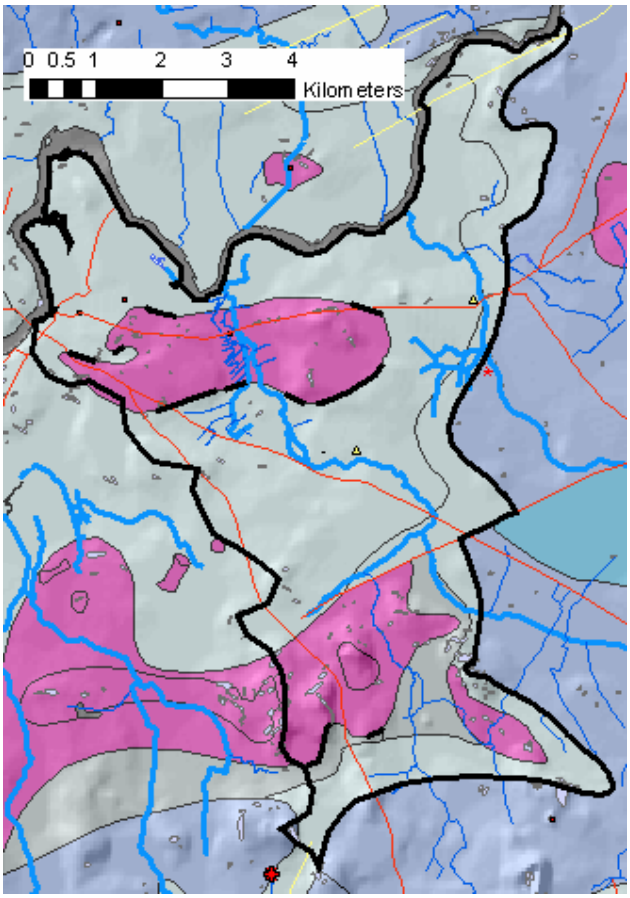
Limerick City East GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
25 - Shannon Estuary Limerick Co. Co.	Rivers: Shannon, Mulkear, Groody.	None.	46

