; Derragh; Sheelin; Nadreegeal; Cornagrow	(001713) Ballynagabry; (000674) Ballynagrenia and Ballinderry Bog; (000689) Lough Sewdy; (001687) Glen Lough; (001812) Lough Garr; (000679) Garriskil Bog; (000687) Lough Iron; (000688) Lough Owel; (000690) Lough Sheever Fen/Slevin's Lough Complex; (000694) Wooddown Bog; (000684) Lough Derravaragh; (001721) Lough Bane; (001814) Lough Naneagh; (000985) Lough Kinale and Derragh Lough; (000987) Lough Sheelin; *(002103Royal Canal)*	1384

Topography	This groundwater body comprises a large area stretching from south Cavan and the eastern boundary of the Shannon RBD to Lough Ree. The River Inny runs south southeast through the centre of this groundwater body from Lough Sheelin in the northeast to Lough Ree in the southwest. In the vicinity of the river the ground is relatively flat with ground elevations, generally 60 –70 m AOD. The lowest point is 40 mAOD at the discharge to Lough Ree. Ground elevation rises gently to just over 100 mAOD to the northwest of the river. To the east and southeast of the river the topography is more varied with ground elevations rising quickly to over 100 AOD. The land is hilly with hilltops generally 120-150 mAOD and occasionally up to 200 mAOD. Northeast of Lough Sheelin ground elevation is generally greater than 120 mAOD. There is the beginning of drumlin dominated topography in extreme northeast of the body. The highest point is 276 mAOD on Slieve na Calliagh southeast of Oldcastle in the eastern most part of the body. Numerous rivers and streams flow off the higher ground in the northwest and southeast to the River Inny in the centre of the body. In addition to Lough Sheelin, other large lakes in the body include Lough Derravaragh and Lough Owel with numerous small lakes also occurring.	
Geology and Aquifers	Aquifer categories	The main aquifer categories are: **Ll:** Locally important aquifer which is moderately productive only in local zones; **Pl:** Poor aquifer which is generally unproductive except for local zones. In the north east of the body a small area (10 km^2) of Dinantian Pure Bedded Limestone (Stackallan Member MEst), and small isolated areas of Dinantian Sandstones (Fearnaght Sandstone & Basal Clastics) are classified as: **Lm:** Locally important aquifer which is generally moderately productive In the south west of the body, on the southern shore of Lough Ree a very small area (1.8 km^2) of Dinantian Pure Bedded Limestone (Visean Limestones (undifferentiated)) is classified as: **Rkc:** Regionally important karstified aquifer dominated by conduit flow
	Main aquifer lithologies	The main aquifer lithologies are Dinantian Upper Impure Limestones, Dinantian Lower Impure Limestones, Dinantian Pure Unbedded Limestones, Dinantian (early) Sandstones, Shales and Limestones and in the extreme north of the body an area of Silurian Metasediments and Volcanics. Much smaller areas within these main aquifer lithologies are composed of Ordovician Metasediments (very small area in north), Basalts and other Volcanic rocks (one tiny area in south), Devonian Old Red Sandstones (small area in south – Moate Inlier), Dinantian Pure Bedded Limestones (small area in northeast Stackallen Member), Dinantian Sandstones (small disjointed areas of Fearnaght Fmn & Basal Clastics). These areas are limited in extent and isolated within the main aquifer lithologies.
	Key structures	The main structural features in this body have a northeast and east-northeast trend. There are a number of major northeast-southwest trending faults (e.g. Ballinalack Fault, Moate Inlier Boundary Fault) with northwest trending cross faults. Some of these faults have been a focus for Zn-Pb mineralisation in the Waulsortian Limestone (Dinantian Pure Unbedded Limestone). Depending on the extent of mineralisation this could act to limit groundwater flow in the faults. The Abbeyshrule Anticline, whose trace is marked by the Ballinalack fault, is found in the south-western half of the body. It trends northeast southwest and exposes Dinantan (early) Sandstones, Shales and Limestones and Dinantian Lower Impure Limestones in it core. In the south of the body vertical displacement at the Moate Inlier Boundary Fault has formed the Moate Inlier which has Devonian Old Red Sandstone in its core. The Ordovician Metasediments in the extreme north of the body are cut by numerous northeast southwest trending faults and northwest trending cross faults.
