

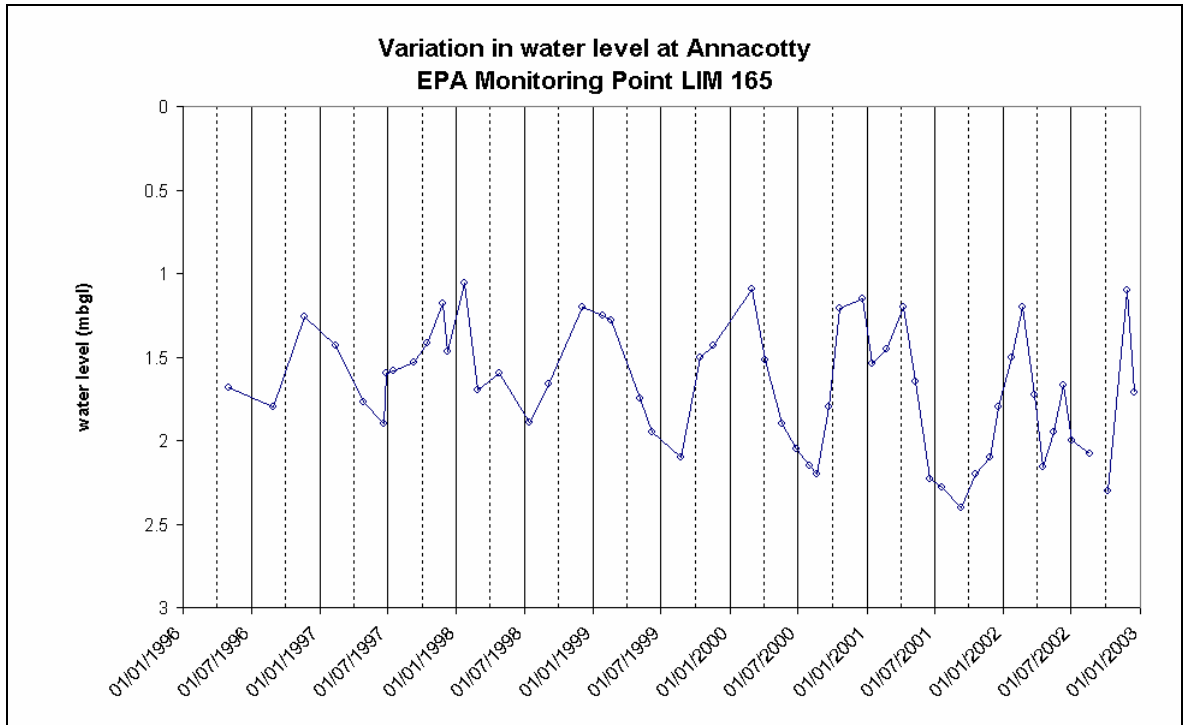
Castleconnell GWB: Summary of Initial Characterisation.

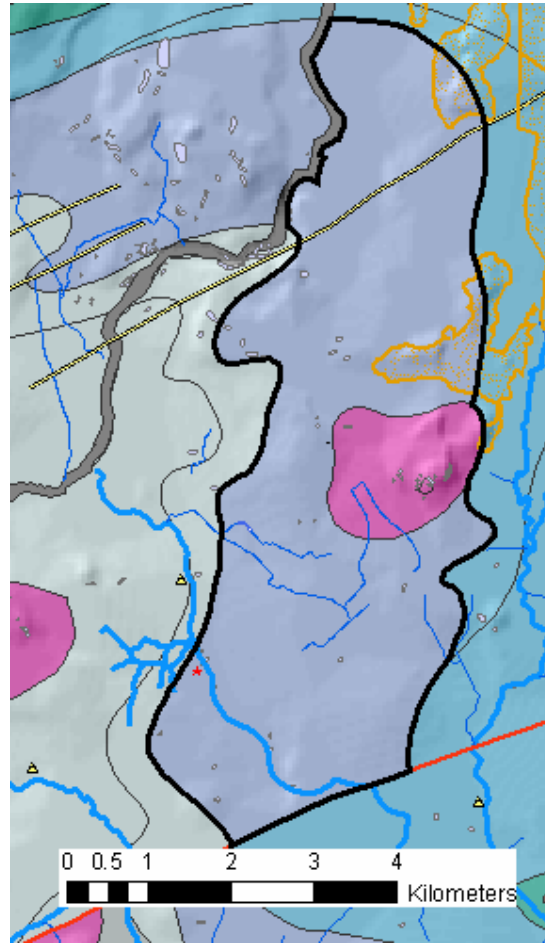
Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km ²)
25 - Mulkear/ Lower Shannon catchment Limerick Co. Co.		Rivers: Shannon, Mulkear.		25
Topography	This narrow GWB is elongated in N-S direction, and is about 9.5 km long by 3 km wide. In general, the ground is 20–40 mAOD, and flat-lying to gently undulating. Ground elevation within the GWB ranges from 20 mAOD along the Shannon and lower reaches of the Mulkear to 81 mAOD at Knockbrack. The highest ground occurs in the east of the GWB, on higher ground underlain by volcanic rocks. Drainage density is low over most of the GWB, but higher just south of the centre of the GWB, near to the Volcanic rocks.			
