Athboy GWB: Summary of Initial Characterisation.

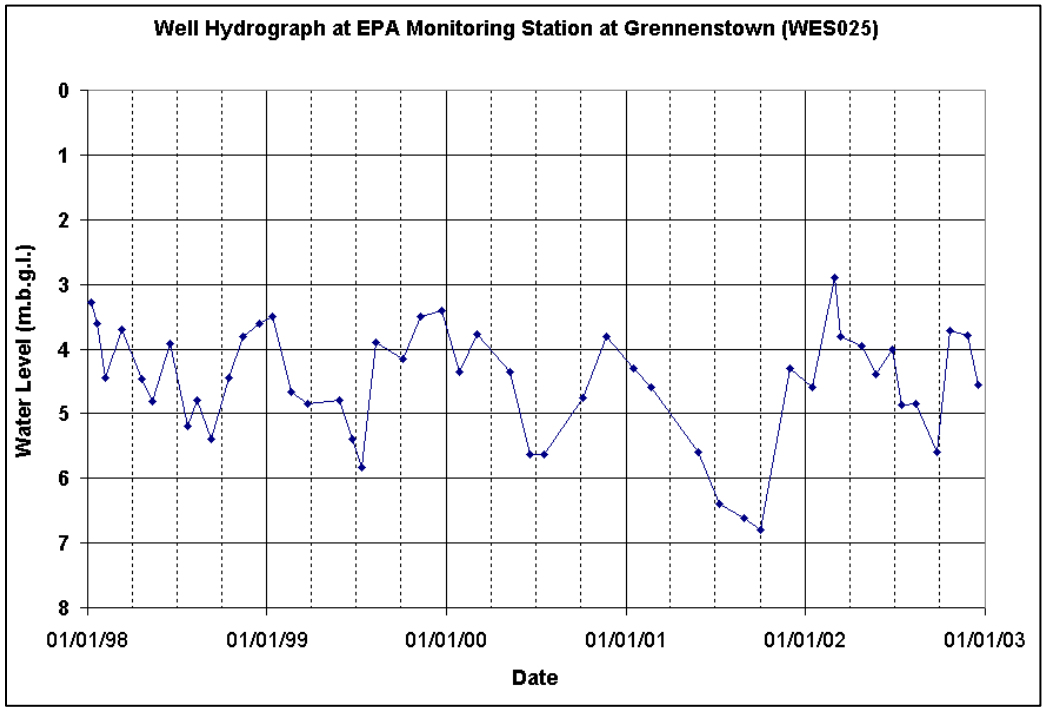
Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km^2)
Meath Co Co Westmeath Co. Co. Offaly Co Co. Hydrometric Area 07	Rivers: Yellow, Stonyford, Rochfordbridge, Riverstown, Milltownpass, Kinnegad, Deel, Castlejordan, Blackwater, Athboy Loughs: Yellow, White, Stillafiddler, Reynella, Newtown, Doolin, Freekan, Cunninghams, Crowinstown, Croboy, Cloran, Bracklin, Black Ballyhealy	Raheenmore Bog (SAC - 582), Mount Hevey Bog (SAC - 1584), Molerick Bog (1582), Girley Bog (1580), Jamestown Bog (1324), Wooddown Bog (694) & Lough Shesk (556)	964

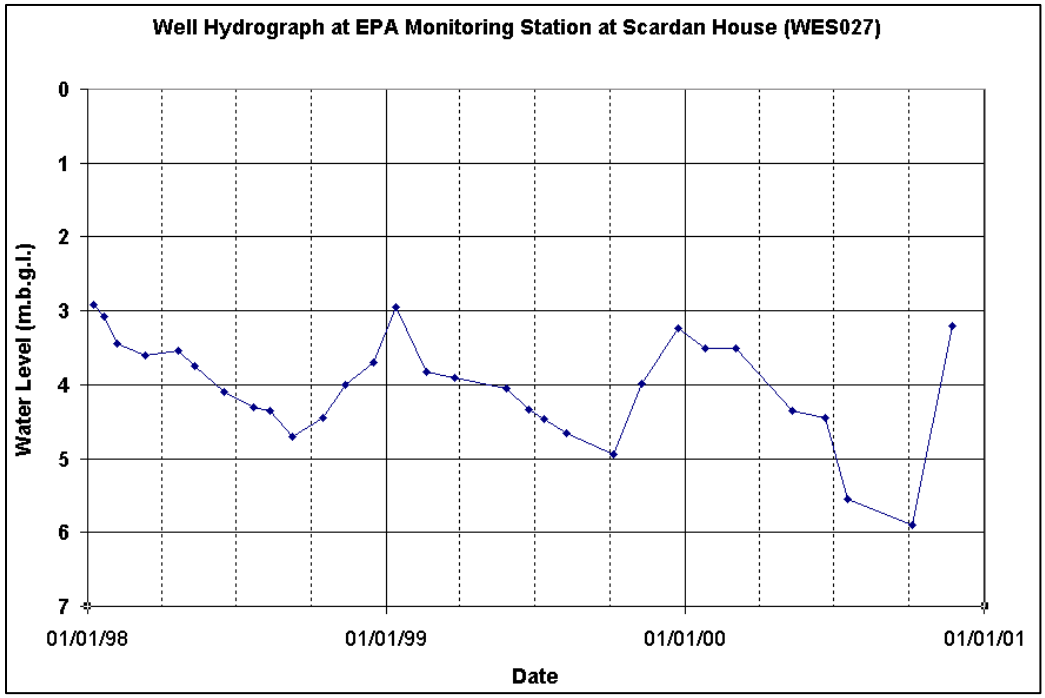
Topography		This large GWB extends from Navan in the northeast to Tyrrellspass and Rochfortbridge in Westmeath. The area is typical of the midlands of Ireland with little relief. There are some isolated hills which rarely rise above 150 m OD. In general the elevation falls from northwest to southeast, reflected in the overall drainage pattern. The region shows a distinctive topography, a typical product of the last glaciation. The land surface is undulating, with large hummocks of glacial drift, deposited under the ice as moraines.
Geology and Aquifers	Aquifer type(s)	Mostly **Ll:** Locally important aquifer, moderately productive only in local zones Small amounts of **Pl:** Poor aquifer, generally unproductive except for local zones (~1.2%) **Lm:** Locally important aquifer, generally moderately productive (~2%)
	Main aquifer lithologies	Dinantian Upper Impure Limestones Dinantian Pure Unbedded Limestones Dinantian Lower Impure Limestones Dinantian Early Sandstones, Shales and Limestones
	Key structures.	
	Key properties	Pumping test analyses from Ballivor WS provided apparent transmissivities of 10 - 200 m^2/d from the 12-hour pumping test and from recovery tests. A value of 50 m^2/d is taken as the most reasonable figure of apparent transmissivity based on test results from other wells in the region. A pumping test at a factory in Ballivor provided an apparent transmissivity of around 30m^2/d. The drilling encountered 28 m of till overlying deeply weathered and broken limestone bedrock. The main groundwater inflow l was met at 51m depth. The aquifer remained confined during the pumping test. (Cullen 1985) Analysis of a 72-hour pumping test at Athboy WS indicated transmissivities around 100-230 m^2/d. Higher figures were estimated from a 12-hour test in 1996; a higher permeability zone may have been developed close to the surface, possibly along the interface of the broken limestone bedrock and the overlying sands and gravels.
