APPENDIX NO. 2

GROUNDWATER RISK ASSESSMENT

EOIN O' BRIEN

ANNISTOWN, KILLEAGH, CO. CORK

APPLICATION FOR IPPC LICENCE

REG. NO. P0790-02

UPDATED -GROUNDWATER RISK ASSESSMENT

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Client :-

Eoin O' Brien,

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1 INTRODUCTION

IE Consulting were requested by Murphy McCarthy Consulting Engineers. on behalf of Eoin O' Brien to prepare a revised groundwater risk assessment report for a pig unit in Annistown, Killeagh, Co. Cork.

Tom O' Brien applied for an Integrated Pollution Prevention and Control (IPPC) Licence for the unit on 27th November 2008 (P0790-02).

In response to the IPPC licence application, the Environmental Protection Agency (EPA) issued a request for the following information in a letter dated 1st May 2009:

"Please submit a comprehensive evaluation of the potential risk to groundwater posed by the Pig farm. This evaluation should include a hydrogeological evaluation, an assessment of the underlying aquifers classification and vulnerability, and should refer to the relevant source protection areas. This evaluation should also include any historical contamination of the groundwater on site".

A report IE565-REPORT 479 was prepared and issued to the Agency in 2011.

The licence was transferred to Eoin O'Brien in 2016. Eoin O'Brien now wishes to make a further Licence application to increase the capacity of the unit to 1500 sows. To support this application the previous report has been revised considering the proposed improvements to the site infrastructure.

2 OBJECTIVES OF ASSESSMENT

The objectives of the assessment are:

- To characterise the existing environment, the existing hydrogeological setting and groundwater flow regime.
- To identify activities/items on site that may pose a potential risk to the groundwater.
- To assess the risk that these activities may have on the existing groundwater quality and flow regime.

3 SCOPE OF WORKS

The scope of works proposed for the groundwater risk assessment is outlined as follows:

- An initial desk based study which included a review of the following:
  - Previous available reports and documents pertaining to the site;
  - Existing hydrogeological data from the Geological Survey of Ireland (GSI);
  - Assessment of on-site activities and any risk to groundwater;
  - Assessment of existing on-site groundwater borehole and groundwater quality;
  - Assessment of hydrological regime of the adjacent Dower River (Aughnasassonagh River);
  - Assessment of existing private wells up-gradient and down-gradient of the site.

- A site visit was undertaken on 6th January 2017 to confirm the findings of the original hydrogeological study, and identify site activities and structures that may pose a risk to groundwater beneath the site.
- Preparation of a groundwater risk assessment report.

4 DATA SOURCES

The primary data sources for the desk study of this assessment were:

- Information submitted by Tom O' Brien as part of the IPPC licence application (P0790-01 and P0790-02);
- Information available on EPA website.
- A review of the An Bord Pleanala Inspectors report PL04-241892
- Previous GES Ltd. report for Dairygold Farms Ltd. entitled "Hydrogeological Assessment" (Report No. 99/19/01)
- Geological Survey of Ireland (GSI) online webmapping;
- Geological Survey of Ireland Source Protection Plan for Dower Spring;
- Ordnance Survey of Ireland (OSI);
- Met Eireann;
- Site walkover on 6th January 2017.

5 SITE INFORMATION

5.1 Site History

A summary of the site development history of the pig farm at Killeagh is presented in *Table 1* below.

Year	Activity
1965	East Cork Co-operative Pig Enterprises Ltd. was formed and 55 acres of agricultural land was purchased at Annistown, Co. Cork.
1965	Planning permission was obtained by East Cork Co-operative Pig Enterprises Ltd.
1975	Planning permission was granted for an extension of the pig unit for sow accommodation.
1982	Planning permission was obtained for the retention and relocation of existing pig fattening units and retention and modification of slurry holding tanks and out-buildings to a final capacity of 300 sows and 2500 fattening places.
1989	Mitchelstown Co-operative Agricultural Society Ltd. (predecessors of Dairygold Co-operative Society Ltd) acquired the "engagements, undertakings and assets" of East Cork Co-operative Pig Enterprises Ltd.
1998	Dairygold Farms Ltd. proposed to convert the pig unit from a 280 to a 600 sow-breeding unit, producing 13,200 weaners per annum.

Year	Activity
2006	Tom O' Brien received planning permission to expand the pig unit from a 280 sow unit to comprise a 600 sow unit. Cork County Council 06/4260
2012	Application to Cork County Council for proposed expansion 12/06653, subsequently granted and the subject of an appeal to An Bord Pleanala
2013	Permission decision upheld by An Bord Pleanala PL 04-241892
2016	Licence P0792-02 transferred to Eoin O'Brien by EPA

Table 1. Summary of Site History and Relevant Planning Applications

The initial pig farm unit was developed on a Greenfield site by East Cork Co-operative Pig Enterprises in 1965. Planning permission was granted for an extension to the unit for sow accommodation in 1975. Planning permission was obtained for the retention and relocation of houses and slurry holding tanks for 300 sows in 1982.Dairygold Farms Ltd. (formerly Mitchelstown Co-Operative Agricultural Society Ltd. acquired the pig unit in 1989. In 1998, Dairygold Farms Ltd. were granted planning permission by An Bord Pleanala for the extension of the unit to comprise a 600 sow integrated pig unit. Subsequently permission was sought to modify the plans and extend the unit. In 1998, Dairygold Farms Ltd. applied to the Environmental Protection Agency (EPA) for an IPPC licence under the 6.2 Intensive Agriculture class of activities (Reg. No. P0438-01). This application and the subsequent IPPC licence application (Reg. No P0438-02) were withdrawn by Dairygold Farms Ltd.

The pig unit was purchased by Tom O' Brien in 2004 and planning permission was sought to expand the 280 integrated sow unit to a 600 sow unit. In 2006, planning permission was granted by Cork County Council for the pig unit extension.

A further application was lodged to Cork County Council in 2012 for demolition of old buildings and construction of new buildings and was granted permission in March 2013. The decision was appealed to An Bord Pleanala but the decision was upheld in a decision dated 04 October 2013

The expansion of the unit from a stocking rate of 600 to 1500 sows requires a revision of the current IPPC Licence Application (P0790-02) for the existing 600 sow integrated pig unit on the site at Annistown, Killeagh, Co. Cork.

5.2 Site Structures

The proposed expansion will involve demolition of existing buildings together with construction of new buildings constructed to industry best practice. As a result the actual site footprint will not be significantly altered.

The new buildings will be constructed over mass concrete slurry storage tanks, which will be completely above ground. The tanks will be 1.5m deep. If the tanks are emptied, a sluice will be opened and allow slurry to flowout of the tank into manure channels which are 300mm deeper than the tank base. The slurry will flow by gravity to the temporary slurry store, before collection and dispatch to the spreadlands.

Each tank/building is underlain by a herringbone network of drainage pipe connected to inspection chambers to act as a leak detection system.

5.2.1 *Fuel*

An oil-fired boiler produces all heat used on the pig unit. A standby generator will fulfil the electrical demands of the unit during a power interruption. The bunded fuel storage locations and the generator are shown on *Drawing No. 214037-01 (Appendix A).*

5.2.2 *Water Supply*

Water supply for the current site is provided from the on-site well on the eastern side of the site (*Drawing No. IE565-002-A and Drawing No. IE565-003-A, Appendix A*).

As shown on the drawing It is proposed to decommission this well in accordance with good practice and construct a new well further to the north-east of the site, constructed in accordance with EPA/IGI guidance *Drawing No. 214037-02 (Appendix A).*

It is proposed to install a water meter on the well to monitor future water usage at the site.

The available water quality information for this existing well is discussed in *Section 6.8.*

5.2.3 *Wastewater Effluent Disposal*

There is an existing septic tank and percolation area for the disposal of domestic sewage from the site. The location of the septic tank and percolation area are marked on the pig manure drainage layout plan *Drawing No 214037-01 Appendix A.* The septic tank and percolation area were constructed when the original pig production unit was constructed in 1965 and there have been no problems or issues with the treatment system.

A site assessment/percolation test was carried out by Murphy Mc Carthy Consulting Engineers Ltd as part of the original I.P.P.C. licence application for the site. After completing the percolation test the subsoil was deemed suitable. The septic tank on site is a standard single house septic tank. Based on the E.P.A. Wastewater Treatment Manual (Table 3) waste water loading rates for Industrial (without canteen) is 30 litres/day per person. The proposed installation will employ nine staff members; this would result in a daily loading of 270 litres per day. This is equivalent to 1.8 Population Equivalents, a population equivalent being 150 litres per day (E.P.A. Code of Practice Wastewater Treatments System (P.E. <10). Therefore, the Hydraulic loading is far less than a single dwelling and the septic tank system is adequate to cater for the development."

5.2.4 *Stormwater Runoff Disposal*

Currently roof water is collected and diverted to existing soak-aways to the east and west of the site. As part of the proposed development, it is proposed to locate an inspection chamber SW1 on the line serving the soakaway on the eastern side of the complex as shown on *Drawing number 2140-37-02-Appendix A.*

5.2.5 *Slurry Collection and Disposal*

All slurry from the proposed pig unit housing will be collected in storage tanks under the slats in each of the pig housing units. These tanks are above ground and underlain by a herringbone leak detection drainage system.

Collection channels, of 1.8m deep will convey the manure directly into the new proposed slurry pit from the newly constructed tanks.

An overview of the proposed slurry collection system is presented in *Drawing Number 214037-01-Appendix A.*

The slurry is currently collected in an open underground slurry pit which comprises a surface area of 462m^2 and slopes from ground level to a maximum depth of approximately 2m below ground level at the centre of the pit. Slurry may be pumped from this pit to the adjacent above-ground slurry tank for additional storage. The capacity of this tank is 1538m^3.

As part of the expansion of the pig unit, it is proposed to decommission the existing open slurry pit and install a covered reinforced concrete tank.

5.3 *Operation Overview*

The objective of the site operation is to serve as a fully integrated pig production unit in which pigs are produced and fattened to factory weight.

The pig population at any one time will consist of the following stock numbers 1050 Dry Sows, 450 Farrowing/suckling Sows, 9000 weaners, 9000 fattening pigs, 400 maiden Gilts and 10 Boars. All places could vary +/- 20%

The annual pig manure production has been calculated using schedule 2-Table 1 of SI No. 610 of 2010 shown in Table 2 below

Water:Meal ratio of finishers	m^3/sow/week	Number of sows	Total m^3/week	Total m^3/year
2.5:1	0.355	1500	532.5	27690

Table 2- predicted pig manure production-Based on Table 1 in SI 610 of 2010

The integrated pig production unit comprises the following components:

- Raw material and energy inputs;
- Disinfection/maintenance/disease prevention;
- Outputs
- Waste products
- Site infrastructure;
- Surface water drainage;

- Effluent drainage;
- Water supply;

As part of the groundwater risk assessment, the various possible contamination sources that may pose a risk to the groundwater beneath the site must be identified. A summary of the various components of these is presented in the following sections.

