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# HYDROLOGY AND HYDROGEOLOGY 6

## INTRODUCTION

6.1 SLR Consulting Ireland (SLR) has been appointed by Roadstone Wood Ltd. to prepare an Environmental Impact Statement (EIS) of the proposed backfilling and restoration of its quarry at Brownswood, Co. Wexford, using imported inert soil material.

6.2 This Chapter of the EIS details the local hydrology and hydrogeology of the application site and surrounding area (up to 3km radius around the site boundary) and identifies potential hydrological and hydrogeological impacts associated with the proposed development.

6.3 The potential impacts from the proposed development are assessed in the first instance without any mitigation measures in place; the potential impacts are then reassessed with appropriate mitigation measures in place. The assessment is based on a detailed baseline description of the local geological, hydrological and hydrogeological regimes.

6.4 The local geology at the site is discussed in detail in Section 5 of this Environmental Impact Statement.



## Background

6.5 Large scale extraction of Ordovician rock at the Old Quarry at Brownswood effectively ceased in the late 1980's / early 1990's as the amount of available land and extractable material was exhausted. Since that time, rock extraction has continued at an adjoining quarry (Murphy's Quarry) to the south and the excavated rock is transferred to the Old Quarry for value added activities, principally concrete and asphalt production.

6.6 A significant part of the Old Quarry has been worked below the water table and the site was previously dewatered by pumping to allow rock extraction to occur. Since extraction ceased at the quarry, pumping of groundwater has also ceased and the groundwater table beneath the site has returned to its natural level prior to dewatering (approximately 7mOD).

6.7 This proposal provides for restoration of the quarry by importing inert soils to partially backfill the existing quarry void and raise the ground level above the groundwater table. The proposed restoration is technically classified as recovery of waste through deposition on land. The large volume of imported inert soil and stone required to complete this task requires an application for planning permission to be submitted to Wexford County Council and a waste licence application to be submitted to the Environmental Protection Agency, together with supporting environmental information (including this EIS).

6.8 This Chapter presents an assessment of the environmental impact of the restoration of the site using inert soil and stones on the hydrological and hydrogeological environment. Further information on the waste types and proposed waste recovery facility is provided in Chapter 2 of this report.

## Scope of Work

6.9 This Chapter of the EIS identifies the local hydrological and hydrogeological environment based on available information in the vicinity of the site. A qualitative assessment has been undertaken of the potential impacts on this environment arising from backfilling of the quarry using inert materials.

6.10 The assessment considers the proposed phasing of the infilling, the waste types and proposals for water management at the site. The assessment methodology of the assessment is also outlined in detail within the Chapter.

## Sources of Information

6.11 The following sources of information have been consulted in order to investigate the hydrology and hydrogeology of the area surrounding the application site:

- The Environmental Protection Agency for Ireland website (www.epa.ie) for maps and environmental information;
- Geological Survey of Ireland website (www.gsi.ie);
- Geology of Carlow-Wexford, Sheet 19, 1:100,000 scale, Geological Survey of Ireland, 1999;
- Groundwater Protection Schemes, Department of the Environment and Local Government, Environmental Protection Agency, and Geological Survey of Ireland, 1999, and Appendix Groundwater Protection Response for Landfills; and
- Water Maps, Water Framework Directive online mapping (www.wfdireland.ie)



## Contributors

6.12 This study of surface water and groundwater was prepared by:

- Peter Glanville BA., M.Sc., Ph.D., PGeo, Associate, SLR Consulting Ireland

## Existing Site Water Management

6.13 At present, surface water and groundwater is managed at the site and is discharged to the River Slaney under licensed consent. Existing water management infrastructure at the site is shown on Figure 6-1. A discharge licence has been issued by Wexford County Council (Ref. SS/W024/81/99R1) in respect of the existing discharge to the River Slaney of dewatered groundwater, surface water runoff from the block yard and excess process water from the concrete production facility.

### *Surface Water Runoff*

6.14 There is currently little or no surface water drainage infrastructure across the application site. Rain falling across the site either:

- percolates through unsealed ground into the underlying bedrock and ultimately intercepts groundwater, the upper surface of which lies at approximately the same level as the water in the worked out quarry void. Once it is part of the groundwater body, the groundwater recharge follows the regional groundwater flow toward the River Slaney;
- runs over sealed ground and falls over the vegetated ground sloping westwards where it infiltrates to the ground and/or is intercepted by local drains; or
- runs over unsealed ground into the existing pond in the quarry void.