	Key properties	No data on hydrogeological properties specific to this groundwater body are available. In general transmissivities in the Silurian rocks in this groundwater body will be low. Transmissivities in the ORS rocks tend to be somewhat higher than those in the Silurian Rocks, especially towards the top of the ORS succession. Within the Dinantian Lower Impure Limestones, transmissivities are likely to be in the range 2-20 m^2/d, with most values at the lower end of the range. Dinantian (early) Sandstones, Shales and Limestones aquifer properties are expected to be in a similarly low range. Pumping tests in the Dinantian Pure Unbedded Limestones (Waulsortian Limestones), outside this groundwater body, in Tulla, Co. Clare and Shinrone, Co. Offaly indicated transmissivities of 13 m^2/d and 27 m^2/d respectively. These values are probably at the middle to higher end of the range for the Dinantian Pure Unbedded Limestones. Within all these rock types, storativities are low. Higher tranmissivity values would be expected in the areas of Dinantian Pure Bedded Limestones that occur within this groundwater body. *(data sources: Rock Unit Group Aquifer Chapters, GWPS Reports,source reports, see references)*

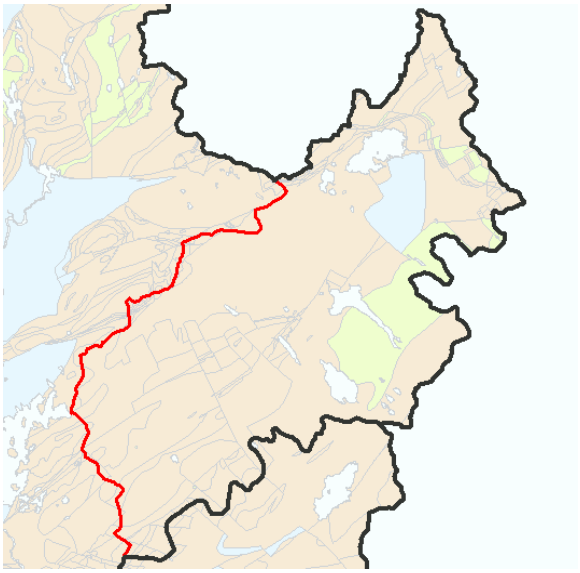
	Thickness	This groundwater body is composed primarily of Dinantian Upper Impure Limestones, Dinantian Pure Unbedded Limestones, Dinantian Lower Impure Limestones and Dinantian (early) Sandstones, Shales and Limestones. In general these rocks extend to over 100m in depth, however individual units within the Dinantian (early) Sandstones, Shales and Limestones group can be quite thin in some areas. In such low permeability rocks the effective thickness of the aquifer is likely to be within 15 m of the top of the rock, comprising a weathered zone of a few metres and a zone of interconnected fissures below this of about 10 m thick. Deeper flow can occur in areas that have undergone a high degree of structural deformation and faulting, where the resulting fissures have remained open. The small areas of pure bedded limestone within this groundwater body, in the southwest of the body adjoining Lough Ree and in the northeast of the body (Stackallan Member (MEst)), have the potential to develop fissure permeability to a greater depth given the pure nature of the limestone and its consequent susceptibility to karstification. In the extreme north of the body the Silurian Metasediments and Volcanics are characterised by low fissure permeability where fractures are in filled with fine-grained material from shaly layers. The effective thickness of the aquifer will be within 15 m of the top of the rock. Productive zones, where they occur, are likely to be concentrated near the surface and in the vicinity of fault zones.
Overlying Strata	Lithologies	*[More information to be added at a later date]*
	Thickness	Small isolated areas of bedrock outcrop scattered throughout the body often coinciding with areas of higher ground particularly in the north of the body. Available depth to bedrock data ranges from 0 to 20 m.