5.4 Raw Materials and Energy Inputs

5.4.1 Feed Stuffs

An automated "wet-feed" system is in operation at the site for all pig stock, apart from 1st stage weaners, which are fed directly with dry feed. The volume of feed given to the 1st stage weaners is less than 2% of the total feed volume on site.

Feed bins set on concrete hardstand at the western side of the site are filled directly from dry feed lorries. The feed is mixed with water in the wet feed mixing unit located in the feed and pump house.

Additional pre-extension feed bins are set in concrete hardstand in the western side of the unit. The 25kg feed bags for the 1st stage weaners are stored in storage building on the site.

The storage locations of these products are presented on *Drawing No. 214037-01* (*Appendix A*).

5.4.2 Site Fuel

The fuel types used on-site are presented in *Table 4* below. The corresponding storage locations are presented in *Drawing. No. 214037-01-A (Appendix A).*

Fuel Type	Storage
Heating Oil/diesel	2 No. bunded raised oil tanks and 1 no. bunded raised diesel tank on raised concrete.

Table 4. Summary of Fuel Type Used On-site and Corresponding Storage Locations

As part of the expansion of the unit, it has been proposed to provide bunding to all fuel tanks on-site.

5.4.3 Veterinary Supplies/Supplements

The facility is being operated as a minimal disease unit so that there is minimal use of antibiotics or vaccines on the site.

All antibiotics and vaccines, when required, for disease prevention, control and treatment, are stored in the refrigerator in the manager's office and in the dry store. Veterinary waste is disposed of by the licenced contractor in accordance with the IPPC licence requirements.

5.4.4 Wastes

A summary of the site waste products and the corresponding storage locations and disposal routes are summarised in *Table 6* below.

Components of pig manure	Collected directly beneath housing units and diverted to below ground and above ground tanks	Collected from on-site storage containers by tankers and landspread
Carcasses-Incidental mortality from production.	Stored in steel skip on gravel area on eastern side of pig unit.	Collected on fortnightly basis (or as required) by licenced contractor (Mick Duggan Skip Hire) and brought to Waterford Proteins for processing (Licence No. SRM-002).
Recycling/Domestic waste from site employees.	Stored in Cork County Council collection bins	Collected by Country Clean contractor and transported to Country Clean Recycling Ltd.

Table 6. Site Waste Products

5.5 Contamination History and Spillages Events

There are no records of historical contamination events on the site. However, elevated nitrates detected in the well during the period 16/5/1996 to 8/4/1998 had been attributed to the historical practice of the excessive application of pig slurry on the adjacent field and to the practice of feeding cattle close to the well. In the IPPC licence application (P0439-01) submitted in 2000, it was noted that this practice had ceased at that stage for several years.

The water quality data for the site well is discussed in further detail in *Section 6.8*.

6 ENVIRONMENTAL SETTING

6.1 Topography

The pig unit is situated in the townland of Annistown, Killeagh, Co. Cork. The site, which comprises 3.86 Hectares, is shown its regional setting in *Drawing No. IE565-001-A* (*Appendix A*).

The site is located at the northern extent of a generally low-lying area which extends southwards towards the coast. The average elevation of the land to east, west and south of the site is 20-30m OD. This low-lying coastal topography is characterised by generally east-west trending hills and valleys. Within the Midleton-Castlemartyr valley to the south, the topography can be described as knolly/hummocky. Immediately north of the site, the land rises into an upland region of north-west/south-east aligned ridges. In a local context, the land immediately north of the site rises to a peak elevation of 149m OD at Drominane (*Drawing No. IE565-001-A, Appendix A*).

Within the site boundary, natural pre-development ground level slopes from 46m OD to 40m OD in the north-eastern corner of the site boundary. From the north-eastern extent of the pig unit to the southern site boundary, the land slopes more gently from 40m OD to 34m OD.

6.2 Meteorology

The closest operational rainfall gauging station (at a similar elevation) is positioned at an elevation of 27m OD approximately 9km south of the site in the townland of Shanagarry North. The average annual rainfall (AAR) recorded at this gauging station, based on data between 1961-1990, is 990mm/yr. The mean annual potential evapotranspiration (PE) from the nearest synoptic station 36km south-west of the site at Cork Airport, is 513mm/yr (based on data between 1961-1990). The actual evaporation (AE), estimated as 0.90PE, is calculated to be 462mm/yr. Rainfall and evaporation data was obtained from Met Eireann (1996). Using these figures, the Effective Rainfall (E.R.) is taken to be approximately 528mm/year.

6.3 Hydrology

In terms of river basin management planning, the site is located in the South Western River Basin District (SWRBD), within the surface water catchment of the Womanagh River, which is the primary regional surface water feature (*Drawing No. IE565-001-A, Appendix A*). The Dower River (also referred to as the Aughnasassonagh River), a minor tributary of the Womanagh River, originates in the hills north-west of the site. This river flows in a southerly direction approximately 60m west of the site boundary and continues its route southwards until it disappears underground into a swallow hole at Ballyvorisheen, approximately 1.8km downstream of the site. The Dower spring emerges approximately 2km south of the swallow hole. Tracer work undertaken on the Dower Spring has established a link between the sinking stream at Ballyvorisheen and the Dower Spring (*Drawing No. IE565-001-A, Appendix A*).

Currently all roof water from the site buildings is collected and diverted to the soakhole in the eastern section of the site. It is proposed to add a second soakhole to service roof drainage from the western side of the complex. Rain water falling on the hardstand area within the confines of the secured pig unit area is collected via an underground drainage system and diverted to the slurry pit at the south-eastern corner of the site. Along the perimeter of the secured pig unit, within the

confines of the site boundary, precipitation can percolate to ground via a crushed stone ground cover.

6.4 Geology

Reference to the 1:100,000-scale map of the Geology of East Cork-Waterford) (Sheet 19) (Geological Survey of Ireland,1995) indicates that the southeast of Cork is characterised by a series of elongated east-west valleys separated by intervening ridges, formed when the rocks were folded 290 million years ago during the Variscan Orogeny (*Sleeman, A.G. and McConnell, B., 1995*). The carboniferous limestones are restricted to the synclinal valley and flanked by the anticlinal ridges of the Devonian and early Carboniferous rocks (*GES Ltd. Report 99/18/01*).

The site is shown to be underlain by both the **Cuskinny Member** and the **Ballysteen Formation**, and possibly the **Gyleen Formation** (*Figure 1, Appendix B*). The Cuskinny member is described as flaser bedded sandstone and mudstone. The Ballysteen Formation is described as fossiliferous dark-grey muddy limestone. The Gyleen formation is described as sandstone with mudstone and silt.

Both the Cuskinny Member and the Ballysteen Formation were deposited during the Carboniferous period. The Cuskinny Member is described in the Generalised Bedrock Map (*Figure 2, Appendix B*) as Dinantian Mudstones and Sandstones of the Cork Group (DMSC). The Ballysteen Formation is referred to as Dinantian Lower Impure Limestones (DLIL). The Gyleen Formation was deposited during the Devonian period and forms part of the Devonian Old Red Sandstones (*Figure 2, Appendix B*).

The rocks have been folded into anticlines and synclines with approximate east-west axes by the Variscan Orogeny. The rock is broken by a system of steeply dipping cross faults running approximately NNW-SSE, roughly at right angles to the fold axes. (*GES Ltd. Report 99/18/01*).

The bedrock beneath the site and surrounding land youngs from north to south, which is reflective of the position of the site on the northern flank of a regional east-west trending syncline (*Figure 2, Appendix B*). (*GES Ltd. Report 99/18/01*).

An inferred regional north-west/south-east trending shear fault is mapped beneath the site along (or within) the eastern site boundary.

The faulted contact between the sandstone and limestone formations beneath the site has the potential to act as a conduit for any contamination arising from site activities. The nature of this fault is particularly important if it is shown that it serves as preferential pathway for groundwater movement in a southerly direction into the Inner Source Protection Area of the Dower Spring source. However its influence will be mitigated by the extensive overlying subsoils.

6.5 Soils and Subsoils

Reference to the General Soil Map of Ireland (1980) indicates that the soils in the area surrounding the site are described as Acid Brown Earths or Brown Podzolics.

The South Western River Basin District (SWRBD) Soil Map (Teagasc/EPA, 2006) indicates that a boundary between two soil types form at the location of the site. Deep poorly drained mineral soils

(AminPD) are mapped as underlying most of the southern portion of the site, where as the northern part of the site is mapped as being underlain by deep well drained mineral soils (AminDW) (*Figure 3, Appendix B*).

The subsoil as described on the SWRBD Subsoil Map (Teagasc/EPA, 2006) indicates that the subsoil comprises Till derived from Devonian Sandstones (*Figure 4, Appendix B*). Limited fieldwork undertaken as part of the Groundwater Source Protection Plan for the Dower Spring (Geological Survey of Ireland, 2002) indicates that the Till is described as mainly Sandy Till, generally free-draining and of moderate permeability.

A soil profile of approximately 2.3m depth is exposed along the eastern edge of the site which indicates that, overall, the soil consists of sandy SILT/CLAY. Given the location of the soil profile on the site, it is likely that this profile represents the deep well drained mineral soils (AminDW) north of the site.

A horizontal layer of gravels, cobbles and boulders were noted at a depth of 1m below ground level. According a previous hydrogeological assessment of the spreadlands undertaken by GES Ltd. (Report No. 99/18/01, June 1999) on behalf of Dairygold Farms Ltd., at least 12m of clay soil was encountered at the site.

6.6 Depth to Bedrock

A review of the geotechnical borehole files from the GSI indicated that no geotechnical boreholes, which provide information on the depth at which bedrock is encountered, have been installed in the vicinity of the site.

The Dower Spring Source Protection Report (GSI, 2002) indicates that the depth to bedrock in the upland catchment of the Dower Spring, the setting of the pig unit, is generally between 3m and 10m below ground level, with areas of shallower depth limited to the small, incised valleys of the streams that drain it.

The GSI webmapping well database was also consulted for depth-to-bedrock information in the vicinity of the site. No wells are recorded within a 500m radius of the site.

A depth to bedrock map was presented in a previous hydrogeological assessment report of the spreadlands undertaken by GES Ltd. (Report No. 99/18/01, June 1999) on behalf of Dairygold Farms Ltd. The depth-to-bedrock points are reproduced on *Drawing No. IE565-003-A (Appendix A*). This information indicates that that the depth to bedrock is variable in the vicinity of the site.

A depth to bedrock of 29m was recorded west of the site, whereas the depth to bedrock south of the site was recorded at 39m below ground level. Depth to bedrock along the road leading south-west of the site was recorded at 12m below ground level (not presented on *Drawing No. IE565-003-A, Appendix A*). The thickness of soil/subsoil material is therefore variable over short distances and irregular in depth.

According to the information in the GES Ltd. report, excavations at the site of the pig unit record a thickness greater than 12m of clay overlying bedrock.

The 6 inch to 1 mile scale geology field maps held by the Geological Survey of Ireland (GSI) are available for the area in which the site is located. These show no information for the low-lying land immediately adjacent to the site. However, outcrops of red and green slates as well as purple sandstone were recorded north of the site. In addition, purplish green sandy shales were recorded along the road south of the hill north of the site (*Drawing No. IE565-003-A, Appendix A*).