6.15 The access road and car parking areas surrounding the office building are sealed by concrete and will remain in place for the duration of the waste recovery activities at the site. Surface water falling across these areas is not currently intercepted by drains, but instead runs over the existing ground surface and falls westwards over the vegetated ground which slopes down and it either infiltrates to the ground or is intercepted by local drains.

6.16 At the present time, within the application site, there are permanent hardstanding areas located around the worked out quarry void. These hardstanding areas are not sealed and any rain falling over these areas either percolates downwards into the underlying soil / bedrock or runs-off over the existing ground surface, toward the existing quarry void.



## *Wheel Wash*

6.17 There is an existing wheelwash facility at the site, located along the access road leading into the Old Quarry. In order to prevent transport of soil onto the public road network, all traffic exiting the quarry site must pass through the wheelwash facility, the location of which is indicated in the site infrastructure layout in Figure 2-2.

## *Fuel and Oil Storage and Refuelling*

6.18 There are existing fuel storage tanks within the existing quarry facility which are bunded to provide a storage volume equivalent to 110% of the tank storage volume. These tanks are constructed on a sealed concrete surface with sealed refuelling area. Fuel for existing quarry activities and the proposed inert waste recovery facility will be stored in existing bunded tanks.

6.19 Plant maintained on site will principally comprise mechanical excavators and/or bulldozers. Mobile plant and equipment undertaking quarry backfilling works will be refuelled from mobile, double skin fuel bowsers or at the existing refuelling area within the Brownswood facility. Oil and lubricant changes and servicing of wheeled or tracked plant will be undertaken at the existing maintenance sheds. Re-fuelling of HGV trucks will take place on site at the auto-diesel tank located on a hardstanding surface to the rear of the existing maintenance shed.

6.20 A small bunded area for waste oils is provided alongside the maintenance shed. Oil collected in tanks are emptied at intervals by a licensed waste contractor and disposed off-site at a suitably licensed waste facility.

### *Foul Sewer*

6.21 There are two waste water treatment systems at the site each comprising a septic tank and associated percolation area. The waste water treatment system caters for the toilets, hand washing and welfare facilities provided at the existing site offices and staff canteen. The location of these facilities and the septic tanks servicing them are shown on the site services drawing in Figure 2-3

## RECEIVING ENVIRONMENT

## Available Information: Geology and Soils

6.22 A detailed description of the local and regional soil, subsoil and bedrock geology is provided in Chapter 5 of this EIS. A summary is provided below

### *Soils and Subsoils*

6.23 The soils in the area around the Old Quarry are classified as Rolling Lowland Soils (Gardiner and Radford, 1980). They consist mainly of a well drained Acid Brown Earth soils with minor amounts of grey and brown podzolic soils, and are primarily derived from Ordovician Shale subsoils.

6.24 The Old Quarry at Brownswood lies outside the limits of the maximum Midlandian ice sheet extent during the last glaciation, and the Ordovician glacial till subsoils in the area around the site were laid down during a previous glaciation.

6.25 The subsoils at the site have previously been removed to facilitate the quarrying operation. The subsoils have been stored / stockpiled around the quarry for the future restoration of the site.



### *Solid Geology*

6.26 The most recent geological map of the area (Tietzsch-Tyler and Sleeman, 1994) shows that the general area around the site is underlain by the rocks of the Campile formation. The Campile formation consists of rhyolites and rhyolitic tuffs in grey and brown slaty mudstones with occasional andesites and andesitic tuffs.

6.27 The GSI memoir that accompanies the 1:100,000 scale geological map of the Enniscorthy area notes that granites have been recorded in the Campile formation south of Enniscorthy and in the thermally metamorphosed rocks at Oilgate on the banks of the River Slaney; these may reflect the presence of a sub-surface granite pluton in the area.

### *Local Geology*

6.28 The geology at the Old Quarry is described as a granodiorite and is therefore untypical of the geology of the Campile formation. Other geologies are also visible in the quarry void and these primarily comprise greywacke mudstone / siltstones. Within the Old Quarry, the quality of the rock is variable, being quite fresh in places while it is heavily weathered elsewhere.

6.29 Drilling of a proposed quarry extension area to the east of the Old Quarry (at locations shown on the well location map in Figure 6-2) and subsequent logging of the core determined that the geological deposit at this location principally comprises granodiorite. Granodiorite is a very hard and durable rock and produces aggregates with good strength characteristics.

