

Environmental Protection Agency

Establishment of Groundwater Source Protection Zones

Kilcoran Group Water Scheme

(Private Scheme)

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PROJECT DESCRIPTION

Since the 1980's, the Geological Survey of Ireland (GSI) has undertaken a considerable amount of work developing Groundwater Protection Schemes throughout the country. Groundwater Source Protection Zones are the surface and subsurface areas surrounding a groundwater source, i.e. a well, well field or spring, in which water and contaminants may enter groundwater and move towards the source. Knowledge of where the water is coming from is critical when trying to interpret water quality data at the groundwater source. The Source Protection Zone also provides an area in which to focus further investigation and is an area where protective measures can be introduced to maintain or improve the quality of groundwater.

The project "Establishment of Groundwater Source Protection Zones", led by the Environmental Protection Agency (EPA), represents a continuation of the GSI's work. A CDM/TOBIN/OCM project team has been retained by the EPA to establish Groundwater Source Protection Zones at monitoring points in the EPA's National Groundwater Quality Network.

A suite of maps and digital GIS layers accompany this report and the reports and maps are hosted on the EPA and GSI websites (www.epa.ie; www.gsi.ie).



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Appendix 2: Geological Survey of Ireland (2004) 1st Draft Cahir GWB Description.

1 Introduction

Groundwater Source Protection Zones (SPZ) have been delineated for the Kilcoran Group Water Scheme (Private Scheme) according to the principles and methodologies set out in 'Groundwater Protection Schemes' (DELG/EPA/GSI, 1999) and in the GSI/EPA/IGI Training course on Groundwater SPZ Delineation.

The Kilcoran Scheme is supplied from one borehole (IE_SE_G_024_23_008).

The objectives of the study were:

- To outline the principal hydrogeological characteristics of the Kilcoran area where the supply well is located.
- To delineate source protection zones for the well.
- To assist the Environmental Protection Agency (EPA) and South Tipperary Council in protecting the water supply from contamination.

SPZs are intended to provide a guide in the planning and regulation of development and human activities to ensure groundwater quality is protected. More details on SPZ are presented in 'Groundwater Protection Schemes' (DELG/EPA/GSI, 1999).

2 Methodology

The methodology applied to delineate the SPZ consisted of data collection, desk studies, site visits and field mapping and subsequent data analysis and interpretation.

An initial interview with the chairman of the group scheme and the field mapping of the study area were undertaken on 26/09/2010.

While specific fieldwork was carried out in the development of this report, the maps produced are based largely on the readily available information and mapping techniques using inferences and judgements from experience at other sites. As such, the maps may not be definitively accurate across the whole area covered, and should not be used as the sole basis for site-specific decisions, which will usually require the collection of additional site-specific data.

3 Location, Site Description and Well Head Protection

The site is approximately 10 km southwest of Cahir, in the townland of Kilcoran. The borehole is 100 m northwest of the National Road N8, and to the rear of a private dwelling and a Garden Centre, as shown in Figure 1.

The compound is accessed from the Garden Centre to the west of the site, where there is a palisade fence and a locked gate. This is the only side of the compound that is currently fenced off. The other sides are bounded to the north and the east by forestry and to the south by the backyard and garden of a private dwelling.



Figure 1: Location Map

The compound, which was originally part of the rear garden of the house, is covered with grass land leading up into the forestry. The well is in a concrete chamber in the garden adjacent to the back yard of the dwelling. The construction of the house involved cutting into the slope to form a level base and consequently both the house and backyard are approximately 1 m lower than the garden.

The well chamber is approximately 3 m to the west and rear of the dwelling and 10 m to the north of the pump house. The pump house is in poor condition. There is no treatment plant or reservoir and currently, water is pumped on demand directly to the distribution network without any treatment.

In 2009, the Kilcoran Group Water Scheme commissioned Mr. Paul Murphy, Consulting Engineer, to undertake an assessment of the water supply scheme and make recommendations for upgrades. A copy of Mr. Murphy's report dated August 2009, is included in Appendix 1.

The Group Scheme has applied to South Tipperary County Council for funding to upgrade the pump house, install a water reservoir and fence off the compound. The Group Scheme Chairman indicated that the work was due to be completed within the next 12 months. The borehole is located in a concrete block chamber (c 1 m by 1 m), fitted with two steel covers. The chamber is not sealed/rendered on the inside, which means that shallow groundwater can seep into the chamber through gaps between the blocks. Water staining on the inside walls of the chamber indicate that shallow groundwater can seep into the chamber through gaps between the blocks. Water staining on the inside walls of the chamber indicate that shallow groundwater can seep into the chamber. According to Mr. Murphy's Report Scheme members indicated that previously hillside drainage ditches on the higher slopes to the rear of the well became flooded and flowed down over the well resulting in it being polluted. Some of these ditches have now been cleaned and deepened and this should stop the immediate risk of flooding. During the OCM inspection there was no evidence of recent direct rainfall run-off in the direction of the well head. The drainage ditches in the forestry located start approximately 50m east of the site and run from south to north at c. 100m intervals. They appear sufficiently deep enough to divert overland flow to the lower ground to the north of the compound. There is evidence of scouring associated with high volume run-off from the drains across the forestry access road located to the north of the compound.

The base of the chamber is 1 m below the ground surface and is not sealed. Because the chamber is set at ground level, surface run-off from the lands to the west can enter the chamber (Photograph 1). The steel borehole casing rises 5 cm above the bottom of the chamber, which should decrease the risk of surface run off or spills from entering the well head directly. However, there is no information (e.g. a borehole or well construction log) to establish whether or not the borehole is adequately sealed to prevent shallow subsurface inflow or to determine the precise location of inflow to the well at depth.



Photo 1: Well Head Chamber

4 Summary of Well Details

The Consulting Engineer's report (Appendix 1) provides information on the distribution network for the Group Scheme but does not contain any information on the borehole construction. Limited information was provided by the Group Scheme Chairman, Mr Patrick McGrath. Mr. McGrath said that the borehole was installed around 1970 and was c.125 ft (38 m) deep. Contrary to the engineer report, the site inspection observations established that the borehole casing is 150 mm diameter. It is likely that the casing extends to bedrock, with an open hole below this depth. The Vulnerability Map for the area indicates that the depth to bedrock is around 3 m.

There is no water reservoir or treatment plant and water is pumped on demand directly to the scheme distribution main. The system is pressurised and when the pressure drops below a certain level the pump activates on the well. This means that the pump is in almost continuous operation. The average volume of water being pumped is 50,000 gallons per day or 227 m^3/d .

Table 3-1 provides a summary of the details as currently known.

	Borehole
EU Reporting Code	IE_SE_G_024_23_008
Grid ref. (GPS)	198376 121638
Townland	Bohernarne
Source type	Borehole
Drilled	1970
Owner	Kilcoran Group Water (Private Scheme)
Elevation (Ground Level)	~100 m OD
Depth (m)	38 m (125 feet)
Depth of casing	Unknown
Diameter	150 mm
Depth to rock	Estimated at 3 m
Static water level	Unknown
Pumping water level	7.70 m bgl for yield 227 m ³ /d
Consumption (Co. Co. records)	9.4 m ³ /h or 227 m ³ /d
Pumping test summary: (i) abstraction rate m ³ /d	Not Tested
(ii) specific capacity	-
(iii) transmissivity	930 m ² /d (based median value of the GWB data)

Table 6-1: Well Details

It was not possible to undertake a pumping test during this assessment because the well is in use continuously and ceasing the pumping for any length of time would have resulted in a depressurisation of the network and a loss of water supply to the scheme.

5 Topography, Surface Hydrology & Landuse

The borehole is located on the eastern footslopes of the Galty Mountains, at approximately 100 m OD. The land slopes from the mountains to the south east, toward the Thonogue River Valley. The highest point in the sub-catchment is 631 m OD, 4.7 km northwest of the source. The topographic gradient on the flanking ridges is steep at approximately 0.10 and decreases significantly to 0.03 in the Thonogue River valley. Approximately 100–120 m up hydraulic gradient of the well, deep channels have been eroded through parts of the forestry and along the roads, indicating high run-off rates in these areas during prolonged or high intensity rainfall events.