6.7 Hydrogeology

6.7.1 Groundwater Body (GWB) Characteristics and Aquifer Classification

The approximate lithological boundary between the Dinantian mudstones and sandstones of the Cuskiny Member and the Dinantian lower impure limestones of the Ballysteen Formation, east and west of the mapped regional fault, also represents the boundary between the Ballinhassig groundwater body to the north and the Midleton groundwater body to the south. Groundwater flow direction is generally from the Ballinhassig groundwater body towards the Midleton groundwater body.

The Ballinhassig groundwater body comprises bedrock aquifers that are classified as **Ll**, locally important aquifers, moderately productive in local zones or **Pl**, poor aquifers which are generally unproductive except for local zones. The key characteristics of this groundwater body have been identified by the GSI as follows:

- Most groundwater flow occurs in the upper 15-20m of the aquifer, in the weathered zone and the interconnected fracture network beneath this;
- Groundwater flow gradients are likely to be in the range 0.01-0.04;
- Transmissivity in the aquifer is low, in the range of 2-10m^2/day, with median values towards the lower end of the range. Storativity values are thought to be low;
- The general low permeability characteristics of the aquifer and the high/steep slopes indicate that a high proportion of recharge will discharge rapidly to surface watercourses.
- Groundwater flow paths are expected to be relatively short, typically 30-300m;
- The bedrock units comprise non-carbonate rocks, with alkalinity ranges about 10-300mg/l (as $CaCO_3$) and conductivities ranging between 125-600µS/cm.

The Midleton groundwater body comprises bedrock aquifers that are classified as **Ll**, locally important aquifers, moderately productive in local zones or **Rkd**, regionally important karstified aquifer dominated by diffuse flow.

The Dinantian lower impure limestones underlying the site and the area south of the site form part of a narrow area around the margins of the body, which is classified as **Ll**. The characteristics of Ll section of the groundwater body have been identified by the GSI as follows:

- Most groundwater flow occurs in an upper weathered layer of a few metres and a zone of interconnected fissures often not extending more than 15m from the top of the rock, although occasional deep inflows associated with major faults can be encountered. Impure limestone is less susceptible to karstification than pure limestones;

- Transmissivity in the aquifer is low, in the range 5-20m²/day but may be higher where karstification has occurred. Storativity is low in the aquifer;
- The sandstone ridges to the north (Ballinhassig GWB) provide abundant runoff which recharges the limestone aquifer in the valley. A small volume of groundwater may cross as throughflow from the sandstone into the groundwater body. Diffuse recharge will occur over the entire GWB via rainfall percolation through the subsoil;
- Regional groundwater flow is towards the rivers draining the valley. Groundwater flow paths can be up to several kilometres long but may be significantly shorter where the water table is very close to the surface;
- The water table elevation is generally within 10m of the surface, except for more elevated parts of limestone aquifers, and the typical annual fluctuation of the water table ranges up to 6 or 7m;
- The groundwater is dominated by calcium and bicarbonate ions. Groundwater alkalinity is high, up to 400µS/cm and typical limestone conductivities are in the order of 500-700µS/cm;
- The major north-south trending shear faults are paralleled by a well-developed system of vertical north-south joints, commonly spaced at 0.5-2m intervals;

The key characteristics of the karstified bedrock south of the site are presented below:

- Transmissivities in the pure bedded limestones can range up to a few thousand m²/day;
- Groundwater gradients are considered to be low, in the range 0.001-0.002.
- Groundwater flow paths can up to several kilometres long, with the groundwater flow direction towards the rivers draining the valleys.

The bedrock units underlying the pig unit are classified as a locally Important aquifer, which is moderately productive in local zones (*Figure 5, Appendix B*). The regionally important karstified aquifer, representative of the Waulsortian Limestones, is mapped approximately 400m south of the site.

6.7.2 *Groundwater Levels, Flow Direction, and Gradient*

There is one water supply well on the site (E197375 N076505), as shown on *Drawing No. IE565-003-A (Appendix A).* This well will be replaced by a new well to the northeast as shown on Drawing NO. 214037-02. The existing site well is calculated to abstract approximately 20m³/day in response to the water demand on site. To obtain a static groundwater level beneath the site, the pump was switched off at 6pm on the evening before a water level measurement was taken on 14th April 2010. The water level was recorded at 11.515m below the top of the steel casing at 08:53.

A summary of previous available static water level monitoring data, for the site well is presented in *Table 7* below.

Monitoring Point	15/5/96	3/6/96	26/6/96	15/4/10
Site Well	11.7	12.9	13.3	11.51

Table 7: Available Water Level Data for Site Well

In the absence of water level data relative to Ordnance Datum (mOD), it is assumed that the groundwater flow direction is a subdued reflection of the topography. Therefore the groundwater beneath the site is assumed to flow in a southerly and south-westerly direction. Given the groundwater table elevation relative to the elevation of the water in the Dower River, it is unlikely that the groundwater is moving towards the river along the section adjacent to the site.

6.7.3 *Groundwater Vulnerability*

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. Where the subsoil thickness is <3m, the vulnerability is rated as Extreme (the highest risk situation). Where the subsoil thickness is >3m, the vulnerability is rated as High, Moderate or Low (depending on the nature and thickness of the subsoil).

The South Western Interim Vulnerability Map for Cork, which was completed as part of GSI's Groundwater Protection Scheme, indicates groundwater beneath the site has been assigned an interim vulnerability rating of **High (H)** along the northern section of the site, whereas the vulnerability of the groundwater beneath the southern section of the site is classified as **Moderate (M)** (*Figure 6, Appendix B*). These ratings are based on the assumption that the depth to bedrock beneath the site is greater than 3m.

6.7.4 *Dower Spring Source Protection Area*

The pig unit is located within the Outer Source Protection Area of the Dower Spring but within 400m of the Inner Source Protection Area *(Figure 7, Appendix B)*. The Dower Spring serves as a public water supply, the abstraction rate for which is approximately 4545m^3/day. The minimum discharge from the spring is recorded as 6,820m^3/day.

The location of the site within the source protection area of the spring means that groundwater moving beneath the site eventually emerges at the Dower Spring. The site is located within the source protection zone designated as SO/M.

The pig unit is referred to in the Dower Spring Source Protection Plan (GSI, 2002) as an activity with the potential to contaminate the water supply source. It is considered that the proposed new housing and slurry storage structures will serve to reduce any potential impact of the unit on the public water supply.

6.8 *Groundwater Quality*

6.8.1 *Regional Data*

As part of the Water Framework Directive (WFD) initial characterisation work, all groundwater bodies in the country were assigned a score based on the likelihood of the groundwater quality

achieving good status by 2015. The **Ballinhassig and Midleton** groundwater bodies were assigned a score of **1a** indicating that the **water body is at risk of achieving good status in 2015.**

Water quality data from the Dower Spring Groundwater Protection Report (GSI, 2002) indicates that nitrate levels in the spring, particularly since 1992, have been noted and considered to indicate significant contamination of the spring. The nitrate range, based on 30 samples, was reported as 12-37.5mg/l. Also, levels of ammonia, E. Coli and Total Coliforms have been found to be periodically unsatisfactory, possibly attributable to runoff following heavy rainfall events.

6.8.2 *Site Groundwater Quality Information*

The analysis results of a groundwater sample taken from the site well on 14th April 2010 is presented in *Table 8* below. The results were compared with the limits and threshold values set out in the following legislation and guidelines:

- European Communities (Drinking Water)(No. 2) Regulations 2007 (S.I. No. 278 of 2007).
- Environmental Protection Agency Interim Guideline Value (EPA IGV) for Groundwater (EPA, 2003).
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).

Parameter	Site Well	EPA IGV	Drinking Water Regs 2007	EC (Environmental Objectives) Ground Water Regs 2010
pH	6.93	> =6.5 <=9.5	> =6.5 <=9.5	-
Alkalinity (mg/l as $CaCO_3$)	129	-	-	-
Electrical Conductivity (µS/cm)	419	1000	2500	800-1875
Nitrate (mg/l NO_3)	38.9	25	50	37.5
Nitrite (mg/l NO_2)	0.066	0.1	0.5	0.375
MRP (mg/l P)	0.06	-	-	0.035
Ammonium (mg/l NH_4)	<0.02	0.15	0.3	0.065 – 0.175
Calcium (mg/l)	36	200	-	-
Magnesium (mg/l)	18	50	-	-
Manganese (mg/l)	0.012	0.05	0.05	-
Iron (mg/l)	<0.03	0.2	0.2	-
Potassium (mg/l)	2.24	5	-	-
Sodium (mg/l)	15	150	200	150
Sulphate (mg/l)	16	200	250	187.5
Chloride (mg/l)	24	30	250	24-187.5
Total Phosphorous (mg/l P)	0.23			-
Total Petroleum Hydrocarbons (mg/l)	<0.01			
Total Coliforms (cfu/100ml)	<1			
Faecal Coliforms (cfu/100ml)	<1	0	0	-
Enterococci (cfu/100ml)	<1	0	0	-

Table 8. Water Quality Data on Site Well on 14th April 2010

The bacteriological quality of the water sample was found to be good. The Ammonia and Chloride concentrations are satisfactory as is the Na:K ratio. There is no indication of hydrocarbon contamination. The nitrate concentration of 38.9mg/l was found to be elevated relative to the Groundwater Threshold Value of 37.5mg/l (S.I. No. 9 of 2010). The phosphate concentration at 0.06mg/l was also elevated compared to the groundwater threshold value of 0.035mg/l.

A summary of all available sampling results for the site well, obtained from previous IPPC Licence applications and planning applications for the site, is presented in *Table 9*.

Table 9. Available Historical Monitoring Data

Parameter	pH	Nitrate (mg/l NO_3)	Ammonium (mg/l NH_4)	COD (mg/l)	Total Phosphorous (mg/l P)	Total Coliforms (MPN/100ml)	Faecal Coliforms(MPN/100ml
16/5/96	6	24.6		5	0.14		
3/6/96		17.5		9			
29/6/96	6	21.5		3	0.05		
16/1/97		10.2					
8/4/98		22.6					
30/5/01		70	<0.1	<		6	0
20/9/05		39.4	0.09			29	0
21/3/07		18	0			0	0
21/9/07		54.5	<0.0			0	0
1/3/12						0	0
14/04/10	6	38.9	<0.0		0.23	<1	<1
12/12/12	7	<1	0.49	4	0.15	0	0
18/7/13	6	21.3	0.03	4	<0.0	0	0
19/12/13						0	0
21/8/14	7	13.0	0.02	3	0.04	0	0
8/4/16		21.8	<0.0			1	1
9/1/17						0	0

The information in *Tables 8-9* indicates that the average concentration of nitrate from the 10 samples taken over the period 1996 to 2016 was 26.7mg/l, which is lower than the Groundwater Threshold Value of 37.5mg/l. This groundwater threshold value was exceeded on 3 occasions during the period 2005 to 2016. Two samples, taken in 2001 and 2007, respectively, were found to exceed the Drinking Water Regulations 2007 Maximum Acceptable Concentration (MAC) of 50mg/l.

