**Brandon Head GWB: Summary of Initial Characterisation.**

| Hydrometric Area<br>Local Authority | Associated surface water features | Associated terrestrial ecosystems | Area ($km^2$) |
|---|---|---|---|
| 23- Coastal Area: North Kerry/ Tralee Bay<br>Kerry Co. Co. | Rivers: Abha na Feothanai (Feohanagh), Febhanagh, Owenmore, Abha na Feinne, Glenahoo, Scorid, Owencashla, Derryquay, Meenascarthy, Finglas.<br>Loughs: Gill/ Gile, An Loch Dubh, Chom an Chnoic, An Loch Iochtarach, na Lice/ Nalacken, Cruite, na Choimin, an Mhonain, Cam, an Duin, Doulach, na mBan, Chom Callain, Neil Phadraig/ Atlea, An Loch Geal, Ui Fhiannachta, Broin, an Pheidleara, Tarbh/ Coumeenoughter, na Bharoidigh, Meain, Iarthair, Thuairin Mharta, Arraglen, Acummeen, Slat, Cumminan. | Smerwick Harbour Sandhills and Marshes (001958), Tralee Bay and Magharees Peninsula, west to Cloghane (002070), Mount Brandon (000375). | 312 |

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| **Topography** | This GWB occupies uplands, slopes, sea cliffs and coastal sections on the north side of the Dingle Peninsula. It is elongated E-W along the north side of the ridge formed by the Slieve Mish. Ground elevation ranges between sea level and more than 950 mAOD. The highest point is 953 m at Brandon Mountain, in the west-centre of the GWB. The mountains that form the ridge down the centre of the peninsula and the surface water divide are generally 600-800 mAOD. The edges of the GWB next to the sea are frequently high cliffs, particularly in the west. The terrain is very steep and mountainous, with numerous rivers incising valleys into the bedrock. The topography becomes flatter towards the coast, especially in the west of the GWB. Drainage density is high, with lots of small channels; most streams flow generally north and west, at right angles to the seaward boundaries of the groundwater body. | |
| **Geology and Aquifers** | Aquifer categories | The majority of the GWB comprises **Ll:** Locally important aquifer which is moderately productive only in local zones. The relatively small areas of Silurian and Ordovician rock unit groups, and the very narrow Dinantian (early) Sandstones, Limestones and Shales are **Pl:** Poor aquifers which are generally unproductive except for local zones. These aquifers occur on the west tip and along part of the southern margin of the GWB. |
| | Main aquifer lithologies | The majority of the GWB comprises Devonian Old Red Sandstones. There are subordinate areas of Silurian Metasediments and Volcanics, of Ordovician Metasediments, and of Dinantian Lower Impure Limestones. These rock unit groups are found near the margins of the GWB. The <20 m thick Dinantian (early) Sandstones, Limestones and Shales separates the ORS from the Lower Impure Limestones. |
