Monaghan Town GWB: Summary of Initial Characterisation.

Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
Hydrometric Area 03 Monaghan Co. Co. N.I.	***Rivers:*** Blackwater, Conawary. ***Streams:*** Clontibret Stream, 93 unnamed streams ***Lakes:*** Aghnasedagh, Billeses, Drumibenagh, Drumreaske, Drumsnat, Griggy, Lambs, Mullaghaden, Peter's, Quig, Rosefield, Tattindonagh, Twin.	None identified (O'Riain, 2004)	60

Topography	This SW-NE aligned, blocky GWB (Figure 1) is predominantly bordered by less productive aquifers to the north, south and east. The western boundary comprises a topographic divide (Hydrometric Area 36). Surrounding Monaghan Town, the general elevations are between 40 mAOD in southeast and 80 mAOD in the northwest. Drumlins (various alignment) of up to 30 m in height are superimposed on the general, gently eastwards sloping topography. Over the majority of the GWB, the surface water flows eastwards (R. Blackwater) although over the westernmost area, flow in the Magheramey is southwards, before its joins the westward-flowing R. Finn.	
Geology and Aquifers	**Aquifer categories**	The sole aquifer unit in this GWB is **Rf:** Regionally important fissured aquifer. It is noted that the Rf aquifers include Pure Bedded Limestone, which are frequently classified as **Rk** (Regionally important karstified aquifers). However, in this instance they are considered to have a higher proportion of shale, which is thought to significant reduce the potential for karstification, although still facilitates a high degree of fissure flow. Furthermore, the Dinantian Shales and Limestones (Lower Benbulben Shales) bordering the north of the GWB are thought to contain dolomitised limestone interbeds, which distinguish them from the rocks immediately to the bordering Tydavent GWB (see Swartz et al, 2002).
	Main aquifer lithologies	This GWB comprises a number of different lithologies, mainly of Dinantian Age. These include Pure Bedded Limestones (40%), Lower Impure Limestones (22%), early/Mixed Sandstones, Shales and Limestones (17%), and Shales and Limestones (18%), and Sandstones (3%). Refer to Table 1 for details.
	Key structures	The rock succession are approximately aligned E-W and are divided by c.7 N-S trending faults and 2 E-W trending faults. The faulting and displacement in this region has resulted in the rocks dipping by c.15-30° to the north.
	Key properties	There are 39 well yields recorded within this GWB ranging from 23-5443 m^3/d (averaging c.1125 m^3/d). Of these, 17 well have specific capacities between 7-255 $m^3/d/m$, averaging c.95 $m^3/d/m$. Transmissivity values range from 50-250 m^2/d in 8 wells, averaging 135 m^2/d (Swartz et al, 2002). The data highlight that high yields and transmissivities are achievable. Storativity is also likely to be good. Of the available data, the Monaghan PWS accounts for 17 well yields, 13 specific capacities and all of the transmissivity values. Although these data have a reasonable distribution, it is noted that none are located in the early Sandstones, Shales and Limestones. However, a similarly high permeability is assumed for these rocks as it is likely to be strongly influenced by the faults and high degree of associated fracturing (Swartz et al, 2002). The available groundwater levels (c.150 from 80 locations) range from 1-65 m below ground level. 70% of these are less than 5 m below the surface. The data are inadequate to calculate groundwater gradients although the flow directions are expected to follow topography i.e. towards the R. Blackwater, which then flows eastwards. *Modelling of the Monaghan PWS also indicates that the zone of influence extends beyond the northern and western boundaries i.e. due to the pumping, groundwater is potentially be pulled in from the adjacent Clones, Tydavnet and GBNI4NW028 GWBs (Swartz, 2001). It is anticipated that the influence of the northern GWBs is limited due to difference in aquifers, and the presence of thick, mainly low permeability subsoil over the majority of these adjacent, northern GWBs.* *(Source Protection Report; Monaghan GWPS*)
	Thickness	Most groundwater flux in all rock groups is expected to be in the uppermost part of the aquifer. This is thought to comprising a broken and weathered zone typically less than 3 m thick, a zone of interconnected fissuring that is likely to extend to a maximum of 30 m thick, and a possibly zone of isolated poorly connected fissuring typically less than 150 m. However, there is minimal evidence for deeper flows; only one record exists for a water strike at 31 m below ground. The large number of small springs recorded in the GWB (49) may also indicate a high proportion of shallow groundwater flow.
Overlying Strata	**Lithologies**	The GWB is predominantly covered by till (67%), with small proportions of other subsoil types, such as alluvium (8%) and peat (6%).
	Thickness	From the available outcrop and topographic information, the subsoil is generally >3 m throughout the GWB, although is sometimes thinner and occasionally absent in the larger, inter-drumlin areas. The drumins themselves generally constitute areas of thick subsoil (>10 m).
	% area aquifer near surface	*[Information will be added at a later date]*