The results above indicate that, historically, the nitrate concentrations in the samples taken from the site well have been elevated. More recent samples since 2013 suggest lower Nitrate concentrations

7 GROUNDWATER RISK ASSESMENT AND POTENTIAL CONTAMINATION SOURCES

The concepts of Risk, Risk Assessment and Risk Management have become important tools in environmental protection. The philosophical basis and language of risk is useful in that it provides a logical framework for considering the impact of potentially polluting activities on the environment.

This framework enables a more rigorous systematic approach to decision making. In reality it is putting a recognised framework to what is done intuitively, but by being systematic. In addition, it is an aid in conceptualising the potential impact of the discharge of effluent on the wider environment.

A **hazard** (**source**) presents a risk when it is likely to affect something of value (the **target/receptor**), which in this case is groundwater and/or surface water, which in turn may impact on humans. It is the probability of the hazard occurring and its consequences that is the basis of Risk Assessment.

The conventional Source-Pathway-Receptor model for environmental management can be applied to identify potential sources, receptors and pathways, and hence potential pollutant linkages relating to the site.

For a particular contaminant to present a risk to receptors, three components must be present:

Source	An entity or action that releases contaminants into the environment
Pathway	A mechanism by which receptors can become exposed to contaminants
Receptors	The human or ecological component at risk of experiencing an adverse response following exposure to a contaminant

The qualitative risk assessment presented in *Table 11* below is based on the hydrogeological information collected to date in relation to the site, and incorporated into previous sections of this report.

Source	Pathway	Receptor	Risk
Veterinary supplies and feed supplements	Crack/joint in building hardstanding. Residues in effluent slurry.	Groundwater beneath the site. Site water supply. Dower Spring.	Very low risk in raw form. Low to moderate risk for residues in effluent slurry if integrity of underground collection channel network and in underground storage tank breached or compromised.
Cleaning products/ Disinfectants.	Crack/joint in hardstanding area. Underground storage tanks. Underground slurry collection system. Underground slurry pit.	Groundwater beneath the site. Site water supply. Dower Spring.	Low to moderate risk if integrity of underground pipe network and in underground sumps breached or compromised.
Pig manure:	Crack/joint in hardstanding area. Underground storage tanks. Underground slurry collection system. Underground slurry pit.	Groundwater beneath the site. Site water supply. Dower Spring. Groundwater beneath spreadlands	High risk if integrity of underground pipe network and in underground storage tanks and slurry pit are breached or compromised.

Source	Pathway	Receptor	Risk
Domestic Effluent	Cracks in septic tank chamber. Direct percolation into subsoils from soakaway.	Groundwater beneath the site. Site water supply. Dower Spring.	Moderate to High risk if depth of soakaway and permeability is such that the effluent is not treated sufficiently before reaching the water table.
		Groundwater beneath the site. Site water supply. Dower Spring.	
Heating Oil/diesel	Crack/joint in hardstanding area. Seepage through hardcore area.	Groundwater beneath the site. Site water supply. Dower Spring.	Low risk from tank failure where integrity of concrete is high, and spillage can be contained. High risk if spillage occurs on ground during refuelling. High risk if underground feed pipes fracture and are undetected.
Animal Carcasses	Seepage through hardcore area.	Groundwater beneath the site. Site water supply. Dower Spring.	Low risk because storage container is steel and does not leak and if stored on concrete hardstand.

Table 10. Qualitative Risk Assessment

8 CONCLUSIONS AND RECOMMENDATIONS

The nature of the activity does create potential risks, in the context that substances that could damage the environment are stored on site. However, the quality of the groundwater beneath the site and the risk of contamination of groundwater and surface water are primarily dependent on the integrity of infrastructure, which includes manure storage tanks, channels and ancillary items such as oil tanks, percolation areas, and general wastes. Good source management and containment features break any potential pollutant linkages.

The following measures, proposed as part of the expansion of the pig unit, will significantly reduce the risk to groundwater of the site activities:

- Leak detection system in new under-house tanks and slurry collection system;
- Replacement of old buildings and construction of new buildings to industry best practice.
- Decommission existing open slurry pit and construction of covered reinforced concrete tank;
- Bunding of site fuel storage tanks.

It is recommended that the site well is tested annually for the suite of parameters as set out in the EPA licence No. PO792-02

9 REFERENCES

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European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).

Geological Survey of Ireland (1995) "*Geology of East Cork_Waterford, 1:100,000 Scale Series Map*". Sheet 22.

Geological Survey of Ireland (2002) "Dower Spring – Groundwater Source Protection Zones".

Sleeman, A.G. and McConnell, B, 1995. "*Geology of East Cork-Waterford*". Geological Survey of Ireland.

S.I. no. 610 of 2010 European communities (good agricultural practice for protection of waters)

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CIVIL-WATER-ENVIRONMENTAL

APPENDIX A

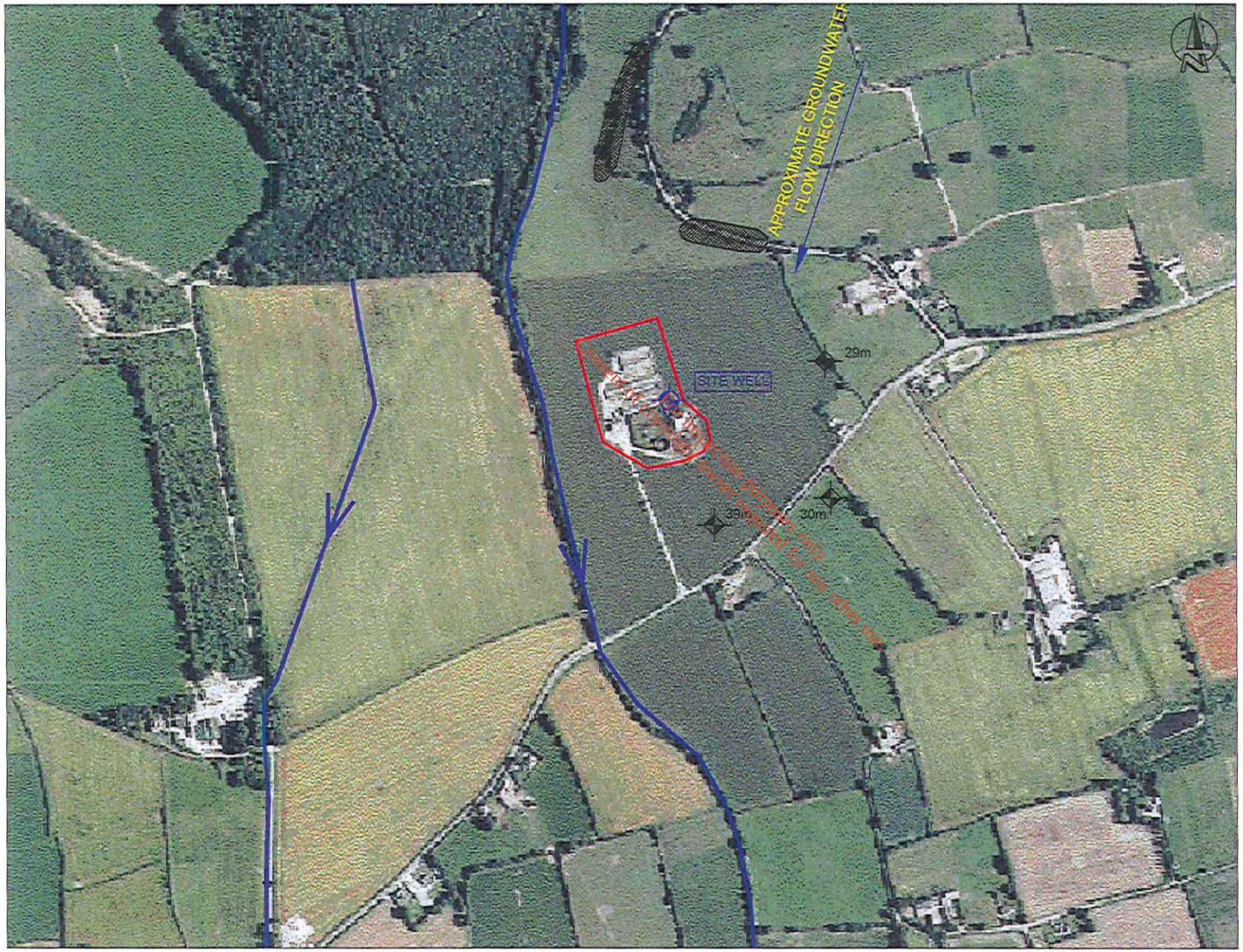
Drawing No. IE656-001-A

Drawing No. IE656-003-A

Drawing No. 214037-01-A

Drawing No. 214037-02-A

Drawing No. 214037-03-A



NOTES:-

1. DO NOT SCALE FROM THIS DRAWING, USE FIGURED DIMENSIONS ONLY

LEGEND

- Site Well
- dtb location (approximate)
- Mapped outcrop
- Watercourse
- Site Boundary
- Approximate drain route

rev.	date	amendment	drn	ckd
C	12.04.17	DRAINAGE LAYOUT AMMENDED	LMc	JK
B	24.03.17	LAYOUT AMMENDED	LMc	PMS
A	27.04.16		TP	PMS

TOM O'BRIEN

GROUNDWATER RISK ASSESSMENT

LOCAL HYDROLOGY & HYDROGEOLOGY

IE CONSULTING
CIVIL - WATER - ENVIRONMENTAL
INNOVATION CENTRE
GREEN ROAD
CARLOW
TELEPHONE: 059 91 33084
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EMAIL: info@iece.ie

