Louth GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
Hydrometric Area 06 Louth Co. Co. Monaghan Co. Co. Meath Co. Co. NI	***Rivers:*** Blackwater, Castletown, Clarebane, County Water, Cully, Fane, Flurry, Garra, Kilcurry, Killary Water, Kilmainham, Longfield, Dee, Glyde, Lagan, Ryland, White, Ballykelly, Ballymascanlan, Big, Proules, Raskeagh, Termonfeckin. ***Lakes:*** Altiduff, Alina, Ballingarry, Black, Bileady, Blaney Castle Lake, Cappagh, Carrickaslane, Carrigan's, Coogan's, Cashel Upper, Clare, Coolcair, Corliss, Corrinsigo, Cornamucklagh, Corrawaddy, Cortial, Drumaavarn, Drumacon, Drumboy, Drumcah, Drumcrew, Drumganny, Drumgeeny, Drumgristan, Drumilland, Drummacavoy, D'umgrististin, Ervey, Ghost, Iassan, Killarus, Killycracken, Killygola, Kilmurry, Lackagh, Laragh, Letterbane, Limagunshin, Lismagunshin, Mhucnu, Nagarnaman, Nahinch, Moybane, Muff, Muckro, Mullaghbane, Mullaghduff, Philip's, Ross, Shilties, Smiley, St Peters, Tapagh, Toprass, Tullynahttina.	Dundalk Bay, Boyne Coast and Estuary and Carlingford Shore (O'Riain, 2004).	1621

Topography	Comprising a large proportion of Hydrometric Area 06, the northern, western and south-eastern boundaries of this GWB are topographic divides (Rivers Dee, Glyde, Fane, Castletown and Flurry). The east is bounded by coastline and the southwest is bound by more productive aquifers. Elevations generally increase moving inland, ranging from sea level in the flatter coastal areas, to c.600 mAOD along the more mountainous north/northeast boundaries. Drumlins are a topographic feature of the western portion of the GWB. The large number of lakes are the predominant surface water features and the general surface water flow direction is to the eastwards towards the coasts.	
Geology and Aquifers	**Aquifer categories**	The majority of the GWB comprises **Pl:** Poor aquifer which is generally unproductive except for local zones (just under 90%). There are two significant SW-NE trending bands of **Pu:** Poor aquifer which is generally unproductive. A small isolated area in the southeast is categorised as **Rk^d:** Regionally important karstified aquifer dominated by diffuse flow, and there are two small zones of **Lm:** Locally important aquifer which is moderately productive (<1% in total). There are also a few thin bands of **Ll:** Locally important aquifer which is moderately productive only in local zones.
	Main aquifer lithologies	The main rock group in this GWB is the Silurian Metasediments and Volcanics (82.56%) although Granites & Other Igneous Intrusive Rocks dominate the northeast portion (12.34%). Smaller areas of other rocks (c.1% each) are also recorded in the GWB (Dinantian Limestones, Sandstones and Shales; Ordovician Metasediments, Namurian Shales) with other minor areas (<1%) of Permo-Triassic Mudstones and Gypsum, Basalts and other Volcanic rocks, Ordovician Volcanics, and Westphalian Shales. The rocks are detailed in Table 1.
	Key structures	Deformation in this part of the county has resulted in rocks dipping steeply (up to 80°) in a predominantly SE direction, and a large number of faults with associated perpendicular faults: SW-NE trending in the south of the GWB (e.g. Tinure Fault); variable directions in the Dinantian rocks; N-S in the Granites.