	Vulnerability	The areas of Extreme and High Vulnerability limited to the lower lying inter-drumlin areas. Where the subsoil is thicker over the main drumlin zones, the vulnerability ranges from Moderate to Low, depending on the permeability of the subsoil (generally Moderate, some areas of Low permeability).
FsRecharge	**Main recharge mechanisms**	Diffuse recharge occurs via rainfall percolating through the subsoil and rock outcrops – especially in the inter-drumlin areas. In areas of Low Vulnerability (thick, low permeability subsoil), only a fraction of the effective rainfall can filter through and recharge the aquifer. However, a large proportion of the GWB is covered by Moderately permeability subsoil, which will allow for some recharge to occur.
	Est. recharge rates	*[Information will be added at a later date]*
Discharge	**Large springs and high yielding wells (m^3/d)**	Sources: Monaghan Town PWS: 2765 m^3/d, 2333 m^3/d, 2088 m^3/d, 1975 m^3/d, 1931 m^3/d, 1900 m^3/d, 1879 m^3/d, 1754 m^3/d, 1720 m^3/d, 1692 m^3/d; 1685 m^3/d, 1662 m^3/d, 1598 m^3/d, 1283 m^3/d, 1250 m^3/d (2 wells), 864 m^3/d. Springs: None identified. Excellent Wells: 5443 m^3/d, 760 m^3/d, 717 m^3/d (4 wells), 1662 m^3/d, 683 m^3/d, 546 m^3/d (2 wells), 544 m^3/d, 500 m^3/d, 432 m^3/d (2 wells). Also Sources above for additional wells. Good Wells: 432 m^3/d346 m^3/d, 272 m^3/d, 259 m^3/d, 207 m^3/d, 156 m^3/d, 130 m^3/d, 109 m^3/d.
	Main discharge mechanisms	The main groundwater discharges are to the R. Blackwater and its tributaries, and lakes and springs within the GWB. The large number of (small) springs recorded within the Blackwater and Cor valleys also suggests that the large rivers are the main discharge zones in the GWB. The baseflow proportion of the total streamflow is expected to be relatively high, due to the generally higher aquifer transmissivities associated with this GWB.
	Hydrochemical Signature	***National classification:*** Dinantian rocks (excluding Sandstones) Calcareous. Generally Ca- HCO_3 signature. Due to possible dissolution of evaporite minerals in the Monaghan-Cavan-Leitrim area, Na/K/Mg-HCO_3 and Ca-SO_4 signatures may also occur. Alkalinity (mg/l as $CaCO_3$): range of 10-990; mean of 283 (2454 data points) Total Hardness (mg/l): range of 10-1940; mean of 339 (2146 data points) Conductivity (μS/cm): range of 76-2999; mean of 691 (2663 data points) ***National classification:*** Dinantian Sandstones Calcareous. Generally Ca-HCO_3 signature. Alkalinity (mg/l as $CaCO_3$): range of 5-524; mean of 153 (65 'non limestone subsoils' data points) Total Hardness (mg/l): range of 5-502; mean of 162 (67 'non limestone subsoils' data points) Conductivity (μS/cm): range of 39-1184; mean of 408 (69 'non limestone subsoils' data points) *(Calcareous/Non calcareous classification of bedrock in the Republic of Ireland report)*
Groundwater Flow Paths		In the absence of inter-granular permeability, groundwater flow is expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones. The presence of limestone interbeds can result in high permeability zones as a result of dissolution and dolomitisation, however in the absence of detailed drilling it is difficult to know how extensive these high permeability zones are. Where sandstones dominate, there will be an increased likelihood of more open fractures and consequently higher fissure permeability. Overall, groundwater flow is thought to be generally of a regional scale. Where unconfined, long flow path lengths (up to 2000 m) would be expected in the Sandstones and Pure Bedded Limestones. Although shorter flow paths are frequently associated with the remaining Dinantian rocks (c.30-300 m), the higher degree of fracturing thought to occur in this GWB suggests that paths may be of a similar magnitude to the other rocks. Groundwater flow directions are expected to be towards the R. Blackwater, which runs through the centre of the GWB. *Dinantian Aquifer Chapters (Pure, Impure and Mixed Limestones/Sandstones); Monaghan GWPS*
Groundwater & Surface water interactions		Groundwater will contribute baseflow to the streams and rivers flowing across this GWB, especially in the inter-drumlin areas, where subsoil is generally thinner.