The borehole is situated between two tributaries of the Thonogue River, 500 m to the north east and 600 m to the south west of the well, respectively. Both flow to the southeast and merge as the main Thonogue River c.1.5 km southeast of the site. The Thonogue joins the River Suir to the south of Cahir, approximately 6 km to the southeast of the site. The unnamed tributary stream to the southwest of the site originates at an elevation of c.120 m OD approximately 700 m northwest of the site. The larger tributary originates as a series of first order streams high up in the Galtees, approximately 5 km to the northwest at an elevation of c.600 m OD.

Land use in the high ground to the west of the borehole is dominated by conifer forestry. East of the borehole in the Thonogue River Valley the landuse is dominated by grassland dairy farming.

6 Hydrometeorology

Establishing groundwater SPZs requires an understanding of general meteorological patterns across the area of interest. Meteorological information was obtained from Met Eireann.

Annual rainfall: 1400 mm. The contoured data map of rainfall in Ireland (Met Éireann website, data averaged from 1961–1990) shows that the source is located on the 1400 mm average annual rainfall isohyet.

Annual evapotranspiration losses: 504 mm. Average potential evapotranspiration (P.E.) is estimated to be 530 mm/yr based on the contoured data map of potential evapotranspiration in Ireland (Met Éireann website, data averaged from 1971–2000) which shows that the source is located close to the 530 mm average annual evapotranspiration isohyet. Actual evapotranspiration (A.E.) is then estimated as 95% of P.E., to allow for seasonal soil moisture deficits.

Annual Effective Rainfall: 896 mm. The annual average effective rainfall is calculated by subtracting actual evapotranspiration from rainfall. Potential recharge is therefore equivalent to this, or 896 mm/year.

7 Geology

7.1 Introduction

This section briefly describes the relevant characteristics of the geological materials that underlie the site. It provides a framework for the assessment of groundwater flow and delineation of the source protection zones. The desk study data used comprised the following:

- Geology of Cork-Waterford. Bedrock Geology 1 : 100,000 Map series, Sheet 22, Geological Survey of Ireland (A.G. Sleeman and B. McConnell, 1995)
- Geology of Tipperary. Bedrock Geology 1 : 100,000 Map series, Sheet 18, Geological Survey of Ireland (J.B. Archer, A.G. Sleeman and D. C. Smith, 1996)
- Forest Inventory and planning system Integrated Forestry Information System (FIPS-IFS) Soils Parent Material Map, Teagasc (Meehan, 2002).
- Geological Survey of Ireland (2004) 1st Draft Cahir GWB Description.

7.2 Bedrock geology

The area is underlain by the Kiltorcan Formation (yellow and red sandstone and green mudstone) from the Devonian period, as illustrated in Figure 2.

The geological map (GSI Sheet No. 22) indicates that the rocks have been folded into anticlines and synclines, with approximately northeast-southwest axes, by the Variscan Orogeny. The well is located on the limb of an anticline, whose axis is situated on the top of the Galtee Mountains, approximately 4.5 km to the north. The bedding dip direction of the formations ranges from 10 to 30° in direction, to the south-southeast.

The older, Devonian, Poulgrania Sandstone (Red Sandstone with some conglomerate) outcrops higher up in the Galtees. The contact between the two formations is mapped 1 km to the northeast of the borehole. During the field mapping, outcrop of the conglomerate sandstone formation was observed in the high ground approximately 100 m west of the borehole along the forestry roads. Carboniferous, dark, muddy limestone and shale of the Ballysteen Formation is in faulted contact with the Kiltorcan formation c.400 m to the south of the borehole, in the floor of the Suir River Valley.

There is a major fault mapped 400 m south of the borehole running roughly southwest to northeast between the Kiltorcan Formation and the Ballysteen Formation. There is also a cross fault trending northwest to southeast at approximately right angles to the fold axis in the Kiltorcan Formation mapped 1.5 km to the northeast.

The Cahir Groundwater Body (GWB) description compiled by the GSI indicates that Kiltorcan Formation in South Tipperary reacted in a brittle manner to orogenic deformation, allowing the development of a denser network of fracturing and fracture permeability than in the shalier sandstones elsewhere in the aquifer. This extensive fracturing and faulting has most likely given rise to zones of enhanced permeability in the formation. This is discussed further in Section 9. The GSI GWB Report is included in Appendix 2.

7.3 Soil and Subsoil geology

The soil and subsoil distributions are illustrated in Figures 3 and 4, respectively. According to the EPA and GSI Web Mapping, the soil is classified over the high ground as Acid Mineral Soil with a shallow peaty surface layer (AminSRPT) and to the south at lower elevations (c.100 m OD) as Acid Mineral Soil Deep Poorly Drained with a shallow peaty surface layer (AminPDPT). Southeast of the borehole, the soil is classified as Acid Mineral Soil Deep Well Drained (AminDW) or Acid Mineral Soil Deep Poorly Drained (AminPD).

From 170 m OD to the top of the Galtee Mountains the bedrock outcrops. Below c.170 m OD, the bedrock is overlain by a Devonian Sandstone Till (TDSs) derived from the underlying Devonian bedrock, which

increases in thickness moving to the southeast into the valley floor. The subsoil thickness at the borehole is unknown but is estimated to be at least 3 m based on the observation of outcrop approximately 100 m to the north of the borehole and the Vulnerability mapping.

The subsoil is characterised as moderate to low permeability on the GSI vulnerability maps. BS5930 field assessment of the soils c100 m to the northwest of the borehole indicated very thin moderately drained tills in the high ground to the north of the borehole. The subsoils immediately to the east of the borehole comprise poorly draining silt dominated tills, while the lands to the south across the N-8 comprise well drained moderate permeability subsoils. The field observations are consistent with the mapped classifications within the local catchment.

7.4 Depth to Bedrock

The GSI vulnerability classification for this area indicates that from an elevation of 120 m OD up to the top of the Galtee Mountains the bedrock either outcrops or is close to the surface (less than 3 m). During the field mapping, bedrock outcrop was observed along the forestry roads from 100 m to the north east of the well. The field observations are consistent with the available mapping data. Over the remainder of the catchment, the subsoil thickness is mapped as being greater than 3 m deep. There is no borehole log or other depth to bedrock data available from the GSI database to establish the actual depth to bedrock in this area.

8 Groundwater Vulnerability

Groundwater vulnerability is dictated by the nature and thickness of the material overlying the uppermost groundwater 'target', which in this case is the bedrock aquifer. This means that in this area, the vulnerability relates to the permeability and thickness of the subsoil. A detailed description of the vulnerability categories can be found in the Groundwater Protection Schemes document (DELG/EPA/GSI, 1999) and in the draft GSI Guidelines for Assessment and Mapping of Groundwater Vulnerability to Contamination (Fitzsimons et al, 2003).

The vulnerability map is shown in Figure 5. In terms of subsoil coverage within the catchment of the wells, the area can be divided into two zones:

- Over the high ground to the north and northwest, situated between approximately 120 m OD and the top of the Galtee mountains and which represents the largest portion of the source catchment (around 80%), the subsoil is very thin or absent. Here the vulnerability is classed as Extreme or Extreme with Rock near the surface.
- Over the remainder of the catchment, from the footslopes of the Galtee Mountains where the source is located, to the Tonogue River valley area, which is between approximately 110 m OD and 90 m OD, the subsoil is estimated to be between 3 and 10 m in thickness and the vulnerability is considered to be High.





Figure 3: Soils Map





Figure 5: Vulnerability Map

9 Hydrogeology

This section describes the current understanding of the hydrogeology in the vicinity of the wells. Hydrogeological and hydrochemical information was obtained from the following sources:

- GSI Website and Database
- County Council Staff
- EPA website and Groundwater Monitoring database
- Local Authority Drinking Water returns
- The Cahir Groundwater Body initial characterisation report
- Misstear, B. Banks, D. Lewis C. (2006) Water wells and boreholes.