	Thickness	In a large limestone aquifer such as this the bedrock is high heterogeneous and the depth to which major groundwater flows are encountered varies even over short distances. In general in a locally important aquifer such as this the majority of groundwater flow is expected to occur in an upper broken and weathered zone, which is considered to be about 3m thick. Additional flows are commonly found in the upper 10m where groundwater flows along fracture networks. Occasionally deeper isolated groundwater flows are found in cavities which may have been layers or pure limestone solutionally enlarged by karstification. The examples below give a details description of the rock profile in a number of locations. A borehole log (61m) for the Athboy borehole indicates 54.5 m of black limestone with shale bands. The upper 4.5 m were reported to be highly broken. A GSI observation borehole 58.8 m deep (Athboy D/H 104) was drilled approximately 17 m from the supply well, and encountered 47.9 m of dark gray to black limestone and shale. The limestone was not regarded as highly broken or fractured and fracturing decreased with depth. No cavities were encountered, although the return water during the drilling was lost between 38m and 48m below ground level, which would suggest higher permeabilities in this zone although the core did not indicate excessive fracturing at this depth. A GSI observation borehole 63 m deep (Ballivor D/H 105) was drilled approximately 25m from the production wells and encountered limestone at 7 m. The limestones are dark gray to black in colour with alternating thin beds of black calcareous shales (1-5cm thick). The limestones were not regarded as highly fractured although the recovered core was very broken due to the brittle nature of the rock. Several of the fractures have been infilled with calcite ranging in thickness from 1-2cm generally. A vein 30cm thick was encountered from 14.4m to 14.7m, which contained small cavities or vugs. There was no evidence of alteration such as dolomitisation.