Conceptual model	• The GWB is bounded by lower permeability aquifers to the north, south and east, and by a topographic divide to the west. General elevations increase westwards, from 40 mAOD in southeast to 80 mAOD in the northwest. Drumlins (additional 30 m in height) are located throughout the GWB. • All of the rocks in this GWB are of Dinantian age and are categorised as Rf: Regionally important fissured aquifer. Pure Bedded Limestone, Lower Impure Limestones, Shales and Limestones (to the north) and early Sandstones, Shales and Limestones (to the south) are the main rock groups. All rock groups are considered to have the potential for relatively high fissure permeability and good transmissivities. The unconfined groundwater flux is likely to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3 m thick, and zone of interconnected fissuring, to a maximum of 30 m thick. There may also be some flow through isolated fissuring typically less than 150m. • Estimated transmissivity values range from 50-250 m^2/d and are thought to be represent the entire GWB as permeability is likely to be strongly influenced by the degree of faulting and associated fracturing. Storativity is also thought to be reasonable. • The aquifer is thought to be able to support regional scale flow systems, with flow paths up to 2000 m with groundwater discharging to the rivers/streams crossing the aquifer, and to small springs and seeps. • Recharge will occur diffusely through the subsoil and rock outcrops although is likely to be limited where subsoil is thicker and especially of a low permeability. • The main discharges are to the streams, rivers, lakes and springs within the GWB. Overall, the flow direction is likely to be to the east, as determined by the topography. • The Monaghan Town PWS is located in this GWB. Modelling of the PWS indicates that groundwater is potentially pulled in from the adjacent northern and western GWBs however, the influence from the northern GWBs is considered to be limited.
Attachments	Figure 1. Table 1.
Instrumentation	**Stream gauges:** 03050, 03054, 03058 **EPA Water Level Monitoring boreholes:** (MON 115), (MON 116), (MON 136), (MON 138; short record), (MON 141), (MON 144) **EPA Representative Monitoring points:** (MON 08), (MON 26) , (MON 32) , (MON 33) , (MON 40) , (MON 43) , (MON 103), (MON 110)
Information Sources	Geraghty, M., Farrelly, I., Claringbold, K., Jordan, C., Meehan, R., and Hudson, M., 1997. *Geology of Monaghan-Carlingford. A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 8/9, Monaghan-Carlingford*. Geraghty, M. (ed.). Geological Survey of Ireland. 60 p. O' Riain, G. 2004. *Water Dependent Ecosystems and Subtypes (Draft)*. Compass Informatics in association with National Parks and Wildlife (DEHLG). WFD support projects. Swartz, M and Daly, D. (2002) *County Monaghan Groundwater Protection Scheme Report*. Main Report. Final Report to Monaghan County Council. Geological Survey of Ireland. Swartz, M. (2001) *Monaghan Public Water Supply – Groundwater Source Protection Zones*. Final Report to Monaghan County Council. Geological Survey of Ireland.
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. Location and Boundaries of GWB.