## Available Information: Hydrology

### *Local Hydrology and Surface Water Quality*

6.30 The major surface water feature in the vicinity of the Old Quarry is the River Slaney to the west of the site, see Figure 6-3. The River Slaney flows in a southerly direction and its estuary reaches as far north as Oilgate, approximately 5km south of Brownswood. Tidal effects on flow are detected as far upstream as Enniscorthy town. The water level of the river opposite the Old Quarry is of the order of 1mOD to 2mOD depending on river flow and tidal conditions.

6.31 Aside from the River Slaney, there are also two small south westerly flowing streams, to the north and south of the Old Quarry, that drain the general area (refer to Figure 6-3). The northerly stream (Stream - 1) flows into the River Slaney, close to the northern property boundary. Its catchment area is approximately 1,008ha. The southerly stream (Stream - 2) joins the Slaney at Edermine Bridge about 1.5km south of Brownswood and has a catchment area of 433ha.



6.32 The Boro River, a small tributary of the River Slaney, joins the main channel just opposite the southern boundary of the quarry (refer to Figure 6-3).

6.33 The River Slaney is a designated Salmonid Water under the Freshwater Fish Directive (78/659/EEC) and the River Slaney Valley is a designated candidate Special Area of Conservation (cSAC) under the Habitats Directive (92/43/EC). The upper River Slaney estuary water quality was assessed as intermediate quality for the period 2001-2005. Current river water quality data for the River Slaney at the site indicates that is rated as being of moderate status, with a Q Value of 3-4.

6.34 The latest results for monitoring undertaken for the purposes of the Water Framework Directive indicates that the River Slaney at the site has a high Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD). Concentrations of both Nitrogen and Phosphorus are classified as moderate.

### *Surface Water Flows*

6.35 The annual average flow, 95% flow and Dry Weather Flows (DWF) of the River Slaney at Enniscorthy are 25.47$m^3$/s, 4.96$m^3$/s and 1.96$m^3$/s, respectively (MacCarthaigh, 1995). The recorded flow in the Boro River (on 15 Oct 1976) was 0.62$m^3$/s (AFF, 1977). This flow is likely to have been less than a 95% flow. There is no flow or water level data available in Environmental Protection Agency publications for either of the two streams to the north and south of the site which discharge into the River Slaney.

### *Flooding*

6.36 The Office of Public Works website (www.floodmaps.ie) indicates that there are no records of historic flooding recorded in the vicinity of the site. The Old Quarry and the proposed inert waste recovery facility are not considered to be at risk of flooding due to their relative elevated location above the River Slaney. Surface water run-off and discharges from site are, and will continue to be managed so that they do not increase the risk of flooding in the vicinity of the application site.

### *Limitations*

6.37 This assessment is largely qualitative and is based on professional experience, visual observations and available desktop published information.

## Available Information : Hydrogeology

### *Aquifer Characteristics and Groundwater Vulnerability*

6.38 The Campile Formation is described as a regionally important aquifer in the Wexford-South Kilkenny-East Waterford region (Tietzsch-Tyler and Sleeman, 1994). Well yields tapping the rhyolites in this formation frequently give well yields of up to 1,000$m^3$/d. However, the granodiorates at Brownswood Quarry are not as productive and are considered to be an aquitard.

6.39 Perched water tables are often found in subsoil deposits which occur in topographic depressions over this type of ground. However, they tend to dry up naturally in the summer.



6.40 Groundwaters in this general area are considered to be moderately soft calcium-magnesium bicarbonate type waters (Burdon and Cullen, 1980), with Total Hardness of around 100mg/l as $CaCO_3$.

6.41 Within the geological strata which occur at the quarry, significant groundwater flow is generally restricted to the shallow weathered zone or fault/fracture zones. Small seeps are visible emerging from local areas in the quarry walls (Ref. Paul Murphy).

6.42 It is understood that historically when the quarry was being dewatered, there were minor groundwater inflows to the quarry that drained to the floor, where they were contained. Water was pumped from the quarry floor as and when required in order to maintain dry conditions on the floor. When active, the pumps had an estimated average discharge rate of 5l/s.

6.43 Groundwater vulnerability maps published by the EPA on its website (www.epa.ie) indicate that the site is located in an area with high to extreme Groundwater Vulnerability status where rock is close to the surface. An extract of the Groundwater Vulnerability map is presented as Figure 6-4. The groundwater vulnerability reflects the potential for rapid groundwater movement through the quaternary subsoil deposits into the underlying bedrock aquifer, particularly where they are thin and afford little attenuation.

