Aughrim GWB: Summary of Initial Characterisation.

Need to sort out about Visean Limestone at Ballinasloe – part of Suck South GWB?

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
26 – Suck Galway & Roscommon Co Co's	Rivers: Suck, Ballinure. Streams: Cuileen, Derrymullan, Laurencetown. Loughs: Lyons, Doo.	(001779) Ballinasloe Esker (Esker & Fen), (001247) Cloonascragh Fen & Black Wood (Wood & Fen), (000216) Shannon River Callows (Turloughs?), (001283) Killure Bog, (000254) Crit Island West (Bog), (000222) Suck River Callows, Castlecoote-Shannonbridge.	250

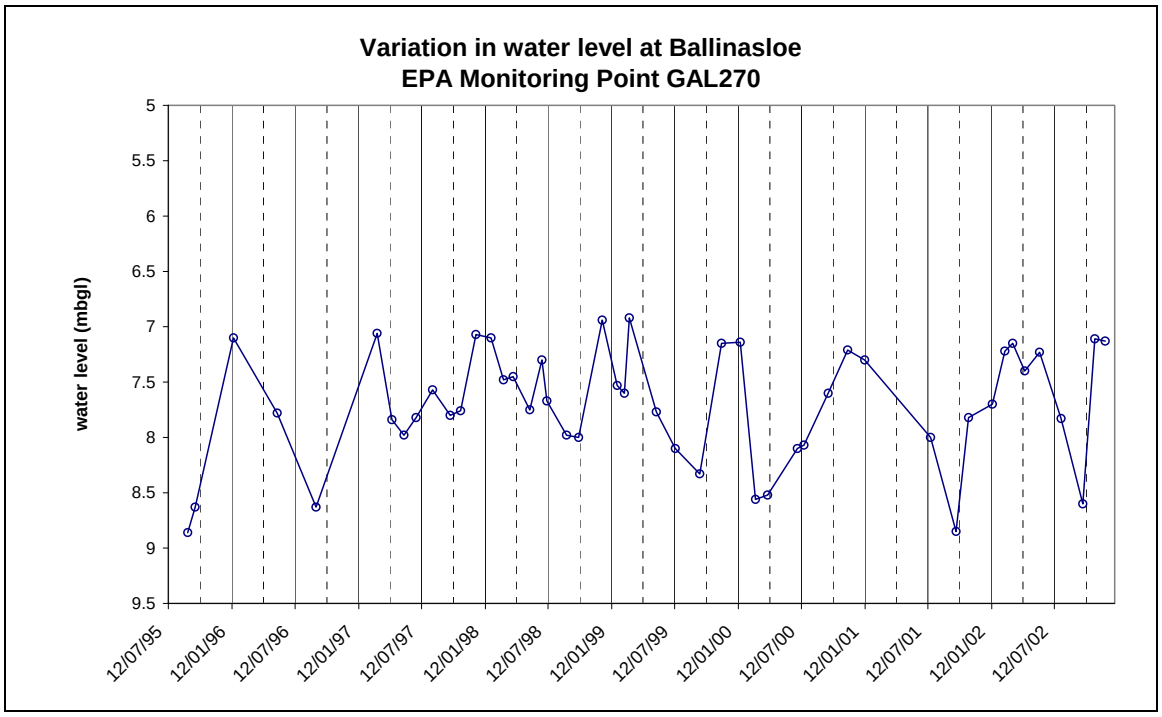
Topography	This GWB consist of flat low-lying areas in the vicinity of the River Suck with higher ground away from the river towards the GWB boundaries. Land adjacent to the River Suck ranges from 40-50 mAOD. Along the banks of the river are the 'Callows', areas of grassland which flood in winter. Flanking the 'Callows' on either side of the river are large areas of raised bog. Ground elevations increase gently away from margins of the bogs towards the boundaries of the body (60-100 mAOD). The highest ground (>100 mAOD) is in the west and extreme south of the body, with the highest point of 140 mAOD located on the western boundary of the body. Much of the land area of this groundwater body, in particular lands in the vicinity of the River Suck, is covered by raised bog, now being harvested for peat by Bord na Mona. As the peat is harvested for fuel the final surface level of the peat is in places lower than the winter water level in the River Suck. The land is drained by several small streams discharging to the River Suck. The peat production bogs are currently drained by a series of large electrical pumps which pump water from the lowlying bogs into the adjacent River Suck.	
Geology and Aquifers	Aquifer categories	The main aquifer category in this GWB is: **Ll:** Locally important aquifer which is moderately productive only in local zones. There is a small area north of Aughrim with an aquifer category of: **Rk^c**: Regionally important karstified aquifer dominated by conduit flow.
	Main aquifer lithologies	The main aquifer lithology is Dinantian Upper Impure Limestone. There are some Dinantian Pure Bedded Limestones in the northeast of the body and there is a small area of Dinantian Pure Bedded Limestones north of Aughrim.
	Key structures	A number of faults are mapped in the north of the body, around Balinasloe, bringing the Dinantian Pure Bedded Limestone into contact with the Dinantian Upper Impure Limestone. However in the area of this GWB due to the extensive covering of peat and glacial deposits the pattern of folds and faults are generally too poorly exposed to allow these structures to be closely mapped.