	% area aquifer near surface	*[Information to be added at a later date]*
	Vulnerability	No detailed groundwater vulnerability mapping available for Longford, Westmeath or Cavan. Meath. Areas of extreme vulnerability occur in the vicinity of bedrock outcrop. *{Information to be added at a later date]*
Recharge	Main recharge mechanisms	Diffuse recharge will occur over the entire groundwater body via rainfall soaking through the subsoil. More recharge will occur where overlying strata are thinner.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	Springs and large known abstractions (m^3/d)	No major supplies listed – EPA Groundwater Sources list has a lot of small supplies. WS & GWS & larger supplies listed below. Lough Owel is used as a source of water for the town of Mullingar. The lake is fed by groundwater. CAV63 Blaney Meats, Cloggagh (Bore – 455 m^3/d); CAV34 Liffey Meats (No data); CAV45 Moydristan (Co Co well) (No data); MEA75 Oldcastle Creamery, Fair Green (Bore-91 m^3/d); LON12 Keenagh W.S. Glenmore (Spring - 550 m^3/d); WES3 Baskin GWS (Well - 10 m^3/d); WES 8 Lissanode GWS, Cloghbreen (Well 7 m^3/d); LON8 Forgney GWS, Forgney (Bore 9 m^3/d); WES15, Taughman GWS, Cullion (Well 1368 m^3/d) – EPA Groundwater Sources list. Doon WSS (218-545m^3/d) – GSI Well Database.
	Main discharge mechanisms	The main discharges will be local, to the River Inny and its tributaries crossing the groundwater body, and to Lough Ree in the southwest. Discharges to the Ballymanus GWB and to the Derravaragh GWB which are enclosed by this groundwater body will be minimal.
	Hydrochemical Signature	No relevant hydrochemical data are available in this GWB for assessment. On the basis of data from other areas it can be assumed that groundwater from this groundwater body have a calcium-bicarbonate signature. Hardness, alkalinity and electrical conductivities vary between the different rock unit group aquifers, however. Reviewing data for similar rock types in the Slievegelim GWB, groundwaters from the Silurian strata are found to range from slightly hard to hard (90–360 mg/l $CaCO_3$). In association, alkalinities range from 60 to 270 mg/l (as $CaCO_3$) and electrical conductivities from 260–600 µS/cm. pHs are neutral, with lab. pHs in the range 7.12–7.33. The majority of samples are at the upper end of the range. At springs, or other systems where throughput is rapid, groundwaters have limited dissolved solids. In the Dinantian (early) Sandstones, Limestones and Shales and the Lower Impure Limestones, groundwaters are Hard to Very Hard (typically ranging between 380–450 mg/l), and high electrical conductivities (650–800 µS/cm) are often observed. Alkalinity is also high, but less than hardness (250-370 mg/l as $CaCO_3$). Within the Impure Limestones, iron and manganese concentrations frequently fluctuate between zero and more than the EU Drinking Water Directive maximum admissible concentrations (MACs). Hydrogen sulphide can often reach unacceptable levels. These components come from the muddy parts of these rock units and reflect both the characteristics of the rock-forming materials and the relatively slow speed of groundwater movement through the fractures in the rock allowing low dissolved oxygen conditions to develop. The bedrock strata of the Silurian aquifers are **siliceous**. The pure and impure limestones and the mixed sandstone, limestone and shale sequences are **calcareous**.
Groundwater Flow Paths		Groundwater flow in this groundwater body will be of a local nature. Groundwater flow will be concentrated in fractured and weathered zones and in the vicinity of fault zones (these rocks do not exhibit intergranular permeability). Groundwater flow paths will be short, in general between 30 and 300 m, with groundwater discharging locally to rivers and streams. Most groundwater flow is likely to circulate in the upper tens of metres of bedrock, recharging and discharging in local zones. The low permeability rocks of this groundwater body will will not accept flow from the enclosed karstic Ballymanus GWB and the Derravarragh GWB's.