| | Key structures | The major structures in this GWB are three large anticlines that plunge to the ENE, of which the rocks in this GWB form the northern limb. Strata dip roughly to the NNW and SSE, at right angles to the fold axes. Bedding is tilted at 10-40$^o$. NE-SW and WNW-ESE trending faults cross-cut the fold axis; there are also many major faults parallel to the fold axes. In addition to fault-related fracturing, folding also caused some fracturing and jointing of the rocks, particularly on the axes of the anticlines. |
| | Key properties | Permeability generally decreases rapidly with depth in all aquifers. In general, the ORS and Lower Impure Limestone aquifer transmissivities will be in the range 2-20 $m^2$/d, with median values occurring towards the lower end of the range. However, 'Excellent' yielding wells are known in some of the ORS units – these yields are usually associated with boreholes being situated on fault zones. Summer yields are sometimes unsustainable. Silurian, Ordovician and Dinantian (early) rock unit group transmissivities will be lower. Aquifer storativity will be low in all rock units. Groundwater gradients are likely to be in the range 0.01 to 0.04.<br>*(data sources: Rock Unit Group Aquifer Chapters, see references)* |
| | Thickness | The Devonian ORS, Silurian and Ordovician rock unit groups reach maximum thicknesses of more than 100's of meters. In this vicinity, the Dinantian Lower Impure Limestones rock unit group is approximately 200 m thick at its maximum. However, in all aquifers within this GWB, most groundwater flow occurs within the top 15-20 m of the aquifer, in the layer that comprises a weathered zone of a few metres and a connected fractured zone below this. Deeper flows occur along generally isolated faults or significant fractures. Springs occur on fault zones, indicating that these major structures are responsible for conducting the groundwater flow. |
| **Overlying Strata** | Lithologies | The GWB is generally covered by Devonian sandstone till at the lower elevations (<150 mAOD, approximately). Above this height, Blanket Peat is the predominant soil cover. There are also extensive areas of bare or shallow rock. There are small areas of cutover peat in the west of the GWB. In areas underlain by or adjacent to Silurian and Ordovician rocks, the subsoil comprises Sandstone and Shale (Lower Palaeozoic) Till. Undifferentiated Alluvium occurs in small patches along river courses. |