	Key properties	No data on hydrogeological properties specific to this GWB are available. Aquifer properties of the Dinantian Upper Impure Limestones vary across Ireland influenced by lithological variations and variations in the extent of deformation. In this area transmissivity in the Dinantian Upper Impure Limestones is expected to be low. A pumping test at Lorrha WS, in the Nenagh GWB southwest of Lough Derg, indicates an aquifer permeability of 5 m/d in the Upper Impure Limestones. The borehole there intercepts a large fissure, so this value is at the high end of what would be expected for this rock unit group, which typically has transmissivities in the range 2-20 m^2/d. The Banagher WS, abstracting from the same rock unit group in the Banagher GWB, has similar characteristics: a single large fault zone supplies the source, resulting in a transmissivity estimate of 45-70 m^2/d, but a thin flowing interval permeability estimate of 20 m^2/d. Pumping tests in the Dinantian Pure Unbedded Limestones (Waulsortian Limestones), outside this GWB, 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 in this area. The rocks in this GWB can have local zones of enhanced permeability and it is to be expected that in the vicinity of fault zones where the rocks have undergone a higher degree of deformation higher transmissivity values can be encountered. Within all the rock units in this GWB, Storativity will be low. Dinantian Pure Bedded Limestones are very susceptible to karstification. As with most karstic systems, permeability and transmissivity are very variable. Transmissivity in karstified aquifers with conduit flow can range from less than 1m^3/d up to a few thousand m^2/d, depending on whether or not the conduit flow system is intersected.
	Thickness	The Dinantian Upper Impure Limestones and Dinantian Pure Unbedded Limestones, of this GWB are more than several hundreds of metres thick. However, most groundwater flows in an upper zone of about 15 m, comprising a weathered zone of a few metres thick and a zone of interconnected fissures that extends approximately 10 m below this. Isolated deeper inflows occur where faults or significant fractures are intercepted by boreholes. In Dinantian Pure Bedded Limestones there is generally an epikarstic layer at the rock surface and the zone interconnected fissures that extends to a depth of up to 30 m. Deeper inflows can occur in areas associated with faults or dolomitisation.