Overlying Strata	Lithologies	There is a varied subsoil cover overlying this aquifer. The dominant subsoil type is till, in most cases this is derived from limestone clasts, although in the northern area of the body there are till derived from Lower Paleozoic rocks. In addition to till there are also numerous deposits of gravels and in other places Peat. Subsoil mapping in Co. Meath indicates there are many gravel deposits overlying the aquifer. The gravel deposits form hummocky hills and also eskers, which are seen through out the area.
	Thickness	Thick till covers most of this area although a high degree of variability is expected over such a large area. Subsoil thickness has not yet been adequately mapped in Westmeath. There are quarries within this groundwater body where the aquifer will be exposed, e.g. at River Dale, Co. Westmeath.

	% Area aquifer near surface	The percentage of the area where the aquifer is close to the surface is quite low.
	Vulnerability	Vulnerability mapping is available only for the area within Meath and Offaly, where the vulnerability is mostly Moderate but with significant areas of both higher and lower vulnerability.
Recharge	Main recharge mechanisms	Diffuse recharge appears to be the dominant process for water to reach the aquifer. The slope and the thickness and permeability of the soil and subsoil will determine the amount of recharge reaching the aquifer. Due to the generally low permeability of the aquifer a high proportion of the recharge will then discharge rapidly to surface water courses via the upper weathered layers of the aquifer, effectively reducing the available groundwater resources in the aquifer. In certain areas of the aquifer the surface drainage system appears to be disjointed, a typical sign of a karstic environment, with rivers disappearing underground in swallow holes or caves and reappearing as springs. It is likely in these areas that point recharge occurs. The gravel deposits overlying the aquifer may also influence the drainage pattern; a more detailed understanding is not possible until subsoil mapping is available for the areas of interest e.g. around Delvin, Co. Westmeath.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	Springs and large known abstractions	**GSI Source Reports** – Athboy & Ballivor Public Supplies **EPA GW Abstraction Register** – *Name (Abstraction (m^3/d))* Clonmellon (94-Spring), BNM at Derrygreenagh (27), Clonard GWS (20), Riversdale Concrete (18), Raharney WS (14), Ballinbrackey Housing (7), Lewinstown GWS (7), Cloneycavan, Robinstown, Kilwarden, Clonard, Rossan, Granstown (Spring), Grennanstown.
	Main discharge mechanisms	This GWB discharges to the overlying rivers and streams. In some instances there may be discharge to the adjacent Trim GWB to the east. Discharge to rivers will be in the form of baseflow. Dry Weather Flows (DWF) are moderate to low. This suggests the aquifer is not maintaining a large baseflow in the summer months. This is typical of karstic and fissured aquifers where the low storativity cannot maintain a large baseflow throughout dry summer months. There is direct discharge of groundwater to the surface at springs, 7 of which are recorded in the GSI karst database, and many others tend to be located along the banks of rivers.
	Hydrochemical Signature	Data collected by the EPA for this GWB shows the water is generally Hard (250-350 mg/l CaCO3) with high Electrical Conductivity (600-700 µS/cm). The Durov diagram attached shows the waters have a calcium bicarbonate signature and the water has alkalinity values of over 250 mg/l.
Groundwater Flow Paths		The specific yield data from various pumping tests in the area indicates that the aquifer is unconfined. Groundwater flow in the aquifer will generally take place in the upper 3 to 5 m of the bedrock where there has been weathering. In some local areas there may be the development of deeper flow through a network of connected fractures and fissures. In some instances these fractures be come enlarged by solution to form karstic conduits, which can transport large quantities of water at high speeds. A calculation of the drainage density for the entire area is 0.662 km/km^2. This is considered to be indicative of a moderately good aquifer. The typical groundwater flow path length is estimated at 0.75 km. The three EPA water level monitoring station located around Sion Hill, north of Kilucan, show the variation in the depth of the water table between the river and the hill. The highest gauge shows the water table around 8 m below ground, the next borehole shows it around 5 m below ground and close the river the water table is less than 2 m below the surface. This indicates a hydraulic gradient of 0.05 on the hill and 0.005 on the flood plain.