	Key properties	Yields from 36 wells in this GWB range from 13-2688 m^3/d. Just under half of these wells have <200 m^3/d, and 9 of the 11 wells with yields >250 m^3/d are located near fault zones along the boundaries of more productive GWBs (e.g. Carrickmacross, Kingscourt and Dundalk). The 8 available specific capacity values range from 0.9-470 $m^3/d/m$, although the highest 5 values (15.6-470 $m^3/d/m$) are associated with the boreholes adjacent more productive GWBs. No local transmissivity data area available for the Silurian rocks and Granites although national data generally reflect low (<20 m^2/d) to moderate (20-80 m^2/d) transmissivity values. The higher values may be achieved in faulted zones (e.g. south of the GWB), and/or in the coarser-grained rocks. Specific dry weather flows from 6 stations in the Silurian rocks and 1 station in the Granites are low: 0.01-0.69 $l/s/km^2$. These values suggest that this aquifer does not make a significant baseflow contribution to streamflow. Storativity is also expected to be low. Of the c.270 wells, two-thirds have groundwater levels 0-10 m below ground level (c.50% <5 mbgl). Groundwater levels deeper than 30 m bgl are recorded in 13 wells (up to 115 mbgl) although these are mainly along the boundaries of more productive GWBs (e.g. Carrickmacross, Kingscourt and Dundalk). Due to the low permeability of the rocks, groundwater gradients are expected to be relatively steep. *(Ordovician Aquifer Chapter; Silurian Aquifer Chapter; Granites Aquifer Chapter*)

	Thickness	Most groundwater flux is likely to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3 m thick, a zone of interconnected fissuring 10-15 m thick (mainly <10 m), and a zone of isolated poorly connected fissuring typically less than 150 m. Deeper water strikes are noted between 30-91 m bgl in 7 borehole although 6 of these appear to be in highly faulted areas.
Overlying Strata	**Lithologies**	Subsoil data are only available for c.70% of the GWB (RoI). Of this area, till is the predominant subsoil (c.72%), with small proportions of other subsoil types, such as peat (5%) and alluvium (5%). Approximately 11% of the mapped area (8% of the total GWB) is recorded as rock outcrop/shallow subsoil.
	Thickness	The available outcrop and borehole data indicate that the higher areas to the northwest, northeast and along the southern boundary have thin subsoil cover (<3 m). Lower-lying valley areas and drumlins appear to have thicker subsoil.
	% area aquifer near surface	*[Information will be added at a later date]*
	Vulnerability	From the Monaghan and Meath GWPSs, the vulnerability is predominantly Extreme in the northwest and very south of the GWB, and mainly High in the southwest. The drumlins in the northwest are categorised as Moderate, due to their thickness. No data are available for Louth or NI.
Recharge	**Main recharge mechanisms**	Diffuse recharge occurs via rainfall percolating through the subsoil and rock outcrops. Due to the low permeability of some subsoil deposits (e.g. thicker till) and the aquifers, a high proportion of the effective rainfall will quickly discharge to the streams in the GWB. In addition, steeper slopes in the mountainous and drumlin areas and promote surface runoff. The relatively high stream density reflecting the higher proportion of surface runoff as opposed to aquifer recharge.
	Est. recharge rates	*[Information will be added at a later date]*
Discharge	**Large springs and high yielding wells (m^3/d)**	Sources: None identified. Excellent Wells: Kingscourt WWS (2688 m^3/d, 1824 m^3/d, 1027 m^3/d, 800 m^3/d, 500 m^3/d), Louth Co.Co. (1091 m^3/d, 1090 m^3/d), Meath Co.Co. (610m^3/d), Drumgoosat (605 m^3/d), Channonrock (518 m^3/d). Good Wells: Dundalk (390 m^3/d, 218m^3/d*2), Glenmore (218 m^3/d), Almondstown (216 m^3/d), Togher (207 m^3/d), Fairhill (153 m^3/d), Mullagharlin (160 m^3/d), Marshes Upper (190 m^3/d), Collops (130 m^3/d), Philipstown (130 m^3/d), Analog (109 m^3/d), Avalbane (109 m^3/d), Ballymakellett (109 m^3/d*2), Brachagh (109 m^3/d), Collon (109 m^3/d), Hitchestown (109 m^3/d), Port (109 m^3/d*2), Shanmullagh (109 m^3/d). Springs: None identified.
	Main discharge mechanisms	The main groundwater discharges are to the rivers and streams crossing the GWB, which reflect short groundwater flow paths. Small springs and seeps are likely to issue at the stream heads and along their course. Seepages will also develop on the coastal cliff faces. A proportion of groundwater may also discharge to adjacent GWBs that comprise more permeable aquifers (e.g. Carrickmacross).
