## Lismore GWB: Summary of Initial Characterisation.

| Hydrometric Area<br>Local Authority | Associated surface water features | Associated terrestrial ecosystem(s) | Area ($km^2$) |
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| 18<br>Waterford & Cork Co.Cos | **Rivers:** Blackwater, Owbeg, Finisk, Funshion, Glenshane. | (000073) Blackwater River & Estuary;<br>(000072) Blackwater River Callows. | 84 |

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| **Topography** | | This GWB occupies the floor of an elongate east-west trending valley in east Cork and west Waterford. The valley is bounded to the north and south by parallel east-west trending ridges which comprise the Knockmealdown and Glenville GWBs respectively. Immediately north of the valley is the Cappoquin Kiltorcan GWB. The valley floor is generally flat to gently undulating. Ground elevations range from sea level up to about 75 m OD. Areas of higher ground occur along the centre of the valley (40-75 m OD) but ground is generally lower along the valley margins, and in the east of the body near the Blackwater estuary (<20 m OD). The ready weathering & erosion of the thin shaly limestones which occur at the margins of the body is thought to be responsible for the topographic lows, along the edges of the valley, where the Blackwater and Owbeg rivers flow. |
| **Geology and Aquifers** | **Aquifer categories** | **Rkd**: Regionally important karstified aquifer dominated by diffuse flow (60%)<br>**Ll:** Locally important aquifer which is moderately productive only in local zones (35%) – around body margins<br>**Pl:** Poor aquifer which is generally unproductive except for local zones (5%) – along northern margin |
| | **Main aquifer lithologies** | The main aquifer lithology in this GWB is Dinantian Pure Unbedded Limestones (Waulsortian Limestone Formation) (60%). Dinantian Lower Impure Limestones occur around the margins of the body (35%) and narrow area of Dinantian (early) Sandstones, Shales and Limestones along the northern margin is also included in this GWB (5%). |
| | **Key structures** | During the Variscan Orogeny (mountain building episode), rocks in the South Munster region 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. 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 major north-south shear faults are paralleled by a very well developed system of vertical or near-vertical north-south joints which are very evident in exposures in quarries and caves in East Cork. These joints are commonly spaced at intervals of about 0.5 to 2 metres (Wright, 1979). |
| | **Key properties** | The pure unbedded limestones of the South Munster region are highly productive. Faults and joints were enlarged by karstification as groundwater moved through the limestones. There are numerous surface karst features in these limestones, (e.g. swallow holes, collapse features and closed depressions) and extensive cave systems (e.g. Carrigtohill, Midleton and Cloyne). The strong structural influence on the development of karstification is demonstrated by cave plans from Southeast Cork (e.g. Poulnahorka Caves, Castlemartyr, Co Cork) where the main passages or 'galleries' have developed along north-south joints in the order of 1 to 6 metres apart (Wright 1979). Transmissivity in the pure unbedded limestones can range up to a few thousand $m^2/d$. Pumping tests in the same rock type in the Cloyne GWB to this south of this body 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 reliable discharges. The pure bedded limestones are also highly productive although less evidence of extensive karstification is currently recorded. 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 Pure Unbedded Limestones (Waulsortian Limestone) are at least 600m thick in the Cork Syncline (Sleeman & Pracht, 1994). 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 which intersect major zones of fissuring at depth have been observed in Waulsortian Limestone at Cloyne, Co Cork (Cloyne GWB), where a major zone of fissuring occurs at approximately 41m below ground level, i.e. approximately 20m below O.D and at Ringaskiddy (Carrigaline GWB), where major water inflows occur 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 margins 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. |

