Banteer GWB: Summary of Initial Characterisation.

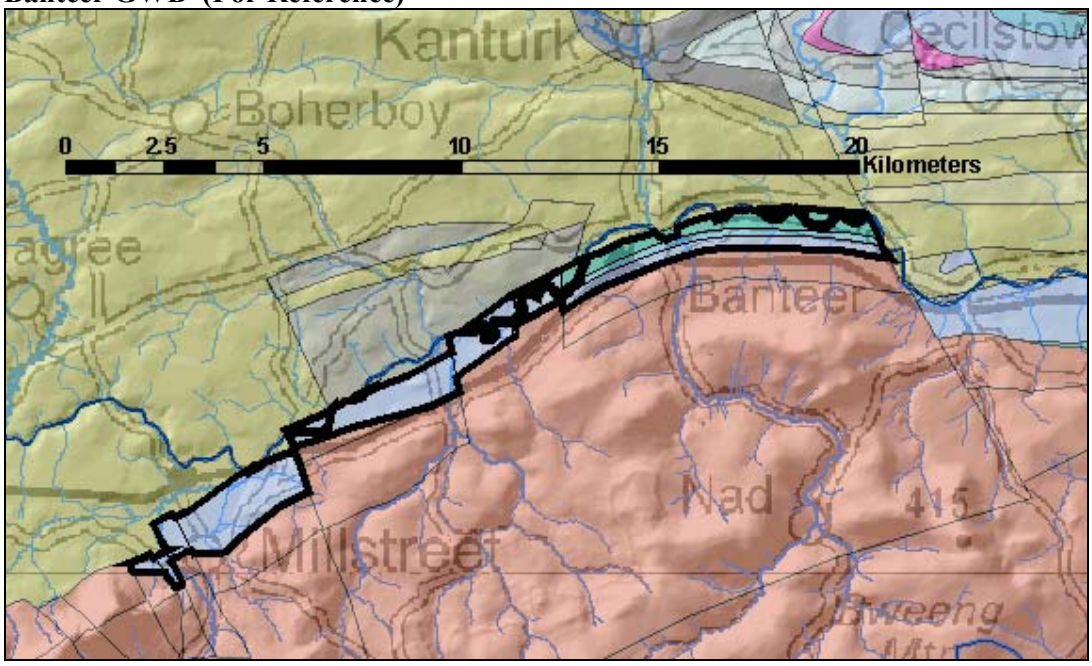
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
18 Cork Co. Co.	**Rivers:** Blackwater, Finnow, Rathcool, Glen	None currently listed	19

Topography	This small GWB occupies the floor of an elongate WSW-ENE trending valley in northwest Cork. The valley is bounded to the north and south by parallel east west trending ridges which comprise the Rathmore and Glenville GWBs respectively. The valley floor is generally flat to gently undulating. Ground elevations range from 75-110 m OD.	
Geology and Aquifers	**Aquifer categories**	**Rk^d**: Regionally important karstified aquifer dominated by diffuse flow (75% -14 km^2) **Ll:** Locally important aquifer which is moderately productive only in local zones (8% - 1 km^2) **Pl:** Poor aquifer which is generally unproductive except for local zones (17% - 3 km^2)
	Main aquifer lithologies	Dinantian Pure Unbedded Limestones (Waulsortian Limestone Formation & area of undifferentiated Dinantian) (75% -14 km^2) Dinantian Lower Impure Limestones (8% - 1 km^2) Dinantian (early) Sandstones, Shales and Limestones (17% - 3 km^2)
	Key structures	During the Variscan Orogeny (mountain building episode), rocks in South Munster were compressed from the south into a series of folds on east west axes. Subsequent erosion stripped the more soluble Carboniferous Limestones from the fold crests or ridges (anticlines) exposing the harder, more resistant sandstones underneath. The Carboniferous Limestones were preserved in the fold troughs (synclines) which today line elongate east-west trending valleys separated by the intervening sandstone ridges. This body lies in the west of the Mallow Syncline. Extensive fracturing and faulting accompanied the folding of the rocks. The ridges and valleys are cut by series of shear faults trending approximately north-south and a series of thrust faults with a general east-west trend. The limestone in this GWB is bounded to the north and south by thrust faults associated with the major Mallow Thrust Zone. The major north-south shear faults are paralleled by a very well developed system of vertical or near-vertical north-south joints, commonly spaced at intervals of about 0.5 to 2 metres (Wright, 1979).
