Birr GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
25 – Little Brosna Tipperary & Offaly Co. Co.'s	**Rivers:** Little Brosna, Camcor, Rock, Rapemills.	(000927) Woodville Woods & peripheral lake/wetland; (000648) Killeen Bog; (000640) Arragh More Bog.	48

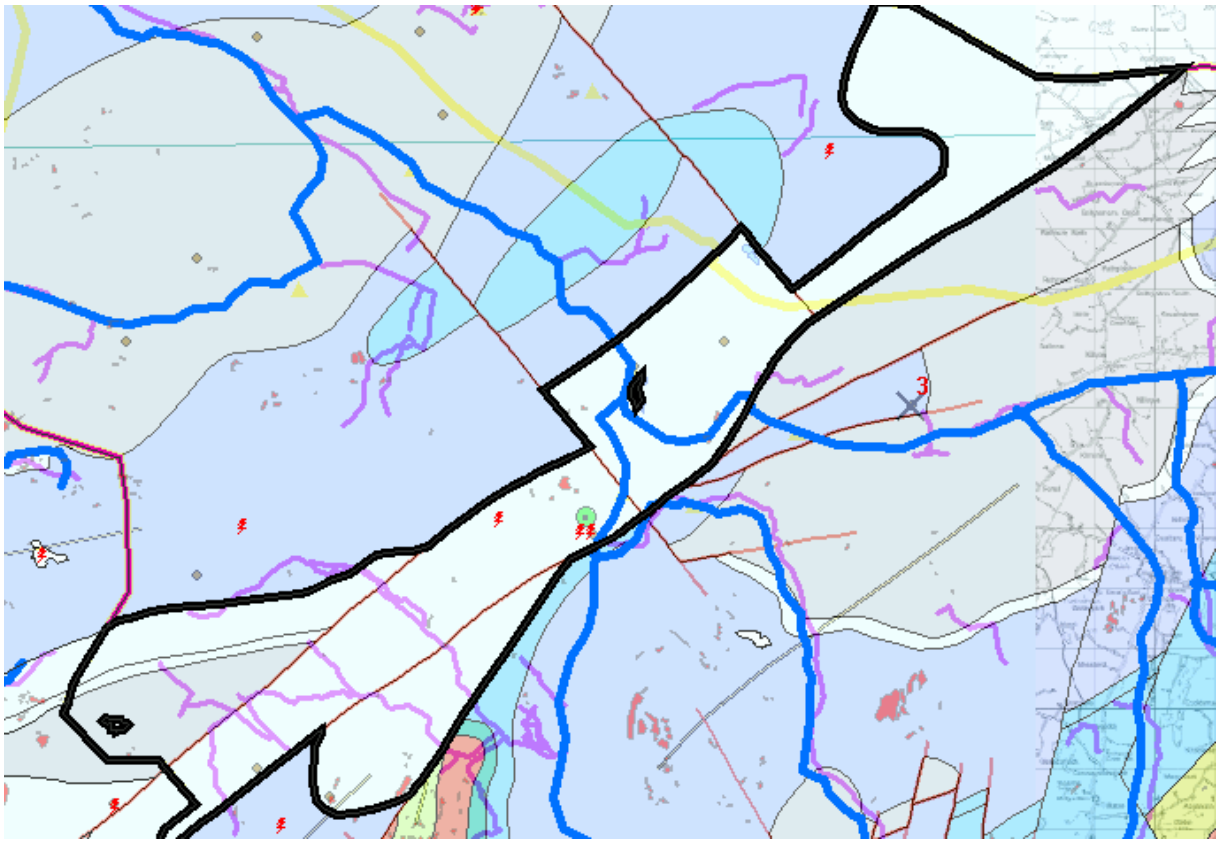
Topography	Ground elevations in this GWB range from 50-90 mAOD. The highest ground is in the south of the body. Most of the body is relatively flat and low lying with much of the area below 70 mAOD. Overall the ground slopes very gently to the northwest. Esker ridges form narrow bands of higher ground within the body. The lowest ground occurs across the centre of the body near the river channels of the Little Brosna and the Camcor Rivers.	
Geology and Aquifers	**Aquifer categories**	The main aquifer category in this GWB is: **Rkd:** Regionally important karstified aquifer dominated by diffuse flow. There is a narrow strip (0.7 km^2) in the southwest of the body with an aquifer category of: **Lm:** Locally important aquifer which is generally moderately productive. There is a small area (4 km^2) in the southwest of the body with an aquifer category of: **Ll:** Locally important aquifer which is moderately productive only in local zones. *The bedrock aquifer is overlain by potentially locally important sand & gravel aquifers* ***(Lg).***
	Main aquifer lithologies	The main aquifer lithology in this GWB is Dinantian Pure Bedded Limestone. This is made up of Visean Undifferentiated Limestone and the coarse grained Terryglass Formation, with a narrow strip (0.7 km^2) of fine-grained limestone, the Lismaline Micrite. A small area (4 km^2) in the southwest of the body is composed of Dinantian Upper Impure Limestone.
