Bruree GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km²)
24 - Maigue Catchment Limerick Co. Co.		River: Maigue.	-	28.6
Topography	The groundwater body is elongated in an ENE-WSW direction along a slightly elevated ridge. The highest elevations are 125 mAOD west of Bruree and 103 mAOD east of Bruree. The River Maigue flows roughly N-S across the GWB at Bruree, where the elevation is approximately 50 mAOD. The area is well drained; streams generally flow off the lower parts of the GWB where they ultimately drain into the River Maigue.			
Geology and Aquifers	Aquifer categories	**Rf:** Regionally important fissured aquifer.		
	Main aquifer lithologies	Devonian Kiltorcan-type Sandstones underlie the centre of the GWB; Dinantian (early) Sandstones, Limestones and Shales underlie the outer margins of most of the GWB.		
	Key structures	The major structure is formed by the core of a large anticline that is orientated ENE-WSW. Major N-S, NE-SW and NW-SE trending faults cross-cut the fold axis. There are also faults parallel to the fold axis. Compression during the folding caused fracturing and jointing of the rocks. The beds dip outwards around the entire GWB at angles of 10-20°.		
	Key properties	The transmissivity in this rock unit group generally ranges from 40 to 100 m^2/d. Analyses of a pumping test at the Ballyagran WS provided transmissivities ranging from 94 to 196 m^2/d with 105 m^2/d appearing to be the best estimate. At Bruree WS, analysis of a 10-hour pumping test gave a transmissivity of 132 m^2/d [range 54–151 m^2/d]. However, water levels and water temperature measurements taken during the test indicated that a significant proportion of the supply is being contributed by the river. At Kilcoleman WS in the nearby Knockaderry GWB, a pumping test on the borehole provided transmissivities in the range 111–197 m^2/d with 154 m^2/d being the best estimate. At Clouncagh WS, also in Knockaderry GWB, analysis of the pumping test data gave a range of transmissivity values from 42–150 m^2/d, with a best estimate of 68 m^2/d. In these rocks, the specific yield is normally about 2%, but near the surface it can be as high as 5%. Groundwater gradients from the higher areas to the river valley are estimated to be approximately 0.04. *(data sources: Rock Unit Group Aquifer Chapters, Limerick GWPS and Source Reports, see references; estimation from maps)*		
	Thickness	The effective thickness of this aquifer is up to 200 m (i.e. the entire thickness of the rock unit groups forming the GWB). The upper 10 m may be more weathered and transmissive than the bulk of the aquifer. It becomes confined where it passes underneath the Ballysteen Formation (Dinantian Lower Impure Limestones).		
Overlying Strata	Lithologies	The dominant subsoils are light orange-brown clayey, stony deposits, with small sub-angular to angular limestone clasts; they are interpreted to be limestone tills. The area lies within the extensive ice marginal deposits in Limerick which stretch from the foot of the Galty Mountains, through south Limerick, and up towards Foynes. The deposits are typically quite thick, reaching 40 m in places, and they comprise a mixture of sands and gravels, silty sands, various tills and stiff clays. There is a channel of alluvium present along the course of the River Maigue. *[More information to be added at a later date]*		
	Thickness	The subsoil varies in thickness from about 3 m to more than 20 m. The thinner subsoils are found in the higher areas, where there are also small scattered outcrops. Deeper subsoils occur around the edges of the GWB, in the lower-lying areas.		
	% area aquifer near surface	*[Information to be added at a later date]*		
	Vulnerability	*[Information to be added at a later date]*		
Recharge	Main recharge mechanisms	Diffuse recharge will occur over the entire groundwater body via rainfall soaking through the subsoil, particularly in the higher areas where subsoils are thinner. A percentage of rainfall will not recharge the aquifer, but will runoff. Gravel lenses in the subsoils may contribute flow and storage to the bedrock aquifer.		
	Est. recharge rates	*[Information will be added at a later date]*		
Discharge	Springs and large known abstractions (m^3/d)	Bruree WS [410 m^3/d]; Ballyagran (Drewscourt/ Castletown) WS [1070 m^3/d] *[More information to be added at a later date]*		

Discharge	Main discharge mechanisms	There are numerous springs occurring to the east and west of Bruree village; these drain into the River Maigue. The streams and rivers crossing the GWB are gaining. Most of the streams originating as springs within the GWB have their origins in the lower-lying ground (<100 mAOD). Known springs occur in similarly low-lying ground (< 70 mAOD). Deakin (1995) considers that the small springs, rises and isolated ponds within the GWB are perched.
	Hydrochemical Signature	The hydrochemical analyses of groundwater at Ballyagran shows a mean conductivity of 650 µS/cm, with hardness in the region of 335 mg/l (as $CaCO_3$), and alkalinity approximately 310 mg/l (as $CaCO_3$). Electrical conductivities are also high at 640–760 µS/cm. Where there is mixing with surface water, such as at Ballingarry (in the adjacent Ballingarry GWB) and at Bruree WS in this GWB, these parameters have lower values. At the source in Bruree groundwater is hard (285–340 mg/l as $CaCO_3$), with moderately high alkalinity (280–295 mg/l as $CaCO_3$). pHs are neutral. All analyses are indicative of a calcium-bicarbonate type water which may either be a carbonate rich sandstone or which may lie at the softer end of the limestone carbonate water scale. (Where the aquifer is significantly confined, ion exchange may have taken place, altering the hydrochemical signature towards sodium-bicarbonate.) Iron can be a problem in the sandstone aquifers. Background chloride concentrations will be higher than in the Midlands, due to proximity to the sea. The bedrock strata of the Old Red Sandstone aquifer are **siliceous**, although they may have some carbonate cementing the sand grains. The Lower Limestone Shale rock unit (part of the Dinantian (early) Sandstones, Limestones and Shales rock unit group) is **calcareous**.
Groundwater Flow Paths		The rocks are devoid of intergranular permeability; groundwater flow occurs in fractures and faults. The fissuring associated with faults results in higher transmissivities, specific capacities and yields for some wells. The sandier units (at the top of the ORS and the base of the Lower Limestone Shales) are more prone to fracturing. In certain areas the rock cement has been dissolved and so the rock is crumbly and easily weathered. Here it may have intergranular permeability - a feature that is very unusual in Irish bedrock. The folding of the rock units renders the aquifer both confined and unconfined; groundwater flow is initially unconfined but, as it travels below thickening subsoils and then underneath the Dinantian Lower Impure Limestones (the Ballysteen Formation), it becomes confined. Water levels vary depending on topography, ranging from near surface to depths of over 20 m. The hydrograph shown in Figure 1 was measured in a well near the highest parts of the GWB, hence the water table ranges between 15-20 mbgl. Despite being near the presumed centre of the recharge mound, the seasonal water table fluctuation is only 5 m, indicating that the specific yield of the aquifer is not as low as most Irish aquifers. Artesian supplies may be obtained where boreholes penetrate the aquifer through the confining shaley beds of the overlying formations, or where subsoils are particularly thick and of low permeability. Confined groundwater circulating at depth discharges to the surface via large faults. Impermeable fault zones may also retard circulation, however, by isolating all or part of an aquifer block from another or by isolating the recharge area from the deepest parts of the formation. The general groundwater flow direction is naturally downhill radiating outwards in all directions (but mainly north- and southwards) from the high ground along the ridge.
Groundwater & Surface water interactions		The pumping test at Bruree WS indicates that pumping at the public water supply induces surface water to flow into the aquifer. Drainage on higher ground is good and there are no drainage ditches. Springs occurring on the hills slopes drain into the local streams. The larger streams crossing the GWB are considered to be in at least partial hydraulic continuity with the aquifer and gaining baseflow from the aquifer. Deakin (1995) considers that most of the small springs, rises and isolated ponds in the area are likely to be sourced from perched groundwater meaning that, in these areas, interaction between surface and groundwaters will be rapid.
Conceptual model		• The groundwater body is elongated ENE-WSW. It is bounded all around by the contact with the surrounding Dinantian Lower Impure Limestone (Ballysteen Limestone), under which the aquifer becomes confined. The upper units of the Lower Limestone Shales (the Ringmoylan Shales - unmapped as a separate unit in this area) also confine the aquifer. The area comprises small hills, ground elevation decreases outwards from the central ridge. • The groundwater body is comprised of high transmissivity fissured bedrock. The topmost unit of the Lower Limestone Shales (the Ringmoylan Shales) is shaley and low permeability. Specific yields in the sandstone are higher than most Irish bedrock aquifers. • Flow occurs along fractures, joints and major faults. In certain areas the rock cement has been dissolved and so the rock is crumbly and easily weathered. Here it may have intergranular permeability. The major faults may compartmentalise the aquifer in certain situations. • Recharge occurs particularly in the upland areas where rock outcrops or subsoils are thin. Groundwater discharges to the small streams emerging mid-way down the slopes. Groundwater can also discharge from depth, by flowing upwards along fault zones. Gravel lenses in the subsoils may contribute flow and storage to the aquifer. • Depending upon topography, the water table can vary between a few metres up to 20 m below ground surface. The aquifer becomes confined where it passes under the Lower Impure Limestones rock unit group, or under thick low permeability tills; here, wells are artesian. Groundwater flow follows topography, radiating outwards mainly to the north and south from the central ridge. Due to the shape of the GWB and the topography, flow path lengths in the unconfined areas are relatively short (≤ 400 m). Confined flow path lengths are considerably longer, and groundwater flow will be slow. There is evidence of some perching of groundwater. • Groundwater discharges to the rivers and streams crossing the aquifer, which are gaining, and near the contact with the overlying impure limestones. Groundwater may also discharge from depth, by flowing upwards along fault zones. Perched groundwater may feed small springs and streams emerging mid-way down the slopes. • The pumping test at Bruree WS indicates that pumping at the public water supply induces surface water to flow into the aquifer. • The Killacolla Gravel GWB slightly overlies this bedrock GWB in the very southwest.

Attachments	Groundwater hydrograph (Figure 1), Hydrochemical signature (Figure 2).
Instrumentation	Stream gauges: 24004. *(Adjusted Specific Dry Weather Flow calculated for this station).* EPA Water Level Monitoring boreholes: Dromin, near Bruff (LIM238) EPA Representative Monitoring boreholes: Castletown-Ballyagran (LIM7) (EPA grid refs incorrect).
Information Sources	Daly, E.P. (1985*). Hydrogeology of the Kiltorcan Aquifer System.* Groundwater Section, GSI Internal Report. Aquifer chapter: Devonian Kiltocan-type Sandstone. Daly, E.P. (1988) The Kiltorcan Sandstone Aquifer. Proceedings of *Eighth Annual International Association of Hydrogeologists (Irish Branch) Seminar, Portlaoise.* 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. (1995) *Ballyagran PS: Groundwater Source Protection Zones*, GSI Report to Limerick Co. Co., 11 pp. Deakin, J. (1995) *Bruree PS: Groundwater Source Protection Zones*, GSI Report to Limerick Co. Co., 6 pp. Deakin, J. (1995) *Ballingarry PS: Groundwater Source Protection Zones*, GSI Report to Limerick Co. Co., 6 pp. Aquifer chapters: Devonian Kiltorcan-type Sandstones; Dinantian (early) Sandstones, Limestones and Shales.
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

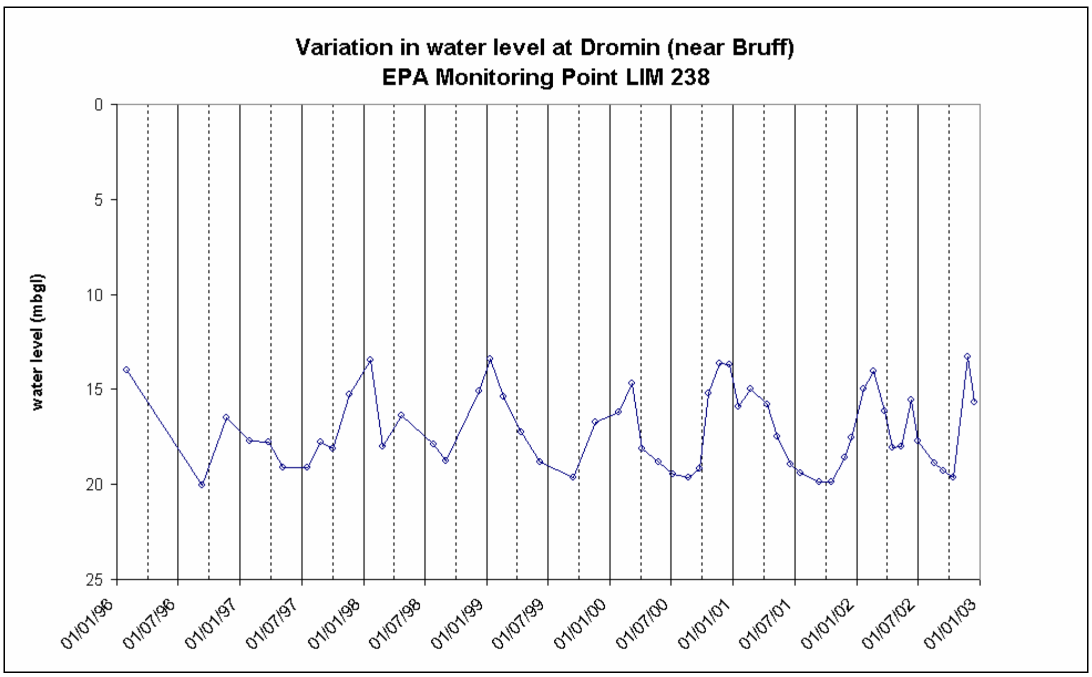
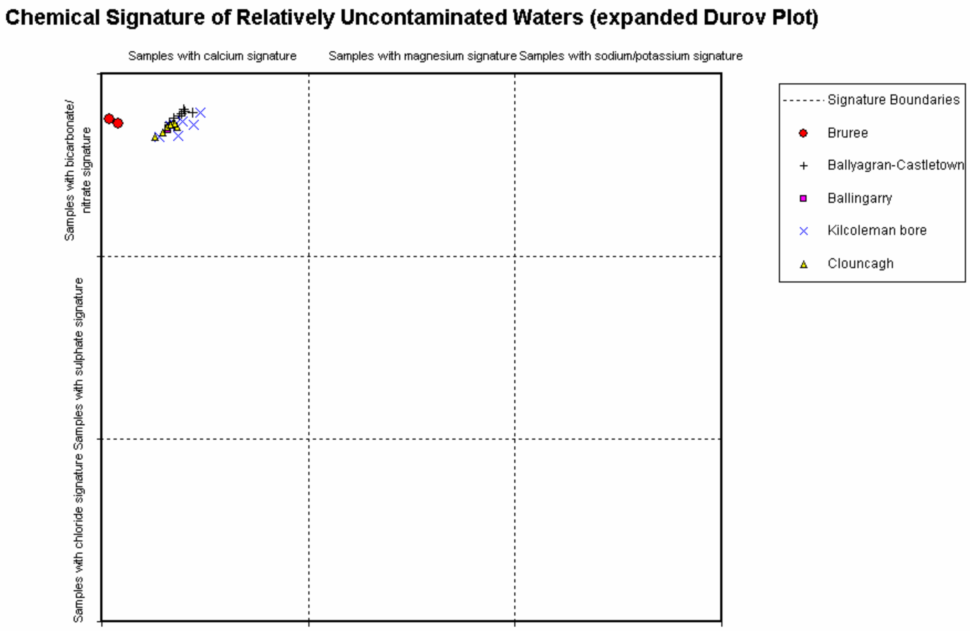
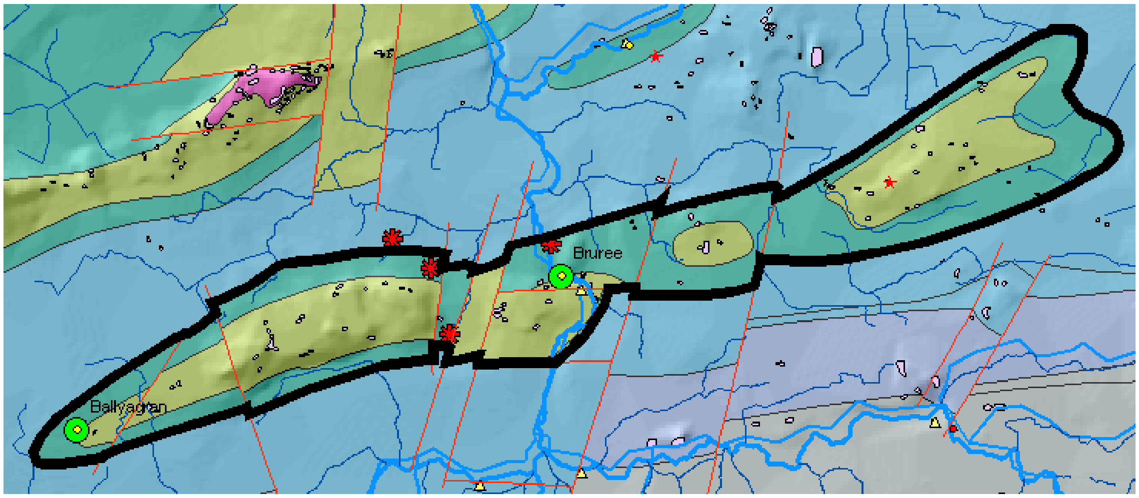


Figure 2: Hydrochemical signature



NB: data used to generate this plot are from Bruree, Ballingarry and Knockaderry GWBs.



Rock units in GWB

Rock unit name and code	Description	Rock unit group
Old Red Sandstone (undifferentiated) (ORS)	Red conglomerate, sandstone and mudstone	Devonian Kiltorcan-type Sandstones
Lower Limestone Shales (LLS)	Sandstone, mudstone and thin limestone	Dinantian (early) Sandstones, Limestones and Shales