file location:	N:\IE_PROJECTS\IE565	scale:	1:5,000 A3
drawing status:		datum:	LOCAL
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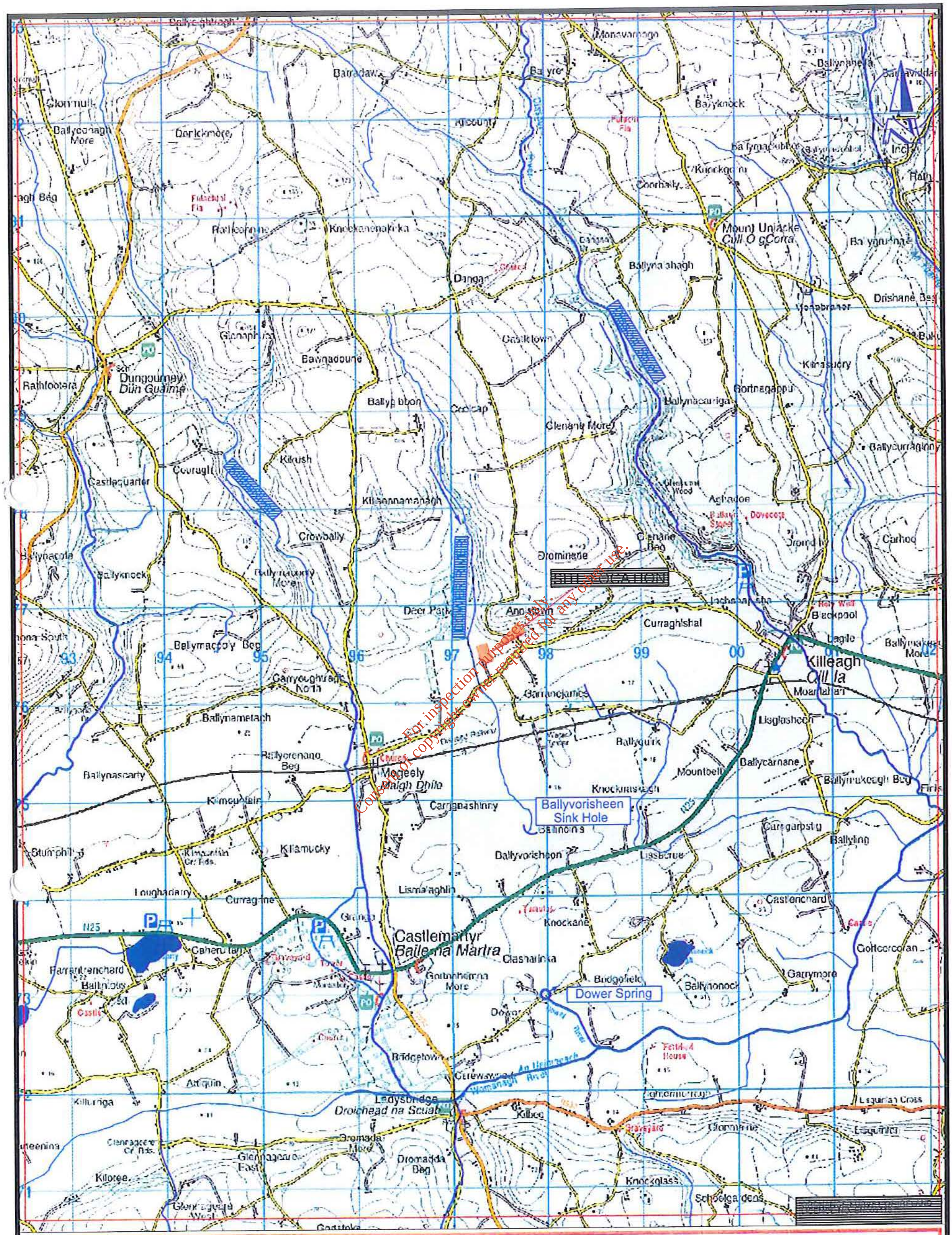
IE565-003	C	approved:	-
		date:	27.04.16



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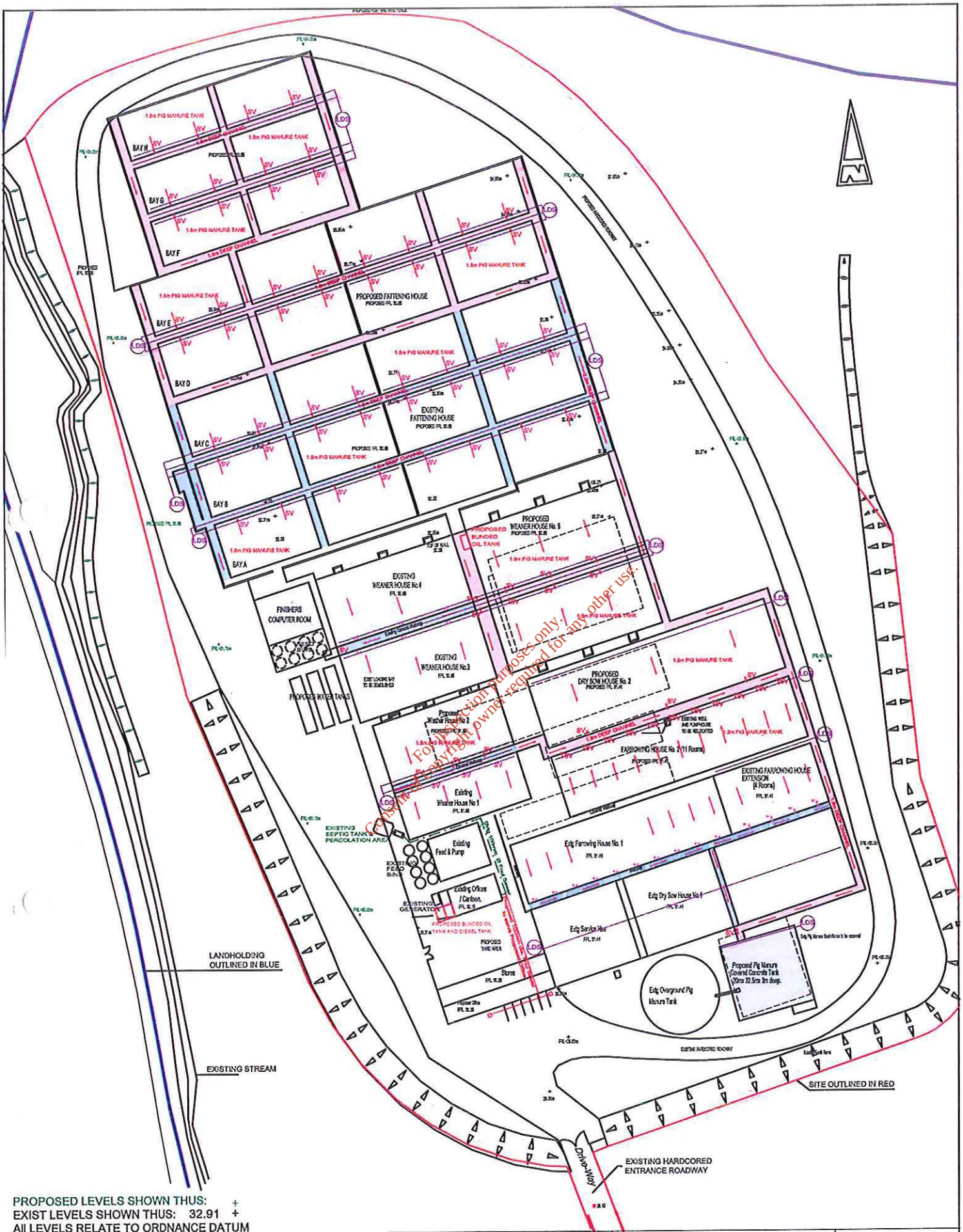
GES LTD

Project Title:	Groundwater Risk Assessment
Project Address:	Annistown, Killeagh, Co. Cork
Client:	Tom O'Brien
Drg. Title:	Regional Topography & Hydrology

Dwg.Scale:	Date:	Dwg.No:	Job No:	Revision:	Dwg.By:
1:50,000	27/04/10	IE565-001	IE565	A	TP



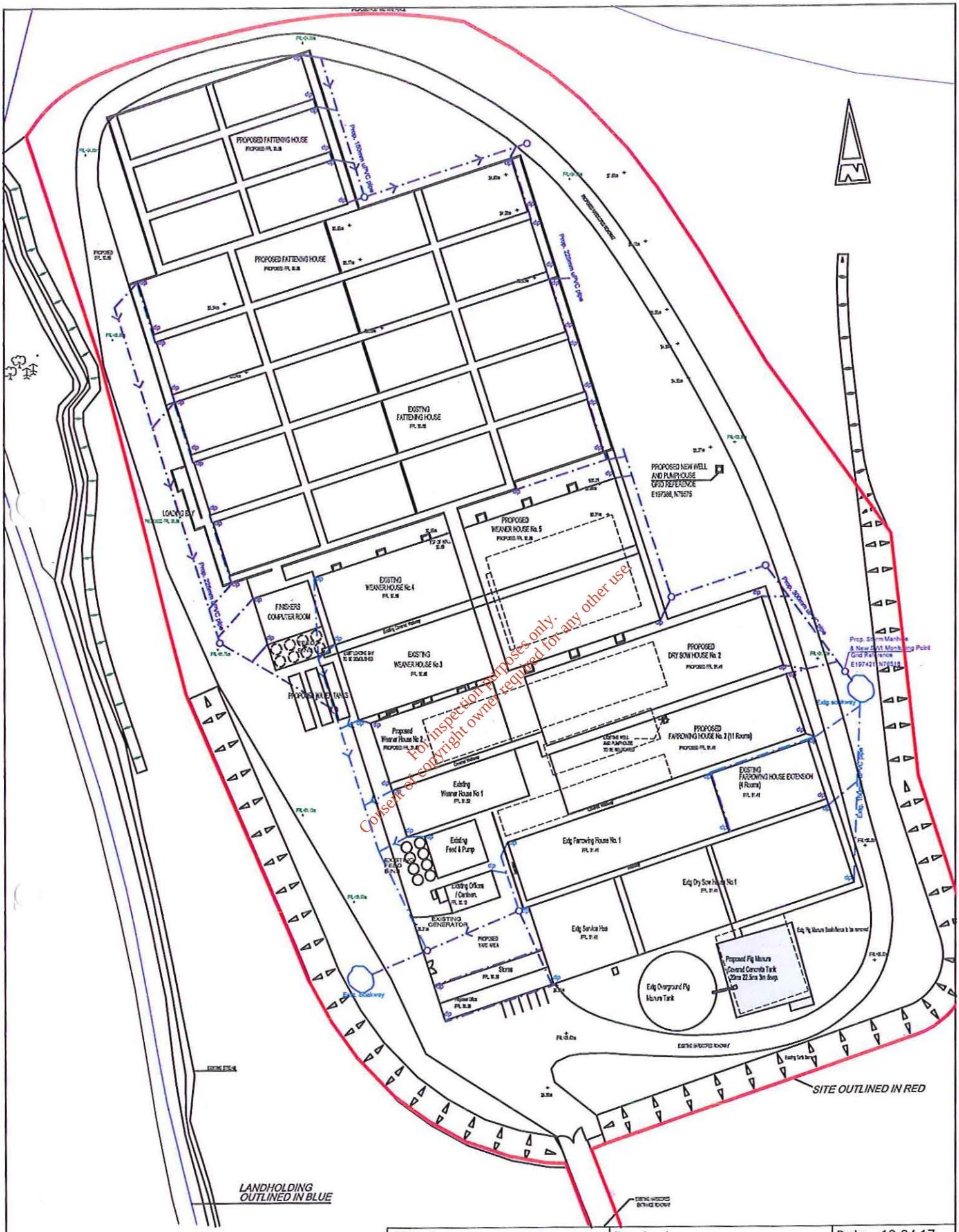
PROPOSED LEVELS SHOWN THUS: +
EXIST LEVELS SHOWN THUS: 32.91 +
All LEVELS RELATE TO ORDNANCE DATUM

EXISTING PIG MANURE CHANNELS INDICATED THUS
PROPOSED PIG MANURE CHANNELS INDICATED THUS
EXISTING PIG MANURE LINES INDICATED THUS
PROPOSED PIG MANURE LINES INDICATED THUS
EXISTING STRUCTURE/BUILDING TO BE DEMOLISHED SHOWN THUS
LEAK DETECTION SUMP (LDS)

Refer to Drg No. 214037-03 for details

Client Eoin O'Brien	Project EPA Submission	Date 12.04.17
		Scale 1:1000@A3
Drawing Title Proposed Pig Manure Drainage Layout Plan		Drawing No 214037–01

Murphy McCarthy Consulting Engineers Ltd.
EastPark House, Marina Commercial Park, Centre Park Road, Cork.
Telephone: 021–4317992 Fax: 021–4311410 Email: murmac@iol.ie



PROPOSED LEVELS SHOWN THUS: + 32.91
EXIST LEVELS SHOWN THUS: + 32.91
All LEVELS RELATE TO ORDNANCE DATUM

EXISTING ROOF WATER DRAINAGE

PROPOSED ROOF WATER DRAINAGE

EXISTING STRUCTURE/BUILDING TO BE DEMOLISHED SHOWN THUS

Client Eoin O'Brien	Project EPA Submission	Date 12.04.17	
		Scale 1:1000@A3	
Drawing Title Storm Drainage Layout Plan		Drawing No 214037–02	

Murphy McCarthy Consulting Engineers Ltd.
EastPark House, Marina Commercial Park, Centre Park Road, Cork.
Telephone: 021–4317992 Fax: 021–4311410 Email: murmac@iol.ie

Leak detection system

A leak detection system shall be installed under every new tank constructed for the containment of pig slurry. The leak detection system shall consist of 100mm land drainage pipes distributed in a herringbone pattern under the tank. The greatest distance between two pipes shall not exceed 3 metres. The pipes shall be laid on a slope and connected to an inspection tank, of at least 2.5m3.