| | Thickness | Over most of the GWB, subsoil thickness generally ranges from 3 m to 7 m. In the easternmost parts, subsoils are apparently thicker; depth to rock can be from 12-40 m. Outcropping and shallow rock is confined to the upland areas and to the coastal cliff sections. Small and isolated outcrops occur along streams. |
| | % 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 via rainfall percolating through the subsoil or areas of outcropping rock. The proportion of the effective rainfall that will recharge the aquifer is determined by the permeability of the soil and subsoil, and by the slope. Due to the generally low permeability of the aquifers within this GWB, a high proportion of the recharge will then discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer. |

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| | Est. recharge rates | *[Information to be added at a later date]* |
| **Discharge** | Springs and large known abstractions ($m^3/d$) | Ballinevenooragh WS (30 $m^3/d$ – EPA database; 136 $m^3/d$ – GSI database), Ballinknockane WS (5 $m^3/d$ – EPA database), Ballyferriter RWS (56 $m^3/d$ – GSI database; 300 $m^3/d$ – EPA database), Ballyferriter RWS (Lateevemore) (327 $m^3/d$ – EPA database; 91 $m^3/d$ – GSI database), Ballyferriter (Kilmakeader/ Kilmarfader) (160 $m^3/d$ – EPA database; 68 $m^3/d$ – GSI database), Ballyferriter RWS (Ballywiheen) (90 $m^3/d$ – EPA database; 104 $m^3/d$ – GSI database), Cloghane (40 $m^3/d$ – EPA database; 114 $m^3/d$ – GSI database), Feoghanagh-Brandon Creek WS (150 $m^3/d$ – EPA and GSI databases), Graigue- Clogher WS (36 $m^3/d$ – EPA database; 68 $m^3/d$ – GSI database), Murreagh (360 $m^3/d$ – EPA database), Teerovane WS (36 $m^3/d$ – EPA database; 45 $m^3/d$ – GSI database), Kerry Spring Water (270 $m^3/d$ – GSI database), Cappagh WS (91 $m^3/d$ – GSI database), Brandon WS (181 $m^3/d$ – GSI database).<br><br>*[More information may be added at a later date]* |
| | Main discharge mechanisms | The main discharges are to the gaining rivers and streams crossing the sandstones, shales and impure limestone rock units and to generally small springs and seeps. Groundwater will also discharge at the coast. Localised seepages may develop on the cliff faces. Cross-flow may occur from the aquifers in this GWB to the adjacent karstic Tralee and Rough Point GWBs. |
| | Hydrochemical Signature | Two data sets are available to assess this GWB; both groundwater samples are from boreholes in the Devonian ORS, which are both situated in the west of the GWB. At the Kerry Spring Water borehole, groundwaters have a calcium-bicarbonate type signature, are generally Moderately Hard (185-275 mg/l as $CaCO_3$) with alkalinities in the range 165-260 mg/l as $CaCO_3$, and Lab pH's in the range 6.77-7.5. In contrast, at Ballinloghig WS, groundwater