## Recharge Mechanisms

6.44 The average annual rainfall in the Brownswood area is around 1,002mm/yr. The potential groundwater recharge is obtained by taking the annual rainfall and subtracting the actual evaporation/evapotranspiration (AE).

6.45 The AE in the agricultural area around the quarry is taken to be 550mm/yr and therefore the aquifer recharge is approximately 452mm/yr. At the existing quarry however, the AE will be much lower due to the absence of significant vegetation cover. The AE is therefore assumed to be approximately 50mm/yr, with the result that the assumed aquifer recharge at the quarry void is approximately 952mm/yr.

## Groundwater Levels and Flow

6.46 Within the geological strata around the Old Quarry, significant groundwater flow is generally restricted to the shallow weathered zone or localised fault / fracture zones. Nevertheless, the rock faces in the existing sites only show a very tight aspect with small seeps visible.

6.47 Prior to quarrying, the depth to the water table in this area ranged from 5m or less at lower ground along the N11 National Primary Road to 15m or less at higher ground the along minor road to the east of the eastern quarry boundary. The water level in the quarry currently lies at 7.2mOD (surveyed in late June 2010) and is approximately 5m to 6m above the level of the River Slaney to the west.



6.48 The quarry has been dewatered in the past to a level of c. -22mOD and had been on-going for in excess of 10 years. It is understood that no dewatering has taken place at the Old Quarry since 2005.

6.49 Four groundwater monitoring wells have recently been installed (July 2010) across the Old Quarry at Brownswood in order to establish baseline groundwater quality in response to a Section 55 direction issued by Wexford County Council and concerns expressed by it about potential for contamination of groundwater by historical activities at the site, specifically relating to oil and/or fuel leakage from quarry related plant and equipment.

6.50 The monitoring well locations are shown in Figure 6-2. A copy of the drillers borehole records is provided in Appendix 6-1. Well identification numbers are shown with corresponding driller borehole identification numbers in Table 6-1:

Table 6.1
Groundwater Monitoring Well ID's and Driller ID's

| Driller Hole | Groundwater Monitoring Well |
|---|---|
| Hole 1 | GW1 |
| Hole 2 | GW2 |
| Hole 3 | GW3 |
| Hole 4 | GW4 |

6.51 Measured groundwater levels and well details are shown in Table 6-2 below.

Table 6-2
Quarry Groundwater Level Monitoring (2010)

| Well ID | Ground Level (mOD) | Borehole Depth (m) | Casing Elevation (mOD) | Groundwater Level (mOD) | | |
|---|---|---|---|---|---|---|
| | | | | 05/08/2010 | 19/08/2010 | 22/09/2010 |
| **GW1** | 9.80 | 22 | 10.98 | na. | 4.57 | 4.92 |
| **GW2** | 8.47 | 25 | 9.02 | 2.65 | 3.02 | 3.16 |
| **GW3** | 27.60 | 25 | 28.25 | 16.07 | 15.35 | 15.49 |
| **GW4** | 16.66 | 25 | 17.49 | 4.52 | 5.07 | 5.42 |

6.52 On the basis of the surveyed pond water level in June 2010 and the groundwater levels in the four monitoring wells in August 2010, the water table level beneath the Old Quarry landholding is deemed to lie between c. 2.5mOD, on the western side of the quarry towards the River Slaney and c. 16mOD, on the eastern side of the quarry.

6.53 Groundwaters in the strata beneath Brownswood Quarry are unconfined and prior to quarrying flowed in a south-westerly direction towards the River Slaney. Over the years, a cone of drawdown (depression in the water table) developed around the periphery of the quarry as a result of excavation below the groundwater table. The cone of drawdown extended to the east of the existing quarry void.



6.54 When quarrying extended below the water table and it was being dewatered, groundwater flowed into the quarry from all sides and was abstracted (along with surface runoff from around the quarry) by pumping from sumps. Since dewatering at the site ceased, the groundwater level has rebounded.

6.55 Previous investigation of bedrock and subsoil conditions in the proposed quarry extension to the east of the Old Quarry comprised drilling 7 No. boreholes in late July 2001 (refer to Figure 6-2). The boreholes were drilled at 50mm diameter (NQ) using rotary coring techniques. The completed boreholes were fitted with 25mm plastic casing and well screen in order to monitor groundwater levels.