Groundwater & surface water interactions		In karstic areas there is a direct link between the surface and groundwater systems. There is evidence that in some areas of this GWB the limestone is karstified. Springs, swallow holes and caves are three typical karstic features present where groundwater and surface water are directly linked. The area contains numerous surface water bodies, which are considered as protected areas and to differing extents are dependent on groundwater. One site at Lough Shesk, near Clonmellon on the Meath/Westmeath border is worth special consideration. The hummocky nature of the terrain in this area produces frequent springs and seepages, rich in lime. Consequently, a series of base-rich marshes have developed in the poorly drained hollows, generally linked with three larger lakes, i.e. Lough Shesk, Freehan Lough and Newtown Lough. This site has been rated as of national importance. There is no other place in the county where the full sequence of stages in the open water/peat bog transition is so well illustrated within a compact area. The main threat to the site lies in drainage of the wetland areas, either directly or by means of dredging of the adjacent river systems or lowering the water table by over abstraction.
Conceptual model	This large GWB extends from Navan in the northeast to Tyrrellspass and Rochfortbridge in Westmeath. The area is low-lying; some isolated hills rarely rise above 150 m OD. The GWB boundary is defined to the south and west by the topographic boundary with other RBDs. To the north the boundary is at the contact with the Lower Paleozoic rocks and to the east the boundary coincides with the change in aquifer classification of the Calp from an Ll aquifer to an Lm aquifer. The GWB is composed primarily of moderate permeability rocks, although localized zones of enhanced permeability do occur. Groundwater flow will mainly occur laterally through the upper weathered zone of the aquifer. Below this, flow occurs along