9.1 Groundwater Body and Status

The boreholes are located within the Cahir Groundwater Body (IE_SE_G_024) which has been classified as being of Good Status. The groundwater body description is available from the GSI website: www.gsi.ie and is provided in Appendix 2. The 'status' is obtained from the Water Framework Directive website: www.wfdireland.ie/maps.html.

9.2 Groundwater Levels, Flow Directions and Gradients

There are no static water data available for the well and there are no other groundwater wells located within 1 km of the site. During the site visit on 26/09/2010, the level in the well while it was being pumped was measured at 7.70 m bgl. The pumping rate was unknown but is estimated to be around 10 m³/hour, based on the daily pumping rate of 227 m³/d.

Based on the topography and surface water drainage, groundwater infiltrates mostly directly to the bedrock to the north and northwest of the borehole and flows to the south-east towards the Thonogue river valley. The topographic gradient in the vicinity of the borehole is steep, around 0.10. It is expected that the groundwater gradient is likely to reflect the topography, therefore a value of 0.10 has been assumed.

9.3 Hydrochemistry and Water Quality

The well has been included in the EPA operational chemical network since 1993. The raw water sample point is a tap located inside the pump house. The laboratory results have been compared to the EU Drinking Water Council Directive 98/83/EC Maximum Admissible Concentrations (MAC) and where relevant mean values have been compared to the Threshold Levels in the European Communities Environmental Objectives (Groundwater) Regulations 2010 recently adopted in Ireland (S.I. No. 9/2010) as part of the implementation of the Water Framework Directive 2000. The EPA data are graphed in Figures 6 to 8 and are summarised below.

The water has a calcium bicarbonate hydrochemical signature and is moderately soft (Average Total Hardness 58.6 mg/l CaCO₃). The average conductivity is 167.5 µS/cm. The pH was lower than the MAC range of between 6.5 and 9.5, on 12 occasions from a total of 23 analyses. The average pH is 6.2which indicates a mildly acidic water, probably related to the siliceous nature of the bedrock.

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 Faecal Coliforms were not detected in any of the 23 EPA analyses. However the Murphy report indicates that faecal coliforms were detected once 2003 and once in 2009. Ammonium values were not recorded above the Threshold Level (0.175 mg/l).



Figure 6: Key Indicators of Agricultural and Domestic Contamination: Bacteria and Ammonium

- The nitrate (as NO₃) level ranges from 0.9 mg/l to 4.0 mg/l, with a mean of 2.6 mg/l. Therefore, the nitrate level is well below the MAC (50 mg/l) and Threshold Value of 37.5 mg/l.
- Chloride can be a constituent of organic wastes, sewage discharge and artificial fertilisers, and concentrations higher than 24 mg/l (Groundwater Threshold Value, Groundwater Regulations S.I. No. 9 of 2010) may indicate contamination, with levels higher than 30 mg/l usually indicating significant contamination (Daly, 1996). Chloride concentrations range from 13.6 mg/l to 21 mg/l with a mean of 16.7 mg/l.
- Turbidity exceeded the drinking water standard limit of 1 NTU only on 2 occasions. This is likely due to the presence of very fine clay particles occasionally entering the borehole.



Figure 7:Key Indicators of Agricultural and Domestic Contamination : Nitrate and Chloride Graph

• The sulphate, potassium, sodium, magnesium and calcium levels are within normal ranges. The potassium: sodium ratio has never been above the threshold value of 0.35.



Figure 8: Key Indicators of Agricultural and Domestic Contamination: Manganese, Potassium and K/Na ratio

- The concentrations of iron and manganese are within the normal ranges.
- Other trace metals were within either the normal range for good quality drinking water or were not detected. Similarly, organic compounds and herbicides have not been detected.

In summary, the water is mildly acidic and with the exception of two incidents of faecal coliform detection in 2003 and 2007 the quality is generally good, which is likely to be a function of the limited pressures in the zone of contribution to the well.

Land use up hydraulic gradient of the supply is dominated by conifer forestry, where typically pesticides are used to control weed growth. In 2008, monitoring for pesticides was undertaken, but none were detected. However more frequent (annual) monitoring is required to establish if there is any impact associated with their use in the catchment.

The pH and electrical conductivity were measured on the 26/09/2010 in a tributary of the Thonogue River located 500 m to the east and at approximately the same elevation as the well. The lower conductivity and higher pH in the stream is indicative of surface run-off from the higher ground. This indicates that there is little interaction between surface and groundwater in the high ground to the west of the well. Data are presented in Table 9-1.

	Borehole	Thonogue river	
	(from EPA analyses)	(from field monitoring)	
Location	On site	Under bridge on N8	
лH	Ave 6.2	07	
рп	Range: 5.5-6.8	8.7	
Conductivity	Ave 167.5	54	
(µS/cm)	Range: 102-208	54	

Table 9-1: Groundwater and Surface Water Quality

9.4 Aquifer Characteristics

Based on the GSI geology map, the borehole abstracts water from the Kiltorcan Formation, which is classified by the GSI as a Regionally important fissured bedrock aquifer (Rf), as indicated in Figure 9. Groundwater flow occurs along bedding planes and through faults, fractures and fissures in the bedrock. The well provides an average yield of 227 m^3 /d. The yield is sustainable and the scheme has never had problems meeting demand.

The aquifer is part of the Cahir Groundwater Body, as delineated by the GSI. It is classified as regionally important because of the higher groundwater yields that can be obtained from these rocks due to the presence of a high density of fractures and faults resulting from brittle deformation during the Hercynian Mountain building phase of deformation.

The Cahir Groundwater Body Description indicates that there can be substantial artesian flows in this aquifer due to the pressure of the water table in the elevated outcrop areas. The largest well yields are obtained at relatively low elevations, close to major structural features and where at least 40 m of the upper part of the Kiltorcan is penetrated. The well at Kilcoran is situated in this sort of hydrogeological setting at a low elevation in the formation, but it is not known whether or not it is artesian. The well has good sustainable yields which most likely relate to, not only the large mapped faults to the south and north east, but also to smaller, unmapped fractures and fissures extending beneath the borehole resulting in enhanced transmissivity in the aquifer.

The transmissivity (T) range for Rf aquifers in this groundwater body is estimated in the Cahir GWB Report to be between 5 and 1850 m²/d. There are no pumping test data available for the well, nor was it possible to undertake a pumping test during the site inspection. Therefore a conservative approach has been adopted in determining aquifer transmissivity for the well by applying the median transmissivity value from the above range, which is calculated as 930 m²/d.

Daly (1985) suggests that sandstone permeabilities can range from 0.5 to 20 m/day, increasing up to 80 m/day in localised areas. Therefore the median would be 10 m/d. The permeability can also be estimated by dividing the transmissivity by the saturated thickness of the aquifer. The saturated thickness of the aquifer locally is not known as there is no borehole log for the well. However, as indicated by the GSI in the Cahir GWB Report, evidence from drilling in the Kiltorcan Formation shows that the largest well yields are obtained where at least 40 m of the upper part of the Kiltorcan Formation is penetrated. At this site, the well is thought to be 125 ft or 38 m deep. Given the sustainable well yield, an estimated saturated thickness of 38 m has been assumed, i.e. the full depth of the well. Based on this assumption, the permeability is estimated to be 24 m/d. Permeability (k) is estimated as follows in Table 9.2:

Table 9-2: Permeability Range

	GWB Median value	Local Assumption (with saturated aquifer thickness of 38 m)
Transmissivity (m ² /d)	930	930
Permeability (m/d)	10	24

The permeability for the aquifer therefore ranges between 10 and 24 m/d.

The velocity of water moving through this aquifer to the borehole has been estimated using Darcy's Law:

The natural gradient is estimated at 0.10 (Section 9.2). Based on typical values for hydraulic properties of Sandstone (Misstear, Banks, Clark 2007), the effective fracture porosity for the Kiltorcan Formation is estimated between 5% and 30% with a median of 15% with secondary porosity likely to be at the lower end of the range for sandstone bedrock formations in Ireland. Given that the Kiltorcan is Regionally Important Fractured Aquifer an effective porosity of 5% has been applied to the formation as part of the current assessment.

