Pettigo GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water bodies	Associated terrestrial ecosystems	Area (km^2)
Hydrometric Area 36 Donegal Co. Co. N.I.		***Rivers:*** Erne, Waterfoot. ***Streams:*** 28 unnamed streams. ***Lakes:*** Lough Aghafoy, Lower Lough Erne.	None identified (O'Riain, 2004)	25
Topography		This narrow, SW-NE elongated GWB (Figure 1) is an isolated area of karst aquifer, bounded by low permeability rocks to the west and east, and fracture-flow rocks to the north. The south is bounded by the northern shore of the Lower Lough Erne. The GWB generally follows the Termon River valley with elevations ranging from c.90 mAOD in the south to c.150 mAOD in the north. The valley is generally flat to gently sloping although drumlins feature in the south. The main surface water flow direction is south-westwards, with water the Termon River discharging in to the Lower Lough Erne.		
Geology and Aquifers	**Aquifer type(s)**	The sole aquifer category in this GWB is **Rk^d**: Regionally important karst aquifer dominated by diffuse flow.		
	Main aquifer lithologies	The GWB comprises Dinantian Pure Bedded Limestones. Refer to Table 1 for details.		
	Key structures	There are a small number of faults that extend in to this GWB, and the Pettigo Fault is located along the western boundary. The available information indicates that the rocks are dipping to the southeast by 10°.		
	Key properties	There are limited data within this GWB however, data are available for this rock type in the local area (Ballyshannon, Donegal-Ballintra and Ballyshannon South GWBs) – 9 well yields 109-1090 m^3/d and 5 specific capacities of between 4-168 $m^3/d/m$. The data show the variability of yields and transmissivities, and indicate that higher values are achievable. The variable discharge and rapid response to rainfall in the Parkhill Spring (Ballyshannon GWB) indicates the potential for rapid groundwater flow and low storativity in this type of aquifer. High annual variation in groundwater levels (up to 25 m) have been recorded in one borehole in the Ballyshanon GWB (Figure 2), which *may* also suggest low storativity in these types of rocks. From the minimal karst work undertaken in County Donegal, c.30 karst features have been recorded in these types of limestones and there are likely to be significantly more unrecorded features. Only 2 groundwater levels are available: 2 m below ground level and an overflowing artesian well. The artesian well is located at a lower elevation and has 3-5 m of overlying, Low permeability subsoil, which may constitute the confining layer. The data are inadequate to calculate groundwater gradients although flow directions are likely to be towards the River Termon and then generally to the southwest, with groundwater eventually discharging to the Lower Lough Erne. *(Minerex Reports; Donegal GWPS; Pure Bedded Limestones Aquifer Chapter)*		
	Thickness	Although no supporting data are available, in the pure limestones in this part of the country, most groundwater is thought to flow in an epikarstic layer 2-3 m thick, and in a zone of interconnected, solutionally-enlarged fissures and conduits that extends approximately 30 m below this. There will also be a zone of isolated, poorly connected fissures – typically less than 150 m bgl.		
Overlying Strata	**Lithologies**	Till is the predominant subsoil in this GWB (c.67%), with small proportions of alluvium (9%) and peat (6%).		
	Thickness	The drumlins in the south of the GWB are recorded as thick subsoil deposits (>10 m deep). Subsoil in the valley floor is considered to be between 3-10 m thick – thicker around the drumlins but becoming thinner in the north. The pattern of thin or absent subsoil occurs in different areas of the body: in the low lying area in the south, and at higher elevations in the north. A similar pattern would be expected in the eastern part of the GWB i.e. within NI.		
	% area aquifer near surface	*[Information will be added at a later date]*		
	Vulnerability	From the Donegal GWPS, the full range of vulnerability categories exist in the north-western portion of this GWB: Extreme where subsoil deposits are negligible, grading through High and Moderate as the thickness increases, to Low over the drumlin area.		
Recharge	**Main recharge mechanisms**	Both point and diffuse recharge occur in this GWB. Diffuse recharge occurs via rainfall percolating through thin subsoil and outcrops. Point recharge to the underlying aquifer occurs by means of swallow holes, dolines and caves. Although recharge along 'losing' sections of streams is also associated with this particular type of karst aquifer, to date none have been recorded in this GWB. Recharge will be restricted where the low permeability subsoil is thicker. Although there are relatively few rivers in the GWB, the topographic setting (valley) and areas of low permeability subsoil may also have influenced the stream density.		
	Est. recharge rates	*[Information will be added at a later date]*		