fractures, faults and karstic conduits. Recharge occurs diffusely through the subsoils and via outcrops and in some local areas direct recharge may be possible where via sinking streams. The aquifers are generally unconfined, but may be locally confined where the subsoil is thicker and/or less permeable. Regional groundwater flow is from northwest to southeast, but locally, groundwater discharges to the streams and rivers crossing the aquifer. In general groundwater flow paths will be less than a kilometre from recharge to discharge point; longer groundwater flow paths may develop where there is a higher degree of karstification. Groundwater discharges to the numerous small streams crossing the aquifer, and to the springs and seeps. There may also be some discharge to the Trim GWB to the east of this body.	

Attachments	Four Borehole Hydrographs measured at EPA Stations within the GWB
Instrumentation	Stream gauge: 07002, 07006, 07008, 07014, 07015, 07023, 07028, 07029, 07030, 07031, 07032, 07036, 07044, 07045, 07049, 07050, 07051, and 07052. **Borehole Hydrograph:** GRENNENSTOWN (Dillon) (WES025) Scardan House (WES027) The following hydrographs are not plotted, as there is very little data available. Sionhill (WES031), Borrow (WES032) **EPA Representative Monitoring boreholes:** Clonard GWS (MEA093) O'Conner (Parke) (MEA107), Lewinstown GWS (WES007), Granston (WES026)
Information Sources	Cullen K T (1985) *Report on the Drilling and Testing of a Water Well at N.E.C. Ltd.* Report to N.E.C. Ltd. Geraghty M, Farrelly I, Claringbold K, Jordan C, Meehan R, & 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.* Geological Survey of Ireland. 60 p. Morris J H, Somerville I D & MacDermot C V (2002). *Geology of Longford-Roscommon.* A Geological Description to Accompany the Bedrock Geology 1:100,000 Bedrock Series Sheet 12. Geological Survey of Ireland, 121pp. McConnell B, Philcox M & Geraghty M, 2001. *Geology of Meath: A geological description to accompany the bedrock geology 1:100,000 scale map series, Sheet 13, Meath.