Groundwater & Surface water interactions	Lough Owel, the most southerly of the large lakes in the body, has no surface water inlet and is fed by groundwater. There is some uncertainty as to the source of the water in Lough Owel and further research is required in this area. The lake is underlain primarily by the Lucan Formation (Inny GWB) and partially by the Derryvarragh Cherts which are part of the adjoining Derryvarragh GWB. Both units are Dinantian Lower Impure Limestones. There is a variation in permeability between these two units. The Derryvarragh Cherts are considered more permeable than the Lucan Formation and are thought to be the source of most of the water in the lake. The Lucan Formation of the Inny Groundwater body is also likely to supply some water to the lake, but given its low permeability it seems unlikely that the unit could supply large amounts of water to the lake. Lough Owel is a source of drinking water to the town of Mullingar. The lake was seriously contaminated by "Cryptosporidium" in 2003. This incident underlies the critical importance of understanding the hydrogeology of the area and indentifying the source of the water in the lake. Groundwater and surface water interactions require special attention where terrestrial ecosystems are dependant on a sustainable balance between the two. A number of fens, bogs and lakes are recorded in this groundwater body which may have varying dependence on groundwater. Water from the rivers flowing onto the adjacent GWB's (Ballymanus & Derravarragh) will recharge the karstic aquifer.
Conceptual model	• The groundwater body is bounded on all sides by topographic highs and groundwater divides which coindie with surface water catchment boundaries. Two small groundwater bodies occur within the Inny Groundwater Body, the Ballymanus GWB the Derravarragh GWB. • The River Inny flows through the centre of the body. The terrain is flat and low-lying in the vicinity of the river, gently rising in the northwest, and hilly in the southeast, east and north of the body. • This groundwater body is composed primarily of low permeability rocks, although localised zones of enhanced peremeability occur along faults and in the vicinity of fault zones. In general the Silurian Metasediments in the extreme north of the body have a lower permeability than the Dinantian Limestones in the rest of the body. Groundwater flows along fractures joints and major faults. • Recharge occurs diffusely through the subsoils and via outcrops. It occurs especially in upland areas where the subsoil is thinner and rainfall higher. • Groundwater is generally unconfined within this GWB. Most flow in this aquifer will occur in a zone near the surface of the rock, particularly in the poor (Pl) aquifer. In general the effective thickness of this aquifer is likely to be about 15m, comprising a weathered zone of a few metres and a connected fracture zone below this. However, deep-water strikes in more isolated faults/fractures can be encountered, though this is less likely in the poor (Pl) aquifer. Groundwater flow in this groundwater body will be of a local nature. Groundwater flow paths will be short in the order of between 30 and 300 m. • Groundwater discharges to the numerous streams and rivers crossing the aquifer. Overall, the flow direction is towards the main channel of the Inny in the centre of the body and towards Lough Ree in the southwest. • Lough Owel, source of drinking water for the town of Mullingar, is a groundwater fed lake that lies partially in this groundwater body. While the source of most water in the lake is currently thought to be the Derryvarragh Cherts of the Derryvarragh GWB, some water is also likely to originate in the Lucan Formation of the Inny GWB. The vulnerability of this water source to contamination was illustrated in 2003 when the lake was contaminated with "Cryptosporidium".
Attachments	Hydrochemical signature (Figure 1).
Instrumentation	Stream Gauges: (26149) Stream, Kildorrogh; (26052) L. Sheelin Trib, Carrick; (26026/26059) Inny, Finnea/Finnea Br.; & numerous other gauges without dry weather flow data. EPA Water Level Monitoring boreholes: None EPA Representative Monitoring boreholes: LON12 Keenagh W.S.; CAV26 Foxfield Mushrooms; CAV45 Moydristen (CoCowell); CAV27 Galligan; CAV10 Ballyheelan N.S.; CAV36 Lynch; CAV29 Gordon; CAV38 McCabe; CAV 55 Walsh; CAV14 Boylan; CAV19 Daly; CAV34 Liffey Meats; WE5 Glasson GWS.