Discharge	**Important springs and high yielding wells**	Sources: None identified. Springs: None identified. Wells: None identified.
	Main discharge mechanisms	The main groundwater discharges are to the streams, rivers, lakes and any springs within the GWB, and eventually into the Lower Lough Erne. Given the permeable nature associated with Rk^d aquifers, the baseflow proportion of the total streamflow is expected to be higher in this GWB than for the adjacent Pl/Pu GWB, especially where the subsoil is thinner or more permeable i.e. in the inter-drumlin areas.
	Hydrochemical Signature	***National classification:*** Dinantian Pure and Impure Limestones Calcareous. Generally Ca-HCO_3 signature. Alkalinity (mg/l as $CaCO_3$): range of 10-990; mean of 283 (2454 data points) Total Hardness (mg/l): range of 10-1940; mean of 339 (2146 data points) Conductivity (μS/cm): range of 76-2999; mean of 691 (2663 data points) *(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)*
Groundwater Flow Paths		As these rocks are generally devoid of inter-granular permeability, groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones, these openings are frequently enlarged by karstification resulting in significantly enhanced rock permeability. Karstification can be also accentuated along structural features such as fold axes and faults. An epikarst layer in the upper few metres of the rock is likely to be present on top of the diffusely karstified aquifer. Shallow groundwater flow is considered to be dominant, although a component of deep groundwater flow would be expected. Continuous water tables that reflect topography are considered to exist in diffusely karstified aquifer as the flow regimes are likely to be hydraulically connected. However the degree of interconnect depends on the frequency of fissures, faults, and joints. Groundwater flow is thought to be *mainly* unconfined. In the karstified aquifers, groundwater flow is regional scale – flow path lengths of several kilometres are not unusual although are likely to be shorter in discharge areas (c.100-300 m). Overall, groundwater flow will be south-westwards, towards the Lower Lough Erne. However, the karstified nature of the pure limestone means that locally groundwater flow directions can be highly variable.
Groundwater & surface water interactions		There is a high degree of interconnection between groundwater and surface water in karstified limestone areas such as in this GWB. Swallow holes, dolines, caves, turloughs, springs, and 'losing' and 'gaining' streams all provide a direct route between surface water and groundwater systems. This rapid interchange between surface water and groundwater is often reflected in their similar water quality as contamination is also rapidly transported between the two systems.

Conceptual model		• Differing aquifers bound the GWB to the north, west and east. The Lower Lough Erne provides the southern boundary. The topography is generally low-lying and gently sloping although drumlins are located in the south.
		• The rock type in this GWB is a karstified limestone that is dominated by diffuse groundwater flow (aquifer category **Rk^d**).
		• Most of the generally unconfined groundwater flux is in the uppermost 30 m of the aquifers. This is most likely to occurs through an epikarst layer (c.3 m), and an underlying zones of interconnected joints, fissures, fractures and faults that have been solutionally enlarged. Deeper groundwater flow can occur along permeable fault or fracture zones.
		• Transmissivity values and well yields are variable, reflecting zones of higher and lower permeability. These rocks are generally associated with rapid response of springs to rainfall events, indicating the potential for high groundwater flow velocities, and for low storativity.
		• In general, the degree of interconnection in karstic systems is high and they support regional scale flow systems. Long flow paths (kilometres in length) can be expected although are likely to be shorter is discharge areas (100-300 m).
		• Recharge occurs by:
		  • diffuse means in all rock types – via outcrops and through thin subsoil, although may be limited by thicker, low permeability subsoil, and
		  • additional point mechanisms; swallow holes, dolines, caves and along lengths of losing streams – mainly occurring where subsoils are thin i.e. areas of extreme vulnerability.
		• Due to the combination of point recharge and rapid flow through solutionally enlarged joint/fissure/fracture zones, there is minimal potential for contaminant attenuation in the limestone aquifer.
		• The main discharges are to the rivers and springs within the GWB, and to the Lower Lough Erne. Overall, the flow direction is to the southwest, as determined by the topography.
		• There is a high degree of interaction between surface water and groundwater in this GWB.

Attachments		Figure 1. Table 1.
Instrumentation		**Stream gauges:** None identified. **EPA Water Level Monitoring boreholes:** None identified. **EPA Representative Monitoring points:** None identified.

Information Sources	Lee M. and Fitzsimons V. (2004). *County Donegal Groundwater Protection Scheme.* Main Report. Draft Report to Donegal County Council. Geological Survey of Ireland 58pp. Long, C.B. and McConnell (1999) *Geology of South Donegal: A geological description, to accompany bedrock geology 1:100,000 scale map, Sheet 3, South Donegal*. With contributions by G.I. Alsop, P. O'Connor, K. Carlingford and C. Cronin. Geological Survey of Ireland, 116pp. Minerex Environmental Ltd. (2003). *Ballyshannon and Rossnowlagh Water Supply Scheme – Groundwater Supply. BH1, BH2, BH3, BH4 and Spring 2 pumping test supervision, monitoring, interpretation an reporting.* MEL Doc.Ref.:1492-103 (First draft). O' Riain, 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects.
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.

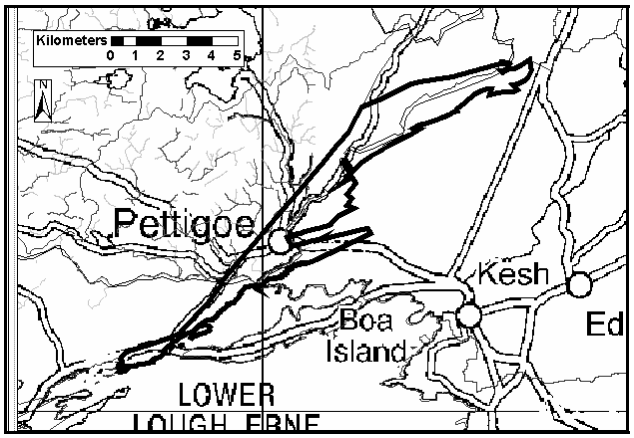

Table 1. List of Rock units in Pettigo GWB

Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Ballyshannon Limestone Formation	BS	Pale grey calcarenite limestone	Dinantian Pure Bedded Limestones		100.00%