* Geological Survey of Ireland. 77 p. McConnell B, Philcox M, Sleeman A G, Stanley G, Flegg A M, Daly E P & Warren W P. 1994. *A Geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 16, Kildare-Wicklow*. Geological Survey of Ireland, 70 pp. Kelly C & Fitzsimons V. (2002) *County Kildare Groundwater Protection Scheme*. Report to Kildare County Council. Geological Survey of Ireland 55pp Woods L, Meehan R & Wright G R, 1998. *County Meath Groundwater Protection Scheme.* Report to Meath County Council. Geological Survey of Ireland. 54 p. Daly D, Cronin C, Coxon C & Burns S J 1998. *County Offaly Groundwater Protection Scheme*. Report to Offaly County Council & Geological Survey of Ireland, 57pp.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Formation Name	**Code**	**Description**	**Rock Unit Group**	**Aquifer Classification**
Agglomerate	Va	Lm	Basalts & other Volcanic rocks	Lm
Ballysteen Formation	BA	Fossiliferous dark-grey muddy limestone	Dinantian Lower Impure Limestones	Ll
Basalt	Vb	Lm	Basalts & other Volcanic rocks	Lm
Derravaragh Cherts	DV	Very cherty limestone	Dinantian Upper Impure Limestones	Lm
Edenderry Oolite Member	AWed	Oolitic limestone	Dinantian Pure Bedded Limestones	Lm
Liscarton Formation	LC	`Laminated Beds & Muddy Limestones	Dinantian (early) Sandstones, Shales and Limestones	Ll
Lower Palaeozoic rocks	LP	Undifferentiated	Ordovician Metasediments	Pl
Lucan Formation	LU	Dark limestone & shale (Calp") "	Dinantian Upper Impure Limestones	Ll
Meath Formation (`Pale Beds)	ME	Pale grainstone	Dinantian (early) Sandstones, Shales and Limestones	Ll
Moathill Formation (`Shaly Pales)	MH	Mudstone, calcarenite & calc. sandstone	Dinantian (early) Sandstones, Shales and Limestones	Ll
Mudbank Limestones	mk	Massive grey micritic limestone	Dinantian Pure Unbedded Limestones	Ll
Old Red Sandstone	ORS	Red conglomerate, sandstone, mudstone	Devonian Old Red Sandstones	Ll
Stackallan Member (`Micrite Unit)	MEst	Micrite, mudstone and dolomite	Dinantian Pure Bedded Limestones	Lm