Table 9-3: Estimated Velocity

	Velocity (m/d)
Local Effective Porosity (5%)	
Local K Assumption	20
(10 m/d)	
Local Effective Porosity (5%)	
Local K Assumption	48
(24 m/d)	

The potential range of velocity for groundwater moving through the aquifer is 20 to 48 m/d.



Figure 9 Aquifer Map

The aquifer parameters are summarized in Table 9-4.

Parameters	Source of Data	BH1
Transmissivity (m ² /d)	Calculated (based median value of the GWB data)	930 m²/d
Permeability (m/d)	estimated from GWB value, and from T value and depth of the borehole	10 to 24
Effective Porosity	Assumed (based porosity range for sandstone Misstear et al 2007)	5%
Groundwater gradient	Assumed based on topography and field observations	0.10
Velocity (m/d)	calculated based on above	20 to 48

Table 9-4: Indicative Parameters for the Kiltorcan Formation

10 Zone of contribution

The Zone of Contribution (ZOC) is the complete hydrologic catchment area to the source, or the area required to support an abstraction from long-term recharge. The size and shape of the ZOC is controlled primarily by (a) the total discharge, (b) the groundwater flow direction and gradient, (c) the subsoil and rock permeability and (d) the recharge in the area. This section describes the conceptual model of how groundwater flows to the source, including uncertainties and limitations in the boundaries, and the recharge and water balance calculations which support the hydrogeological mapping techniques used to delineate the ZOC.

10.1 Conceptual Model

Toward the top of the Galty Mountains, groundwater flows through the Locally Important Poulgrania sandstone aquifer (LI). Here groundwater flow paths are likely to be shallow and short with discharge to local streams and also to the Regionally Important fissured Kiltorcan sandstone aquifer (Rf) down hydraulic gradient.

Groundwater in the Kiltorcan Formation in the high ground above the well flows in a south-easterly direction towards the borehole and beyond to limestone aquifers in the Thonogue River valley (Figure 10). Shallow groundwater most likely discharges into the Thonogue River with deeper flows into the aquifers beyond the river toward the main Suir River, approximately 6 km to the southeast.

The borehole is situated at a low elevation in the formation and has good sustainable yields which result from faults to the south and north east and most likely related, smaller, unmapped fractures and fissures extending beneath the borehole. These fractures and fissures enhance the transmissivity of the aquifer in this area. The aquifer is unconfined in the vicinity of the borehole at Kilcoran. Approximately 80m up hydraulic gradient of the well the aquifer vulnerability is extreme due to the presence of very thin moderate permeability subsoil . A schematic representation of the conceptual model is shown in Figure 10.



Figure 10: Conceptual Model

10.2 Boundaries of the ZOC

The boundaries of the area contributing to the source are considered to be as follows (Figure 11).

The northern, eastern and western boundaries are primarily based on the topography, conceptualised groundwater flow-lines, which flow to the southeast in the direction of the Thonogue River, and the size of the estimated ZOC using the recharge and water balance equations in Section 10.3.

The southern boundary – the down gradient boundary is the maximum downgradient distance that the borehole can pump water from which is based on the uniform flow equation (Todd, 1980).

$$xL = Q / (2 * T * i)$$

where Q is the daily pumping rate +/- X%, T is Transmissivity (taken from aquifer characteristics), i is gradient.

Given the pumping rate is 227 m³/d, the transmissivity is 927 m²/d and the hydraulic gradient is 0.10, the approximate maximum downgradient distance is 0.40 m. To allow for the limited site specific data and associated uncertainties in the calculation of the aquifer parameters, the down gradient limit has been increased to 4 m.

10.3 Recharge and Water Balance

The term 'recharge' refers to the amount of water replenishing the groundwater flow system. The recharge rate is generally estimated on an annual basis, and assumed to consist of input (i.e. annual rainfall) less water loss prior to entry into the groundwater system (i.e. annual evapotranspiration and runoff). The estimation of a realistic recharge rate is critical in source protection delineation, as it will dictate the size of the zone of contribution to the source (i.e. the outer Source Protection Area).

At Kilcoran therefore, the main parameters involved in recharge rate estimation are: annual rainfall; annual evapotranspiration and a recharge coefficient. The recharge is estimated as follows.

Potential recharge is equivalent to 896 mm/year i.e. (Annual Effective Rainfall as outlined in Section 6).

Actual recharge: 421 mm/yr. The Kiltorcan formation is classified as a Regionally important in fissured bedrock aquifer (Rf). The majority of the area surrounding the source (80% of the ZOC to the source) is mapped as Extreme Vulnerability, where the bedrock outcrops. Guidance document GW5 recommends a recharge coefficient in the range of 0.60 to 1 be applied for these conditions, with an inner range of 0.80-0.90 (IWWG, 2005). The moderate drainage density, the steep slopes in the forestry up hydraulic gradient of the well and the deeply gouged channels observed through the forestry area indicate a relatively high runoff. Therefore a recharge coefficient of 0.60 has been applied.

In the High to Low Vulnerability areas near the well (20% of the ZOC), the bedrock is overlain by till subsoil, which is turn is overlain by poorly drained soils. Given the position close to the footslope of the Galtee Mountains, it is likely that the vulnerability of the area is mostly high. The guidance document GW5 recommends a recharge coefficient in the range of 0.15 to 0.50 be applied for these conditions, with an inner

range of 0.25-0.40 (IWWG, 2005). The slope decreases significantly in this area and the drainage density is still moderate, therefore, it considered that an inner range coefficient of 0.25 can be applied in this case.

Runoff losses are assumed to be 47% of the potential recharge (effective rainfall). This value is based on an assumption of c.40% runoff for 80% of the area (extreme vulnerability – rock close to surface) and 75% runoff for 20% of the area (High to Low vulnerability). The **bulk recharge** coefficient for the area is therefore estimated to be 53%.

Runoff losses: 475 mm. Runoff losses are assumed to be 47% of potential recharge.

These calculations are summarised as follows:

Average annual rainfall (R)	1400 mm	
Estimated P.E.	530 mm	
Estimated A.E. (95% of P.E.)	504 mm	
Effective rainfall	896 mm	
Potential recharge	896 mm	
Runoff losses	47%	
Bulk recharge coefficient	53%	
Assumed Recharge	421 mm	

The water balance calculation states that the recharge over the area contributing to the source, should equal the discharge at the source. At a recharge of 421 mm/yr, an average yield of 227 m³/day would require a recharge area of 0.20 km². The ZOC also accounts for the topography to account for the up hydraulic gradient area from which water is likely to reach the well. This results in a ZOC area of 0.25 km² and is approximately 30 % larger than the area required to sustain the current abstraction rate. This is the area of the ZOC described above, and shown in Figure 11.

To allow for daily variations in abstraction, a possible increase in demand, and for the expansion of the ZOC during dry weather periods, the GSI recommends increasing the abstraction rate by 50% for the purposes of delineating the ZOC. Therefore, assuming an abstraction of $340.5 \text{ m}^3/\text{d}$, the size of the required recharge area would be increased to 0.29 km^2 .

The boundaries of both ZOC options are shown in Figure 11.



11 Source Protection Zones

The SPZs are a landuse planning tool which enables an objective, geoscientific assessment of the risk to groundwater to be made. The zones are based on an amalgamation of the source protection areas and the aquifer vulnerability. The source protection areas represent the horizontal groundwater pathway to the source, while the vulnerability reflects the vertical pathway. Two source protection areas have been delineated, the Inner Protection Area and the Outer Protection Area.

The Inner Protection Area (SI) is designed to protect the source from microbial and viral contamination and it is based on the 100-day time of travel to the supply (DELG/EPA/GSI 1999). Based on the indicative aquifer parameters presented in Section 9.4, the groundwater velocity range is between 20 m/d and 48 m/d. Hence, the 100-day time range of travel is between 2000 and 4800 m. Given the lack of site specific hydrogeological information available for the well, the lower velocity value has been applied as part of this assessment. This value based on data compiled in Daly 1985 for other wells in the Kiltorcan Formation the Inner Protection Zone is illustrated on Figure 12.

The Outer Protection Area (SO) encompasses the entire zone of contribution to the source. In order to take the more conservative approach, the ZOC based on the 50% increased yield is adopted, i.e. 0.29 km².