	Key structures	The major structural features (large folds and major faults) in the region in which this GWB occurs have a northeast southwest orientation. Knockshigowna Fault runs northeast to southwest to the southeast of the body, in places bringing the Dinantian Pure Bedded Limestones of this body in contact with the less permeable Dinantian Pure Unbedded Limestones and Dinantian Impure Limestones of the Shinrone GWB. This GWB is cross cut by a number of northwest to southeast trending normal faults. Dips over the body are generally to the southeast ranging from 5-20°. To the southwest of the body is the Borrisokane Syncline, a large syncline, whose axis plunges to the WSW. Deformation associated with folding will have caused fracturing, in addition to deformation caused by faulting.
	Key properties	This GWB consists primarily of high permeability Dinantian Pure Bedded Limestones similar to those occurring in the Tullamore GWB. Hydrogeological data for these rocks obtained in the Tullamore GWB are as follows: *Modelled transmissivities from work carried out at groundwater sources at Tully and Hollimshill, Co Offaly, were 140 and 650 m^2/d respectively (Kelly, 2001). Field transmissivities of 52-530 $m^2\ d^{-1}$ have been recorded at Hollimshill and 13 m^2/d at Tully. Modelled permeability was 4.5 m/d at Tully and 13 m/d at Hollimshill. Aquifer properties at Agall Spring, Co Offaly are estimated to be similar to those at Hollimshill and possibly higher as it is a spring with a high discharge. Permeability at Agall Spring has been estimated to be about 20 m/d with porosity taken to be about 0.02 (Kelly, C. 2001). Analysis of data from a 10 hr pumping test of groundwater supply boreholes at Kilcormac gave transmissivity estimates of 20-40 $m^2\ d^{-1}$. The groundwater gradient is relatively flat within the permeable limestone aquifer. The natural hydraulic gradient is estimated to be approximately 0.002 (Kelly, 2001 – Tully WS).* High permeability zones caused by fissuring in the vicinity of faults may be present across the area of this GWB and may cause local changes to the hydraulic gradient. Pure Bedded Limestones, such as those found in this GWB can be susceptible to karstification, which enhances the permeability of the rocks although few karst features are currently recorded for this GWB. Storativity in such aquifers will be low. The limited occurrence of Lismaline Micrite, a pure bedded limestone that occurs in a small area in the southwest of the body, is expected to have a lower transmissivity the rest of the Dinantian Pure Bedded Limestones in this body. The Dinantian Upper Impure Limestone that occurs in a small area in the southwest of the body is expected to have a lower transmissivity than the Pure Bedded Limestones. Yields and productivities of boreholes drilled in the Upper Impure Limestones are often low. Transmissivity is generally in the range 2-20 m^2/d. However, permeabilities in the vicinities of Aglish and Borrisokane WS springs in the adjoining Ballinderry GWB have been estimated: 10 m/d and 18 m/d. These values are much higher than is general for this rock unit group type, and pertain only to the top few metres or so of very weathered rock or thin fault zones. Low transmissivities are more characteristic of the bulk of the aquifer. Storativity is low, on the order of 0.015-0.03. In this generally flat-lying area, groundwater gradients on the order of 0.005 to 0.02. Sand & gravel deposits overly the bedrock over a large percentage of this GWB and constitute a potential locally important gravel aquifer (Lg). (There is little information on the saturated thickness of these deposits and potential gravel aquifers were identified on the basis of areal extent and limited data from existing public supplies and group schemes.) The main aquifer in this GWB is likely to be the limestone bedrock, however the sand & gravel deposits are likely to provide storage for groundwater and probably maintain yields in dry weather.

	Thickness	The rock units within the Dinantian Pure Bedded Limestone group in this GWB have varied thicknesses. They also vary laterally in thickness. The Visean Undifferentiated limestones can be up to 250 m thick. The coarse-grained Terryglass Formation pinches out laterally from a maximum of 200 m. The Lismaline Micrite is about 40 m thick in most places, with a maximum-recorded thickness of 69m thick 5km northwest of Lismaline Quarry. Notwithstanding the considerable combined thickness of the units, most groundwater flow is likely to take place in the top ~30 m, in the zone that comprises a weathered layer of 1-2 metres (epikarst) and a connected fractured (Lismaline Formations) or diffusely karstified (Terryglass Formation & Visean Undifferentiated Limestone) layer below this. Deeper groundwater flow occurs along fault zones and large fractures. The Dinantian Upper Impure Limestones (Slevoir Formation) in the southwest of the body are about 250 m thick in this vicinity. However, permeability tends to decrease rapidly with depth. Most groundwater flow occurs in the upper ≤ 15 m or so, in the zone that comprises a weathered layer and a connected fracture zone below this. Deeper flows may occur along faults or significant fractures. There are some purer limestone beds within this succession – these may display greater dissolution than the impure limestones. There is likely to be an epikarstic layer of 1-2 m at the top of all of the limestone aquifers, which acts to redistribute recharge in the subsurface and, in high water table conditions, is a very high transmissivity layer.