Tober Colleen Formation	TC	Calcareous shale, limestone conglomerate	Dinantian Upper Impure Limestones	Pl
Visean limestones, undifferentiated	VIS	Undifferentiated limestone	Dinantian Upper Impure Limestones	Ll
Volcanics (in Carboniferous)	V	Lm	Basalts & other Volcanic rocks	Lm
Waulsortian Limestones	WA	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones	Ll


Well Hydrograph at EPA Monitoring Station at Grennenstown (WES025)
Water Level (m.b.g.l.)
0
1
2
3
4
5
6
7
8
01/01/98
01/01/99
01/01/00
01/01/01
01/01/02
01/01/03
Date


Well Hydrograph at EPA Monitoring Station at Scardan House (WES027)
Water Level (m.b.g.l.)
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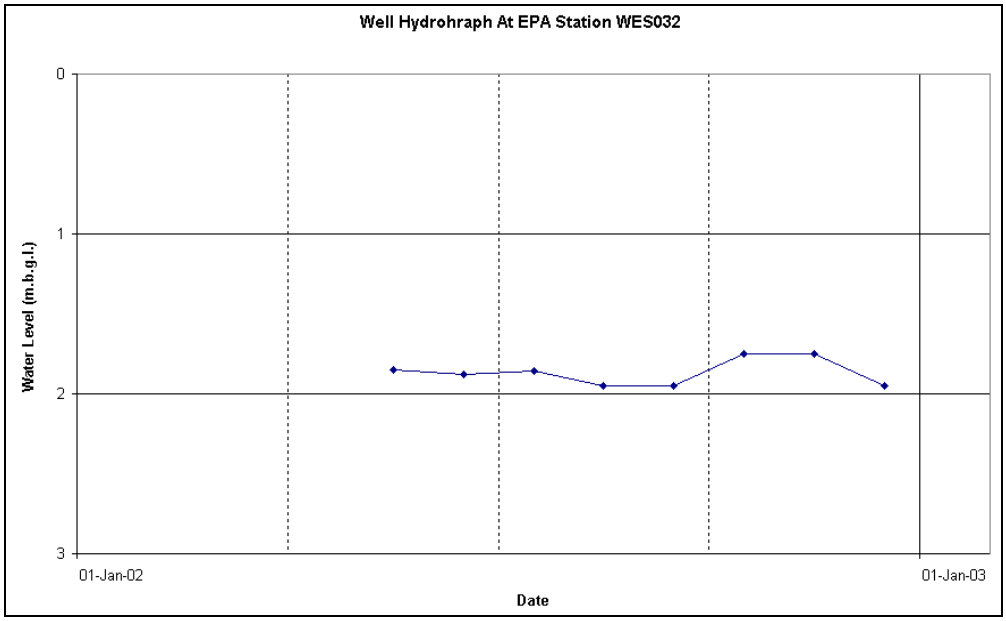
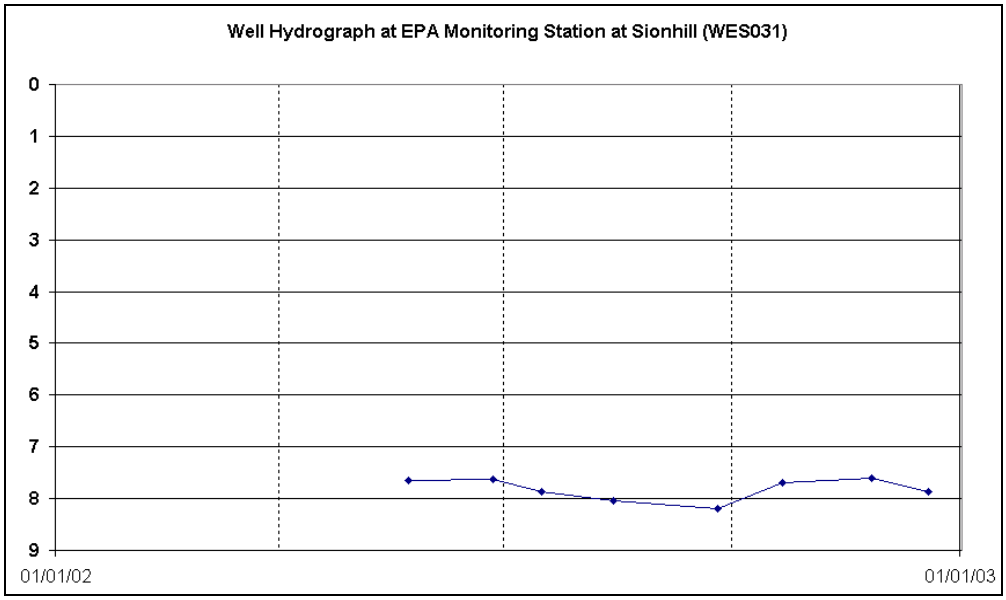
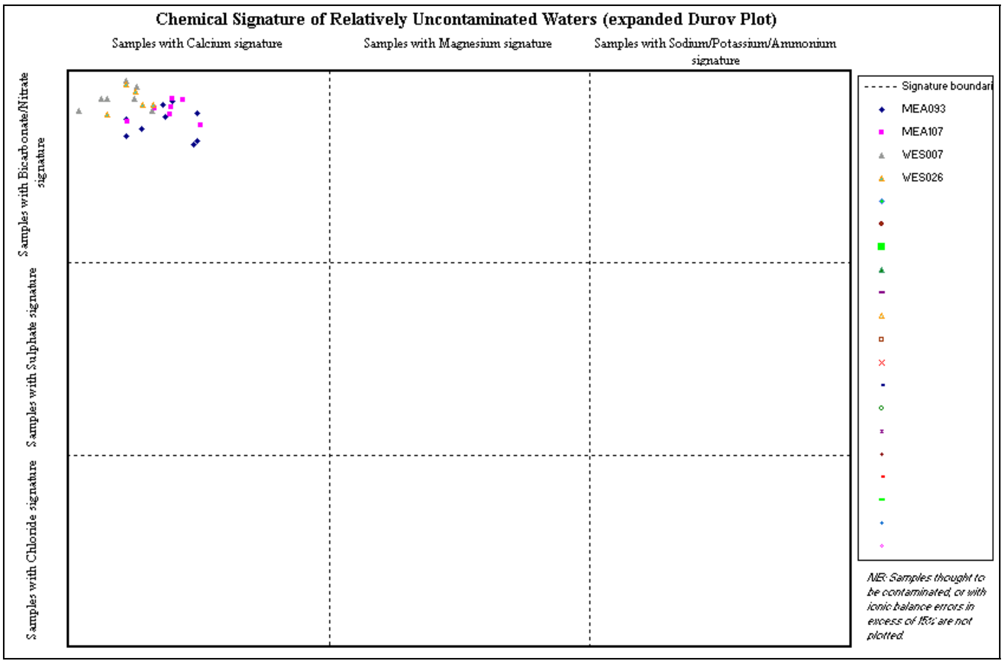
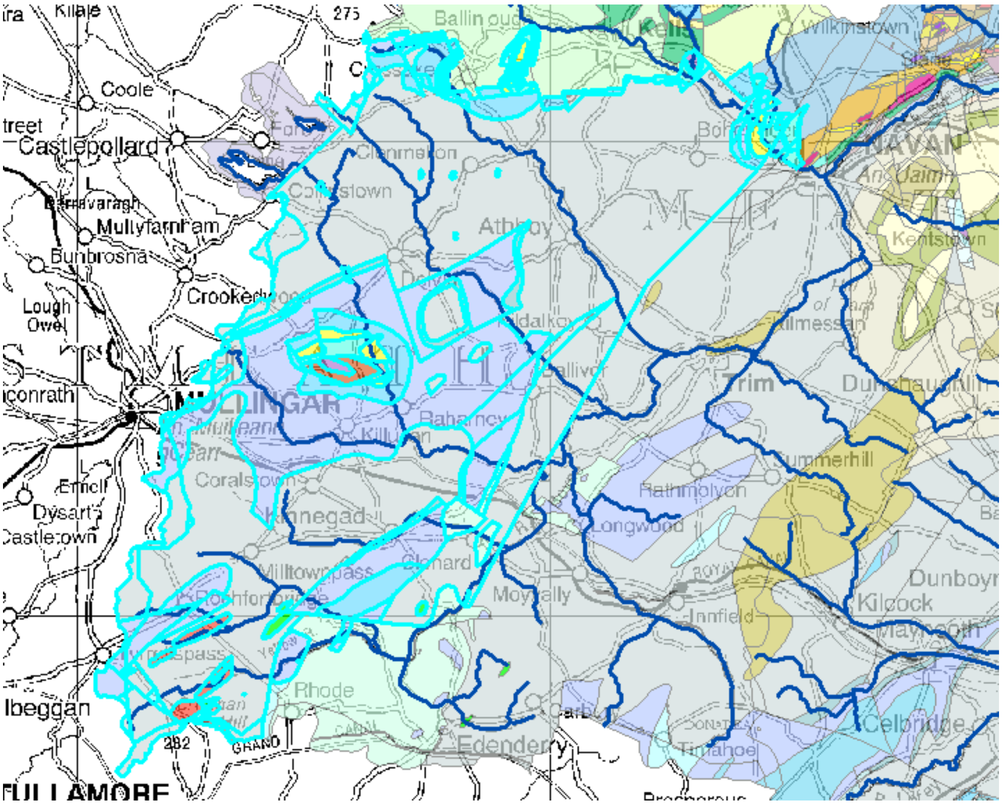
2
3
4
5
6
7
01/01/98
01/01/99
01/01/00
01/01/01
Date


Well Hydrohraph At EPA Station WES032
Water Level (m.b.g.l.)
0
1
2
3
01-Jan-02
01-Jan-03
Date


Well Hydrograph at EPA Monitoring Station at Sionhill (WES031)
0
1
2
3
4
5
6
7
8
9
01/01/02
01/01/03


Chemical Signature of Relatively Uncontaminated Waters (expanded Durov Plot)
Samples with Calcium signature
Samples with Magnesium signature
Samples with Sodium/Potassium/Ammonium signature
Samples with Bicarbonate/Nitrate signature
Samples with Sulphate signature
Samples with Chloride signature
Signature boundari
MEA093
MEA107
WES007
WES026
NB: Samples thought to be contaminated, or with ionic balance errors in excess of 15% are not plotted.


Killale
Coole
Castlepollard
Mullyfarnham
Bunbrosna
Lough Owel
Crookedwood
MULLINGAR
Coralstown
Kinnegad
Milltownpass
Rochfortbridge
Rhode
Edenderry
Clonmellon
Collinstown
Athboy
Delvin
Killucan
Raharney
Trim
Kilmessan
Summerhill
Rathmolyon
Longwood
Moynalty
Innfield
Kilcock
Maynooth
Celbridge
Timahoe
NAVAN
Kentstown
Dunboyne
Wilkinstown
Ballinough
Dysart
Castletown
Tyrrellspass
Ibeggan
TULLAMORE
275
282