is Soft (55-80 mg/l as $CaCO_3$) with low alkalinity (< 40-65 mg/l as $CaCO_3$). Furthermore, the hydrochemical signature varies between Ca-$HCO_3$ (calcium-bicarbonate) in summer and Mg-$SO_4$ (magnesium-sulphate) in winter (see Figure 1). This seasonal variation indicates that there is rapid movement of winter recharge waters into the aquifer, giving lower conductivities, alkalinities, hardness, calcium, etc. (Figure 2) in winter than in summer. Since summer 1999, concentrations have been relatively stable, and groundwater has an Mg-Ca-$HCO_3$ signature. In general, high iron (Fe) and manganese (Mn) concentrations can occur in groundwater derived from ORS, due to the dissolution of Fe and Mn from the sandstone/shale where reducing conditions occur. It has been demonstrated that at low pumping rates water does not reside long enough in the well for oxidation to occur, thereby resulting in elevated Fe and Mn in small domestic supplies (Applin *et al*, 1989). No other data are currently available for this GWB. In the impure limestones, groundwater will be Hard to Very Hard, with corresponding high alkalinities. In the Silurian and Ordovician rock units, groundwaters will be relatively soft with low alkalinities. pH's will be neutral. Background chloride concentrations in all aquifers will be higher than in the Midlands, due to the proximity to the sea. |
| **Groundwater Flow Paths** | | These rocks are devoid of intergranular permeability; groundwater flow occurs in fractures and faults. The rocks are dependent on fracturing and fissuring to enhance their permeability. Permeabilities in the upper few metres are often high although they decrease rapidly with depth. In general, groundwater flow is concentrated in the upper 15 m of the aquifer, although deeper inflows from along fault zones or connected fractures are encountered. Deeper and slower groundwater flows are indicated by major ion hydrochemistry at Ballinloghig WS. Significant yields can be obtained where boreholes are drilled into known fault zones. However, yields are not necessarily sustainable, since there is not an extensive connected fracture network. Springs are noted to occur in some instances on fault zones. Groundwater levels are about 1.5-12 m below ground level, and will generally follow the topography. Next to the rivers and streams, water levels will be close to ground level. Surface water features are considered to be in hydraulic continuity with the water table. The water levels are both above and below the base of the subsoils; groundwater is considered to be unconfined in the main since the sandstone till is not likely to act as a confining layer. Groundwater flow paths are short, typically from 30-300 m, with groundwater discharging to streams and springs. Locally, groundwater flow directions are controlled by local topography. Overall, groundwater flows northwards and westwards from the topographic ridge at the south of the body, and outwards from the topographic highs in the west of the GWB. |