Overlying Strata	**Lithologies**	A Teagasc Parent Material Map is not currently available for County Offaly or County Tipperary. The Offaly Groundwater Protection Scheme Quaternary Geology Map identifies areas of sand and gravel deposits (including some esker deposits), peat, and some areas of glacial till and river alluvium. Similar deposits are found in the part of this GWB in Co Tipperary *(The gravel deposits overlying this body were identified in the County Offaly Groundwater Protection Scheme as a potential locally important gravel aquifer and a sand and gravel deposit along the left bank of the Little Brosna river, in Co. Tipperary was identified in the Tipperary North Interim Groundwater Protection Scheme as a locally important gravel aquifer (Lg).)* *[Information to be added at a later date]*
	Thickness	Subsoil thickness data are sparse. Available data indicate thickness in the range 0-10 m. There is outcropping rock and shallow rock west and southwest of Birr, Co. Offaly. [Information to be added at a later date]
	% area aquifer near surface	[Information to be added at a later date]
	Vulnerability	Groundwater Vulnerability Maps have been prepared as part of the County Offaly and County Tipperary (North) Groundwater Protection Schemes (The Tipperary North Scheme is an interim scheme where only areas of extreme vulnerability have been delineated. High, Moderate and Low vulnerability areas have not been delineated). Areas of Extreme vulnerability occur west and southwest of Birr. In County Offaly some areas of Moderate vulnerability are designated in the northeast of the body. Remaining areas are designated as High vulnerability.
Recharge	**Main recharge mechanisms**	Diffuse recharge will occur throughout this GWB via rainfall percolating through the subsoil. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope. The highest amount of diffuse recharge will occur at rock outcrop and where subsoils are thinnest and most permeable. Where the water table is very close to ground surface, recharge may be rejected The many sand and gravel deposits are considered to have a 'high' permeability, and provide a permeable pathway for percolation of recharge to the underlying aquifer. The sand and gravel deposits can also act to augment storage in the aquifer. It is likely that there will be some recharge from adjoining low permeability GWB's.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	**Large springs and high yielding wells (m^3/d)**	None currently recorded [Information to be added at a later date]
	Main discharge mechanisms	The main discharges are to springs which occur within the body and to the streams and rivers crossing the body.
	Hydrochemical Signature	The groundwater in this body is calcium bicarbonate water type, reflecting the predominance of limestone bedrock and, in areas not underlain by limestone, of overlying limestone tills. As a consequence, it is generally hard (251-350 mg/l) to very hard (>350 mg/l).

Groundwater Flow Paths	The bedrock in this GWB is generally devoid of intergranular permeability. Groundwater flows diffusely through fissures, joints and along bedding planes. Flow is concentrated in an epikarstic layer a few metres thick, and along fault, fracture and joint planes in the zone below the epikarst in which the fractures are more dense and open. In the pure bedded limestones of this GWB fissuring is generally well developed and interconnected and support regional-scale flow systems. Flow path lengths can be up to several kilometres in length. There is some evidence of karstification, which where it occurs will enhance the permeability of the rock. Groundwater is generally unconfined in this GWB. Water levels will broadly reflect the topography within the body however topographic highs formed by some esker ridges have been shown to have no effect on the water table due to the highly permeable nature of the deposits. Local groundwater flow will be from the higher ground between surface water bodies to the rivers and streams, where it discharges. Regional groundwater flow directions are generally northwestwards, following the general decrease in elevation towards Lough Derg. Current data in the GSI well database show static water levels ranging from 1-8 m below surface in this GWB. Water levels will be closer to ground level in the vicinity of the rivers. There are sand and gravel deposits overlying the body in many areas. These deposits are in hydraulic continuity with the underlying bedrock aquifer. Whilst often not sufficient to constitute a gravel aquifer these deposits provide storage for the underlying bedrock aquifer.
Groundwater & Surface water interactions	The streams and rivers crossing the aquifer are generally gaining. Due to the shallow groundwater flow in this aquifer the groundwater and surface waters are closely linked. Designated NHA's include Killeen Bog, Arragh More Bog and WoodvilleWoods, have a peripheral lake/wetland, which may have varying dependence on Groundwater.