EXISTING STRUCTURE/BUILDING TO BE DEMOLISHED SHOWN THUS

Client Eoin O'Brien	Project EPA Submission	Date 12.04.17	
		Scale 1:1000@A3	
Drawing Title Proposed Leak Detection System		Drawing No 214037-03	

Murphy McCarthy Consulting Engineers Ltd.
EastPark House, Marina Commercial Park, Centre Park Road, Cork.
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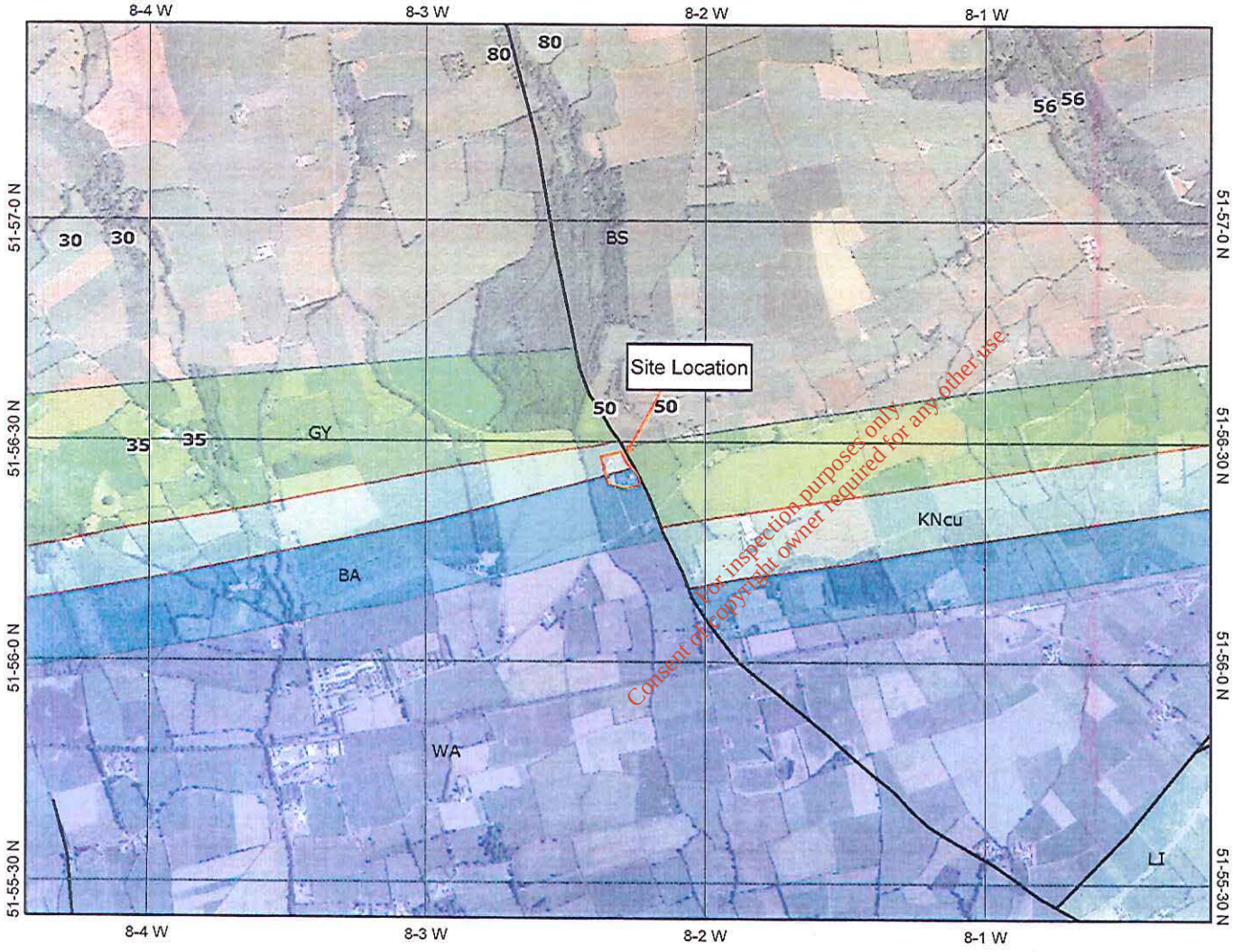
APPENDIX B

GSI WEB MAPPING

Figure 1 - Bedrock Geology



Map center: 197347, 76480

Legend

Symbol Labels 100k

Cross Section Labels

Symbols 100k

Cross Sections 100k

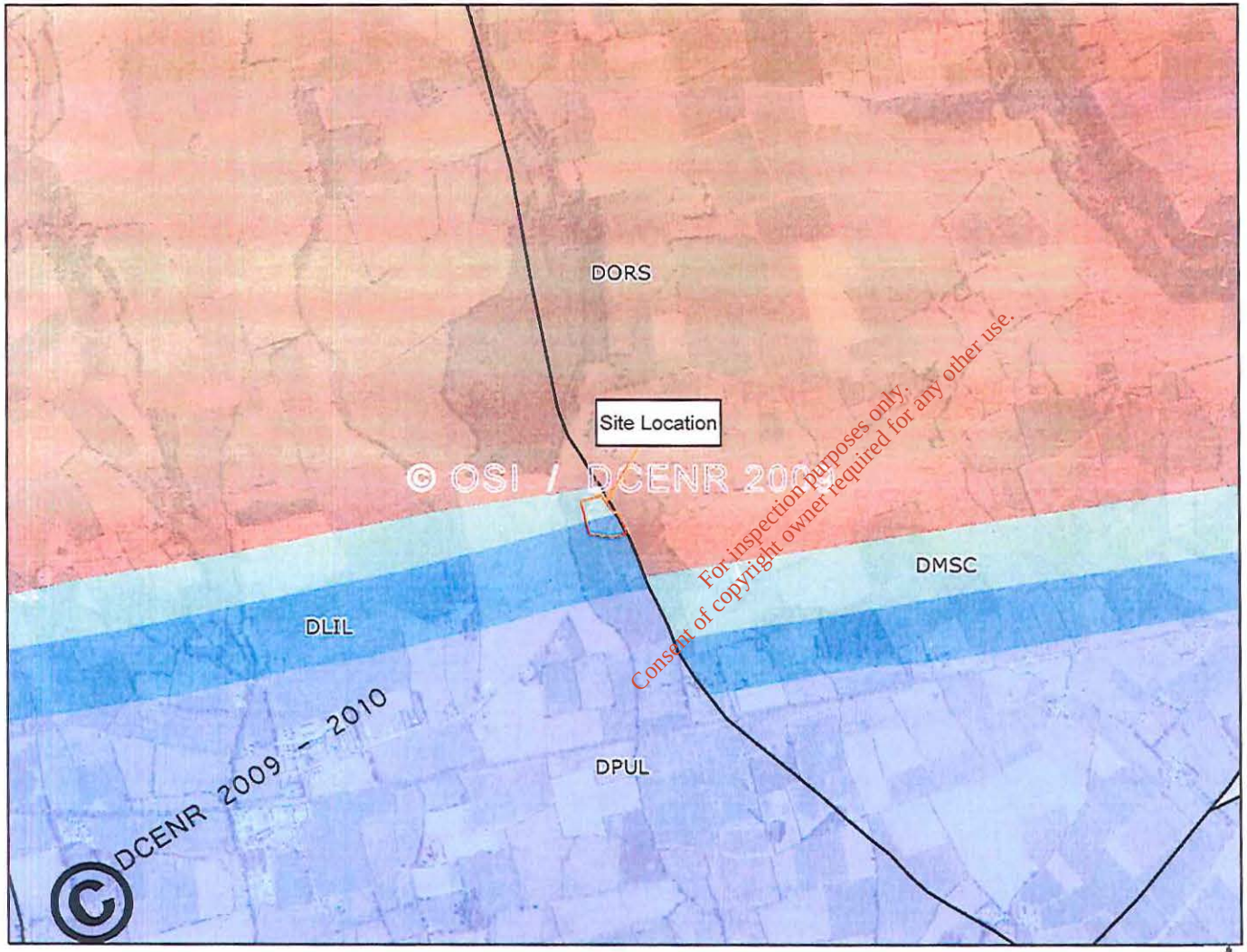
100k Structural Linework

- Anticlinal axis
- Antiformal axis
- Fault
- line od cross section
- Slide
- Synclinal axis
- Synformal axis
- Thrust

100k Stratigraphical Linework

- Area of abundant P-dykes
- Area of fine-grained metabasite pods
- Basalt with mantle xenoliths (Bx)
- Boundary of Felsic igneous intrusion
- Boundary of dolomitization
- Boundary of igneous intrusion
- Boundary of raft cluster within MdGr
- Boundary of volcanic b
- Coal seam
- Dyke/Sill
- Ghost Line
- Limit of MdGr D6 granitic sheets
- Limit of granite sheeting (Ox Mountains)
- Lithologica[illegible]
- Metadolerite sheet
- Outer limit of high-grade aureole
- Outer limit of metamorphic aureole
- Shear zone boundary
- Stratigraphic marker (diagrammatic)
- Tertiary dolerite dyke
- Tertiary dyke

Figure 2 - Generalised Bedrock Map



Legend

- Bedrock Faults 100k
- National Draft Generalised Bedrock Map
- BV - Basalts and other Volcanic rocks
- CM - Cambrian Metasediments
- DDL - Dinantian Dolomitised Limestones
- DESSL - Dinantian early Sandstones, Shales and Limestones
- DKS - Devonian Kiltorcan type Sandstones
- DLIL - Dinantian Lower Impure Limestones
- DMSC - Dinantian Mudstones and Sandstones Cork Group
- MSSL - Dinantian Mixed Sandstones, Shales and Limestones
- DORS - Devonian Old Red Sandstones
- DPBL - Dinantian Pure Bedded Limestones
- DPUL - Dinantian Pure Unbedded Limestones
- DS - Dinantian Sandstones
- DSL - Dinantian Shales and Limestones
- DUIL - Dinantian Upper Impure Limestones
- GII - Granites and other Igneous Intrusive rocks
- NSA - Namurian Sandstones
- NSH - Namurian Shales
- NU - Namurian Undifferentiated
- OM - Ordovician Metasediments
- OV - Ordovician Volcanics
- PM - Precambrian Marbles
- PQGS - Precambrian Quartzites, Gneisses and Schists
- PTMG - Permo Triassic Mudstones and Gypsum
- PTS - Permo Triassic Sandstones
- SMV - Silurian Metasediments and Volcanics
- WSA - Westphalian Sandstones
- WSH - Westphalian Shales

Watermark

Scale: 1:25,000

Map center: 197441, 76655

Snapshot Date: 30-Apr-2010

EPA Maps Online

The Legend must be printed separately.