| **Groundwater & Surface water interactions** | | The water table is above or close to the base of the subsoils. The streams crossing the aquifer will be gaining. Groundwater will discharges to small springs and seeps. There is a number of groundwater-dependent ecosystems in this GWB. Smerwick Harbour Sandhills and Marshes (001958) contains a system of freshwater marshes on the landward side of the site that many rare flora occupy. At Tralee Bay and Magharees Peninsula, west to Cloghane (002070) erosion has removed the sand down to the watertable there are temporary ponds or dune slacks with many additional species. The dune slack waterbodies and also the more permanent lagoonal lakes such as Lough Gill and Lough Naparka are used for breeding by the Natterjack Toad, a species of international importance protected by European and national legislation. Several aquatic plants of interest grow in Lough Gill, including Red Data Book species. On Mount Brandon (000375), Coumanare Bog is quite an impressive tract of mountain bog dominated by Purple Moor-grass and Deergrass (*Scirpus cespitosus*). It features a large and particularly well-developed and unique scraw, associated with a series of springs along the Scorid River. |

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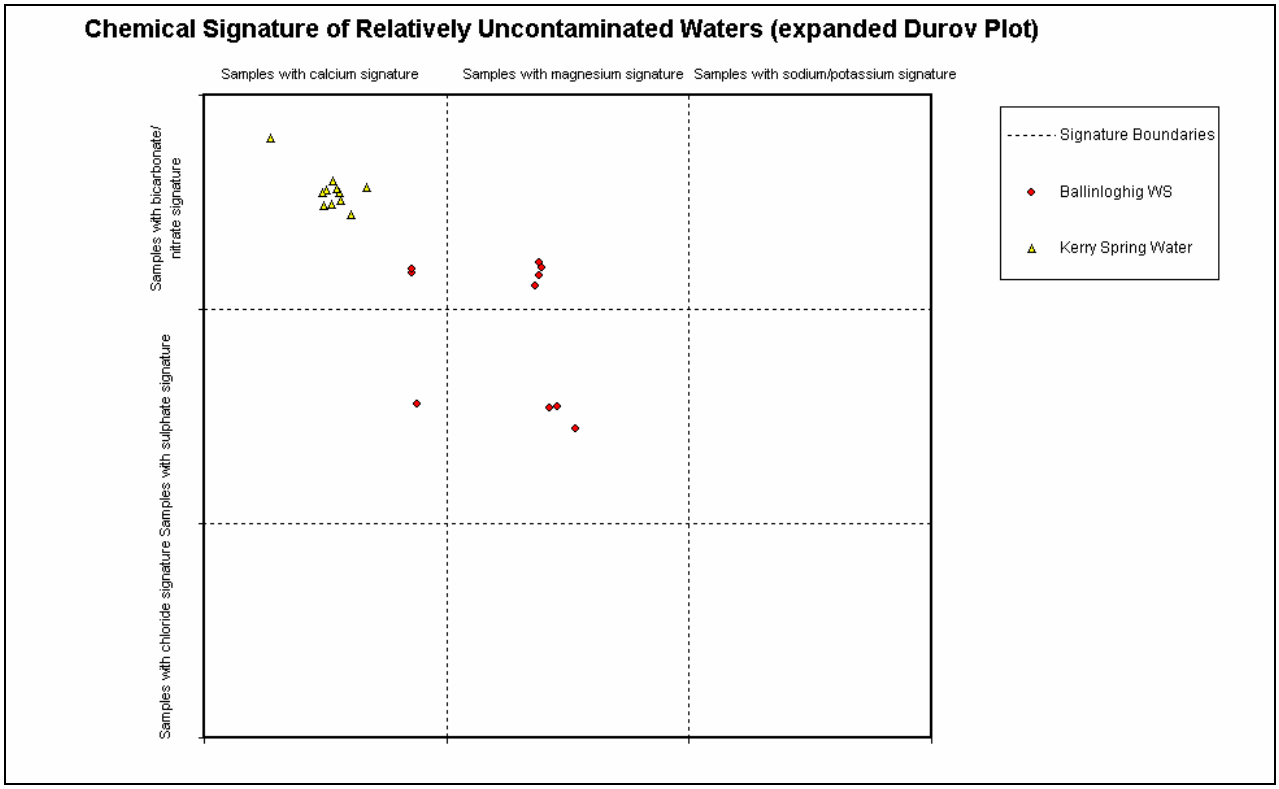
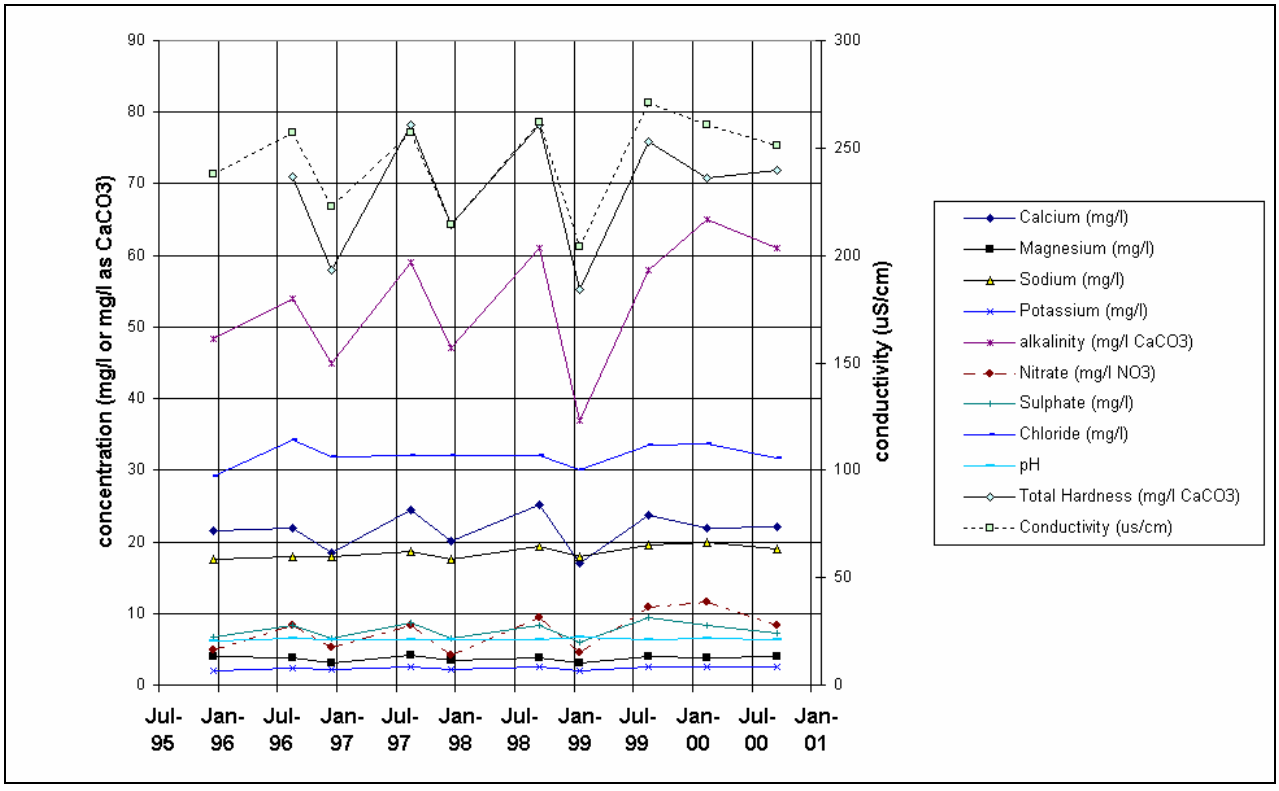
| **Conceptual model** | • The groundwater body is bounded to the west and northwest by the coast, to the northeast by the contact with karstic limestones of the Tralee GWB. The southern boundary is a topographic high and surface water divide. The topography is mountainous, with ground level continually rising to the highest elevations in the centre-west and south of the body.<br>• The groundwater body is comprised of low transmissivity and storativity rocks, although localised zones of enhanced permeability occur along fault zones.<br>• Flow occurs along fractures, joints and major faults. Flows in the aquifer are generally concentrated in a thin zone at the top of the rock, although deeper groundwater flows along faults and major fractures.<br>• Diffuse recharge occurs across the GWB through the subsoils and rock outcrops. Due to the generally low permeability of the aquifers within this GWB, a high proportion of effective rainfall will runoff, or discharge rapidly to surface water courses via interflow and shallow flow. Where water levels within the unconfined aquifer are high, potential recharge will be rejected.