Geology and Aquifers	Aquifer categories	The GWB comprises predominantly an Rk ^d . Regionally important karstified aquifer dominated by diffuse flow. An area about 2km ² of volcanic rock occurs in the east of the GWB; it is currently classified as an Lm : Locally important aquifer which is generally moderately productive.		
	Main aquifer lithologies	Dinantian Pure Unbedded Limestones predominate in this GWB. There is an area of Basalts and other Volcanic Rocks in the centre-east of the GWB.		
	Key structures	The rocks of this GWB occur on the SE limb of a WSW-plunging syncline. Bedding dips generally NE at low angles of approximately 10-20°. There are minor folds mapped in the northern part of the GWB. Fractures and joints may be more open on the axis of the minor anticlines. Conversely, fractures may be closed in the minor synclines and in the north of the GWB, which is near the major fold axis.		
	Key properties	Transmissivities in diffusely karstified aquifers are in the range 20–2000 m ² /d. In this area of the country, the median value will probably be towards the lower-middle end of the range. At Croom and Fedamore WSs in the nearby Fedamore GWB, transmissivities are 120 m ² /d [estimate range 95–145 m ² /d] and 34 m ² /d [estimate range 23–41 m ² /d], respectively. Groundwater gradients within the karstic aquifer are low, ranging from approximately 0.005 to 0.01. Storativity in this aquifer is low (effective porosity ~1.5-2.5%). Transmissivities in the volcanic rocks are variable; in places, clays from weathering after their deposition have blocked the fissures; in other areas, these weathering products have been washed out of the fracture system. Transmissivities will be in the range 2–100 m ² /d. Groundwater gradients can be up to 0.05 in these rocks, since they tend to form higher ground with steep slopes. <i>(data sources: Rock Unit Group Aquifer Chapters, Limerick GWPS and Source Reports, see references; estimates from maps)</i>		
Thickness	The Dinantian Pure Unbedded Limestones attain maximum thicknesses of more than 1200 m. However, most groundwater flows in an epikarstic layer a few metres thick and in a zone of interconnected solutionally-enlarged fissures and conduits extending about 30 m below this. Deeper groundwater flows can occur along fault zones. On Aughinish island, on the south side of the Shannon Estuary, there are very deep (~ 60 mbsl) conduits that relate to an ancient baselevel. There may be such conduits in this area, but they are not known; field work would be required to confirm their presence or otherwise. Two boreholes in the adjacent GWB with low yields and big drawdowns had inflows between around 75 mbgl and 115 mbgl. The low yields indicate flow through small fissures, not conduits. Within the volcanic rocks, most groundwater flux is likely to be in the top ≤ 20 m, this zone comprising a weathered layer of a few metres and a connected fractured zone below this, although more isolated water-bearing fractures or faults can be intercepted at greater depths.			
Overlying Strata	Lithologies	The GWB is mainly covered by Limestone Till subsoils. There are small pods of gravel and of Undifferentiated Alluvium within the Till that are separately mapped. At the foot of the hill underlain by volcanic rock, on the eastern side, there are Peat deposits, together with a complex assemblage of Alluvium, and Limestone Till. Parts of the Gardenhill and Gooig Gravel GWBs overlie the NE of this GWB.		
	Thickness	There are few data available for this area. Rock outcrops are small and scattered, occurring only in the centre and south of the GBW, excepting along the River Shannon in the north of the GWB. Available thickness data indicate subsoils thicknesses in the range 7-24 m.		
	% area aquifer near surface	<i>[Information to be added at a later date]</i>		
	Vulnerability	Groundwater vulnerability over most of the GWB is High. There are small areas of Extreme vulnerability in the areas where rock outcrops. In the NE of the GWB, there is an area of Moderate vulnerability.		