6.56 Summer water table levels obtained from the boreholes in the proposed extension area vary in depth from less than 7m beneath the low lying ground in the north of the site to almost 13m below the highest ground in the south (see Table 6-3 below). The recorded annual water table fluctuations to the east of the Old Quarry ranged from about 2.5m beneath lower ground to up to 5m beneath higher ground.

Table 6-3
Groundwater Level Monitoring in Proposed Extension Area (August 2001)

| Borehole | Top of Casing (mOD) | Borehole Depth (mOD) | Groundwater Levels (mOD) |
|---|---|---|---|
| **BH1** | 68.00 | -13.20 | 60.23 |
| **BH2** | 78.00 | -19.00 | 67.3 |

| Borehole | Top of Casing (mOD) | Borehole Depth (mOD) | Groundwater Levels (mOD) |
|---|---|---|---|
| **BH3** | 77.50 | -0.30 | BH obstructed |
| **BH4** | 78.49 | 2.89 | 65.69 |
| **BH5** | 78.50 | -51.70 | BH obstructed |
| **BH6** | 60.00 | -8.80 | BH obstructed |

6.57 The results of the water level monitoring (Table 6-3 and Table 6-2) indicate a very steep gradient from the existing water level in the void at the Old Quarry to that recorded below the site of the proposed extension to the east in 2001.

6.58 The available water level monitoring data from 2001 suggests that at that time, the groundwater table dropped by at least 45m between BH1 at the proposed extension area and the Old Quarry approximately 450m down-hydraulic gradient to the west. This gives an average hydraulic gradient of approximately 10%, which is very steep.

6.59 In 2001, at a time when the Old Quarry was being dewatered, the gradient between boreholes BH1, in the western side of the proposed extension, and BH2 about 270m further east was about 2.6% which is within the normal range for an aquitard. The available information therefore suggests that the cone of drawdown associated with the previous (and any future) drawdown is of limited extent and only likely to extend eastwards for up to 450m.

6.60 In 2001, the volume of water pumped from the large, deep excavations in Brownswood Quarry was relatively small indicating rocks in the quarry have very limited permeability and are essentially aquitards, i.e. or poor aquifers.



## *Groundwater Abstractions, Use and Quality*

6.61 The GSI groundwater well database indicates one well in the vicinity of the site. The well is approximately 0.9km to the south of the site in Brownswood townland. The well is located within the Ordovician volcanics which are classified as a regionally important (fissured) aquifer. The well is c.38m in depth, with c.9m of subsoil cover. The well is classified as having a moderate yield which is estimated at c. 54m$^3$/day. This well services a farm residence.

6.62 There is a mains water connection supplying potable water to the office and washroom facilities at the site.

6.63 It is understood that recycled water from quarry void is currently supplied to the concrete batching plant and asphalt plant and is used for washing of aggregates and to replenish the wheel wash.

6.64 Water samples taken from the pond at Old Quarry in recent years for routine monitoring purposes were sent to QLAB in Wexford for testing nad the results of these analyses are presented in Table 6-4. More recent sampling undertaken for the this environmental impact assessment purposes were sent to BHP Laboratory in Limerick for analysis and these results are also presented in Table 6-4. Detailed results are presented in Appendix 6-2. The monitoring locations are shown in Figure 6-1.

Table 6-4
Water Quality Results from Quarry Voids

| Parameter | Units | Sample Date | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 22/02/2008 | 03/11/2008 | 01/12/2008 | 08/01/2009 | 02/02/2009 | 23/03/2010 | 20/04/2011 | 20/04/2011 | 20/04/2011 | 20/04/2011 |
| **Laboratory** | | **QLAB** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** |
| **Sample ID** | | **Bottom Quarry** | **BWQ** | **BWQ** | **Q** | **BW** | **Q** | **1a** | **1b** | **2a** | **2b** |
| **Sample Location** | | **PM Quarry** | **BW Quarry** | **BW Quarry** | **PM Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** |
| BOD | mg/l | 1.1 | <1 | <1 | <1 | 3 | <1 | 3 | 2 | 2 | 2 |
| pH | pH value | 7.94 | 7.69 | 8.22 | 8.22 | 8.17 | 8.07 | 6.97 | 6.92 | 7.11 | 7.04 |
| Suspended Solids | mg/l | <2 | 6.7 | 2.5 | <1 | 3.6 | 1 | 15 | 1 | 11 | 7 |
| COD | mg/l | 4 | 6 | 1 | <1 | 8 | 3 | - | - | - | - |
| Total Coliforms | cfu/100mls | | 233 | none | 17 | 308 | 1 | - | - | - | - |
| Total Ammonia | mg/l $NH_3$-N | | <0.01 | 0.01 | 0.02 | 0.09 | 0.02 | 0.14 | 0.12 | 0.3 | 0.18 |
| Nitrate | mg/l $NO_3$ | | 17.57 | 15.61 | 19.54 | 15.3 | 20.48 | 21.7 | 32.9 | 24 | 26.9 |
| Nitrite | mg/l $NO_2$ | | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Oils, Fats & Grease | | | 1 | <1 | 1 | 1 | <1 | - | - | - | - |
| Total Phosphorous | mg/l as P | | 0.11 | 0.18 | 0.01 | 0.03 | 0.02 | - | - | - | - |