The groundwater Source Protection Zones are shown in Figure 13 and are listed in Table 11-1. The whole ZOC is included in the Inner Protection and They include SI/X, SI/E, SI/H. The majority of the ZOC is designated as SO/X.

Source Protection Zone		% of total area (km ²)
SI/X	Inner Source Protection area / ≤1 m subsoil	78.15% (0.224 km ²)
SI/E	Inner Source Protection area / <3 m subsoil	8.87% (0.027 km ²)
SI/HL	Inner Source Protection area / High vulnerability	12.97% (0.04 km ²)

Table 11-1 Source Protection Zones



Figure 12: Inner and Outer Source Protection Areas



Figure 13: Source Protection Zones

12 Potential Pollution Sources

The borehole is not located in a securely fenced and locked compound and is not sealed to protect against the inflow of contaminated surface or shallow subsurface water. The ground surface in the compound comprises open grass land leading to forestry.

A heating oil fuel storage tank for the adjacent private dwelling is located 10 meters up hydraulic gradient of the borehole (Photograph 2). While the tank is in good repair and constructed of polyethylene, the fuel line runs under ground to the dwelling. During the site inspection it was noted that line had been disconnected and kerosene was observed in a 25 litre plastic container beside the tank (Photograph 3). It is assumed that this was used to collect kerosene from the line when it was being disconnected. The disconnected fuel line and storage of kerosene in a non-secure container presents a serious risk of contamination of the water supply.



Photographs 2 and 3: Oil Storage Tank



Borehole

The land use within the Inner Source Protection Area is primarily conifer forestry, with one dwelling and a garden centre. The main potential microbial pollution source is individual on-site wastewater treatment systems of the dwelling and the garden centre, though both are located down hydraulic gradient of the well where the subsoil increases in thickness and provides more protection to the underlying bedrock aquifer. Faecal coliforms have been detected on 2003 and 2009 in the well water indicating that these potential pollution sources could probably have an impact on the water supply. However, given that the land use up hydraulic gradient of the source is all forestry the potential risk from cryptosporidium and viruses is low.

The majority of land within the Outer Source Protection Area is conifer forestry. There are no dwellings or farms up hydraulic gradient of the compound. .The highest risk of pollution in the outer protection zone is the use of pesticides to control weed growth in the forestry, although none has been detected to date. Given the current land use within the outer zone, the potential risk for contamination is low.

In summary, given the current land use, the potential risk for contamination from land use is low. However, the presence of a fuel storage tank with a fuel line running underground within 10 m of the well head is a potentially very serious pollution risk that requires immediate attention.

13 Conclusions

The Kilcoran Group Water Supply Scheme (Private) comprises a single borehole installed in 1970. The borehole abstracts water from the Kiltorcan Sandstone Formation. The aquifer is classified as a Regionally Important fractured bedrock aquifer (Rf). The well provides 227 m^3 /d and pumps directly, untreated, to the supply network on a continuous basis. This pumping rate has been sustainable since the well was commissioned. Water quality is generally good but slightly acidic which is likely due to the lack of contaminant pressures within the zone of contribution (ZOC).

The groundwater vulnerability within the ZOC is Extreme with Rock close in the high ground to the west, and is designated as High-Low in the vicinity of the well. The ZOC encompasses 0.29 km².

The source protection zones are based on the current understanding of the groundwater conditions and the available data. Additional data obtained in the future may require amendments to the protection zone boundaries.

The presence of a heating oil tank located 10 m uphydraulic gradient of the well with a fuel line running underground to an adjacent dwelling is a serious pollution risk and requires urgent attention.

14 Recommendations

The following actions are recommended:

- That the oil fuel storage tank be moved to a location down hydraulic gradient of the well and that the fuel line from this tank run above ground to the dwelling to minimise the risk of hydrocarbon contamination of the well.
- That the pump house and the concrete manhole cover of the well should be upgraded as recommended in the Paul Murphy Report (Appendix1).

- That when works are being undertaken to install a reservoir, where there will be an interruption in the supply, that a pumping and or recovery test be carried out to provide better data on the aquifer characteristics (Transmissivity, Specific Yield), which would in turn allow the protection areas to be refined.
- That the water quality monitoring programme should include pesticides on an annual basis.

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APPENDIX 1

Report on Kilcoran Group Water Scheme at Cahir, Co. Tipperary. Paul Murphy (2009) Mr. Michael Murphy Chairman Kilcoran GWS. Whitechurch, Cahir, Co Tipperary.

Ivy Bush, Parksgrove, Ballyragget, Co. Kilkenny. Tel: 056 8832264 Mob: 087 2066860 Email: paulmurphyce@iol.ie Date: 13th August 09.

Dear Michael,

Re: Kilcoran Group Water Scheme Cahir, Co. Tipperary.

Further to recent discussions and my letter requesting additional information on your scheme attached please find my report and budget estimates for the refurbishment and upgrade of your scheme.

I have made a number of recommendations in this report including that you immediately install a UV disinfection system on the water main in the pump house before it enters the distribution system.

A copy of this report with the cost estimates for upgrading your scheme has been issued to Liam O'Dwyer of Tipperary Co. Co. You should arrange to request grant aid assistance to refurbish your scheme and install a 500 m³ reservoir, a Sanosil based disinfection system and a soda ash based corrosivity inhibition system as soon as possible. Also I have outlined the requirement for fitting bulk meters at key locations across your scheme together with the replacement of defective valves and scour facilities. Together with these fittings I would recommend that water supply outlets at all consumer outlets should be metered to minimize wastage and encourage water conservation. An allowance has been made for rerouting sections of the schemes distribution mains from private lands to the nearby public roadway to maintain continuity of supply to those members affected.

You should have a meeting with Barry Dean of National Federation of Group Water Schemes outlining your current predicament and seek their assistance when making representations to Tipperary Co. Co and seeking up to €40k in funding from your scheme members.

Should you have any queries or wish to discuss any point do not hesitate to contact me.

Yours Faithfully,

Paul Murphy

Chartered Engineer

Report

<u>on</u>

Kilcoran Group Water Scheme

<u>at</u>

Cahir, Co. Tipperary.



Scheme Secretary John Arrington New Burgess, Ballyluby Cahir, Co Tipperary.

Prepared by:

Paul Murphy. Chartered Engineer Ivy Bush, Parksgrove, Ballyragget, Co. Kilkenny.

Date: 17th August 09

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1 Introduction

Kilcoran Group Water Scheme was formed around 1973 for the purpose of supplying water to householders and farmers in the townslands of Kilcoran located 10km SW of Cahir. The source of water for this scheme is the original borehole facility located in Kilcoran circa 0.5km NE of the Kilcoran Lodge Hotel and 100m W of the N6 roadway to the rear of a dwelling house and garden centre. A variable speed 7kW 3 phase submersible pump is located at a depth of 35 m in the 8" borehole and this provides water at a constant pressure of 5 bar into the distribution main. The average volume of water being pumped directly into the schemes distribution main is 50,000 gallons per day (225 m^3/d). Presently the water going into the distribution mains is not being disinfected.

2 Water Quality Review

Attached in Appendix A is a listing of the water quality test results for this scheme that is available presently. Water quality would be considered very good with the exception of 2 bacteriological failures, one on 27th April this year and the other in 2003.

In general results for true/apparent colour, turbidity, iron, manganese, ammonium, nitrate and nitrite, are very low. However pH is relatively low with negative LSI levels indicating that it is a mildly corrosive water. The test results for 27th April 09 indicate that there was high SS levels and over 200 Coliform organisms and 4 units of Escherichia coli in 100 millilitres of water sample taken. This is unacceptable and would indicate that some form of permanent disinfection for all water entering the distribution system will be required

Scheme members indicated that hillside drainage ditches on the higher slopes to the rear of the well became flooded and flowed down over the well resulting in it being polluted. Some of these ditches have now been cleaned and deepened and this should stop the immediate risk of flooding of the wells.

Additional analysis of this water source will be required to determine its true quality and it is planned to carry out this later this year.