	Key properties	There is little information on aquifer properties in this GWB, so comparisons must be made with limestone aquifers in other GWBs nearby. The pure limestones of the South Munster region are highly productive. Faults and joints were enlarged by karstification as groundwater moved through the limestones. Karst features are characteristic of these limestones. In this GWB karst features appear to be limited to a narrow belt of limestone cliffs to the south of the Blackwater east of Banteer, where there are substantial caves (Donellaroska's Cave and Gortmore East Cave), and springs) (Poulgorm, Tobernaheena and St Fursey's Well), and a large spring (Tubrid) to the northwest of Millstreet. Other karst features probably remain to be identified, while yet more are probably obscured by the subsoil cover. Transmissivity in the pure unbedded limestones can range up to a few thousand m^2/d. Pumping tests in the same rock type near Cloyne gave a range of transmissivity of 200 to over 2000 m^2/day, and 900 - 13,000 m^2/d for a water supply borehole near Dungarvan, Co Waterford (Dungarvan GWB, SERBD). Groundwater gradients within the pure unbedded limestones are low, around 0.001-0.002. (Wright & Gately 2002). Springs in the pure unbedded limestone range in size from small to large, but have fairly reliable discharges. In the impure limestones, transmissivities are lower; they will generally be in the range 5-20 m^2/d but may be higher where karstification has occurred. Storativity is low in all aquifers, but may be enhanced by overlying sand and gravel deposits which are in continuity with the underlying limestone and provide them with additional storage.
	Thickness	The Dinantian Limestones (Waulsortian Limestone) are at least 600m thick in the Cork Syncline (Sleeman & Pracht, 1994), so the limestone succession in this GWB is probably at least a few hundred metres thick. Most groundwater flow may occur in an epikarstic layer a couple of metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits that extends approximately 30 m below this. However deeper flows can occur. Boreholes have intersected major zones of fissuring at depth in Waulsortian Limestone at Cloyne, Co Cork (Cloyne GWB, at c. 41m below ground level) and at Ringaskiddy (Carrigaline GWB, down to 40m below O.D (Wright, 1979)). In the past sea level is estimated to have been approximately 50-60m below present day O.D., the level to which the now infilled channel of the River Lee was eroded (Farrington, 1959) enabling karstification at depth. Today this region is an example of a drowned karst terrain. In the Impure Limestones that occur at the margin of this GWB, most groundwater flow occurs in an upper weathered layer of a few metres and a zone of interconnected fissures often not extending more than 15 m from the top of the rock, although occasional deep inflows associated with major faults can be encountered. Impure limestones are also much less susceptible to karstification.

Overlying Strata	**Lithologies**	Subsoil Types identified in Banteer GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Blanket Peat (BktPt); Lake sediments undifferentiated (L); Made Ground (Made); Rock outcrop and rock close to surface (Rck); Raised Peat (RsPt); Till –Devonian Sandstone Till (TDSs); Limestone Till (TLs); Namurian Sandstone and Shale Till (TNSSs). This GWB is primarily covered by glacial till and alluvium. Few if any areas of rock outcrop or shallow rock occur in this GWB.
	Thickness	Borehole data are very sparse and subsoil depths are largely unknown. Boreholes in Drishane Beg townland, NE of Millstreet, and one at nearby Flintfield, have recorded depths to rock (beneath alluvium) of 15m, 23m and 27m. The underlying pure unbedded limestone in this valley is highly karstified and likely to have a very irregular bedrock surface. Subsoil depths may therefore be highly variable within short distances, as the above figures indicate.
	% area aquifer near surface	
	Vulnerability	This GWB appears to have few areas of Extreme Vulnerability. If the subsoil is assumed to be of generally moderate permeability (as in most of south Cork) it is likely that the groundwater vulnerability is generally Moderate to High.