| Parameter | Units | Sample Date | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 22/02/2008 | 03/11/2008 | 01/12/2008 | 08/01/2009 | 02/02/2009 | 23/03/2010 | 20/04/2011 | 20/04/2011 | 20/04/2011 | 20/04/2011 |
| **Laboratory** | | **QLAB** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** | **BHP** |
| **Sample ID** | | **Bottom Quarry** | **BWQ** | **BWQ** | **Q** | **BW** | **Q** | **1a** | **1b** | **2a** | **2b** |
| **Sample Location** | | **PM Quarry** | **BW Quarry** | **BW Quarry** | **PM Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** | **BW Quarry** |
| Ortho Phosphate | mg/l as P | | 0.03 | 0.11 | 0.01 | 0.03 | 0.02 | 0.11 | 0.12 | 0.14 | 0.09 |
| TPH | mg/l | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| PRO | mg/l | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| DRO | mg/l | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

PM Quarry (Paul Murphy Quarry) BW Quarry (Brownswood Quarry)

6.65 The water quality results in the quarry void pond, reproduced in Table 6-4 above, indicate that the water quality is generally good, and slightly alkaline. The elevated total coliforms and nitrate indicate some contamination of the water (organic pollution), from a human or agricultural source.

6.66 There is no hydrocarbon pollution of the water in the quarry void.

6.67 The only obvious sources of organic pollution in the area are the foul waste from houses (septic tanks) and farms surrounding the site. The well-drained, thin subsoils, in the area, will permit the rapid percolation of effluent from these sources into the bedrock where only minimal attenuation takes place. Groundwater contamination has been found elsewhere in Ireland where similar circumstances prevail.

### *Groundwater Protection*

6.68 Groundwater in Ireland is protected by European Community and national legislation. The Geological Survey of Ireland (GSI) in conjunction with the Department of Environment and Local Government (DoELG) and the EPA have developed a methodology for the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater (DoELG / EPA / GSI, 1999). This methodology incorporates land surface zoning and groundwater protection responses.



6.69 While the DoELG / EPA / GSI has developed a scheme (Groundwater Protection Response Matrix for Landfills) to assessing potential landfill sites on the basis of groundwater vulnerability and aquifer status, it is noted that this scheme has been developed for new non-hazardous landfills and is therefore NOT appropriate to use it in assessing site suitability for inert soil recovery facilities such as that proposed at Brownswood.

6.70 Notwithstanding this, a review of the Groundwater Vulnerability Map (Figure 6-4) and the Aquifer Map (Figure 6-5) in accordance with the DoELG / EPA / GSI methodology indicates that the Old Quarry site at Brownswood is located within an area of extreme (E) groundwater vulnerability, primarily as rock occurs at or close to the ground surface.

6.71 Given that site backfilling and restoration activities (such as those envisaged for this site) can only be undertaken where previous activities have created void space in the landscape, the requirement to identify other sites in lower risk areas does not apply. It is asserted that the proposed backfilling of the existing quarry using predominantly cohesive inert glacial till subsoils will provide an enhanced degree of groundwater protection, over and above that which exists at present.

## PROPOSED DEVELOPMENT

6.72 There are a number of key activities and working practices associated with the proposed recovery of inert waste material which may have an impact on the surface water and groundwater at the site.

## Materials Quarantine Area

6.73 Any imported waste which, it is suspected, may not comply with waste acceptance criteria for the waste recovery facility, will be transferred across the application site to a covered structure which currently is unused and located in the south-western corner of the application site (refer to Figure 2.2). This shed is constructed over a sealed concrete slab and will serve as the waste inspection and quarantine facility for the waste recovery operation.