3 Source Protection:

The well and pumping facility is located on the side of a shallow sloped forested hillside over a dwelling house and garden centre complex. The borehole finishes below finished ground level to the rear of a dwelling house and could be subject to being polluted by hillside surface water. It would be recommended that the area around the borehole should be elevated circa 200mm above finished ground level and sealed with concrete to prevent infiltration into the well from surface water.

Also the scheme has only recently acquired land surrounding the borehole site as well as the interconnecting area up to the pump house site circa 10m from it, making it fully accessible. The ditches that criss-cross the hillside and forestry area need to be deepened and should be graded to allow surface run off water to be diverted to streams and away from the well. The effluent treatment facilities associated with the pump house and the garden centre should be checked for suitability. Ideally the effluent should be treated in an efficient waste water treatment facility i.e. Activated sludge, fixed film biofilters, sand filters etc to produce effluent with BOD levels < 10 mg/l, SS levels < 15mg/l and discharge into a percolation area as far away as possible from the site of the well. Surface water from both sites should discharge via piped drainage collection system to the stream located to the North of the well site

With regards to any proposed development of dwelling houses within 500m of the well my comments are as follows:

- Percolation Tests would have to be carried out to confirm waste water treatment requirements of site.
- A proven purpose built leak free sewage treatment plant would have to be installed on the site.
- A raised percolation area should be constructed with a T value of circa 16 (This may require pumping)
- A run off pipe should be provided to the Bypass drainage system.
- Approval from landowners and Tipperary Co Co. would have to be sought for this

Three dwelling houses are within 150m of the well. As these houses were constructed more than 10 years ago more than likely the percolation areas associated with their septic tanks would not comply with latest SI 6 standard. It would be advisable to carry out percolation tests on each of these properties and encourage the owners to construct percolation areas in compliance with latest IS standard. Runoff water from these dwellings and associated developments would preferably be directed into the land drainage collection system described above and not into soak holes where water could enter the wells aquifer source quite easily and could pollute it. Preferably each of the developments would connect up a communal sewage treatment facility or install a purpose built sewage treatment plant with raised percolation areas and controlled excess water run off facilities all as per details in 4 below.

It would also be necessary to investigate method of disposal of effluent and run off water from the farm developments east and south of the well. As indicated above all effluent would have to be collected and surface water and roof drainage run off water would have to enter the bypass drainage system around the well.

Rules should be agreed with landowners for application of farmyard slurry and artificial fertilizers on lands within a 2 mile radius of well. This would include max. application rates, acceptable application times in year, weather conditions, etc. Tipperary Co Co. and Teagasc should be able to assist in getting this procedure into place.

4 Pump House and Site

The pump house building is 3.6m long by 2.5m wide and has an internal wall height of 3m. Building is constructed from 9" cavity block; nap plastered internally and externally and would be considered in good condition. However the same could not be said about the felt roof, timber door or window which will have to be replaced in full. Double skin insulated Tegral sheeting and flashing would be a good replacement for the defective roof. A vandal proof lockable steel door should be fitted and the windows will have to be made vandal proof and protected. Alternatively it could be in-filled as it is not necessary to have natural sunlight entering the pump room.

A pathway should be provided between the pump house and the well. Similarly a stoned area should be provided alongside the pump house for parking of a service van and delivery of chemicals along the roadway through the garden centre for which the scheme has a right of way.

A 3 phase submersible Grundfos 7 kW pump is installed in the borehole and is controlled by frequency inverter to provide sufficient volumes of water into the scheme's distribution system at a constant pressure of 5 bar. A galvanised mild steel pressure vessel is erected in the pump house but level control system is not operating effectively and is heavily corroded. This unit needs to be replaced with an adequately sized rubber lined accumulator vessel.

No results of yield tests carried out on the borehole are available nor is there information on the variations in water level in the borehole when pumping during prolonged periods of prevailing wet or dry weather conditions. It would be prudent to carry out yield tests on the well to confirm its output capability before commencing the proposed upgrade programme.

5 Water Treatment Facility.

The existing scheme has no water treatment facility installed and this needs immediate rectification to ensure that water being supplied to consumers is suitable for drinking at all times. First of all a UV disinfection system should be installed in the pump house on the delivery line from the submersible pump. The UV unit should be validated to deliver over 400 J/m^2 to the water in accordance with German Standard DVGW or USEPA requirements assuming a minimum UV transmisivity in the water of > 85%. This dose should give a 99.99% deactivating of the difficult to treat Cryptosporidium and Giardia, virus's and other harmful bacteria that may be present in the borehole supply. Because the well water has a very low level of turbidity and hardness it is not necessary to provide an automatic cleaning system on the UV tubes. Bypass valving arrangements should be provided around the unit.

Usually a chlorine based disinfection system is provided on potable water supplies to ensure that water at each consumers tap is of potable water grade and safe for drinking. However in this instance the scheme wishes to use Sanosil.

Sanosil Super 25 is a multi-component disinfectant. The oxidizing agent used is hydrogen peroxide, which is bonded with stabilising agents to form a complex solution. Hydrogen peroxide effectively destroys the cell membranes of micro-organisms. In order to achieve a long-lasting effect, silver (Ag) is added. Silver has an oligo-dynamic effect and acts as a catalyst.

Contact time should be minimum 12 hours from the time it is injected into the water until it is delivered to the consumers tap. Different concentrations of Sanosil Super 25 are used for the disinfection procedure, depending on the material of the pipes to be treated and their surface structure. Also the longer the contact time the lower the dose rate needs to be and they are outlined as follows:

Sanosil Super Dose in mg/l	100% bactericidal effect	99.9% Bactericidal effect
30	1 hr 20 mins	40 mins
25	3 hr	2 hr
20	4hr	2 hr
15	24 hr	12 hr
10	48 hr	24 hr
5	96 hr	48 hr

The maximum dosage of Sanosil Super 25 required for the treatment of drinking water is 50 mg/l (ppm). Higher doses would result in a taste being detectable in the treated water.

The minimum residual concentration in drinking water is approx. 1 - 5 mg/l (ppm).

A fully automatic Sanosil 25 Measuring and Control Unit is compulsory for dosing and monitoring the Sanosil 25 content in water being delivered to consumers.

From this information it is recommended that the contact tank should provide at least 24 hours and preferably 48 hrs. A tank of 50,000 gallons will be required for 24 hrs contact time and over 100,000 gallons is required to lower the residual dose to 5 mg/l. This is a key issue as Sanosil 25 is a very expensive solution to disinfect water. As can be seen from data in Appendix B costs can increase from an average \notin 600 per year for Chloros(Sodium hypochlorite solution at 12% conc.) which only requires a contact time of 30 minutes Vs \notin 6k if Sanosil 25 is used at a dose of 10 mg/l requiring a contact time of 24 hrs.

Water has very low alkalinity and has corrosive characteristics. A Soda Ash preparation and dosing system shall have to be provided in the plant house to ensure that the LSI (Langelier Saturation Index) of the water going into supply is greater than zero. The final chemical selection and system design will be confirmed after analysing a number of representative samples of the untreated water over the next 12 months and a full evaluation has taken place.

Sufficient land is available at the pump house away from the well to erect a large reservoir. The reservoir should be not more than 4m high as the water will super-load the ground near the bore hole and possibly inhibit the performance of the well especially if the springs line and water table levels are relatively high in the well. This will have to be investigated further before a final decision is made on the vertical height and location of the reservoir.

Covered circular glass coated steel tanks would provide up to 30 year design life for a reservoir where as concrete in situ or precast tanks like the Shay Murtagh pre-stressed post tensioned tank would be expected to have a minimum design life of 50 years. The concrete tanks would be more expensive but would still offer good value for money. Rubber lined galvanized mild steel tank could also be considered but design life of the butyl lining may be reduced with the hydrogen peroxide.

