Ballina GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority		Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
34 Mayo Co. Co.		**Rivers**: Adergool, Brusna, Bunnafinglas, Castlehill, Deel, Glasheens, Owenrevagh, Tooreen, Behy, Glenree, Moy, Slieveclaur **Streams**: Carrowkeribly Lough. **Lakes**: Ballycong, Ballyderg, Ballymore, Carrowkeribly, Cartron, Cloonagh, Cloonyvollow, Corrower, Derrymannin, Knocknagun, Agawna, Alick, Brohly, Caorhann, Conn, Doo, Keeran, More, Loughnapastia, Shanclogh, Wood.	Killala Bay/Moy Estuary (000458), Bellacorick Bog Complex (001922), Cloonagh Lough (001458), Lough Conn and Lough Cullin (000519), Lough Alick (001527).	265
Topography	The land surface is characterised by relatively flat to undulating ground, with elevations from 0-90 mAOD. The GWB occupies an area between Crossmolina and Ballina. The boundaries are the contacts with the poorer aquifers of the Lahardaun, Bellacorrick-Killala, Foxford GWB's. L. Conn also acts as a boundary where it cuts into the southern half of the GWB. The surface drainage network is complicated and circuitous. The majority of the surface drainage in the northern and western parts of the GWB focuses water to L. Conn. Water in the lake generally flows to the south, where upon its exit from the southeast corner it flows into the river Moy, continuing its journey northwards to Ballina and Killala Bay. Most of the surface drainage in the east of the GWB is toward the river Moy.			
Geology and Aquifers	**Aquifer categories**	**Rk:** Regionally important karstified aquifer.		
	Main aquifer lithologies	Dinantian Pure Bedded Limestones. See table 1 for a full list.		
	Key structures	The southern boundaries of the GWB are primarily faults trending E-W and NE-SW. A NW-SE trending syncline is present in the southern half of the GWB cutting through Derrymannin Lake and L. Conn. The beds on the northern limb dip 3-5^o SW and the beds on the southern limb dip 15-25^o NE. Throughout the rest of the GWB the dips are generally 5-10^o SW.		
	Key properties	Well yields are variable. There are 6 "Good", 2 "Excellent" and 1 "Poor" wells. Specific capacity of 172 m^2/d/m is available for one well near Ballina town, indicating high transmissivity. In the southwestern part of the GWB 20 m separates an 'excellent' yielding well from a 'poor' one, thus aquifer properties are variable over short distances. Transmissivity is estimated to range from 1 m^2/d to greater than 200 m^2/d. Storativity is likely to be in the range of 1-2%. Water levels vary from 0-20 m below ground level. The data are inadequate to calculate groundwater gradients, but these are expected to be greater than 0.0005. There are no records of karst features, probably due in part to the thick mantle of subsoils. However, cavities are recorded at depth in a number of boreholes. One record for a borehole north of Ballina, indicates that it is 'overflowing', thus it is likely that confining conditions exist locally. Two borehole logs refer to "brown rock" which may be an indication of local dolomitisation.		
	Thickness	Most groundwater flux is likely to be in the upper part of the aquifer, comprising three broad zones: a zone comprising a broken and weathered zone typically less than 3 m thick; a zone of interconnected fissuring up to 30 m thick; and a zone of isolated poorly connected fissuring typically less than 150 m. Cavities are recorded at 64 m below ground and between 27-41 m below ground in two boreholes in the southwestern part of the GWB.		
Overlying Strata	**Lithologies**	The subsoils are dominated by limestone till, covering 60% of the GWB. A list of subsoils in the GWB are presented in table 2.		
	Thickness	The subsoils are generally greater than 3 m thick. Typical depths north of Ballina range from 5-10 m. Southwest of Crossmolina there is one recorded thickness of 23 m.		
	% 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 occurs via rainfall percolating through permeable subsoil and rock outcrops. Although there are no records of karst features it is expected that point recharge may occur via many small sinks that are present in the low permeability till areas where the subsoil is breached and also through any karst features that are currently unmapped.		
	Est. recharge rates	*[Information to be added at a later date]*		