6.74 As the floor of the shed is sealed by a concrete slab and as no rainfall will come into contact with consignments of suspected contaminated waste, there is no requirement to install drainage infrastructure to provide for the separate collection and storage of potentially contaminated surface water run-off at the waste inspection and quarantine facility.

## Dewatering of Quarry Void

6.75 Available survey data suggests that the depth of water in the groundwater pond within the worked out quarry void is up to 29m deep. Prior to commencement of backfilling, it will be necessary to dewater the quarry void by pumping. The water will be pumped to the top of the quarry via existing pipe networks to settlement ponds / mobile silt trap and oil interceptor (yet to be installed). Thereafter, it will flow (under gravity) to the existing water holding tank system before being discharged via existing drainage pipe network, settlement ponds and drainage ditch to the River Slaney, refer to Figure 2-3. A discharge licence has been issued by Wexford County Council (Ref. SS/W024/81/99R1) in respect of the existing discharge of groundwater, surface water runoff from the block yard and treated process water from the concrete production facility to the River Slaney.



6.76 It is envisaged that the lowering of the existing groundwater pond will be undertaken initially over approximately 6 weeks, following grant of planning permission and a waste licence and prior to the commencement of the quarry restoration activities.

## Surface Water Management During Quarry Backfilling

6.77 As backfilling of the quarry proceeds over the short-to-medium term, the flow of surface water run-off into the quarry will be minimised by the construction of drainage channels around the edge of the quarry. These channels will collect and divert overground surface water flows to temporary infiltration areas (excavated and constructed at the ground surface as required).

6.78 Groundwater intercepted by ongoing dewatering of the worked-out quarry will be pumped via the proposed silt trap and oil interceptor to the water holding tank and the existing drainage network leading to the River Slaney.

6.79 During the infilling operations, the upper surface of the backfilled soil will be graded so as to ensure that surface water run-off falling over the quarry footprint falls to sumps at temporary low points within the worked-out quarry. These temporary sumps will effectively function as primary settlement ponds and water collecting in them will be pumped (causing minimum agitation to ponded water) to the proposed new settlement ponds / mobile silt trap and oil

interceptor and from there, via the water holding tank to the existing drainage network leading to the River Slaney discharge.

6.80 In the longer term, toward the end of the quarry backfilling works, ground contours within and around the backfilled quarry void will be modified to ensure that surface water run-off across the area is directed to a closed depression in the south-eastern corner of the area to be restored (refer to Figure 2-4). The restored ground level at this closed depression will be slightly below the natural groundwater level (at approximately 6-7mOD) and as such, it is expected that a small surface water pond will form within it. This shallow water feature will facilitate recharge of surface water run-off across the restored area to the groundwater body.

# IMPACT OF THE PROPOSED WASTE FACILITY

## Evaluation Methodology

6.81 The impact of the proposed remediation on hydrology and hydrogeology are assessed in this section. The methodology applied in the assessment is a qualitative risk assessment methodology in which the probability of an impact occurring and the magnitude of the impact, if it were to occur, are considered. This approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development. This approach allows effort to be focused on reducing risk where the greatest benefit may result. The assessment of risk is outlined below in Table 6-5.



Table 6-5
Matrix Used to Assess Potential Impacts

| Probability of Occurrence | Magnitude of Potential Impacts | | | |
|---|---|---|---|---|
| | Severe | Moderate | Mild | Negligible |
| High | High | High | Medium | Low |
| Medium | High | Medium | Low | Near Zero |
| Low | Medium | Low | Low | Near Zero |
| Negligible | Low | Near Zero | Near Zero | Near Zero |

6.82 The magnitude of potential impacts in relation to geology, hydrogeology and hydrology are detailed in Table 6-6 below.