6 Water Pumping and Monitoring Systems

An effective layout for the upgraded plant would include the replacement of the submersible pump in the well with a smaller unit designed to transfer water to the reservoir having passed through the UV unit and then disinfected with Sanosil 25 solution. Baffling will have to be fitted into the reservoir to ensure a plug flow movement of the water through the tank from the inlet at the top of the tank to the low level outlet pipe. A separate set of duty standby multi stage centrifugal pumps rated at 15 m³/hr Vs 6 bar would be fitted in the pump house which would be controlled by frequency inverter. They would normally operate as duty standby but during high flow conditions could operate as duty & duty assist say if water was being drawn off from a hydrant during a fire when demand could be in excess of 25 m³/hr. However the distribution main is only 3" across most of the scheme and will necessitate higher operating pressure to overcome friction loss in the line at the high flow rates.

The reservoir feed pumps would be sized to transfer all daily water requirements to the reservoir over a 9 hour period which would ensure pumping costs would be minimized with low rate cost electricity. Pumps could be arranged to start during the day or high cost period if say the level of water in the reservoir dropped below 50% full during high demand periods

To reduce the treated water network feed pumps energy consumption it is recommended that an On/Off control system be provided in tandem with the frequency inverters fitted on each of the

pumps. During normal daily operating conditions the reservoir outlet pumps will run at a speed that produces sufficient water to match the demands of the system maintaining constant pressure in the system. This would mean that the pressure vessel and associated control system operates during low flow conditions.

It is recommended that this additional control system is fitted to switch off the pumps during low demand periods. Pumps would only be allowed to run continuously at low speed set point for say 1 minute before switching off and then switched on again as soon as the operating pressure drops 1 bar below set point. Operation of the pumps would be interval duration timers and pressure switches.

The pump house should be fitted with a thermostatically controlled heater, twin power socket as well as light fittings inside and outside the house.

An automatic dial out alarm and monitoring system should be provided in the pump house and linked up to a computer on the scheme where information would be downloaded including disinfectant residual levels in the water at all times, recording of water usage, pump failures, reservoir tank level, etc.

- 1. A proprietary colorimeter type disinfectant residual test kit should be made available. The caretaker would record the disinfectant residual level in the water leaving the pump house and at a house on the scheme every week.
- 2. A bund should be provided for the Sanosil Solution and dosing pumps.
- 3. A level sensor should be provided in the Sanosil tank to monitor the level of solution in the tank and send out an alarm through the dial out unit to the caretaker should the level drop below low level set point.
- 4. A residual Sanosil monitor should be provided on the pumped rising mains out of the reservoir. This would continuously monitor the concentration of disinfectant in the water entering the distribution mains and this information can be recorded locally and downloaded to remote PC via dial out facility

7 Distribution Network

Detailed drawings of the schemes distribution network are not available. It will be necessary to survey the entire scheme and draw up a fully detailed set of layout drawings for the distribution network. These drawings which would indicate the size and location of the existing distribution network around the scheme, indentifying where existing sluice, scour, hydrant and air valves are located as well as each consumer outlet.

Nearly all pipelines are 3" class B?? rated indicating the max operating pressure should not be greater than 6 bar. All connections will have to be checked to confirm residual discharge pressures greater than 2 bar during maximum demand periods. These mains are now over 25 years old and fittings may need refurbishment or replacement due to corrosion attack. It should be noted however that there is very few reports of leakage on the distribution network.

The following is recommended:

1 A survey should be carried out on all fittings particularly mains isolation and scour valves, air valves, saddles, ferrules and stop cocks, to determine condition and which would require replacement or where additional units are required.

- 2 A consumer box containing a flow meter, non return valve and isolation valve should be provided at each outlet from the distribution network at site boundary adjacent to the road margin.
- 3 When all fittings are refurbished a leak test should be carried out on each section of the distribution system.
- 4 All lines should be scoured out fully at least once per year.
- 5 Bulk flow meters to be installed on all the main supply and branch lines across the scheme to determine if and where leakages are occurring.
- 6 Hydrants and isolation valves to be fitted on distribution mains at 1 km intervals

8 Safety Statements, Training, etc.

- 1 Safety statement should be prepared for whole scheme
- 2 Caretaker(s) and assistant should attend a recognized training course for scheme water quality monitoring and leak analysis
- 3 Way leave agreements be drawn up for each member of scheme.
- 4 Set of scheme rules if not already done so should be drawn up and issued to each member of the scheme.

9 Funding of Upgrade Work

- 1 Budget costs are available in Appendix C for the upgrade of the scheme.
- 2 Grant Aid Assistance is available up to a value of €6475per house or 85% of the value of upgrade works whichever is the least.
- 3 Seek necessary contribution from each consumer on scheme to fund the upgrade works so that water of adequate quality in sufficient quantity is always available.

10 Pump House Site Information

Borehole and Pump House Site



Location of pump house and borehole in foreground near dwelling house boundary wall

- Existing trees being retained but area behind pump house has to be deforested to allow construction of reservoir
- Timber post and rail boundary fences are required on house side of the site and peripheral boundary fence to be refurbished and made good

Area of site approx 1000m²



Borehole cover

Site shared with house owner

Appendix A

Water Quality Analysis Summary Sheet

Name of Scheme Kilcoran GWS, Cahir Co. Tipperary

Contact John Arrington Mob 087 7720454

Analvsis by	Tipperary Co co	Nat Drinking Water	Tipp SR CC	Tipp SR CC	Tipp SR CC	Tipp SR CC
Date	27/04/2009	16/07/2003	30/04/2003	12/11/2001	08/12/1999	12/11/1998
Temp			11			12
Turbidity	0.17	0.191	0.6	0.71		0.1
Colour True	0	<1	0	0	0	0
рН	6.7	6.12	6.1	7.09	6.19	6.44
Odour	0			none	none	none
Taste	0			none	none	none
Suspended Solids mg/l	170					
Conductivity		183	164		165	172
Alkalinity mg/I CaCO3						
Total Hardness mg/l Ca						
Calcium mg/l Ca						
Magnesium mg/l Mg						
aluminium		<20				
Free Iron ug/I Fe		<20	0	0	-10	
Manganese ug/l		5				
Ammonium	BLD		0.04			
Ammonia		<0.01		0		

Nitrite mg/I NO2		<0.05				
Nitrate mg/I NO3	2.11	<0.01	2.12	1.86	1.61	1.73
Nitrate mg/I NO3N						
Chloride mg/l Cl						
Oxidisability Mg/I O2						
Copper ug/I Cu						
Zinc ug/I Zn						
Lead ug/I Pb						
Sulphate mg/l SO4						
Sodium mg/l Na						
Potassium mg/l K						
O Phosphorous mg/I P						
Phosphorus						
Hydrogen Sulphide mg/l S						
Fluoride ug/I F						
Boron mg/l						
Barium mg/l						
Trihalomethanes THMs ug/I						
Total Chlorine mg/I Cl	0					
Free Residual Chlorine mg/l Cl2	0					
Coliform organisms in 100 millilitres	>200.5	3	0	0	0	0
Escherichia coli in 100 millilitres	4	0				
Clostridium Perfringens	0	0				
Faecal Coliforms			0	0	0	0
Total Counts at 37 deg C in 1						
millilitres						
Total counts at 22 Deg C in 1 millilitre						
Plate Count @ 22 Deg C /ml						
Plate Count @ 37 Deg C /ml						
Comments	Notice					

Appendix B

Sanosil Vs Chloros Disinfection Costs

Kilcoran GWS					
No of connections		100		100	
Water usage		50000		50000	gals/day
Water usage		227.3		227.3	metre cubed per day
Sanosil					
dose rate for 24 hour kill		15		10	mg/l
dose per day		3.4		2.3	kg/day
usage per year		1244		830	kg's
Weight per pallet of Sanosil		720		720	kgs
Cost per pallet of Sanosil		3000		3000	Euro
Yearly Cost for Sanosil		5185		3456	Euro
			€		
Cost per day	€	14.20	9.47		
	€		€		
Cost /m^3 of water	0.06		0.04		
Chloros Costs					
Chloros Dose		0.8		0.8	mg/l
Chloros Conc.		12		12	%
Chloros qty per day		1515.15		1515.15	grms/day
Chloros weight per litre		1.14		1.14	kg/l
Chloros qty per day		1.33		1.33	litres
Chloros qty per week		9.30		9.30	litres
Chloros qty per year		483.8		483.8	litres
Chloros Cost per 25 litres		30		30	Euro
Chloros cost		580.5		580.5	Euro

Appendix C Kilcoran GWS Upgrade Budget Costs Aug 09

Estimates prepared by: Paul Murphy and checked by Michael Murphy, Chairman Kilcoran GWS.