Conceptual model	• This GWB consists of an elongate northeast southwest trending area. The body is bounded to the northwest and southeast by the contact with the low permeability Dinantian Pure Unbedded Limestones and Dinantian Upper Impure Limestones of the Banagher, Neenagh and Shinrone GWBs. The body meets the adjoining Lismaline, Ballinderry and Borrisokane GWBs to the southwest, along the surface water catchment boundary between the Little Brosna and the Neenagh/Lough Derg catchments. The body meets the adjoining Tullamore GWB to the northeast, along the surface water catchment boundary between the Little Brosna and the Brosna catchments. • Ground elevations in this GWB range from 50-90 mAOD. Most of the body is flat and low lying with much of the area below 80 mAOD. Esker ridges from occasional narrow bands of higher ground. • The GWB is composed of Dinantian Pure Unbedded Limestones, typically a high transmissivity limestone. Groundwater flows diffusely through fissures, joints and along bedding planes. Current records of karst features are limited in this GWB, however pure limestones are susceptible to karstification, and where it occurs it will enhance the permeability of the rock. A small area in the southwest of the body is composed of Dinantian Upper Impure Limestone which generally has a lower transmissivity than the pure bedded limestones. There is likely to be an epikarstic layer of 1-2 m at the top of all of the limestone aquifers, which acts to redistribute recharge in the subsurface and, in high water table conditions, is a very high transmissivity layer. • Diffuse recharge will occur throughout this GWB via rainfall percolating through the subsoil. Much of the overlying subsoil consists of high permeability sand and gravel deposits which will provide a permeable pathway for recharge to the underlying aquifer. Potential recharge may be rejected in areas where the water table is very close to the surface. There is likely to be some additional recharge from adjoining low permeability GWB's. • Groundwater discharges to the streams and rivers crossing the body. • The groundwater in this body is generally unconfined. Most of the groundwater flow will be concentrated in an upper highly weathered layer and in a zone of interconnected fissures, possibly enlarged by karstification in some areas, generally extending to a depth of 30 m. Deep water strikes in more isolated faults/fractures can be encountered. Typically Dinantian Pure Bedded Limestones, such as those founding this GWB, have a degree of interconnection between fractures zones and they generally support regional scale flow systems. Flow paths can potentially be several kilometres in length. Groundwater gradients are relatively flat within the permeable limestone. Water levels will broadly reflect the topography within the body however topographic highs formed by some esker ridges have been shown to have no effect on the water table due to the highly permeable nature of the deposits. • Overlying sand and gravel deposits are in hydraulic continuity with the underlying bedrock aquifer and in many areas partially contribute to well and spring yields and provide additional storage for the aquifer. • Most of the area of this GWB is of High Vulnerability with areas of Extreme Vulnerability west and southwest of Birr and areas of Moderate Vulnerability in the northeast of the body. • The streams and rivers crossing the aquifer are generally gaining. Due to the shallow groundwater flow in this aquifer the groundwater and surface waters are closely linked.
Attachments	None
Instrumentation	Stream gauges: 25021, 25106. EPA Water Level Monitoring boreholes: None EPA Representative Monitoring points: Riverstown Spring (TIN 85)

Information Sources	Hunter Williams, N., Motherway, K. and Wright, G. (2002) *North County Tipperary Groundwater Protection Scheme*. Main Report. Draft report to North Tipperary County Council. Geological Survey of Ireland 56pp. Daly, D., Cronin, C., Coxon, C. & Burns, S.J. 1998. *County Offaly Groundwater Protection Scheme*. Main Report. Offaly County Council & Geological Survey of Ireland, 57pp. Cronin C., Daly, D., and R. Flynn, 1999. *Hollimshill Public Supply. Groundwater Source Protection Zones.* Geological Survey of Ireland Report, 12 pp. Cronin C., Daly, D., and R. Flynn, 1998. *Tully Public Supply. Groundwater Source Protection Zones.* Geological Survey of Ireland Report, 18 pp. 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 (Publication Pending) Kelly, C. 2001. *Agall Water Supply Scheme. Groundwater Source Protection Zones.* Geological Survey of Ireland Report. Kelly, C. 2001. *Kilcormac Water Supply Scheme. Groundwater Source Protection Zones.* Geological Survey of Ireland Report. Kelly, C. 2001. *Ballyboy Water Supply Scheme. Groundwater Source Protection Zones.* Geological Survey of Ireland Report.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Birr GWB (For Reference)



List of Rock units in Birr GWB

Rock unit name and code	Description	Rock unit group
Slevoir Formation (SV)	Muddy limestone & calcareous shale	Dinantian Upper Impure Limestones
Lismaline Micrite Formation (LM)	Medium-grey micritic limestone	Dinantian Pure Bedded Limestones
Terryglass Formation (TS)	Grey calcarenitic and oolitic limestone	Dinantian Pure Bedded Limestones
Visean Limestones (undifferentiated) (VIS)	Undifferentiated limestone	Dinantian Pure Bedded Limestones