Recharge	Main recharge mechanisms	Diffuse recharge will occur over most of the GWB via rainfall soaking through the subsoil and directly to the aquifer via outcrop. The epikarst redistributes diffuse recharge in the subsurface. The lack of surface drainage over most of this GWB indicates that potential recharge readily percolates into the groundwater system. However, in low-lying areas with a high water table in this highly transmissive aquifer, there may be some rejected recharge, i.e. a proportion of the effective rainfall is rejected due to lack of storage space in the aquifer. Linear recharge may occur along losing river stretches where the Mulkear River crosses onto this GWB from the low transmissivity GWB to the south and east.		
	Est. recharge rates	<i>[Information to be added at a later date]</i>		

Discharge	Important springs and high yielding wells (m ³ /d)	There are no High yielding springs (>2,160 m ³ /d) or Excellent (>400 m ³ /d) wells known in this GWB. Near Annacotty, Limerick Horsepackers Ltd. abstract 136 m ³ /d from a 57 m deep borehole, indicating at least a Good (100 m ³ /d < yield < 400 m ³ /d) yield.
	Main discharge mechanisms	The main discharges are to the streams crossing the aquifer, and to the River Shannon in the NW of the GWB and the Mulkear River in the south of the GWB. There is probably some cross-flow from this GWB to the lower transmissivity pure bedded limestone aquifer of the Limerick East GWB.
	Hydrochemical Signature	There are no data available to assess this GWB. The hydrochemistry of groundwaters from the nearby Fedamore GWB indicates Very Hard (370–430 mg/l as CaCO ₃), calcium-bicarbonate type waters with high alkalinities (330–380 mg/l as CaCO ₃) and electrical conductivities, and neutral pHs. Conductivities range between 720–900+ µS/cm. In general, background chloride concentrations will be higher than in the Midlands, due to proximity to the sea.
Groundwater Flow Paths		<p>The limestone rocks are devoid of intergranular permeability; groundwater flows through a diffuse network of solutionally-enlarged fissures and small conduits, and along faults. Dissolutional enlargement of joint, fracture and fault planes is the major mechanism that has created permeability. Groundwater is likely to flow in two main hydrogeological regimes:</p> <p>(1) an upper, shallow, highly karstified weathered zone, known as the epikarst, in which groundwater moves quickly, through solutionally enlarged conduits, in rapid response to recharge;</p> <p>(2) a deeper zone, where a dispersed slow groundwater flow component in smaller fractures and joints outside the main conduit systems.</p> <p>In some areas, the aquifer may be highly karstified, with groundwater flowing through interconnected, solutionally enlarged conduits and cave systems. These localised high permeability zones can give rise to rapid groundwater velocities.</p> <p>The GWB is considered to be unconfined. It is considered that the rivers and streams are in hydraulic continuity with the aquifer. Therefore, they represent the water table elevation. Near streams and rivers, water levels should be within 2 m of ground level. Figure 1 shows a hydrograph from a borehole near Annacotty that is situated near to the Mulkear River. The seasonal water level variation is less than 1 m. In relatively elevated areas between rivers, the water table may be considerably deeper, giving significant unsaturated zones. The water table is likely to generally follow the topography.</p> <p>Groundwater flow paths in this GWB are generally long, and can be up to several km's long. Groundwater may also discharge locally to streams, however, if the topography is variable. In discharge zones, flow paths will be shorter, around 100–300 m. The regional groundwater flow direction in the northern half of the GWB is from south to north, to the River Shannon. In the south of the GWB, groundwater flows at an oblique angle to the Mulkear River. Groundwater may also flow westwards into the Limerick City East GWB. Local groundwater flow will be from the higher ground between surface water bodies to the streams.</p> <p>The epikarst is thought to be relatively modern, being formed after the last ice age, while the deeper karst is likely to be a remnant of not only recent solution, but also glacial and pre-glacial solution. The groundwater flow regimes will be hydraulically connected, with the degree of interconnection depending on the faults and joints associated with the structural deformation. Groundwater flux is thought to be concentrated in the top 30 m or so of the aquifer.</p> <p>In the volcanic rocks, groundwater flow occurs in fractures, joints and faults. Where clayey weathering products or alteration minerals occur, this may block the flow conduits, unless they have been flushed from the system by high groundwater gradients in the hilly terrain. In the zones where the fractures and joints are not clogged with clays, transmissivities can be relatively high. Groundwater is unconfined; the water table follows the topography and significant unsaturated zones occur in elevated areas. In general, flows in the aquifer are likely to be concentrated in a thin zone near the top of the rock; the weathered zone may be up to 3 m thick, with a connected fractured zone a further 15-20 m, below which is a generally poorly fractured zone</p>