	Hydrochemical Signature	***National classification:*** Ordovician/Silurian Metasediments Non-calcareous. $CaMgHCO_3$ signature. However, Cavan and Monaghan also have $CaMgSO_4$ record a signature. Alkalinity (mg/l as $CaCO_3$): range of 9-470; mean of 172 (445 'non limestone subsoils' data points) Total Hardness (mg/l): range of 5-481; mean of 222 (389 'non limestone subsoils' data points) Conductivity (μS/cm): range of 80-477; mean of 490 (477 'non limestone subsoils' data points) ***National classification:*** Granites & Other Igneous Intrusive Rocks Non-calcareous rocks. Alkalinity (mg/l as $CaCO_3$): range of 43-298; mean of 179 (22 'non limestone subsoils' data points) Total Hardness (mg/l): range of 103-304; mean of 183 (10 'non limestone subsoils' data points) Conductivity (μS/cm): range of 317-1017; mean of 495 (24 'non limestone subsoils' data points) As minerals present in granite are generally acidic, corrosion and leaching of metals such as iron and manganese may present a problem. Radon and Uranium are also associated with granitic bodies. *(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)*
Groundwater Flow Paths		In the absence of inter-granular permeability, groundwater flow is expected to be concentrated in upper fractured and weathered zones and in the vicinity of fault zones. Available groundwater levels are mainly 0-10 m below ground level (c.50% <5 mbgl). Flow paths are likely to be short (30-300 m) with groundwater discharging rapidly to nearby streams and small springs. Water strikes deeper than the estimated interconnected fissure zone suggest a component of deep groundwater flow, however shallow groundwater flow is dominant. Groundwater flow directions are expected to follow topography – overall in a easterly direction.
Groundwater & Surface water interactions		Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is relatively low.

Conceptual model	• Western, northern and south-eastern boundaries are topographic divides. The southwest boundary of the GWB is marked by more productive aquifers and the eastern boundary comprises coastline. Drumlins are noted in the west of the GWB. • The GWB is composed primarily of low transmissivity rocks. Most of the groundwater flux is likely to be in the uppermost part of the aquifer comprising: a broken and weathered zone typically less than 3m thick; a zone of interconnected fissuring typically less than 10m; and a zone of isolated fissuring typically less than 150m. • Recharge occurs diffusely through the subsoil and rock outcrops, although can be limited by thicker till, and the low permeability bedrock. Therefore, most of the effective rainfall is not expected to recharge the aquifers. • Flow paths are likely to be short (30-300 m) with groundwater discharging rapidly to the streams crossing the aquifer, and to small springs and seeps. Overall, the flow direction is expected to be to the east, as determined by the topography.
Attachments	Figure 1. Figure 2. Table 1.
Instrumentation	**Stream gauges:** 06011*, 06012, 06013, 06014*, 06016, 06021, 06023*, 06026*, 06027, 06029, 06030*, 06031*, 06032, 06033*, 06034, 06035, 06036, 06037, 06039, 06040, 06041, 06044, 06045, 06046, 06047, 06048, 06049, 06050, 06051, 06052, 06053, 06055, 06070, 06071, 06072 . * Adjusted dry water flow data available. **EPA Water Level Monitoring boreholes:** LOU009, LOU099, MEA143, MEA146 **EPA Representative Monitoring points:** CAV 18, CAV90, LOU2, LOU9, LOU11, LOU 18, LOU24, LOU25, LOU26, LOU28, LOU29, LOU30, LOU31, LOU32, LOU33, LOU35, LOU36, LOU38, LOU39, LOU41, LOU42, LOU44, LOU45, LOU47, LOU48, LOU50, LOU51, LOU52, LOU53, LOU55, LOU74, MEA9, MON 16, MON104, MEA143, MEA114.
Information Sources	Geraghty, M., Farrelly, I., Claringbold, K., Jordan, C., Meehan, R., and Hudson, M., 1997. *Geology of Monaghan-Carlingford. A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 8/9, Monaghan-Carlingford*. Geraghty, M. (ed.). Geological Survey of Ireland. 60 p. 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. O' Riain, 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects. Swartz, M and Daly, D. (2002) *County Monaghan Groundwater Protection Scheme Report*. Main Report. Final Report to Monaghan County Council. Geological Survey of Ireland Woods, L., Meehan, R. and Wright, G. R., 1998. *County Meath Groundwater Protection Scheme*. Main report. Final report to Meath County Council. Geological Survey of Ireland. 54 p.
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. Location and Boundaries of GWB.