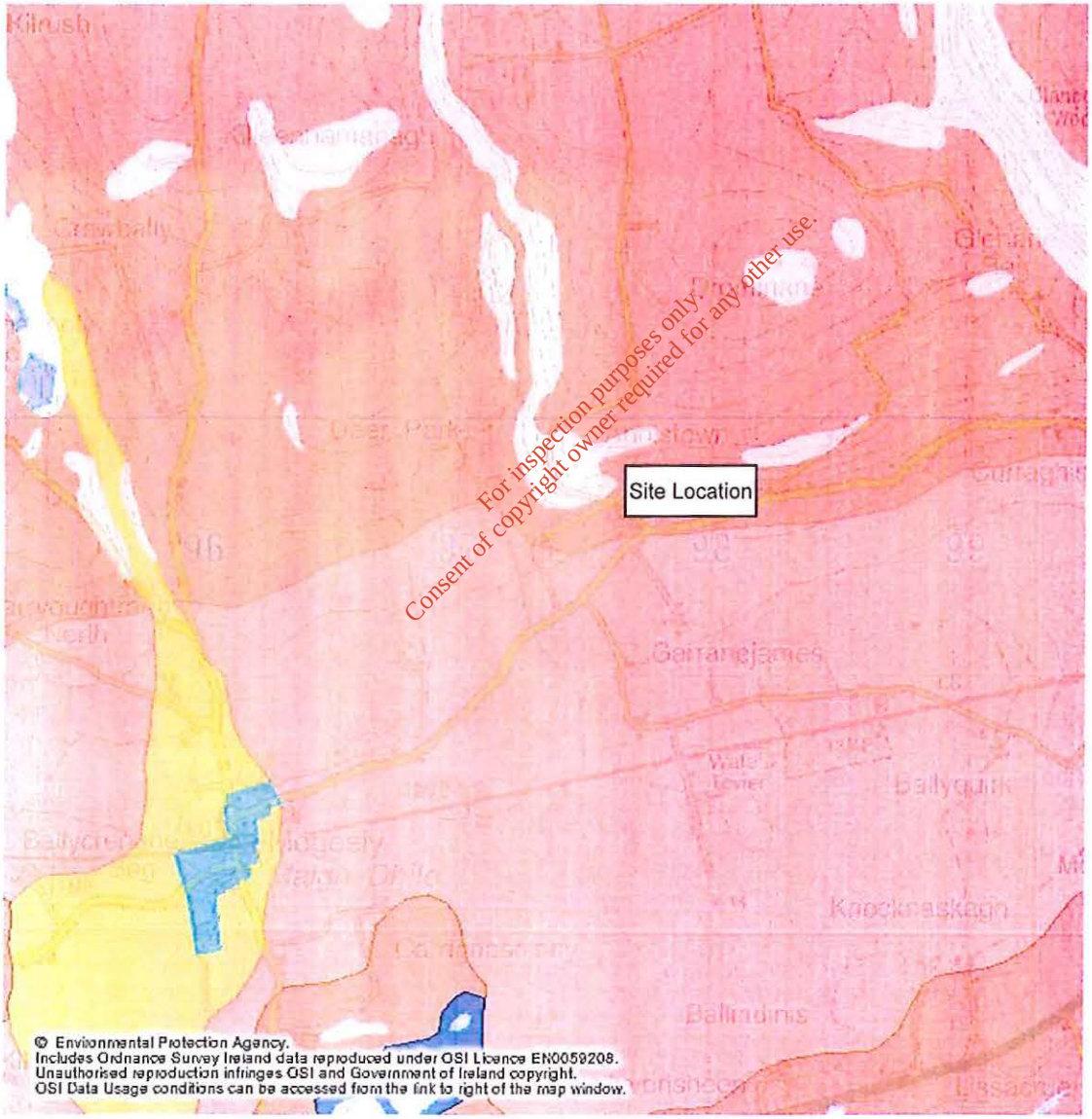
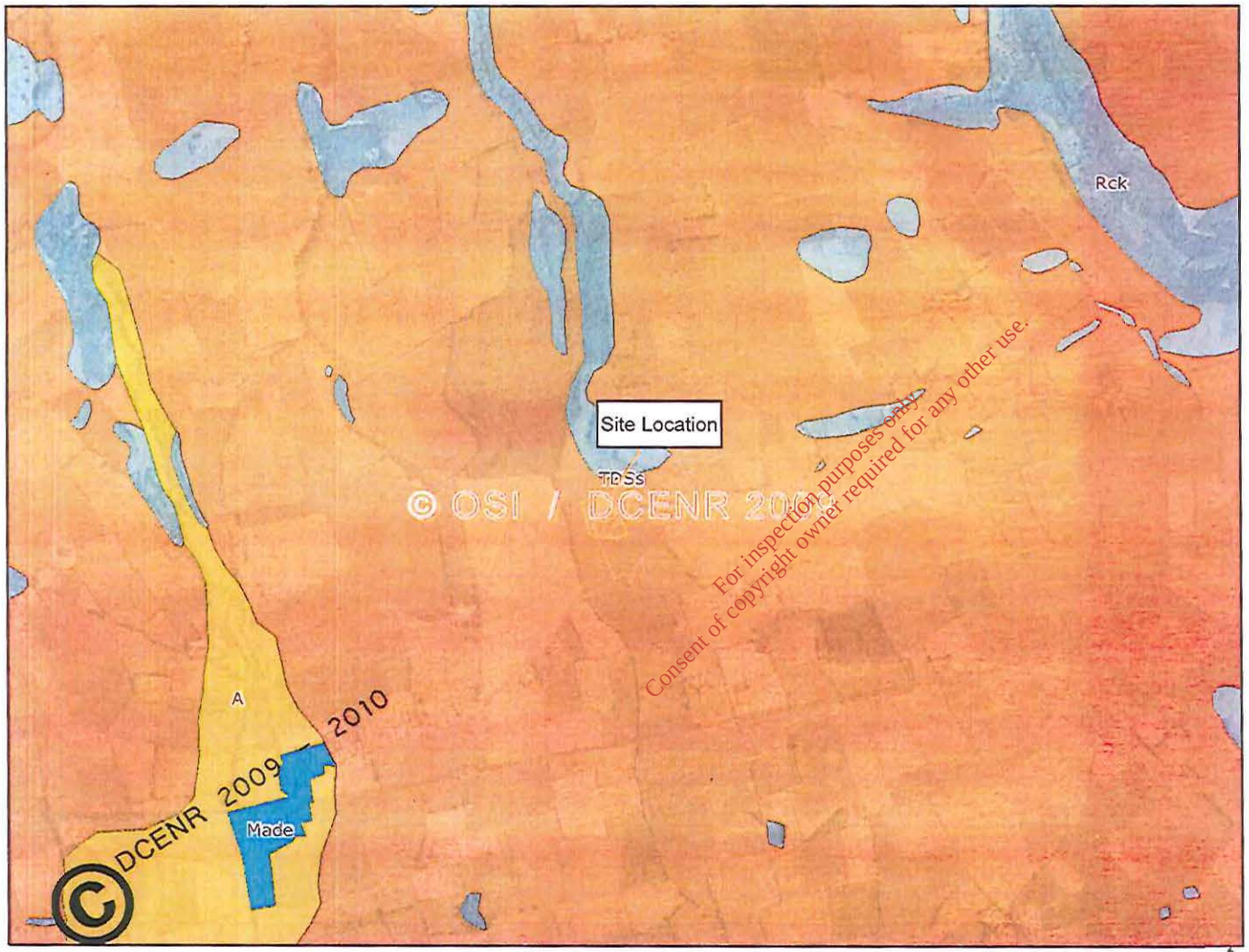


Figure 4 - Subsoils Map



Legend

South Western RBD Subsoils

- Alluvium
- Beach sands and gravels
- Bedrock outcrop and subcrop
- Esker sands and gravels
- Glaciofluvial sands and gravels
- Irish Sea till
- Lake sediments
- Made ground
- Marine/estuarine silts and clays
- Marsh
- Peat
- Scree
- Till derived chiefly from Devonian sandstones
- Till derived chiefly from Lower Palaeozoic rocks
- Till derived chiefly from Namurian rocks
- Till derived chiefly from basic igneous rocks
- Till derived chiefly from limestone
- Till derived from mixed Devonian and Carboniferous rocks
- Water
- Windblown sands