Overlying Strata	Lithologies	Extensive areas of peat, which are being harvested on a large scale, occur along both sides of the River Suck. The peat areas are generally underlain by lacustrine clay and marl. There is a line of gravel deposits and esker ridges running west to east from just west of Kilconnell, through Ballinasloe and southeast to Cloonfad. There are also some west to east trending gravel deposits and small esker ridges just east of Aughrim. There are alluvial deposits along the rivers crossing the body. Areas of rock outcrop or rock close to the surface are common particularly on the hills and higher ground. *Subsoil Types identified in body by Teagasc Parent Material Mapping: Cut Peat (Cut); Limestone Till (TLs); Rock outcrop and rock close to surface (Rck); Karstified Limestone outcrop & Karstified Limestone close to surface (KaRck), Gravels (GLs), Esker (BasEsk) and Alluvium (A),* *[Information to be added at a later date]*
	Thickness	There are limited data available on depth to rock in this GWB. Areas of <3 m subsoil will be occur around rock outcrop and areas of shallow rock. These are common particularly on hills and higher ground in the northeast of the body east of Ballinasloe, north and northeast of Kilconnell and east and southeast of Aughrim. Elsewhere in areas overlain by glacial till subsoils are generally 3-10 m deep. In the vicinity of the River Suck, in areas covered by the vast expanses of raised bog, the bedrock can be >10 m below ground surface, with the peat underlain by layers of marl and lacustrine clay ('blue clay'). In areas where peat harvesting has ceased, there can be as little as 1 m of peat remaining. *[Information to be added at a later date]*
	% area aquifer near surface	*[Information will be added at a later date]*
	Vulnerability	A Groundwater Vulnerability Map is not currently available for County Galway. 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 southwest and north east of the body where there are frequent rock outcrops and shallow rock. *[Information will be added at a later date]*
Recharge	Main recharge mechanisms	Diffuse recharge will occur 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. Percolation of recharge will be somewhat restricted in some parts 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 Galway but the sub peat subsoil would be expected to be of 'low' permeability. Subsoils of 'high' permeability such as the gravel deposits will allow easy percolation of recharge However, due to the generally low permeability of the aquifers within this GWB, a high proportion of the recharge will then discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer. There can be some point recharge to the GWB through swallow holes or collapse features which occasionally occur in the Dinantian Upper Impure Limestones and frequently in Dinantian Pure Bedded Limestones.
	Est. recharge rates	*[Information will be added at a later date]*
Discharge	Important springs and high yielding wells (m^3/d)	From EPA Groundwater Sources List: GAL119 Mid West Co-op. Kilconnel, 425 m^3/d (Borehole) From GSI Borehole database: 1721NEW009 Timothy Barley, Abbeypark – 109 m^3/d; 1721NEW010 Galway Co Co, Coolcarta West - 109 m^3/d; 1723SWW002, Kilconnell - 130 m^3/d; 1723SWW003 Galway Co Co, Kilcloony - 153 m^3/d; 1723SWW004, Kilconnell - 163 m^3/d; 1723SWW018 Kilcloony, Kilcloony - 153 m^3/d
	Main discharge mechanisms	The main discharges will be local, to the River Shannon and to springs and streams crossing 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.
	Hydrochemical Signature	Typcially groundwater from this GWB has a calcium-bicarbonate signature. Groundwaters will be Hard to Very Hard (typically ranging between 350-450 mg/l), and high electrical conductivities are also observed. Alkalinity will also be high, but less than hardness. In 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 also be problematic in shaly limestones. 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 hydrochemical signature of groundwater from two wells in this GWB is demonstrated in an expanded Durov plot in Figure 2 below.