Date 17th August 09

Item	Description	No off	rate	Cost	Cost Source
1	Submersible fixed speed transfer pump rated at 30 m^3/hr c/w starter			3500	Est
2	UV Disinfection system			11000	Cantwell
	local pipework and bypass assembly			1000	Est
3	Sanosil Dosing system including duty standby pumps and 200 l storage tank and bund			3000	Cantwell
	Sanosil residual monitoring system			6000	Sanosil
	Sanosil Handheld photometer			1000	Sanosil
4	pH elevation to ensure LSI > 0.0				
	200I Soda Ash make up system c/w mixer and D/Sby dosing pumps			2500	
	pH control sensor			1500	
	IIT 4215 532m^3 Glass Coated Steel Reservoir c/w cover, access ladder, inlet and outlet				
5	pipes			47649	Irish Ind Tanks
	Internal Baffling or Curtain System			5000	Est
	Preparation of site for the tank base			3000	Est
	Delivery pipes to the reservoir			1500	Est
	Set of Delivery pumps each rated at 15 m^3/hr using existing frequency inverter for one of				
6	the pumps			5000	Est
7	Endress & Hauser data Acquisition unit c/w GSM modem & Tele Alarming module,			4500	Cantwell
8	upgrade of electrics on site and in building			1200	Est
9	Purchase of site for the well + Solicitor and Surveyor fees			10000	Scheme
	Erection of fence around site	60	45	2700	Est
	Development of site with paths and car park facility, boundary fence etc			2500	Est
	Refurbishment of the pump house roof and door			5000	Est

10	Boundary boxes on all outlets across scheme	110	30	00	33000	Est
11	Bulk meters	5	90	00	4500	Est
12	Refurbish valves and fittings	6	65	50	3900	Est
13	Insertion of additional valves and fittings	4	650		2600	Est
14	Relocation of existing undersized mains with 100m nb uPVC PN 10 pipe in road margin	900	50		45000	Est
15	Misc Works and Contingencies				7500	Est
	Upgrade costs			€ 2	14,049.00	
	Engineering fees 6%				12842.94	
	Scheme misc costs 3%				6421.47	
	Total Excl VAT			2	233313.41	
	VAT	13.50%			31497.31	
	Total Cost incl VAT			€ 264,	810.72	
	Grant Aid Claim					
	General Upgrade Work	85%	249810.72	2	212339.11	
	Disinfection system incl UV and Sanosil dosing units excl reservoir	100%	15000		15000	
	Grant Aid Required			€ 227,	339.11	
	Local Contribution			€ 37	,471.61	
	No of House and Farm connections on scheme			£	110	
	Average contribution per connection			340).65	
	Contribution amount to be requested	Say			€350	
	·	•				

Date 17th August 09

APPENDIX 2

Geological Survey of Ireland (2004) 1st Draft Cahir GWB Description.

Cahir GWB: Summary of Initial Characterisation.

Hyc Lo	lrometric Area cal Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km²)			
S. T	16 – Suir Tipperary Co Co	Shanbally, Burncourt, Tar, Thonoge, Suir.	None listed	34.5			
Topography This groundwater body lies at the eastern foot of the Galty Mountains. Elevations range from 200m to 50 The topography of the land surface is at times tightly incised by mountain river valleys.							
	Aquifer type(s)	Rf: Regionally Important Fractured Aquifer.					
	Main aquifer lithologies	KT : Kiltorcan Formation – Yellow & red sandstone & green mudstone					
quifers	Key structures.	The rocks have undergone at least one major phase of structural deformation. The Kiltorcan sandstone has in other parts of South Tipperary reacted in a brittle manner to the deformation, allowing the development of a denser network of fracturing and fractures permeability than in the shalier sandstones elsewhere in the aquifer. Although major faults may not be mapped it is most likely that they exist on a smaller scale.					
eology and A	Key properties	Results of aquiter testing undertaken in the aquifer are very variable. Daly (1985) reports estimates of 5 m ² /day to 1850 m ² /day, and suggests that the highest values are likely to be associated with low-lying areas close to anticlines or faults. Daly suggests that sandstone permeabilities are in the order of 0.5 to 20 m/day, increasing up to 80m/day in localised areas. Transmissivity will be reduced at depth, where the Kiltorcan Formation is thinner in the centre of the synclines and fractures are closed by the deep burial.					
0	Thickness	Geophysical borehole logging data suggest that significant water movements occur at depths of over 60m where the aquifer is not confined by overlying shaly limestones. Where confined, active groundwater circulation is expected to be much more limited, but some deep flow has been inferred from mineral exploration boreholes at depths of over 200m (Daly, 1985). Kiltorcan Formation is thinner in the centre of the synclines and permeability is reduced by the deep burial					
ata	Lithologies	The overlying deposits are not described (in the GWF	PS), but are assumed to be Old Red Sands	tone derived tills.			
ng Str	Thickness	Over most of the Galtees rock is close to the surface; there will be some thickening of subsoil at the outer area of the groundwater body.					
ırlyiı	% area aquifer	Rock is close to the surface over the surface of this aquifer.					
Ove	Vulnerability	Vulnerability is mostly EXTREME. There may be some areas of LOW vulnerability southwest of Caher.					
harge	Main recharge mechanisms	Because of the large area of rock close to surface and the overlying impermeable rock, most recharge may be point. There is likely to be orographic rainfall to the south of the mountains and therefore more recharge in the south					
Rec	Est. recharge rates	[Recharge estimates will be added at a later date]					
Springs and large known abstractions Kilcoran							
charge	Main discharge mechanisms	There is no obvious discharge zone for groundwater moving at depth in this aquifer, but it probably flows via large faults and complex pathways into shallower groundwaters and from there to surface water bodies where outcrop areas are the lowest elevations.					
Hydrochemical Signature Waters are 'soft' to 'moderately hard' in the sandstones. The hydrochemical signature varies bicarbonate and calcium-magnesium bicarbonate. Daly suggests that the signature depends or overlying subsoil, with calcium magnesium waters being associated with areas of thicker sub- strata of this aquifer are Siliceous , but there may be some localities where there are calcareou layers of the formation.			s between calcium on the thickness of osoil. The bedrock ous beds in the top				
Groundwater Flow PathsSubstantial artesian flows have been recor outcrop area. Evidence from drilling in the relatively low elevations, close to major st Kiltorcan is penetrated.			aquifer due to the pressure of the water ta Formation shows that the largest well yie tures and where at least 40 m of the uppe	ble in the elevated lds are obtained at r part of the			
Gro S i	oundwater and urface water interactions	The balance of abstraction with recharge will require aquifer which are confined and/or which occur as isol The rivers have relativly high specific baseflows.	careful attention, particularly if consideri lated faulted blocks.	ng portions of the			
The Kiltorcan Formation and the boundary of the SERBD to the west define the extent of this groundwater body. A conceptual analogy has been drawn to the Kiltorcan Sandstone of the Carrick-on-Suir syncline. This has been done because there has been m study on the latter and both appear similar in physiographic nature. This groundwater body must be viewed in three dimensions. The rocks in question extend underground underneath the Galty Mountains. The aquifer becomes progressively more confined by an increase in thickness of the overlying beds. The aquifer has not been greatly exploited by public supply abstraction.				A conceptual here has been more e dimensions. The onfined by an h.			

Attachments	
Instrumentation	Stream gauge: None ?
	Borehole Hydrograph: none
	EPA Representative Monitoring boreholes: Kilcoran GWS (borehole) (#28 - R983217)
Information	Daly, D., Keegan, M., & Wright, G., (2001) Co. Tipperary (South Riding) Groundwater Protection Scheme.
Sources	Daly, E.P. (1985). Groundwater Resources of the Nore River Basin: Hydrogeology of the Kiltorcan Aquifer System.
	Unpublished internal GSI report.
Disclaimer	Note that all calculations and interpretations presented in this report represent estimations based on the information
	sources described above and established hydrogeological formulae