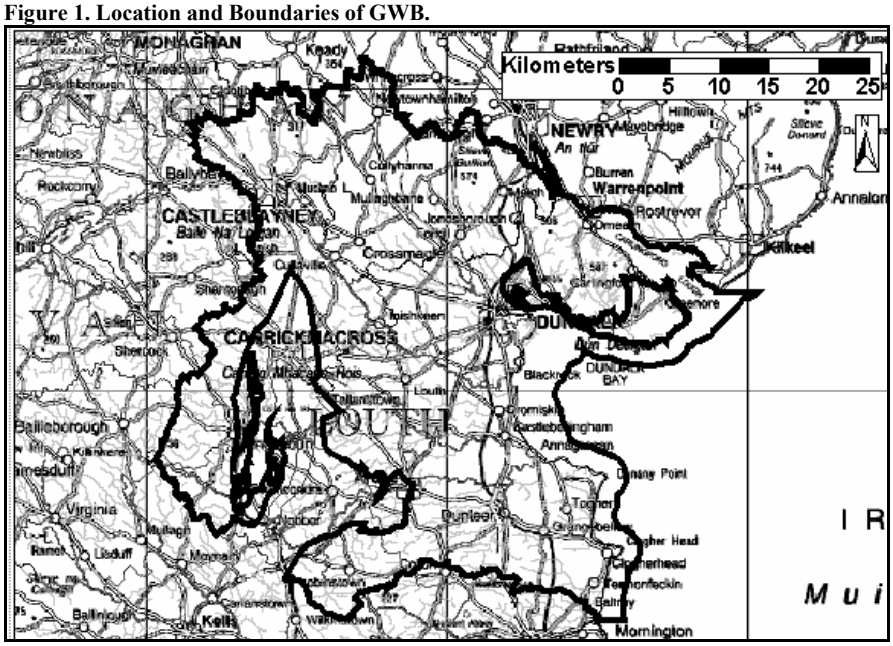

Table 1. List of Rock units in Louth GWB

Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Clontail Formation	CL	Calcareous red-mica greywacke	Silurian Metasediments and Volcanics	Pl	31.72%
Central Belt (undifferentiated)	CBT	Undifferentiated turbidite & mudstone	Silurian Metasediments and Volcanics	Pl	13.69%
Salterstown Formation	bsSA	Calcareous greywacke & banded mudstone	Silurian Metasediments and Volcanics	Pu	7.45%
Castlerahan Formation	RA	Dark quartz greywacke, microconglomerate	Silurian Metasediments and Volcanics	Pl	5.59%
Lough Avaghon Formation	LA	Massive sandstone & microconglomerate	Silurian Metasediments and Volcanics	Pl	5.01%
Granophyre	Gr	Microgranite with granophyric texture	Granites & other Igneous Intrusive rocks	Pl	4.88%
Newry Granite	Ng	Granodiorite	Granites & other Igneous Intrusive rocks	Pl	4.01%
Clogherhead Formation	CV	Thickly bedded calcareous greywacke	Silurian Metasediments and Volcanics	Pu	3.08%
Shercock Formation	SK	Fine to coarse grained turbidite	Silurian Metasediments and Volcanics	Pl	3.02%
Taghart Mountain Formation	TM	Turbidite, massive sandstone & siltstone	Silurian Metasediments and Volcanics	Pl	2.57%
Little Harbour Formation	LT	Calcareous greywacke & mudstone	Silurian Metasediments and Volcanics	Pl	2.33%
Magoney Bridge Formation	MB	Medium to thick turbidite & sandstone	Silurian Metasediments and Volcanics	Pl	2.04%
Glaspistol Formation	GP	Black mudstone & quartzose greywacke	Silurian Metasediments and Volcanics	Pl	1.91%
Rathkenny Formation	RK	Black mudstone, siltstone, greywacke	Silurian Metasediments and Volcanics	Pl	1.79%
Inniskeen Formation	IN	Turbidite with red mica & red shale	Silurian Metasediments and Volcanics	Pl	1.08%
Layered Gabbro	Ex	Undifferentiated, or layered gabbro 1-4	Granites & other Igneous Intrusive rocks	Pl	1.03%
Porphyritic granophyre	Pg	Porphyritic granophyre	Granites & other Igneous Intrusive rocks	Pl	0.94%
Dolerite	Do	Dolerite	Granites & other Igneous Intrusive rocks	Pl	0.93%
Ardagh Shale Formation	AD	Black shale	Namurian Shales	Pu	0.92%
Taghart Mountain Formation	TM	Greywacke, massive sandstone & siltstone	Silurian Metasediments and Volcanics	Pl	0.89%
Dinantian Limestones (undiff.)	DIN	Limestone	Dinantian Mixed Sandst., Shales and Limest.	Lm	0.89%
Kingscourt Gypsum Form.	KG	Mudstone with gypsum & anhydrite	Permo-Triassic Mudstones and Gypsum	Pl	0.56%
Kehernaghkilly Formation	KY	Black shale & minor rhyolitic tuff	Ordovician Metasediments	Pl	0.42%
Porphyritic Felsite	Pf	Porphyritic Felsite	Granites & other Igneous Intrusive rocks	Pl	0.39%