<br>• The water table can vary between a few metres up to more than 10 m below ground surface, depending upon topography. Groundwater is generally unconfined, except where blanket peats overlie the aquifer. Flow path lengths are generally short, ranging from 30-300 m. Local groundwater flow directions are controlled by local topgraphy. Overall, groundwater flows north- and westwards away from the ridge along the south of the body, and outwards from the topographic highs in the west of the GWB.<br>• Groundwater discharges to the numerous streams and rivers crossing the aquifer, which are gaining, and to springs. Seepage zones may exist on the cliff faces. A small volume of groundwater may cross-flow into the adjacent karstic Tralee and Rough Point GWBs. |
| **Attachments** | Hydrochemical signature (Figure 1), Variation of major parameters with time (Figure 2). |
| **Instrumentation** | Stream gauges: 23023, 23026, 23027, 23028.<br>EPA Water Level Monitoring boreholes: Kerry Spring Water (KER 068). Ballinloghig WS (KER 005) is just outside (by <200 m) the RBD boundary. |
| **Information Sources** | Applin, K. R. and N. Zhao (1989) The Kinetics of Fe(II) Oxidation and Well Screen Encrustation. *Ground Water*, Vol 27, No 2.<br>Conlon, V. and Wright, G. (1998) *County Kerry Aquifer Classification (draft)*. Geological Survey of Ireland Report to Kerry Co. Co., 18 pp.<br>Aquifer chapters: Devonian Old Red Sandstone; Silurian Metasediments and Volcanics; Ordovician Metasediments; Dinantian Lower Impure 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 |

## Figure 1: Hydrochemical signature

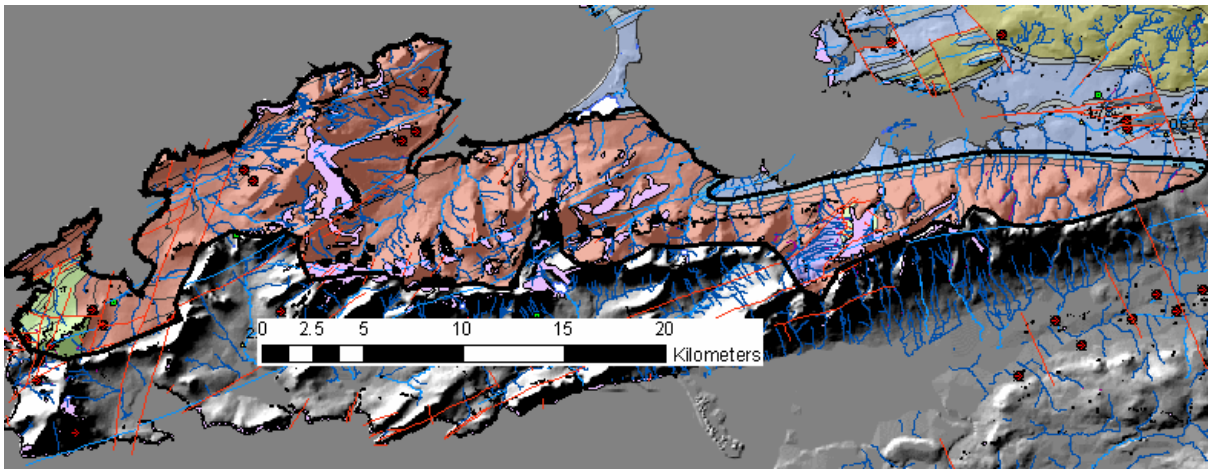



*NB: Ballinloghig WS is just outside the RBD boundary, but is included since it is abstracting groundwater from the same rock units.*

## Figure 2: Seasonal variation of major hydrochemical parameters at Ballinloghig WS (KER 005)




*NB: Ballinloghig WS is just outside the RBD boundary, but is included since it is abstracting groundwater from the same rock units.*




**Rock units in GWB**

| Rock unit name and code | Description | Rock unit group |
|---|---|---|
| Ballydavid Formation (BD) | Sandstone with conglomerate | Devonian Old Red Sandstones |
| Ballyferriter Formation (BF) | Grey & red siltstone & mudstone | Devonian Old Red Sandstones |
| Ballymore Sandstone Formation (BM) | Rhythmically bedded sandstone | Devonian Old Red Sandstones |
| Bulls Head Formation (BH) | Red sandstone & siltstone | Devonian Old Red Sandstones |
| Cappagh Sandstone Formation (CA) | Purple cross-bedded sandstone | Devonian Old Red Sandstones |