Watermark

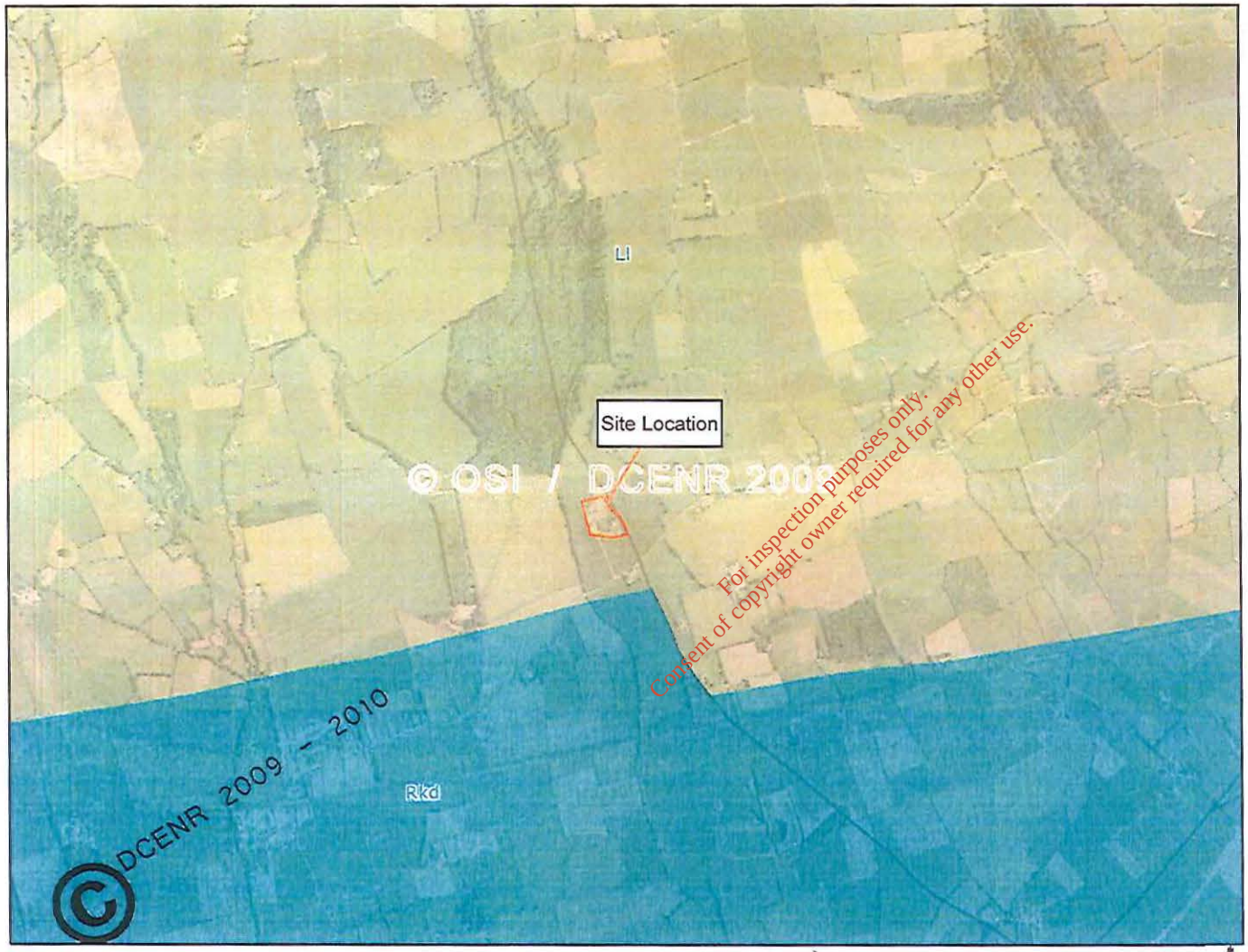
0 650 1300 1950 m.

Map center: 197441, 76655

Scale: 1:25,000

Snapshot Date: 30-Apr-2010

Figure 5 - Aquifer Map



0 650 1300 1950 m.

Map center: 197441, 76655

Legend

National Draft Bedrock Aquifer Map

- Rf - Regionally Important Aquifer - Fissured bedrock
- Rk - Regionally Important Aquifer - Karstified
- Rkd - Regionally Important Aquifer - Karstified (diffuse)
- Rkc - Regionally Important Aquifer - Karstified (conduit)
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Unclassified

National Draft Gravel Aquifer Map

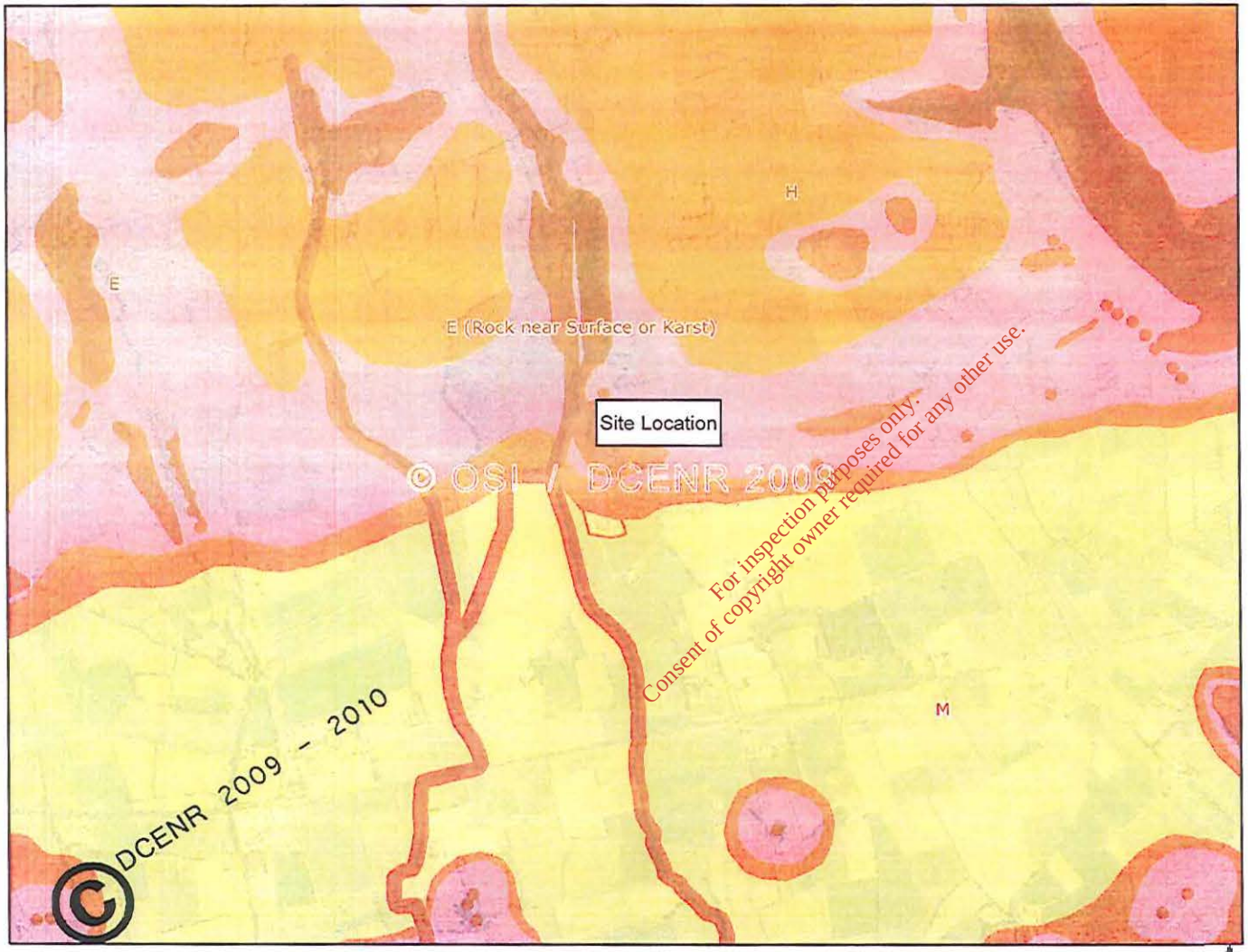
- Rg - Regionally important, extensive sand/gravels aquifers
- Lg - Locally Important, sand/gravel aquifers
- No gravels present
- Not Mapped

- Bedrock Faults 100k
- Watermark

Scale: 1:25,000

Snapshot Date: 30-Apr-2010

Figure 6 - Vulnerability Map



Legend

South Western Interim Vulnerability

- E (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- HL - High to Low. Only an interim study took place.
- Water
- Watermark

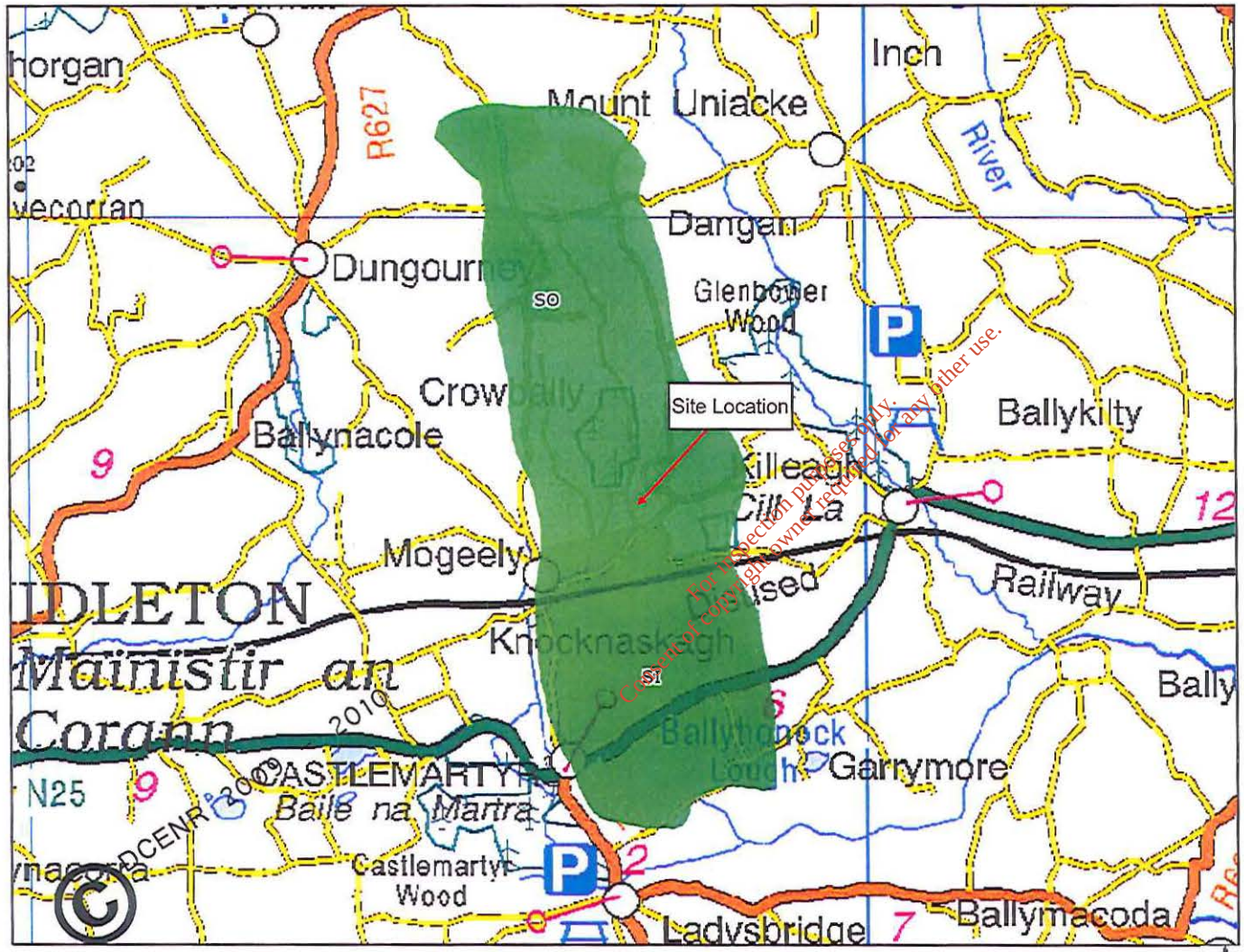
0 650 1300 1950 m.

Map center: 197441, 76655

Scale: 1:25,000

Snapshot Date: 30-Apr-2010

Figure 7 - Dower Spring Source Protection Area



Legend

Source Protection Area

- SI - Inner Protection Area
- SO - Outer Protection Area

Scale: 1:76,000

Snapshot Date: 02-Jul-2010