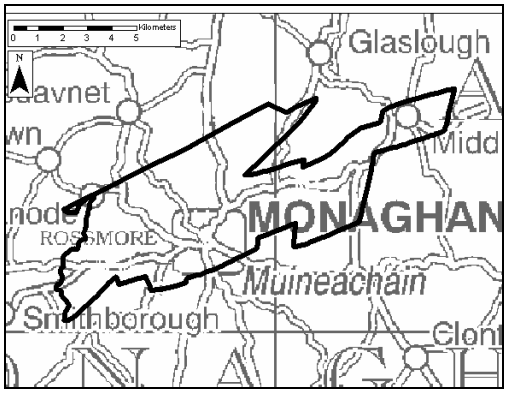
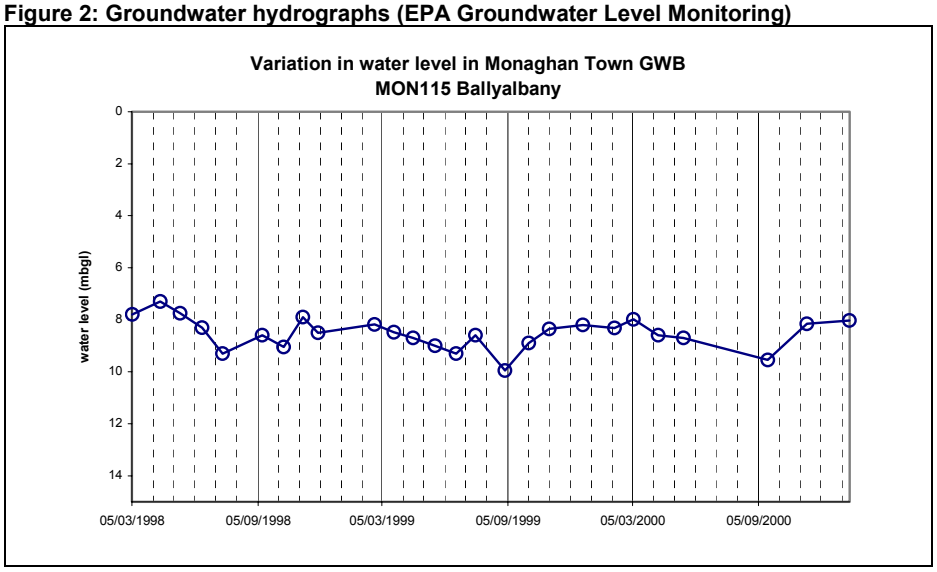
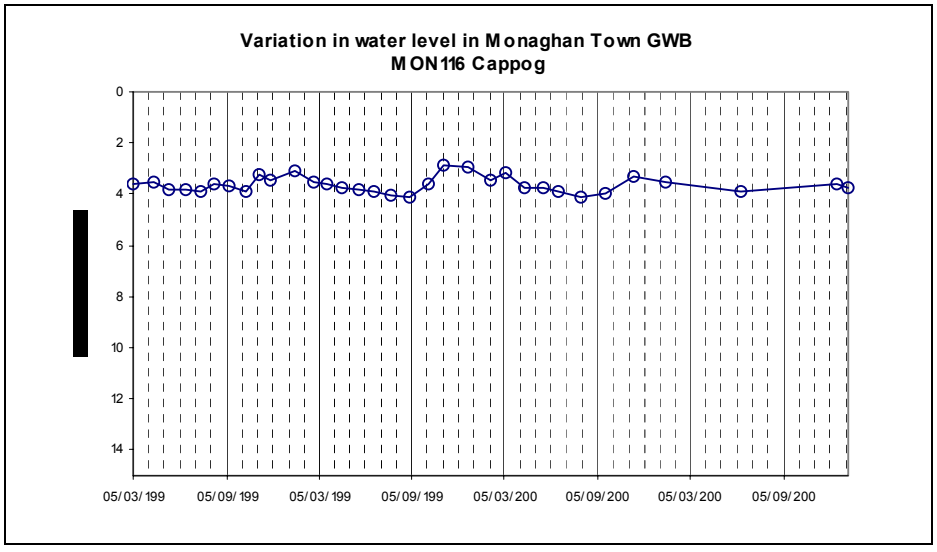