| Coosglass Conglomerate Member (GBcs) | Clast-supported polymict conglomerate | Devonian Old Red Sandstones |
| Coosgorrib Conglomerate Member (GBco) | Clast-supported polymict conglomerate | Devonian Old Red Sandstones |
| Coumeenoole Sandstone Formation (CO) | Cross-bedded sandstone | Devonian Old Red Sandstones |
| Eask Sandstone Formation (EK) | Purple sandstone & siltstone | Devonian Old Red Sandstones |
| Farran Sandstone Formation (FN) | Medium-grained sandstone | Devonian Old Red Sandstones |
| Glashabeg Conglomerate Formation (GB) | Conglomerate & sandstone | Devonian Old Red Sandstones |
| Inch Conglomerate Formation (IC) | Conglomerate with metamorphic clasts | Devonian Old Red Sandstones |
| Kilmurry Sandstone Formation (KM) | Aeolian sandstone | Devonian Old Red Sandstones |
| Lack Sandstone Formation (LK) | Micaceous sandstone and siltstone | Devonian Old Red Sandstones |
| Lough Slat Conglomerate Formation (LS) | Quartz-pebble conglomerate | Devonian Old Red Sandstones |
| Pointagare Group (PGG) | Conglomerate, sandstone & siltstone | Devonian Old Red Sandstones |
| Sauce Creek Formation (SC) | Fluvial and aeolian sandstone | Devonian Old Red Sandstones |
| Slea Head Formation (SH) | Pebbly sandstone & conglomerate | Devonian Old Red Sandstones |
| Slieve Mish Group (SMG) | Conglomerate, sandstone & siltstone | Devonian Old Red Sandstones |
| Smerwick Group (SWG) | Fluvial, aeolian sandstone, conglomerate | Devonian Old Red Sandstones |
| Caherconree Formation (CC) | Green-grey graptolitic siltstone & wacke | Silurian Metasediments and Volcanics |
| Clogher Head Formation (CH) | Ignimbrite, lavas and siltstone | Silurian Metasediments and Volcanics |
| Coosglass Slate Formation (CG) | Fossiliferous olive-grey laminated slate | Silurian Metasediments and Volcanics |
| Croaghmarhin Formation (CM) | Fossiliferous green to grey siltstone | Silurian Metasediments and Volcanics |
| Derrymore Glen Formation (DG) | Purple to green fossiliferous siltstone | Silurian Metasediments and Volcanics |
| Drom Point Formation (DP) | Grey siltstone with trace fossils | Silurian Metasediments and Volcanics |
| Ferriters Cove Formation (FC) | Fossiliferous siltstone & pyroclastics | Silurian Metasediments and Volcanics |
| Foilnamahagh Formation (FM) | Red-beds with lava & pyroclastic rocks | Silurian Metasediments and Volcanics |
| Mill Cove Formation (MC) | Siltstone with pyroclastic rocks | Silurian Metasediments and Volcanics |
| Ballysteen Formation (BA) | Fossiliferous dark-grey muddy limestone | Dinantian Lower Impure Limestones |
| Annascaul Formation (AL) | Mudstone, siltstone & breccia | Ordovician Metasediments |