Topography	Ground elevation generally increases from north to south. Much of the GWB is low-lying, with elevations ranging from < 10 mAOD to about 40 mAOD in areas underlain by the pure bedded limestones. Higher ground occurs in the areas underlain by volcanic rocks; in the west of the GWB, elevations range from 10-50 mAOD, whilst in the south, ground underlain by volcanics ranges from 30-90 mAOD in elevation. The highest ground is found along the western and SW boundary of the GWB. The land is poorly drained in the low-lying ground next to the lower reaches of the Groody River, and also along parts of the Mulkear River.	
Geology and Aquifers	Aquifer categories	The majority of the GWB comprises an **Lm:** Locally important aquifer which is generally moderately productive. The Basalts and other Volcanic rocks rock unit group is currently classified as **Lm**. In the south of the GWB there is a small area (2.5 km^2) of **Ll:** Locally important aquifer which is moderately productive only in local zones. There is a small area (< 0.1 km^2) in the SW of **Rk^d**: Regionally important karstified aquifer dominated by diffuse flow.
	Main aquifer lithologies	Dinantian Pure Bedded Limestone is the major rock unit group in the GWB. There are smaller but significant areas of Basalts and other Volcanic rocks. In the very SW of the GWB, there is a very small area (< 0.1 km^2) of Dinantian Pure Unbedded Limestone. In the south of the GWB, there is approximately 2.5 km^2 of Dinantian Upper Impure Limestones.
	Key structures	The rocks form part of the core and southern limb of a large syncline, whose axis is oriented ENE-WSW. Bedding dip angles range between 5° to 15° and are generally to the NW. Minor folds associated with the major structure are present. An ENE-WSW trending fault is mapped in the southern part of the GWB, juxtaposing volcanic and pure bedded limestones. Other, unmapped, faults are likely.
	Key properties	Transmissivities are likely to be in the range 5-150 m^2/d, with the median value towards the lower-middle end of the range. Transmissivity in the similar limestone aquifer of the Pallas Grean GWB, 15 km to the SE, was estimated as 26 m^2/d. In the Volcanic rocks, transmissivities will be similar, with median values towards the lower end of the range. Transmissivity in the Volcanic rocks in this area may be variable: in some zones, columnar cooling joints provide a connected pathway for groundwater flow. In other parts, alteration of the rocks during their emplacement in shallow seas, or subsequent weathering during subaerial exposure in a tropical environment may have clogged potential flow pathways (both cooling joints and tectonic fractures) with clays. At Herbertstown WS in the nearby Knockroe SW GWB, transmissivity is about 100 m^2/d. However, there are failed wells known in this rock unit group. Transmissivity in the Upper Impure Limestones will be significantly lower, in the range 5-20 m^2/d. Groundwater gradients in low-lying areas will be low (~0.005-0.01), ranging up to 0.03 in the steeper areas. *(data sources: Rock Unit Group Aquifer Chapters, GWPS Reports, Source Reports, see references; estimation from maps)*
	Thickness	The Dinantian Pure Bedded Limestones vary laterally in maximum thicknesses from 150 m to up to 500 m. However, most groundwater flow is likely to take place in the top ~30 m, in the zone that comprises a weathered layer of a few metres (epikarst) and a connected fractured layer below this. Deeper groundwater flow occurs along fault zones and large fractures. In the volcanics, most groundwater flux is likely to be in the top ≤ 20-30 m, in the zone comprising a weathered layer of a few metres and a connected fractured zone below this. However, more isolated water-bearing joints or faults can be intercepted at greater depths. In the lower transmissivity impure limestones, groundwater flux will be concentrated in the upper ~ 15 m of the aquifer, in a weathered zone of a few metres and connected fractured layer below this.
Overlying Strata	Lithologies	The GWB is mainly covered by Limestone Till subsoils. Undifferentiated Alluvium occurs along the River Groody, and there areas of river gravel mapped along the Groody and Mulkear Rivers. A significant gravel area occurs in the east of the GWB, where the Mulkear River is joined by several tribuataries. A significant proportion of the north part of the GWB is covered by the made ground of Limerick City and its suburbs.
	Thickness	Subsoil thickness data are sparse. Available data indicate thickness in the range 2-23 m. There is outcropping rock and 'rock close' particularly in the elevated areas and on local high points within the GWB.
	% area aquifer near surface	*[Information will be added at a later date]*
	Vulnerability	Groundwater vulnerability is Extreme and High. Extreme vulnerability occurs in more extensive areas over the Volcanic rock aquifers in the north and south of the GWB, and only in small isolated areas over the limestone aquifers. The aquifers in the remainder of the GWB are Highly vulnerable.
Recharge	Main recharge mechanisms	Diffuse recharge will occur over most of the groundwater body via rainfall soaking through the subsoil and directly to the aquifer via outcrop. Where the water table is very close to ground surface, recharge may be rejected. Recharge will be inhibited in urban, paved areas.
	Est. recharge rates	*[Information will be added at a later date]*