Recharge	**Main recharge mechanisms**	The sandstone uplands to the north and south of this GWB provide abundant runoff which supplements recharge to the limestone aquifer in the valley. A small volume of groundwater may cross as through-flow from the sandstones into this GWB. In the GWB itself both point and diffuse recharge may occur; although no swallow holes have been identified, the very high flow in Tubrid Spring (Millstreet WS), without an obvious large catchment area, implies substantial recharge through karstic access points. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. In this highly productive aquifer there are some low-lying areas with a high water table, where a proportion of the effective rainfall is rejected due to lack of storage space in the aquifer. Groundwater in this body will probably show a rapid response to recharge. The generally 'moderate' permeability subsoils should not greatly restrict percolation of recharge.
	Est. recharge rates	
Discharge	**Large springs and high yielding wells (m^3/d)**	*Note: The following data need to be checked and updated by RBD Project Consultants.* Data from GSI Well Database: • Tubrid (Millstreet WS) – a High Spring, yield claimed to be 2637 m3/d (Cork Co. Co.) • Poulgorm Spring (Banteer WS) – Intermediate Spring Additional data from EPA Groundwater Sources List:
	Main discharge mechanisms	Groundwater discharges to springs within the GWB and to the Blackwater River crossing the GWB. Rivers overlying the limestones in the South Munster Synclines generally have relatively high dry weather flows representing contributions from the underlying aquifer.
	Hydrochemical Signature	Hardly any data are available, hence the following is based on similar aquifers nearby. The groundwater in this body will be dominated by calcium and bicarbonate ions. Hardness may range from moderately hard to very hard (200 to >400 mg/l (as $CaCO_3$). Spring waters tend to be softer as throughput is quicker and there is less time for the dissolution of minerals into the groundwater. Groundwater alkalinity will be high, up to 400 mg/l (as $CaCO_3$). Like hardness and alkalinity, electrical conductivity (EC) can vary greatly. Typical limestone water conductivities are of the order of 500-700 µS/cm. Due to the high level of interaction between groundwater and surface water in karstic aquifers, microbial pollution can travel very quickly from the surface into the groundwater system, the normal filtering and protective action of the subsoil being bypassed. One analysis from Poulgorm Spring, Banteer (2/12/86) indicates a Total Hardness of 240 mg/l, and 12 mg/l Nitrate (as NO_3), which is in line with the above generalisations.

Groundwater Flow Paths	These rocks have no intergranular permeability. Groundwater flow occurs in numerous faults and joints, enlarged by karstification. Past depression of the sea level enabled karstification at depth, which further enhances the permeability of these rocks. Because of the high frequency of fissures in this region, overall groundwater flow is thought to be of a diffuse nature, although solutionally enlarged conduits and cave systems do occur. Groundwater flow occurs in an upper shallow highly karstified weathered zone in which groundwater moves quickly in rapid response to recharge. Below this is a deeper zone where there are two components to groundwater flow. Groundwater flows through interconnected, solutionally enlarged conduits and cave systems that are controlled by structural deformation. In addition there is a more dispersed slow groundwater flow component in smaller fractures and joints outside the larger conduits. The water table is generally within 10 m of the surface, except for the more elevated parts of the limestone aquifers, and the typical annual fluctuation of the water table ranges up to 6 or 7 m (Wright 1979). Owing to the limited extent of the aquifer, flow systems will be rather localised. Groundwater flow paths can hardly be more than a kilometre long, and may be significantly shorter in areas where the water table is very close to the surface. Regional groundwater flow is towards the Blackwater River. The limestones in this body are frequently overlain by alluvial deposits which are in hydraulic continuity with the underlying bedrock. Where present they may provide a pathway for recharge to the karstic aquifer and where additional storage for the underlying bedrock aquifer.
Groundwater & Surface water interactions	The nature of the karstic system may leads to rapid interchanges of water between surface and underground. Swallow holes and caves may receive surface water, and groundwater discharges to surface as springs or as baseflow to the Blackwater River.
Conceptual model	• This small GWB occupies the floor of an elongate east west trending valley in northwest Cork. The body is generally flat to gently undulating (75-110 m OD). • The GWB is bounded to the north and south by the contact with the low permeability sandstones and mudstones of the Rathmore and Glenville GWBs respectively. • The GWB is composed mainly of diffusely karstified, highly permeable pure limestones with some impure limestone on the southern margins of the body. To the north and south of the body are uplands of low permeability sandstones. • The regional structural deformation that created the characteristic South Munster sandstone ridge (anticline)-limestone valley (syncline) topography was accompanied by intense fracturing and high frequency jointing (N-S jointing dominates) within the limestone synclines. Subsequent karstification of these openings has significantly enhanced the permeability of the pure limestones. A few Karst features (caves, springs) are known in this GWB. Karstification is known to extend well below present sea levels, and is estimated to extend to depths of 50 to 60 m below O.D. Malin Head. • Groundwater flows through the many faults and joints subsequently enlarged by karstification. Most groundwater flow probably occurs in an upper shallow highly karstified weathered zone of a few metres thick in which groundwater moves quickly in rapid response to recharge. Below this is a deeper zone where there are two components to groundwater flow. Groundwater flows through interconnected, solutionally enlarged conduits and cave systems that are controlled by structural deformation (influence of N-S jointing). In addition there is a more dispersed slow groundwater flow component in smaller fractures and joints outside the larger conduits. Generally this connected fractured zone extends to about 30 mbgl in pure limestones, however in the pure bedded limestones of South Munster, deep inflows from major zones of fissuring have been encountered to 40-50 mbgl. • Groundwater in this body is probably unconfined. The water table is generally less than 10 metres below the surface with an average annual fluctuation up to 6 metres. Groundwater gradients may be very low in the permeable limestones (0.001-0.002). The highly permeable aquifer can support regional scale flow systems. Groundwater flow paths will probably be short because of the narrowness of the valley. Overall groundwater flow is to the Blackwater River. • Recharge to this GWB is both point and diffuse. The uplands to the north and south of this GWB (Rathmore and Glenville GWBs) provide runoff which supplies recharge to the limestone aquifer in the valley. There is no known field evidence for point recharge but some may occur. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. A relatively small volume of groundwater may cross as through-flow into this GWB from the adjacent low transmissivity GWBs. • There are few areas of Extreme Vulnerability within this GWB. In a highly karstified aquifer such as this GWB the underlying limestone will have a very irregular surface. Subsoil depths in this GWB can therefore be highly variable within short distances. In general, vulnerability is probably High to Moderate. There may be a high degree of interaction between surface water and groundwater in this GWB. Swallow holes and caves may receive surface water, and groundwater discharges to surface as springs or as baseflow to the Blackwater River.
Attachments	
Instrumentation	**Stream gauges:** **EPA Water Level Monitoring boreholes:** ? **EPA Representative Monitoring points:** CON 62 (Millstreet WS)
Information Sources	Farrington A (1959) *The Lee Basin Part one: glaciation.* Proc. R. Ir. Acad. 60B (3), 135-166. Pracht M (1997) *Geology of Kerry-Cork. A geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 21*. Geological Survey of Ireland, 70pp Wright GR (1979*) Groundwater in the South Munster Synclines.* In: Hydrogeology in Ireland, Proceedings of a Hydrogeological Meeting and associated Field Trips held in the Republic of Ireland from 22 to 27 May, 1979. Published by the Irish National Committee of the International Hydrological Programme.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Banteer GWB (For Reference)



List of Rock units in Banteer GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Dinantian Limestones (undifferentiated) (DIN)	Undifferentiated limestones	Dinantian Pure Unbedded Limestones	Rk^d
Waulsortian Limestones (WA)	Massive unbedded fine-grained limestone	Dinantian Pure Unbedded Limestones	Rk^d
Ballysteen Formation (BA)	Fossiliferous dark-grey muddy limestone	Dinantian Lower Impure Limestones	Ll
Lower Limestone Shales (LLS)	Sandstone, mudstone and thin limestone	Dinantian (early) Sandstones, Shales and Limestones.	Pl