Discharge	**Large springs and high yielding wells (m^3/d)**	Good wells : Knockbaun – 109 m^3/d, Culleens – 217 m^3/d, 218 m^3/d, Corroy – 158 m^3/d, Farranoo – 108 m^3/d, 109 m^3/d. Excellent wells: Kinard – 546 m^3/d, Ballina – 1308 m^3/d. Bonniconlon WSS abstracts 1818 m^3/d, apparently from a series of springs.
	Main discharge mechanisms	The main discharges are to the small springs, streams, rivers and lakes. The stream density is greater than 1 km/km^2, which is relatively high, particularly for an area dominated by pure limestones. This is probably a reflection of the subsoils overlying the GWB.
	Hydrochemical Signature	The groundwater has a calcium bicarbonate signature. From 2 samples the following parameters are selected: Alkalinity (mg/l as $CaCO_3$): 284, 320. Total Hardness (mg/l): 316, 380 (Hard to very Hard). Conductivity (μS/cm): 629, 755. Iron (mg/l): 1.8, 0.08. Manganese (mg/l): 0.1-0.015. A slightly sulphurous smell is reported in one well north of Ballina. High iron and sulphur are reported to be common (Long, 1992).
Groundwater Flow Paths		These rocks are generally devoid of intergranular permeability. Groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones these openings are enlarged by karstification which significantly enhances the permeability of the rock. There are no mapped karst features nor large springs, however there are cavities at depth and variability of well yields, often over short distances. Two sub-types of karst aquifers are recognised, termed **Rk^c** and **Rk^d**. The data are not adequate to determine which sub-type it belongs to. Groundwater flow through karst areas is extremely complex and difficult to predict. As flow pathways are often determined by discrete conduits, actual flow directions will not necessarily be perpendicular to the assumed water table contours. Flow velocities can be rapid and variable, both spatially and temporally. Rapid groundwater flow velocities indicate that a large proportion of groundwater flow takes place in enlarged conduit systems. Flow path lengths can be up to a several kilometres in length. Overall groundwater flow will be towards the rivers and lakes, but the highly karstified nature of the bedrock means that locally, groundwater flow directions can be highly variable.
Groundwater & Surface water interactions		There is a high degree of interconnection between groundwater and surface water. The close interaction between surface water and groundwater in karstified aquifers is reflected in their closely linked water quality. Any contamination of surface water is rapidly transported into the groundwater system, and vice versa. There are a number of terrestrial ecosystems with varying dependence on groundwater (Duchas National Heritage data).
Conceptual model		• The GWB occupies an area between Crossmolina and Ballina, and is encompassed by the Nephin Beg and the Ox Mountain ranges. The boundaries of the GWB are the contacts with the poorer aquifers of the Lahardaun, Bellacorrick-Killala, Foxford GWB's. L. Conn acts as a boundary where it cuts into the southern half of the GWB. • The land surface is characterised by relatively flat to undulating ground, with elevations from 0-90 mAOD. • The aquifer is a Regionally important karstified aquifer (**Rk**). • Transmissivity is estimated to range from 1 m^2/d to greater than 200 m^2/d. Storativity is in the range of 1-2%. • Most groundwater flux is likely to be in the upper part of the aquifer, although cavities are recorded at 64 m below ground and between 27-41 m below ground in two boreholes in the southwestern part of the GWB. • Till and cutover peat dominate the subsoils, the thickness of which is up to 23 m in places but is generally greater than 3 m. • It is possible that the aquifer is confined in places. • Diffuse recharge occurs via rainfall percolating through permeable subsoil and rock outcrops. Although there are no records of karst features it is expected that point recharge occurs. • The main discharges are to the small springs, streams, rivers and lakes. The stream density is relatively high, probably due to the subsoils overlying the GWB. • The groundwater has a calcium bicarbonate signature. • There is a high degree of interconnection between groundwater and surface water.
Attachments		Table 1, 2 and Figure 1.
Instrumentation		**Stream gauges:** 34001, 34007, 34017, 34029, 34035, 34039, 34040, 34040, 34044, 34051, 34052, 34056, 34057. **EPA Water Level Monitoring boreholes:** **EPA Representative Monitoring points:** (MAY048)
Information Sources		Long, B., Mac Dermot, C.V., Morris, J.H., Sleeman, A.G., Tietzsch-Tyler, D., (1992). ***A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 6, North Mayo.*** Geological Survey of Ireland Map Series Report.
Disclaimer		Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae.

Table 1. List of Rock units

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Ballina Limestone Formation (Upper) (BU)	Grey limestone, thin shale	Dinantian Pure Bedded Limestones	Rk
Rinmore Formation	Thin bedded limestone and mudstone	Dinantian Upper Impure Bedded Limestones	Ll

Table 2. Subsoils in the GWB

Parent Material	Code	% Area gwb
Alluvium	A	2.57
Blanket peat	BktPt	4.34
cutover peat	Cut	16.43
eskers	Esk	0.12
Limestone sands and gravels (Carboniferous)	GLs	11.46
Metamorphic sands and gravels	GMp	0.36
Lake sediments undifferentiated	L	0.25
Lake sediments undifferentiated	Lake	0.10
Made ground	Made	1.73
Estuarine sediments (silts/clays)	Mesc	0.01
Bedrock at surface	Rck	0.47
Raised peat	RsPt	0.01
Sandstone till (Devonian)	TDCSs	0.55
Limestone till (Carboniferous)	TLs	60.13
Metamorphic till	TMp	1.48
Quartzite till	TQz	0.01

Figure 1. Location and Boundaries of Ballina GWB.