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| **Overlying Strata** | **Lithologies** | *Subsoil Types identified in Lismore GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Blanket Peat (BktPt); Cutover Peat (Cut); Sandstone sands and gravels (Devonian) (GDSs); Karstified limestone bedrock at surface (KaRck); Lake sediments undifferentiated (L); Made Ground (Made); Rock outcrop and rock close to surface (Rck); Till – Devonian Sandstone Till (TDSs), Limestone Till (TLs).*<br><br>This GWB is primarily covered by glacial till of generally shallow depth. Frequent areas of rock outcrop and shallow rock occur in this GWB. There is a good deal of alluvium in a narrow band along the rivers. |
| | **Thickness** | There are many areas within this GWB with subsoils of <3m where rock outcrop is common, Elsewhere subsoil depths of 5-10m are frequently recorded, although isolated points of deep and shallow subsoil do occur. The underlying pure unbedded limestone in this valley is highly karstified and likely to have a very irregular bedrock surface. Subsoil depths in these areas can therefore be highly variable within short distances. |
| | **% area aquifer near surface** | |
| | **Vulnerability** | Only the Co. Waterford part of this GWB had a pre-existing vulnerability map. However, the characteristics shown in Waterford are likely to persist in the other areas.<br><br>The GWB has many small areas of Extreme Vulnerability, but is predominantly of High Vulnerability. |
| **Recharge** | **Main recharge mechanisms** | The sandstone ridges to the north and south of this GWB (Knockmealdown & Glenville GWBs), provide abundant runoff which may augment 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 will occur. Swallow holes and collapse features provide the means for point recharge to the karstified aquifer. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. The lack of surface drainage in several parts of this GWB indicates that potential recharge readily percolates into the groundwater system. 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 generally shows a rapid response to recharge. Where gravels overlie the karstified aquifer they provide a permeable pathway for recharge to the underlying aquifer. They can also act to augment storage in the aquifer. The generally 'moderate' permeability subsoils in the west of the body will generally not restrict percolation of recharge. |
| | **Est. recharge rates** | *To be assessed.* |
| **Discharge** | **Large springs and high yielding wells ($m^3/d$)** | *Note: The following data needs to be checked and updated by RBD Project Consultants.*<br>Data from GSI Well Database:<br><br>Additional data from EPA Groundwater Sources List: |
| | **Main discharge mechanisms** | Groundwater discharges to springs within the GWB and to the rivers and streams crossing the GWB. Rivers overlying the limestones in the South Munster Synclines have relatively high dry weather flows representing contributions from the underlying aquifer. |
| | **Hydrochemical Signature** | The groundwater in this body is dominated by calcium and bicarbonate ions. Hardness can range from moderately hard to very hard (200 mg/l 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 is high, up to 400 mg/l (as $CaCO_3$). Alkalinity is generally less than hardness, indicating that ion exchange (where calcium or magnesium are replaced by sodium) is not significant. These hydrochemical signatures are characteristic of clean limestone. Like hardness and alkalinity, electrical conductivities (EC) can vary greatly. Typical limestone water conductivities are of the order of 500-700 µS/cm. Chloride levels in groundwater in this body can be elevated near the coast. 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 is often bypassed in karstic aquifers due to the number of swallow holes, dolines and large areas of shallow rock. |

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| **Groundwater Flow Paths** | These rocks have no intergranular permeability. Groundwater flow occurs in the many 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). Groundwater in this GWB is generally unconfined. The highly permeable aquifer supports a regional scale flow system. Groundwater flow paths can be up to several kilometres long, but may be significantly shorter in areas where the water table is very close to the surface. Regional groundwater flow is towards the rivers draining the valley to the east. |
| **Groundwater & Surface water interactions** | The nature of the karstic system leads to rapid interchanges of water between surface and underground. Swallow holes and caves receive surface water, and groundwater is discharged to surface as springs or as baseflow to rivers crossing the groundwater body. |

**Conceptual model**

- This GWB occupies the floor of an elongate east west trending valley in east Cork and west Waterford. The body is generally flat to gently undulating (0-75 m OD) with ground elevation at centre of the valley often higher than at the valley margins.
- To the north and south are the low permeability sandstones and mudstones of the Knockmealdown and Glenville GWBs, but immediately north of the valley is the Cappoquin Kiltorcan GWB.
- The GWB is composed mainly of diffusely karstified, highly permeable pure limestones with a narrow underlying layer of less permeable impure limestone around the margins of the body. To the north and south of the body are ridges 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. Karst features such as cave systems, sinking streams, springs, swallow holes and other collapse features are common 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 formed by deformation that were subsequently enlarged by karstification. Most groundwater flow 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 the South Munster region, deep inflows from major zones of fissuring have been encountered to 40-50 mbgl.
- Groundwater in this body is unconfined. The water table is generally less than 10 metres below the surface, but may be greater in higher topographic areas, with an average annual fluctuation up to 6 metres. Groundwater gradients are very flat in the permeable limestones (0.001-0.002). The highly permeable aquifer can support regional scale flow systems. Groundwater flow paths could be up to a few kilometres long, but may be significantly shorter in areas where the water table is very close to the surface, and in any case will be limited by the narrowness of the valley. Overall groundwater flow is to the rivers draining the valley, predominantly the Blackwater, and ultimately to the sea.
- Recharge to this GWB is both point and diffuse. The ridges to the north and south of this GWB (Knockmealdown & Glenville GWBs) provide runoff which should augment recharge to the limestone aquifer in the valley. Swallow holes, collapse features and sinking streams can provide access for point recharge to the karstified aquifer. Diffuse recharge will occur over the entire GWB via rainfall percolating through the subsoil. The lack of surface drainage in much of this GWB indicates that potential recharge readily percolates into the groundwater system. A relatively very small volume of groundwater may cross as through-flow into this GWB from the adjacent low transmissivity GWBs.
- There are many areas of Extreme Vulnerability within this GWB. Elsewhere, the remainder of the body appears to be predominantly High Vulnerability. In a 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.
- There may be a high degree of interaction between surface water and groundwater in this GWB. Swallow holes and caves receive surface water, and groundwater is discharged to surface as springs or as baseflow to rivers crossing the groundwater body.