Groundwater Flow Paths	These rocks are devoid of intergranular permeability; groundwater flow occurs in fractures and faults. Permeability is highest in the upper few metres of bedrock, but decreases rapidly with depth. In general groundwater flow is concentrated in the upper 15 m of the aquifer. Local zones of high permeability can be encountered near fault zones and in areas of intensive fracturing. Groundwater flow in this body will be of a local nature. Groundwater flow paths are generally short, with groundwater discharging to small springs, or to the streams and rivers that traverse the aquifer. Flow directions are expected to approximately follow the local surface water catchments. Overall, groundwater flow is to the east and south towards the River Suck. In general groundwater is unconfined in this GWB, however groundwater can become confined beneath the clayey till and lacustrine clay deposits that underlie the large bogs along the River Suck. Water level data for wells within this GWB are shown in Figure 1 attached. There are no hydrogeological data currently available relating to the gravel deposits in this body. The gravel deposits will provide a permeable pathway for recharge to the aquifer and where saturated may provide an element of storage for the underlying bedrock.
Groundwater & Surface water interactions	There are many areas of raised bogs within this GWB. Raised bogs are generally considered as ecosystems that are independent or only locally dependant on groundwater. However, lagg zones can develop at bog fringes, where mixing of upwelling groundwater flow and surface runoff from the bog provide added nutrients for the development of a diverse range of plant species. Groundwater is generally confined beneath low permeability clayey till and 2-3 m of lacustrine clay which underlie the peat in the large bogs. In areas where the underlying clays are thin or absent there is potential for upward movement of groundwater to the bog system. The complete removal of up to 10 m of peat from large areas of bog adjacent to the River Suck, and the cessation of pumped drainage once harvesting is complete may have implications for future groundwater surface water interactions. Occasionally the post harvesting level of peat is lower that the winter water levels of the River Suck. Karstification is rare in the limestones in this GWB however some features can occur. There area also some areas of fen within this GWB which are highly groundwater dependant ecosystems. Surface water flowing off a small area of Dinantian Pure Unbedded Limestones in the north east of the body are in the zone of contribution of the Killeglan/Tobermore Spring PWS in County Roscommonn (Suck South GWB). The surface water sinks into the karst groundwater system of the Suck South GWB and potentially reaches the springs.
Conceptual model	• This GWB is bounded to the north by the contact with the Pure Bedded Limestones of the karstic Suck South GWB. The western, southern and eastern boundaries are formed by groundwater divides and topographic highs which coincides with surface water catchment boundaries. The western boundary of the body is also part of the Shannon RBD boundary. • This GWB consist of flat low-lying areas in the vicinity of the River Suck with higher ground away from the river towards the GWB boundaries. Much of the land area of this groundwater body, in particular lands in the vicinity of the River Suck, is covered by raised bog. • This GWB is composed primarily of low permeability rocks which have localised zones of enhanced permeability. Groundwater flows along fractures joints and major faults. • Recharge occurs diffusely through the subsoils. Recharge is limited in areas where the aquifer in confined beneath clayey till and lacustrine clay which underlie the bogs. • In general groundwater is unconfined in this GWB, however groundwater can become confined beneath the clayey till and lacustrine clay deposits that underlie the large bogs along the River Shannon. Most groundwater flow occurs in the upper 15 m of the bedrock, comprising a weathered zone of a few metres and a connected fractured zone below this. Deep-water strikes in more isolated faults/fractures can be encountered. Groundwater flow in this body will be of a local nature. Groundwater flow paths will generally be short. • Groundwater will discharge to the streams crossing the body and to the River Suck. Overall, the flow direction is towards the River Suck. • Groundwater surface water interactions may be an issue in lagg zones on the margins of the raised bogs within this GWB. Removal of the peat cover and alterations to drainage patterns post harvesting may influence groundwater surface water interactions in these areas. • There may be a limited number of karst features, such as swallow holes and enclosed depressions, within the body. Where present these would act as a focus for point recharge and groundwater surface water interaction, however karstification is quite rare in the limestones found in this GWB. Fens are recorded in two locations. Fens are highly groundwater dependant ecosystems. • Surface water flowing off a small area of Dinantian Pure Unbedded Limestones in the north east of the body are in the zone of contribution of the Killeglan/Tobermore Spring PWS in County Roscommonn (Suck South GWB). The surface water sinks into the karst groundwater system of the Suck South GWB and potentially reaches the springs.
Attachments	Groundwater hydrograph (Figure 1); Hydrochemical signature (Figure 2).
Instrumentation	Stream gauges: 25315, 26038, 26039, 26152, 26249, 26301, 26304. EPA Water Level Monitoring boreholes: Ballinasloe (GAL 270), Coolderry (ROS 081). EPA Representative Monitoring points: Coolderry (ROS 81), Oldtown (ROS 90).