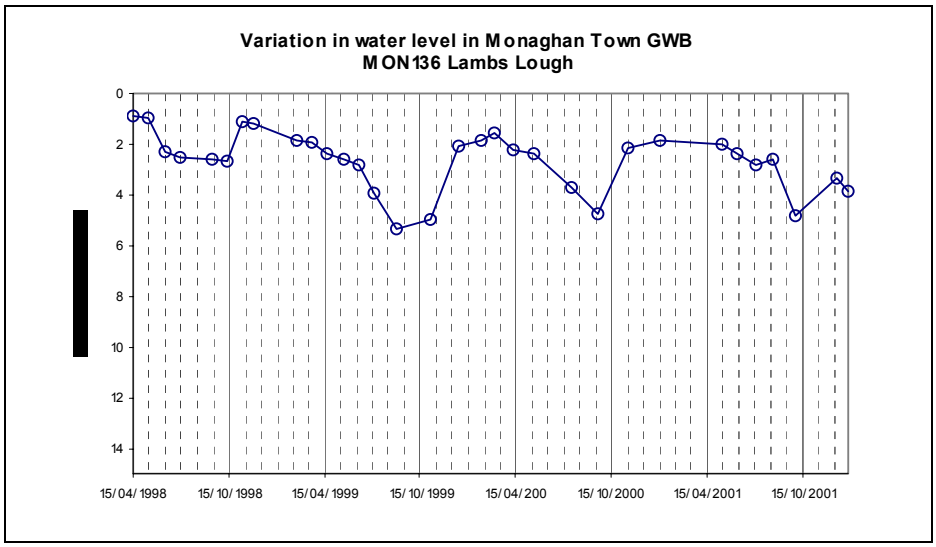
Table 1. List of Rock units in GWB

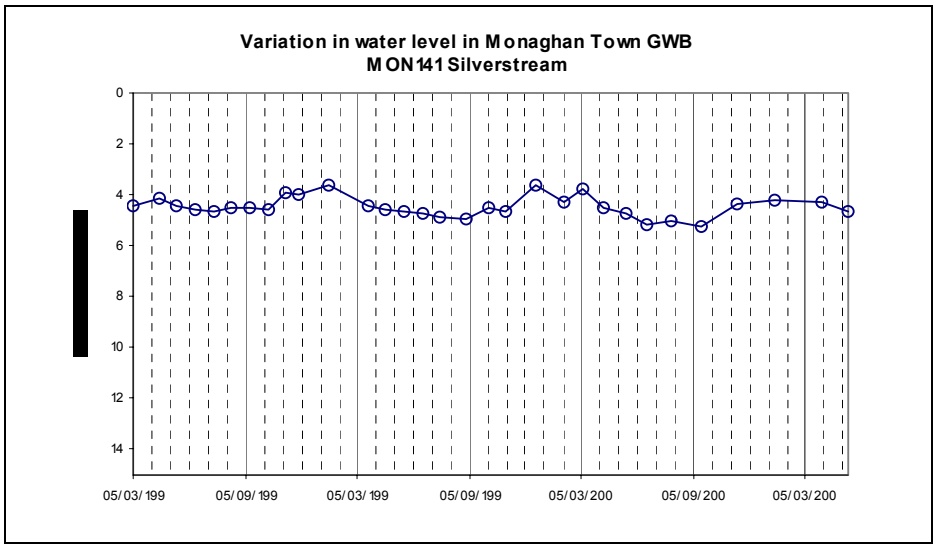
Rock Unit Name	Code	Description	Rock Unit Group	Aquifer Class.	% Area
Ballyshannon Limestone Formation	BS	Crinoidal limestone & silty shale	Dinantian Pure Bedded Limestones	Rf	30.64
Ballysteen Formation	BA	Dark muddy limestone, shale	Dinantian Lower Impure Limestones	Rf	22.10
Bundoran Shale Formation	BN	Dark shale, minor fine-grained limestone	Dinantian Shales and Limestones	Rf	18.30
Cooldaragh Formation	CH	Pale brown-grey flaggy, silty mudstone	Dinantian (early) Sandstones, Shales and Limestones	Rf	13.92
Dartry Limestone Formation	DA	Dark fine-grained cherty limestone	Dinantian Pure Bedded Limestones	Rf	9.28