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| **Attachments** | |
| **Instrumentation** | **Stream gauges:** 18002*; 180040; 18045; 18059.<br>* Adjusted Dry Water Flow available.<br>**EPA Water Level Monitoring boreholes:** None<br>**EPA Representative Monitoring points:** (WAT108) Ballyhane WS; (WAT111) Monument (CappoquinWS); (WAT113) Lefanta (borehole). |

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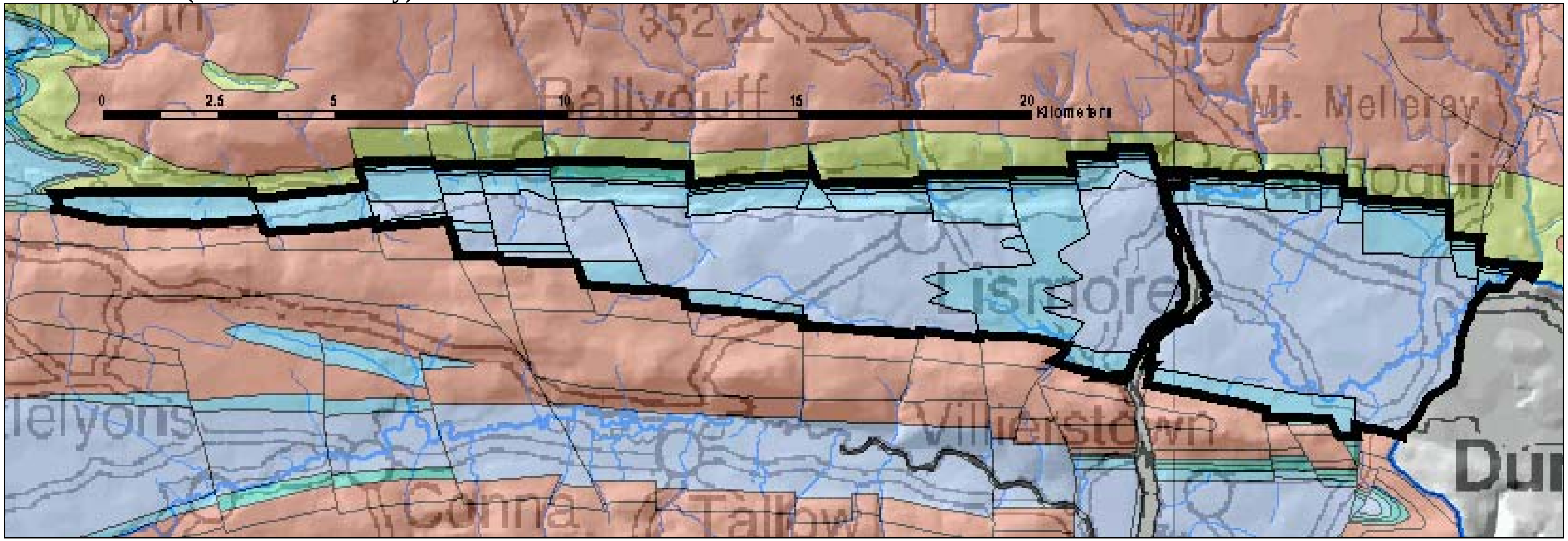
| **Information Sources** | Farrington A (1959) The Lee Basin Part one: glaciation. Proc. R. Ir. Acad. 60B (3), 135-166.<br>Kelly C (2000) Conna Water Supply Scheme (village bore): Groundwater Source Protection Zones. Report to Cork County Council (Northern Division). Geological Survey of Ireland.<br>Sleeman AG, McConnell B (1995) Geology of East Cork - Waterford. A geological description of East Cork, Waterford and adjoining parts of Tipperary and Limerick, to accompany the Bedrock Geology 1:100,000 scale map series, Sheet 22, East Cork - Waterford. Geological Survey of Ireland.<br>Wright G, Gately C (2002) *Whitegate Regional WaterSupply Scheme (Dower Springs)*. Groundwater Source Protection Zones. Geological Survey of Ireland Report, 19pp.<br>Wright G. (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 |

## Lismore GWB (For reference only)




## List of Rock units in Lismore GWB

| Rock unit name and code | Description | Rock unit group | Aquifer Classification |
|---|---|---|---|
| Waulsortian Limestones (WA) | Massive unbedded lime-mudstone | Dinantian Pure Unbedded Limestones | $Rk^d$ |
| Ballysteen Formation (BA) | Fossiliferous dark-grey muddy limestone | Dinantian Lower Impure Limestones | Ll |
| Ballymartin Formation (BT) | Limestone & dark-grey calcareous shale | Dinantian Lower Impure Limestones | Ll |
| Lower Limestone Shale (LLS)<br>*(on northern side only)* | Sandstone, mudstone & thin limestone | Dinantian (early) Sandstones, Shales and Limestones | Pl |