Information Sources	Lee, M. & Daly D. (2003) *County Roscommon Groundwater Protection Scheme*. Main Report. Roscommon County Council & Geological Survey of Ireland, 54pp. Lee, M. and Kelly, C. (2003) Killeglan Water Supply Scheme (Tobermore Springs), Groundwater Source Protection Zones. Geological Survey of Ireland Report to Roscommon Co. Co., 12 pp. 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). 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.
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 Hydrograph
(EPA Groundwater Level Monitoring)



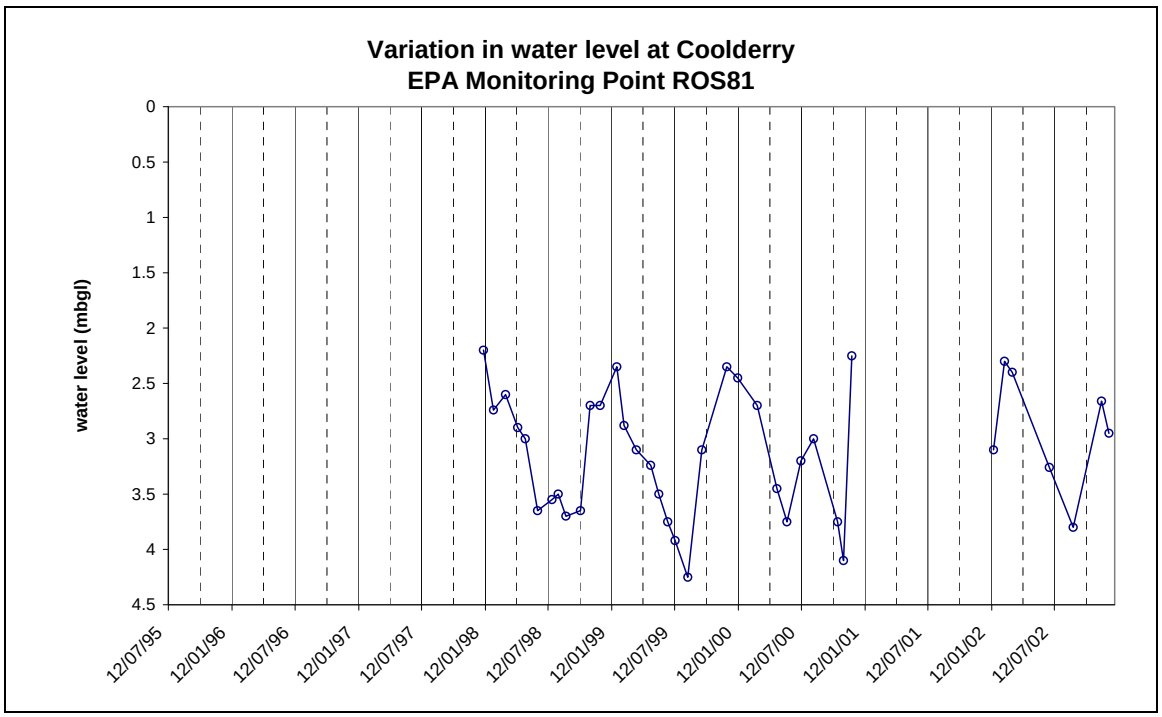