Discharge	Important springs and high yielding wells (m^3/d)	There are no Excellent yielding boreholes (> 400 m^3/d) known in the GWB. No significant springs are known. Two boreholes, at Dawn Dairies in the pure bedded limestones and at Cahernarry Group Water Scheme in the volcanics, are known to have yields at the lower end of the 'Good' yield range (100 m^3/d < yield < 400 m^3/d).
	Main discharge mechanisms	The main discharges are to the streams and rivers crossing the GWB, and to the River Shannon that forms the northern boundary of the GWB. Regions in which groundwater is discharging are indicated by higher stream densities, i.e. near Newtown and Singland, in the north of the GWB.
	Hydrochemical Signature	No relevant hydrochemical data are available for the limestone aquifer in this GWB for assessment. By analogy with other pure limestone aquifers, the groundwater is likely to be hard to very hard, with corresponding high alkalinity and conductivity, and a neutral pH. It is likely to have a calcium–bicarbonate signature. Water quality data from volcaniclastic aquifers in nearby GWBs indicate conductivities of between 470–700 µS/cm. In general, background chloride concentrations will be higher than in the Midlands, due to proximity to the sea.
Groundwater Flow Paths		These rocks are devoid of intergranular permeability; groundwater flow occurs in fractures and faults. In the pure limestone aquifers, groundwater flows through an epikarstic layer and a zone in which fractures are more dense and open. The epikarst is thought to be relatively modern, being formed after the last ice age. The groundwater flow regimes in the epikarst and fractured zones will be hydraulically connected, with the degree of interconnection depending on the faults and joints associated with the structural deformation. Within the volcanic rocks, groundwater flows through the weathered zone and the connected fractured zone below this. Groundwater flows through fractures and faults and may also flow through primary structures formed when lava flows cooled causing jointing. Groundwater flux is thought to be concentrated in the top 30 m or so of the aquifer, with the exception of in the impure limestones, in which groundwater flow is generally shallower. The GWB is considered to be unconfined, with the rivers and streams in hydraulic continuity with the aquifer, which therefore represent the water table elevation. Groundwater levels are generally shallow, ranging from near ground level near streams and rivers, up to 6-12 mbgl away from surface water bodies. The water table is likely to generally follow the topography. 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 E-W to northwards, oblique to the N-S flowing rivers, and northwards to the Shannon. Groundwater flow path lengths are on the order of 500–1500 m over the bulk of the GWB. In discharge zones, flow paths will be much shorter, at around 100–300 m.
Groundwater & Surface water interactions		Groundwater sustains flows in the gaining rivers and streams crossing the GWB. Groundwater will flow into the Inner River Shannon as direct baseflow, and via baseflow to Rivers Groody and Mulkear, which flow into the Shannon. Specific dry weather flows computed for stations at rivers in this GWB are moderate-high (0.44 and 5 $l/s/km^2$). This is thought to be due to the gravels and alluvium supporting baseflow along the rivers.
Conceptual model		• The groundwater body is bounded to the north by the River Shannon, to the east by the contact with the karstified Pure Unbedded Limestones of Castleconnell GWB, to the SE and south by the karstified Pure Unbedded Limestones of the Ballyneety GWB, and by a surface water catchment boundary which is an implied groundwater divide in the west. The terrain is gently undulating over much of the GWB, with small hills occurring in the north and the SW. • Groundwater flow occurs along fractures, joints and faults in the limestones and volcanic rocks. There is likely to be an epikarstic layer at the top of the limestones, which acts to redistribute recharge in the subsurface and, in high water table conditions, is a very high transmissivity layer. The aquifers have low storativity. • Recharge occurs diffusely through the subsoils and at outcrop. Potential recharge may be rejected in areas where the water table is very close to the surface. Recharge will be inhibited by urban made ground in the north of the GWB. • Groundwater flux in the limestone 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 joints, fractures and faults. Deeper groundwater flow can occur along permeable fault zones or deeper fractures. The flow regime in the volcanic aquifer is similar, excepting the epikarstic layer. • The aquifers in the GWB are unconfined in the main. Near rivers and streams, the water table is close to the surface. Beneath higher ground, significant unsaturated zones may exist. Depending upon topography, the water table can vary between 2 metres up to ~15 m below ground surface. 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 or local topographic highs in the limestones, the water table elevation may vary considerably. • Flow path lengths are generally long (up to 1500 m). In discharge zones, flow paths will be much shorter, at around 100–300 m. On a local scale, groundwater discharges to the streams and smaller rivers crossing the aquifer. Local groundwater flow directions are determined by topography and local drainage patterns. Regional groundwater flow directions are roughly E-W to northwards, oblique to the major N-S rivers. • Groundwater discharges to the gaining rivers crossing the GWB, and the Shannon at the north of the GWB.

Attachments	None.
Instrumentation	Stream gauges: 25001*, 25012, 25061, 25076, 25151* *(Stations marked with * have specific dry weather flows calculated).*
Information Sources	Deakin, J. (1995) *Herbertstown Public Supply, Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 6 pp. Deakin, J., Daly, D. and Coxon, C. (1998) *County Limerick Groundwater Protection Scheme*. Geological Survey of Ireland Report to Limerick Co. Co., 72 pp. Deakin, J. and Daly, D. (2000) *County Clare Groundwater Protection Scheme.* Geological Survey of Ireland Report to Clare Co. Co., 67 pp. Aquifer Chapters: Dinantian Pure Bedded Limestones, Basalts and other Volcanic rocks, Dinantian Upper Impure Limestones, Dinantian Pure Unbedded Limestones.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae



Rock units in GWB

Rock unit name and code	Description	Rock unit group
Visean Limestones (Undifferentiated)		Dinantian Pure Bedded Limestones
Lough Gur Formation (LR)	Pale cherty crinoidal limestone	Dinantian Pure Bedded Limestones
Volcaniclastic Rocks (V)		Basalts and other Volcanic rocks
Basalt (B)		Basalts and other Volcanic rocks
Rathkeale Formation (RK)	Dark muddy limestone & shaly mudstone	Dinantian Upper Impure Limestones
Waulsortian Limestones (WA)	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones