## Charleville GWB: Summary of Initial Characterisation.

| Hydrometric Area<br>Local Authority | Associated surface water features | Associated terrestrial ecosystems | Area (km$^2$) |
|---|---|---|---|
| 24 - Maigue<br>Limerick, Cork, South Tipperary Co. Co.'s | Rivers: Maigue, Loobagh, Morningstar.<br>Streams: Charleville, Flemingstown. | No groundwater-dependent ecosystems. | 218 |

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| **Topography** | | This GWB is elongated ENE-WSW, and has an irregular southern boundary. Elevation ranges from about 70 mAOD along the centre of the northern boundary, to >510 mAOD at Seefin Mountain in the east. Most of the GWB is less than 130 mAOD. The higher ground (>190 mAOD) is underlain by the more resistant Silurian rock unit group and older Devonian rocks, whilst the lower ground is underlain by more easily-eroded impure limestones. The southern and eastern boundaries coincide with the boundary of the Shannon RBD. Drainage is poor. The rivers and their tributaries generally flow in a northerly direction, creating valleys in the bedrock in the upland areas. |
| **Geology and Aquifers** | Aquifer category(ies) | Most of the GWB comprises rocks that are **Ll** : Locally important aquifer which are moderately productive only in local zones. In the southeast, small areas of Devonian Kiltorcan-type sandstone are classified as **Rf:** Regionally important fissured aquifers. Namurian Shales in the southwest corner and thin bands of Dinantian (early) Shales in the southeast are classified as **Pl**: Poor aquifers which are generally unproductive except for local zones. Also, there is less than 1 km$^2$ of karstified limestone in the SE, and tiny areas in the NE of Volcanic rocks currently classified as a **Lm:** Locally important aquifer which is generally moderately productive. |
| | Main aquifer lithologies | The dominant rock unit groups in the northern part of the GWB are the Dinantian Upper Impure Limestones. In the southeastern part, Devonian Old Red Sandstones, Silurian Metasediments and Volcanics, and Dinantian Lower Impure Limestones predominate. Namurian Undifferentiated rocks occur in the southwest and centre. There are small areas of Dinantian (early) Sandstones, Shales and Limestones, Devonian Kiltorcan-type Sandstones, and Dinantian Pure Unbedded Limestones in the southern part of the GWB. In the northeast, there are tiny areas of Volcanic rocks. |
| | Key structures | The rocks within the north part of the GWB are on the southern limb of a major WSW-plunging anticline. Here, strata are tilted at about 35-45$^o$, to the southeast. There are likely to be smaller, parasitic folds on the larger structures. In the southeast of the GWB, south of the thin band of Namurian strata, there is a major thrust zone. The WSW-ENE thrust faults strongly deform and in some cases overturn the rocks. Fractures and joints are more open on the fold axes and will be more developed in the thrust zone. Faults oriented NE-SW and E-W cross-cut the rock units; because of the thickness of subsoil, not all structures are mapped. |
| | Key properties | Transmissivity in the Dinantian Upper Impure Limestones will be in the range 5-20 m$^2$/d, with water table gradients of up to 0.02. Gradients in the Dinantian Lower Impure Limestones are likely to be similar; transmissivities are usually in the range from 2-20 m$^2$/d, although their location within the thrust zone will have augmented fracturing and therefore transmissivity is likely to be higher (up to 80 m$^2$/d). Within the Namurian aquifer, transmissivity is in the range 2–20 m$^2$/d, with median values biased to the lower end of the range (Namurian strata aquifer chapter). Gradients are likely to be in the range 0.02 – 0.05, but may be steeper where confined conditions occur. A pumping test at Mortlestown, in the ORS, gave a transmissivity of 60 m$^2$/d. Within this GWB, transmissivities in the Devonian Old Red Sandstones are likely to be relatively high, in the range of 40-100 m$^2$/d, and possibly higher. This is because of their position within the thrust zone. Within the Silurian rocks in this area, transmissivities are in the range 30-80 m$^2$/d due to the thrust faulting; groundwater gradients are in the range 0.01-0.1, depending upon ground surface elevation.<br>*(data sources: Rock Unit Group Aquifer Chapters, Source Reports, see references; estimation from maps)* |
| | Thickness | Flow in the aquifer is likely to be concentrated in a thin zone at the top of the rock. In the Upper Impure Limestones, the effective thickness of this aquifer is likely to be ≤15 m, comprising a weathered zone of a few metres and a connected fractured zone below this. Isolated deeper fractures and fault zones may be intercepted. Within the thrust zone, the weathered zone may be up to 15 m thick in some places but will usually be on the order of a few metres, with a zone of well-fractured bedrock below this extending 15-20 m, and a final zone of poorly fractured bedrock up to 60 m thick where significant inflows can sometimes be encountered. Within the Namurian strata, confined conditions may occur in the more permeable layers. |
| **Overlying Strata** | Lithologies | *[Information to be added at a later date]* |
| | Thickness | Subsoil thickness is very variable, but is generally significant. On the lower slopes (<140 mAOD), subsoils are from 15 m to >50 m thick. (Subsoil thicknesses can be up to 79 m, but these values may include broken rock, due to proximity to the thrust.) On the higher slopes, the few depth to bedrock data indicate subsoil thicknesses of 4-10 m. Outcrops are confined, in the main, to river valleys or ridges between them, and mainly occur along the northern boundary of the GWB, or in the uplands over the Silurian and ORS rock units in the southeast. |
| | % area aquifer near surface | *[Information to be added at a later date]* |
| | Vulnerability | *[Information to be added at a later date]* |

<table>
<tr><td rowspan="2">Recharge</td><td>Main recharge mechanisms</td><td>Diffuse recharge will occur over the south part of the groundwater body via rainfall soaking through the subsoil or directly into the aquifer where rock is at the surface. In the lower parts of the GWB, subsoil is thick and will probably prevent recharge occurring via infiltrating rainfall over most of this area.</td></tr>
<tr><td>Est. recharge rates</td><td>[Information to be added at a later date]</td></tr>
<tr><td rowspan="3">Discharge</td><td>Springs and large known abstractions ($m^3/d$)</td><td>Mortlestown WS (360 $m^3/d$), Golden Vale Food Products x 3 (unknown), Martinstown (Cush) GWS (unknown), Kilmallock GWS (364 $m^3/d$ – spring, may be fed from perched groundwater), Ballinmona GWS (131 $m^3/d$), Ballinvreena GWS (unknown).<br><br>[More information to be added at a later date]</td></tr>
<tr><td>Main discharge mechanisms</td><td>The main discharges are to the streams and rivers crossing the upland aquifers, and to springs. In the lowland areas, where subsoils are generally thick, groundwater discharge to the rivers will occur along limited stretches of the rivers and occasionally to springs. There may be a small volume of cross-flow from this GWB to the karstic North Kilmallock GWB that lies immediately to the north.</td></tr>
<tr><td>Hydrochemical Signature</td><td>The lower and upper impure limestone aquifers that form the bulk of the GWB have a calcium-bicarbonate signature, are hard (280-360 mg/l $CaCO_3$) and alkaline (240-290 mg/l $CaCO_3$), with high conductivities (630-660 µS/cm). Both iron and manganese can exceed allowable concentrations, with these components coming from the shales. Hydrogen sulphide may be problematic. The bedrock strata of these aquifers are calcareous. Groundwaters in the Namurian rocks are slightly hard and have moderate alkalinities (no data for this aquifer exist in this GWB). Both iron and manganese can exceed allowable concentrations, these components coming from the shales. Reducing conditions may occur. Hydrochemical signatures varying from Ca-$HCO_3$ to Na/K-$HCO_3$ and alkalinities greater than total hardness can occur. This is typical of confined waters where ion exchange has occurred. The bedrock strata of this aquifer are siliceous. In the Old Red Sandstones and Silurian rocks, groundwaters measured in this GWB have moderate hardness (160-220 mg/l $CaCO_3$), alkalinity (160-240 mg/l $CaCO_3$) and conductivity (360-410 µS/cm). The groundwater has a calcium-bicarbonate signature, which is likely to have been affected by carbonate in the subsoils. The bedrock strata of these aquifers are siliceous. Background chloride concentrations may be higher than in the Midlands, due to proximity to the sea.</td></tr>
<tr><td colspan="2">Groundwater Flow Paths</td><td>These rocks are devoid of intergranular permeability; groundwater flow occurs in faults, fractures and joints. Over most of the GWB, flows in the aquifer are generally concentrated in a thin zone at the top of the rock; the weathered zone may be up to 3 m thick, with a connected fractured zone a further 10-15 m, below which is a generally poorly fractured zone. In the southeast of the GWB, the weathered and connected fracture zones extend deeper, due to the high deformation within the thrust zone.<br><br>Within the Upper Impure Limestones (in the north of the GWB), groundwater levels generally range from between 5-15 mbgl, with the majority of values less than 9 mbgl. Deeper groundwater levels of around 20 mbgl are found just east of Charleville. Water levels are closer to the surface near the northern edge of the GWB, indicating a potential discharge zone near the junction with the North Kilmallock GWB. A hydrograph from a well in this area (shown below) displays a seasonal variation of about 2 m. In the low-lying areas, subsoils are thick and the dug wells are drawing water from perched water tables within the subsoils. Groundwater is frequently confined by the subsoils in this area, although unsaturated zones do exist in some areas.<br><br>In the upland areas, groundwater is unconfined. The water table ranges from ground level to more than 20 mbgl. Most groundwater levels are between 2-12 mbgl, with a median value of about 7 mbgl. Water levels are deeper (5-17 mgbl) in the highest areas than in the rest of the GWB. Dug wells in this area are probably tapping the true water table, and are sited in areas where it is close to the surface. Compartmentalisation due to faulting is indicated by two water level measurements of 22 mgbl measured in wells in Lower Impure Limestones.<br><br>Groundwater flow is influenced by topography and most flow is of a local nature. Unconfined groundwater flow paths are short (30-300 m), with groundwater discharging to the streams. Confined flow paths may be significantly longer. Overall, the groundwater flow direction is northwards.</td></tr>
<tr><td colspan="2">Groundwater & Surface water interactions</td><td>Where subsoil is not thick, due to the shallow nature of the groundwater flow in this GWB the groundwater and surface waters are closely linked. The streams and rivers crossing the aquifers in the uplands of the GWB are gaining. Rivers crossing the northern parts of the GWB may be in hydraulic connection with the groundwater along only parts of their lengths.</td></tr>
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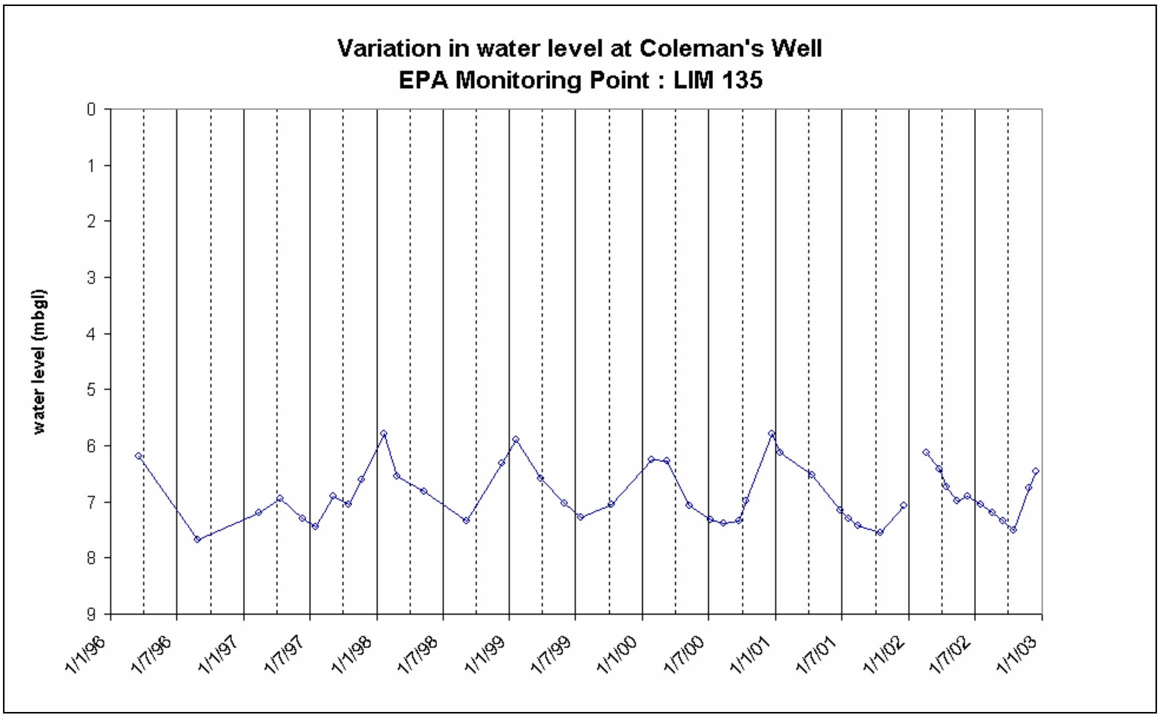
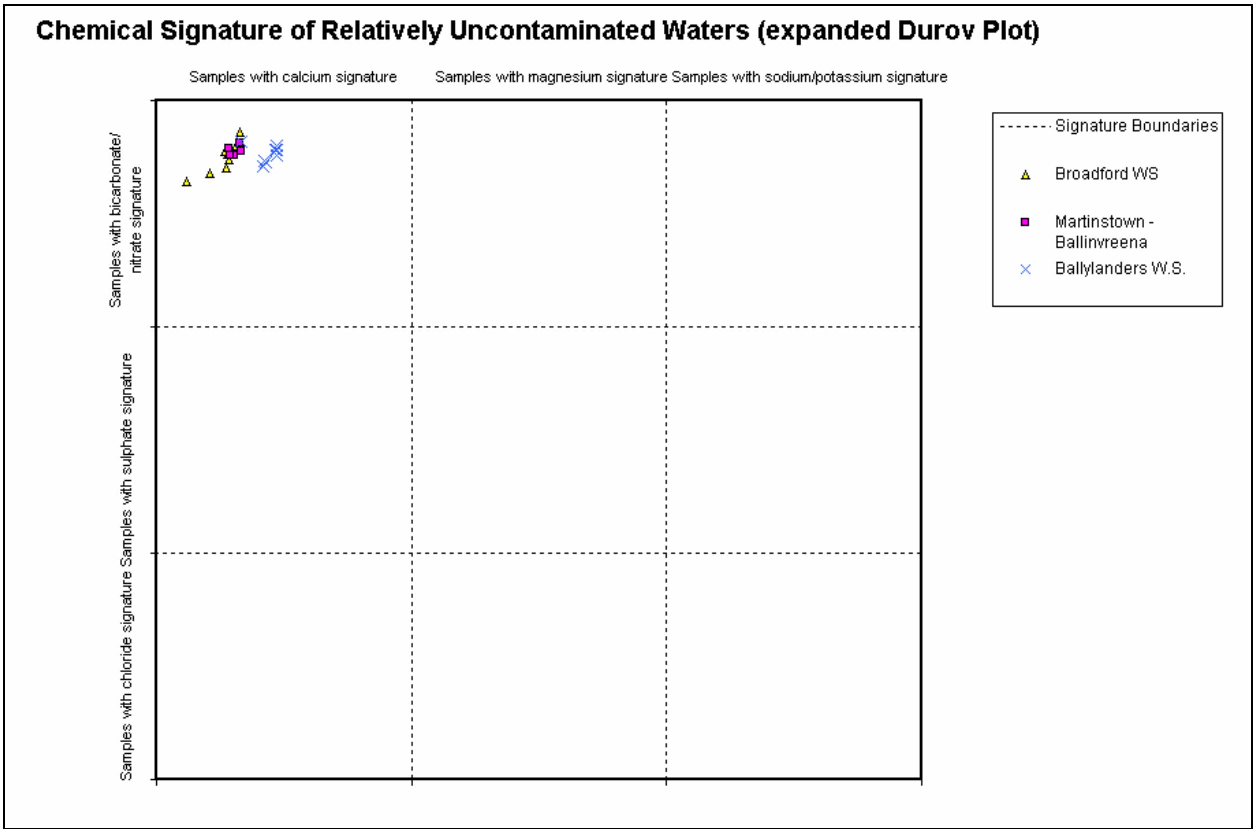
| **Conceptual model** | <ul><li>The groundwater body is bounded on its southern, eastern and western boundaries by topographic highs, some of which coincide with the Shannon RBD boundary. In the north, the contact with the karstic limestones of the North Kilmallock GWB bounds the GWB. In the northern part of the GWB, the terrain is gently undulating. In the southeastern part, the terrain is hilly and dissected by mountain streams and rivers.</li><li>The groundwater body is composed primarily of low transmissivity rocks, although localised zones of enhanced permeability do occur along faults. Transmissivity is further enhanced in the thrust zone in the southeastern corner of the GWB, due to the intense deformation. Groundwater flows along fractures, joints and major faults.</li><li>Recharge occurs diffusely through the subsoils and via outcrops. It occurs in upland areas where the subsoil is thinner and rainfall higher. Over the bulk of the GWB, subsoils are generally thick and recharge is likely to be very limited.</li><li>Most flow in this aquifer will occur near the surface of the rock. In the northern part of the GWB, the effective thickness of this aquifer is likely to be about 10-15 m, comprising a weathered zone of a few metres and a connected fractured zone below this. Within the thrust zone, the weathered zone may be up to 15 m thick in some places but will usually be on the order of a few metres, with a zone of well-fractured bedrock below this extending 15-20 m. In all areas, a final zone of poorly fractured bedrock up to 60 m thick is present, where isolated inflows can be encountered.</li><li>The aquifers within this GWB are both unconfined and confined (by thick subsoils). In the upland areas, groundwater is unconfined, and the water table is generally 2-12 mbgl but is deeper in the highest areas, and follows the topography. In the low-lying areas, groundwater levels generally range from between 5-15 mbgl, with the majority of values less than 9 mbgl. Groundwater is nearer to the surface along the northern margin of the GWB. In the lowlands, groundwater is generally confined by the the subsoils, although unsaturated zones do occur. Dug wells tap perched water tables within the subsoils. Water level measurements indicate compartmentalisation due to faulting in some areas. Groundwater flow is influenced by topography and most flow is of a local nature. Unconfined flow path lengths are relatively short, and in general are between 30 and 300 m. Confined flow path lengths may be significantly longer. Groundwater flow is influenced by topography and most flow is of a local nature.</li><li>The main discharges are to the streams and rivers crossing the upland aquifers, and to springs. In the lowland areas, where subsoils are generally thick, groundwater discharge to the rivers will occur along limited stretches of the rivers and occasionally to springs. There may be a small volume of cross-flow from this GWB to the karstic North Kilmallock GWB that lies immediately to the north.</li><li>Groundwater-surface water interaction is restricted to the southeast where, due to the shallow nature of the groundwater flow, groundwater – surface water interaction will be rapid. Along the northern boundary, a groundwater discharge zone is tentatively identified on the basis of groundwater levels.</li></ul> |
| **Attachments** | Groundwater hydrograph (Figure 1), Hydrochemical signature (Figure 2). |
| **Instrumentation** | Stream gauges: 24003*, 24007, 24016*, 24024, 24026, 24034*, 24036, 24037, 24039, 24084. *(stations marked with 8 have specific dry weather flows calculated.)*<br>EPA Water Level Monitoring boreholes: Coleman's Well (LIM135).<br>EPA Representative Monitoring boreholes: Ballinlyna (LIM 102); Martinstown – Ballinvreena (LIM 110).<br>[Ballylanders WS (LIM 11) is just outside the RBD boundary, in Silurian rocks.] |
| **Information Sources** | Daly, D., Keegan, M. and Wright, G.R. (2001) *County Tipperary (South Riding) Groundwater Protection Scheme*. Geological Survey of Ireland updated and revised Report to Tipperary (South Riding) County Council, 54 pp.<br>Deakin, J., Daly, D. and Coxon, C. (1998) *County Limerick Groundwater Protection Scheme.* Geological Survey of Ireland Report to Limerick Co. Co., 72 pp.<br>Hudson, M. (1995) *Mortlestown PS: Groundwater Source Protection Zones*. Geological Survey of Ireland Report to Limerick Co. Co., 7 pp.<br>Aquifer chapters: Dinantian Upper Impure Limestones; Devonian Old Red Sandstones; Silurian Metasediments and Volcanics; Dinantian Lower Impure Limestones; Devonian Kiltorcan-type Sandstones; Namurian Shales; Dinantian (early) Sandstones, Limestones and Shales; Dinantian Pure Unbedded Limestones; Basalts and other Volcanic Rocks. |
| **Disclaimer** | Note that all calculations and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae |

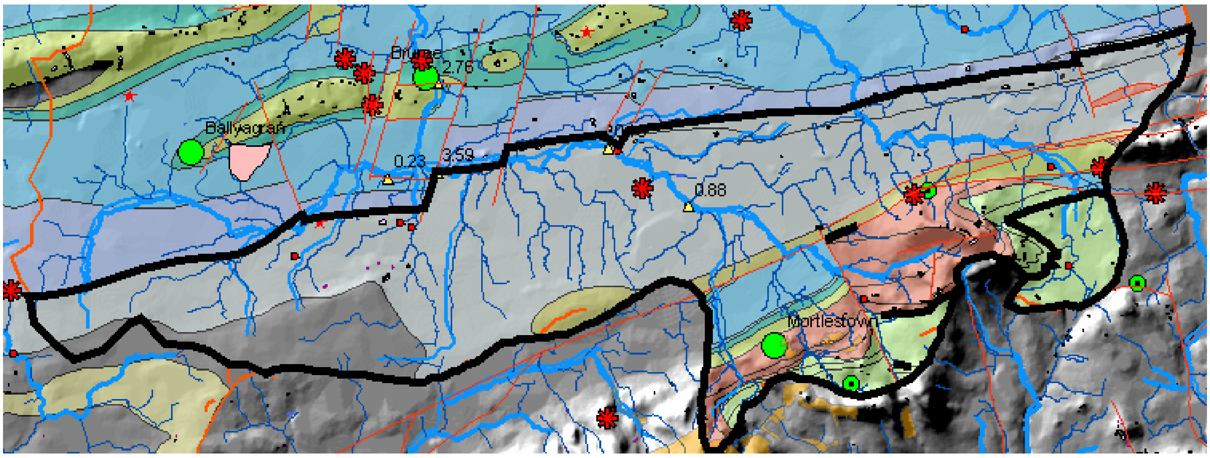
## Figure 1: Groundwater hydrograph




## Figure 2: Hydrochemical signature




*NB: Broadford WS abstracts groundwater from a Dinantian Upper Impure Limestone aquifer in the adjacent Ballylongford GWB. Martinstown – Ballinvreena abstracts from Devonian Old Red Sandstone strata. Ballylanders WS is just outside (~300 m) the Shannon RBD, but is over the same Silurian strata and the hydrochemistry data are considered representative.*




**Rock units in GWB**

| Rock unit name and code | Description | Rock unit group |
|---|---|---|
| Namurian Undifferentiated (NAM) | | Namurian Undifferentiated |
| Clare Shale Formation (CS) | | Namurian Shales |
| Athassel Limestone Formation (AT) | | Dinantian Upper Impure Limestone |
| Waulsortian Limestones (WA). | | Dinantian Pure Unbedded Limestones |
| Ballysteen Formation (BA) | | Dinantian Lower Impure Limestones |
| Ballymartin Formation (BT) | | Dinantian (early) Sandstones, Shales and Limestones |
| Lower Limestone Shale (LLS) | | Dinantian (early) Sandstones, Shales and Limestones |
| Kiltorcan Formation | | Devonian Kiltorcan-type Sandstones |
| Old Red Sandstone (undifferentiated) | | Devonian Old Red Sandstone |
| Slievenamuck Conglomerate (SM) | | Devonian Old Red Sandstone |
| Slievereagh Conglomerate (SH) | | Devonian Old Red Sandstone |
| Poulgrania Sandstone Formation (PL) | | Devonian Old Red Sandstone |
| Ardane Formation (AE) | | Devonian Old Red Sandstone |
| Inchacoomb Formation (IB) | | Silurian Metasediments and Volcanics |
| Assaroola Member (IBas) | | Silurian Metasediments and Volcanics |
| Ballygeana Formation (BN) | | Silurian Metasediments and Volcanics |
| Volcanics (undifferentiated) (V) | | Basalts and other Volcanic Rocks |