Information Sources	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). McConnell, B., Philcox, M. and Geraghty, M., 2001. *Geology of Meath: A geological description to accompany the bedrock geology 1:100,000 scale map series, Sheet 13, Meath*. With contributions from J. Morris, W. Cox, G. Wright, and R. Meehan. Geological Survey of Ireland. 77 p. Gately, S., Sommervill, I., Morris, J.H., Sleeman, A.G. and Emo, G. (2003) *Geology of Galway-Offaly. A Geological description of Galway-Offaly, and adjacent parts of Westmeath, Tipperary, Laois, Clare and Roscommon to accompany the bedrock geology 1:100,000 scale map series, Sheet 15.* With contributions from W. Cox (Minerals), T.Hunter-Williams (Groundwater) and R. van den Berg and E. Sweeney (Carboniferous Volcanics), edited by A.G. Sleeman. O'Callaghan Moran & Associates – Report on the Contamination of Lough Owel, Co Westmeath. Aquifer Chapters: Dinantian Upper Impure Limestones; Dinantian Lower Impure Limestones; Dinantian Pure Unbedded Limestones; Dinantian (early) Sandstones, Shales and Limestones; Silurian Metasediments and Volcanics.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Figure 1: Hydrochemical signature



GROUNDWATER BODY (For Reference)



List of Rock units in Inny Groundwater Body

Rock unit name and code	Description	Rock unit group
Lucan Formation (LU)	Dark Limestone & shale (calp)	Dinantian Upper Impure Limestones
Argillaceous Limestone (AL)	Dark limestone & shale, chert	Dinantian Upper Impure Limestones
Derryvarragh Cherts	Very cherty limestone	Dinantian Upper Impure Limestones
Visean Limestones (Undifferentiated) (VIS)	Undifferentiated Limestone	Dinantian Pure Bedded Limestones
Waulsortian Limestone (WA)	Massive unbedded lime mudstone	Dinantian Pure Unbedded Limestones
Mudbank Limestones (mk)	Massive grey micritic limestone	Dinantian Pure Unbedded Limestones
Ballysteen Formation (BA) *(ABL)*	Dark muddy limestone, shale	Dinantian Lower Impure Limestone
Moathill Formation (MH) *(Shaly Pales)*	Limestone, calcareous sandstone, shale	Dinantian (early) Sandstones, Shales and Limestones
Meath Formation (ME) *(Pale Beds)*	Limestone, calcareous sandstone	Dinantian (early) Sandstones, Shales and Limestones
Stackallan Member (MEst)	Micrite & mudstone (Navan micrite)	Dinantian Pure Bedded Limestones
Navan Beds (NAV)	Dark limestone, mudstone, sandstone	Dinantian (early) Sandstones, Shales and Limestones
Basal Clastics (BC)	Sandstone, siltstone, conglomerate	Dinantian Sandstones
Fearnaght Formation	Pale conglomerate and red sandstone	Dinantian Sandstones
Old Red Sandstone (undifferentiated) (ORS)	Red conglomerate, sandstone & mudstone	Devonian Old Red Sandstone
Castlerahan Formation (RA)	Dark quartz greywacke, microconglomerate	Silurian Metasediments and volcanics
Clontail Formation (CL)	Calcareous red-mica greywacke	Silurian Metasediments and volcanics
Kilnaleck Shale Formation (KK)	Dark grey laminated shale and mudrock	Silurian Metasediments and volcanics
Cootehill Member (LAcl)	Thin turbidite & tubititic pellite	Silurian Metasediments and volcanics
Lough Avaghon Formation (LA)	Massive sandstone & conglomerate	Silurian Metasediments and volcanics
Oghill Formation (OL)	Massive sandstone & conglomerate	Silurian Metasediments and volcanics
Slieve Glah Formation (SG)	Siltstone, mudstone & thin turbidite	Silurian Metasediments and volcanics
Carrickatee Formation (CK)	Black shale, maffic volcanics & tuff	Ordovician Metasediments
Kehernaghkilly Formation (KY)	Black shale & minor rhyolitic tuff	Ordovician Metasediments
Agglomerate (Ag)	Volcaniclastic agglomerate	Basalts and other volcanic rocks