Tullyallen Formation	TA	Pale micritised grainstone-wackestone	Dinantian Pure Bedded Limestones	Rkd	0.34%
Carrickatee Formation	CK	Black shale, mafic volcanics & tuffs	Ordovician Metasediments	Pl	0.32%
Red Mans Cove Formation	RD	Red, green, black mudstone	Silurian Metasediments and Volcanics	Pl	0.26%
Laragh Formation	LH	Pyritic, graptolitic, black shale	Ordovician Metasediments	Pl	0.26%
White Island Bridge Form.	WI	Tuff, tuffaceous siltstone, mudstone	Ordovician Volcanics	Pl	0.22%
Westphalian (undiff.)	WES	Grey shale, thin siltstone & sandstone	Westphalian Shales	Pu	0.20%
Vent agglomerate	Va	Vent agglomerate	Basalts & other Volcanic rocks	Ll	0.17%
Cam Lough Breccia	Bc	Slieve Gullion outer ring crush breccia	Basalts & other Volcanic rocks	Ll	0.16%
Early Gabbro	Eg	Basic intrusive	Granites & other Igneous Intrusive rocks	Pl	0.16%
Black shale & chert	bs	Black shale & chert	Silurian Metasediments and Volcanics	Pl	0.12%
Hawaiite Lava	Ha	Basaltic lava	Basalts & other Volcanic rocks	Ll	0.11%
Collon Formation	CM	Andesite breccia/conglomerate/sandstone	Ordovician Volcanics	Pl	0.10%
Knockerk Formation	KC	Tuffaceous sandstone, shale	Ordovician Volcanics	Pl	0.08%
Cruicetown Group (undiff.)	CRT	Argillaceous bioclastic limestone	Dinantian Lower Impure Limestones	Ll	0.07%
Bryanstown Formation	BF	Crystal & lithic tuff	Ordovician Volcanics	Pl	0.06%
Navan Group (undiff.)	NAV	Limestone, mudstone and sandstone	Dinantian (early) Sandst., Shales and Limest.	Ll	0.05%
Basal Beds	BAS	Calcareous sandstone	Dinantian Sandstones	Ll	0.03%
Broomfield Formation	BO	Black shale with chert	Ordovician Metasediments	Pl	0.03%
Fieldstown Formation	FI	Olive to grey mudstone, tuff	Ordovician Metasediments	Pl	0.03%
Basalt & Trachyte Lava	Bt	Basalt & Trachyte Lava	Basalts & other Volcanic rocks	Ll	0.03%
Fingal Group (undiff.)	FNG	Dark limestone, shale and micrite	Dinantian Upper Impure Limestones	Ll	0.02%
Slieve Glah Formation	SG	Siltstone, mudstone & thin turbidite	Silurian Metasediments and Volcanics	Pl	0.01%
Brittstown Formation	BW	Coarse- to fine-grained tuff	Ordovician Volcanics	Pl	0.01%
Hill Of Slane Formation	HS	Massive lapilli tuff	Ordovician Volcanics	Pl	0.01%
Volcanics	mv	Mafic & felsic volcanic tuff	Ordovician Volcanics	Pl	0.0029%
Diorite	Di	Diorite	Granites & other Igneous Intrusive rocks	Pl	0.0025%
Vent Agglomerate	Vg	Vent agglomerate & granophyric fragments	Basalts & other Volcanic rocks	Ll	0.0017%
Milverton Group (undiff.)		Milverton Group (undifferentiated)	Dinantian Pure Bedded Limestones	Rk	0.0001%

Figure 2: Groundwater hydrographs (EPA Groundwater Level Monitoring)