Groundwater & Surface water interactions		<p>There is an effective hydraulic interconnection between groundwater and surface water in the karst limestone. Groundwater is discharged to the surface as baseflow to streams and rivers crossing the GWB, and to the River Shannon at the NW of the GWB.</p>

Conceptual model	<ul style="list-style-type: none"> • The terrain in this GWB is flat-lying to gently undulating. Ground elevation is slightly higher in the east, and in the centre of the GWB at the hill underlain by volcanic rocks. It is bounded to the NW by the River Shannon. The northern, eastern and southern boundary is formed by the contact with the lower transmissivity rocks of the Lough Graney GWB. The southern/ SE boundaries are formed by the contact with the low transmissivity Lower Impure limestones of the Slieve Phelim GWB. The contact with the with the Pure Bedded Limestones of the Limerick City East GWB form the western margin. • The GWB mainly comprises diffusely karstified limestones in which groundwater is transmitted through a network of small conduits and fissures, and an epikarstic zone. The fault and fracture network and bedding-parallel pressure solution planes have been enlarged by dissolution, resulting in a highly transmissive aquifer with rapid groundwater flow in which the more permeable zones have specific orientations. In the relatively lower transmissivity volcanic rocks, groundwater flow occurs in fractures, joints and faults. The aquifers have low storativity. • Recharge occurs diffusely through the subsoils or at rock outcrop. Linear recharge may occur along losing river stretches where the Mulkear River crosses onto this GWB from the low transmissivity GWB to the south and east. Potential recharge may be rejected in areas where the water table is very close to the surface. • Groundwater flux in this aquifer will be concentrated in an approximately 30 m zone at the top of the bedrock. This zone comprises an epikarstic layer of a few metres, below which is a network of diffuse solutionally-enlarged joints and small conduits, fractures and faults. Deeper groundwater flow can occur along permeable fault zones or deeper fractures. The volume of flow may be significantly less in these deeper systems, as evidenced by the poor yields and drawdown characteristics of boreholes in the adjacent GWB in which inflows were measured at around 75-115 m³/d. • It is possible that, as the focus of drainage, the area near to the River Shannon is more karstified than other parts of this GWB, thus affecting the distribution of transmissivity in the subsurface. • Most of the GWB is unconfined. Near rivers and streams, the water table is close to the surface. Beneath higher ground, significant unsaturated zones may exist. Water table fluctuations in discharge areas will be relatively low (on the order of 1-2 m) whereas, in the high ground underlain by volcanic rocks, the water table elevation may vary considerably. • Groundwater discharges to the rivers and streams crossing the GWB, and to the River Shannon in the NW. The regional groundwater flow direction in the north of the GWB is northwards, towards the Shannon. There is a groundwater divide in the GWB, with groundwater flowing at oblique angles to the Mulkear River in the south of the GWB, or northwards to the Shannon in the north of the GWB. Local groundwater flow directions are determined by topography and local drainage patterns. Flow path lengths are generally long (up to several km's). In discharge zones, flow paths will be much shorter, at around 100–300 m. • Rivers may be both losing and gaining, depending upon the location within the system, and also upon the time of year. The Mulkear is thought to be generally gaining.
Attachments	Groundwater hydrograph (Figure 1).
Instrumentation	EPA Water Level Monitoring boreholes: Annacotty (LIM 165).
Information Sources	<p>Deakin, J. and Daly, D. (2000) <i>County Clare Groundwater Protection Scheme</i>. Geological Survey of Ireland Report to Clare Co. Co., 67 pp.</p> <p>Deakin, J., Daly, D. and Coxon, C. (1998) <i>County Limerick Groundwater Protection Scheme</i>. Geological Survey of Ireland Report to Limerick Co. Co., 72 pp.</p> <p>Deakin, J. (1995) <i>Croom WS – Groundwater Source Protection Zones</i>. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp.</p> <p>Deakin, J. (1995) <i>Fedamore WS – Groundwater Source Protection Zones</i>. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp.</p> <p>Aquifer chapters: Dinantian Pure Unbedded Limestones.</p>
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Figure 1: Groundwater hydrograph





Rock units in GWB

Rock unit name and code	Description	Rock unit group
Waulsortian Limestones (WA)	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones
Tuff (Tu)		Basalts and other Volcanic rocks