Ulster Canal Formation	UC	Calcareous sandstone, shale, micrite	Dinantian (early) Sandstones, Shales and Limestones	Rf	3.14
Fearnaght Formation	FT	Pale conglomerate & red sandstone	Dinantian Sandstones	Rf	2.6

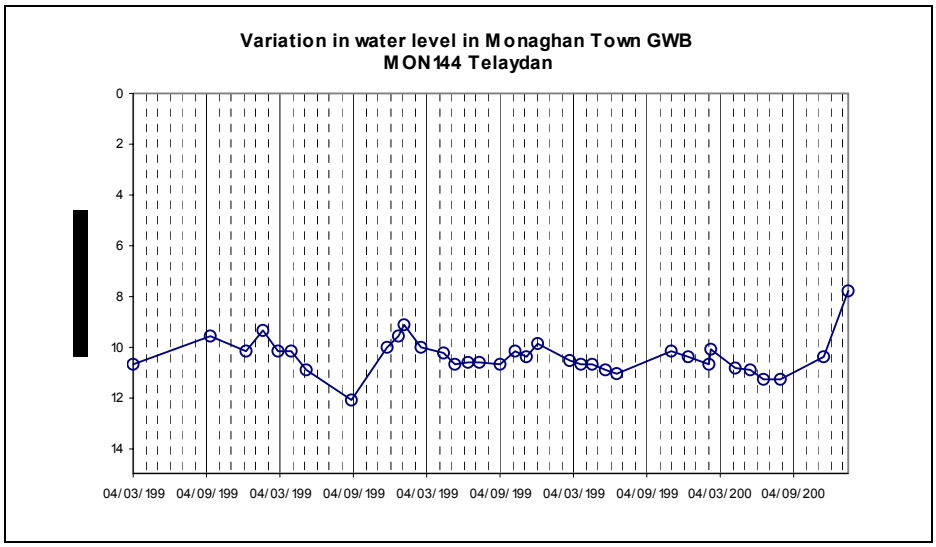
Figure 2: Groundwater hydrographs (EPA Groundwater Level Monitoring)






Variation in water level in Monaghan Town GWB
MON136 Lambs Lough
0
2
4
6
8
10
12
14
15/04/1998
15/10/1998
15/04/1999
15/10/1999
15/04/200
15/10/2000
15/04/2001
15/10/2001


Variation in water level in Monaghan Town GWB
MON141 Silverstream
0
2
4
6
8
10
12
14
05/03/199
05/09/199
05/03/199
05/09/199
05/03/200
05/09/200
05/03/200


Variation in water level in Monaghan Town GWB
MON144 Telaydan
0
2
4
6
8
10
12
14
04/03/199
04/09/199
04/03/199
04/09/199
04/03/199
04/09/199
04/03/199
04/09/199
04/03/200
04/09/200