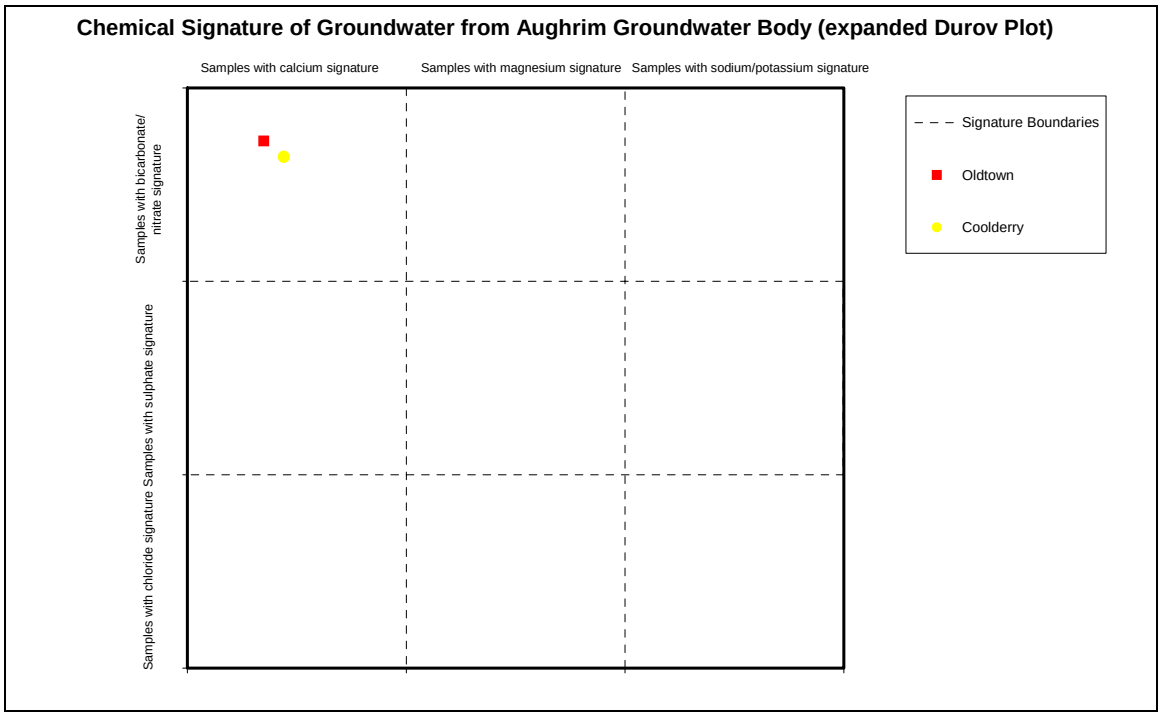
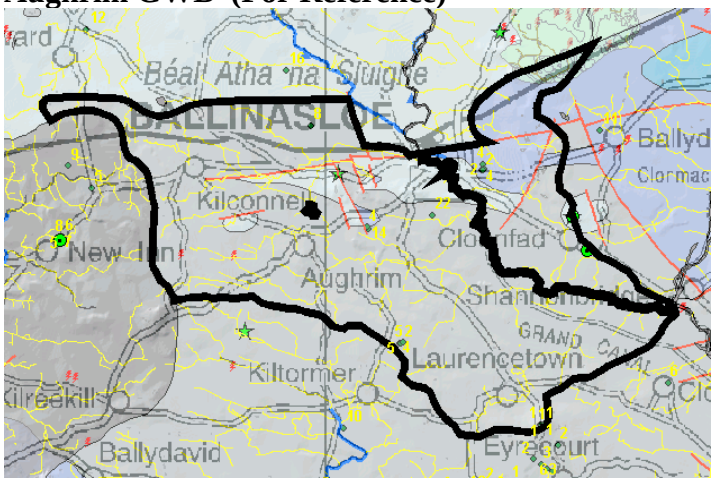


Figure 2: Hydrochemical signature
(EPA Representative Monitoring)



Aughrim GWB (For Reference)



List of Rock units in Aughrim GWB

Rock unit name and code	Description	Rock unit group
Visean Limestones (Undifferentiated) (VIS)	Undifferentiated Limestones	Dinantian Pure Bedded Limestones
Lucan Formation (LU)	Dark Limestone & shale (calp)	Dinantian Upper Impure Limestones
Waulsortian Limestone (WA)	Massive unbedded lime mudstone	Dinantian Pure Unbedded Limestones
Oolitic Limestone (oo)		Dinantian Pure Bedded Limestones