Table 6-6
Magnitude of Potential Hydrological and Hydrogeological Impacts

| Magnitude | Potential Impact |
|---|---|
| Negligible | No impact or alteration to existing important geological environs or important soil settings (i.e. valuable agricultural land)<br>No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns;<br>No alteration to groundwater recharge or flow mechanisms; and<br>No pollution or change in water chemistry to either groundwater or surface water. |
| Mild | Some loss of important soils or peat, but which has no long term impact<br>Minor or slight changes to the watercourse, hydrology or hydrodynamics;<br>Changes to site resulting in slight increase in runoff well within the drainage system capacity;<br>Minor changes to erosion and sedimentation patterns; and<br>Minor changes to the water chemistry. |
| Moderate | Slope failure or instability which may cause foundation problems, loss of extensive areas of important soils or peat, damage to important geological structures / features;<br>Some fundamental changes to watercourse, hydrology or hydrodynamics;<br>Changes to site resulting in an increase in runoff within system capacity;<br>Moderate changes to erosion and sedimentation patterns; and<br>Moderate changes to the water chemistry of surface runoff and groundwater. |
| **Severe** | Slope failure or instability which results in loss of life, permanent degradation and total loss of peat environment across the entire development site, loss of important geological structure/feature.<br>Wholesale changes to watercourse channel, route, hydrology or hydrodynamics;<br>Changes to site resulting in an increase in runoff with flood potential;<br>Significant changes to erosion and sedimentation patterns; and<br>Major changes to the water chemistry or hydro-ecology. |



6.83 In addition to their nature and significance, the potential impacts will be assessed in terms of their duration, whether they are direct or indirect impacts, and also if the impact will be cumulative.

6.84 The following sections identify the potential impacts of the proposed development on the hydrological and hydrogeological environments. It also assesses the likelihood of occurrence of each identified impact in accordance with Table 6-5 and Table 6-6. It should be noted that the impacts are initially assessed with no mitigation or design measures incorporated to reduce the risk.

## Potential Impacts on Surface Water

6.85 The principal surface water feature at the site is the flooded quarry void at the site. Other than this, there are only a few temporary channels or sumps required for surface water management at the site. It is considered that the potential impact of backfilling the quarry void with inert fill in the short to medium term could result in suspended soil particles or other contaminants being discharged off site to the River Slaney.

6.86 An Assimilative Capacity risk assessment was undertaken for the discharge of groundwater to the River Slaney designated Natura 2000 site as part of the Appropriate Assessment for the proposed development on the river, refer to the Ecology Chapter of this EIS (Chapter 4 and Appendix 4-1).

6.87 The results of the risk assessment are indicated in Table 6-7 below. The results show that for the key water quality chemical and physical parameters which influence the river biological quality, the discharge of untreated water from the quarry void would have a negligible impact on the surface water quality, and hence the biological quality of the river.

Table 6-7
River Slaney Assimilative Capacity Risk Assessment

| | Receiving Waters | | | |
|---|---|---|---|---|
| | EQS* (SI 272 of 2009) (50%ile limit) | Background conc. (Upstream) | Assimilative Capacity | Mass Balance of Pollutant (Downstream of Discharge Point) |
| **Pollutant** | **(mg/l)** | **(Mean Value mg/l)** | **(kg/day)** | **(mg/l)** |
| **BOD** | **1.5** | 1.375 | 214.92 | 1.38 |
| **Suspended Solids** | **25**** | 13.50 | 19772.64 | 13.43 |
| **Total Ammonia** | **0.065** | 0.03 | 60.18 | 0.03 |
| **Orthophosphate** | **0.035** | 0.04 | -8.60 | 0.04 |

* EQS = Environmental Quality Standard for 'Good River Quality Status' (to be achieved by 2015)
(set by Table 9 of SI. 272 of 2009 : European Communities Environmental Objectives (Surface Water) Regulations 2009)

**EQS for Suspended Solids in Salmonid Rivers.
(set by 'Second Schedule - Salmonid Water Quality Standards' of S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations, 1988).



6.88 The mass balance results indicate that with untreated discharge from the quarry void, the concentrations of key water quality parameters downstream of the discharge point would be less than the relevant EQS limit for 'Good River Quality Status' except for orthophosphate. The results for Orthophosphate indicate however that the untreated discharge would have a negligible impact on this parameter in the river. The mass balance for Suspended Solids indicates that the level in the river is below the Suspended Solids EQS of 25mg/l for Salmonid Rivers (S.I. No. 293/1988).

6.89 Notwithstanding this assessment, the probability of suspended soil particles or other contaminants being discharged off site to the River Slaney when the proposed inert waste recovery facility is operational is considered to be '***medium***' to '***high***'. The magnitude of impact is considered to be '***moderate***' and the overall impact, prior to mitigation, is therefore assessed as '***medium***' to '***high***'.

6.90 In the longer term, it is likely that much of the run-off from the completed landform will generally recharge to ground within the site boundary. Any surface water runoff from the site which does not infiltrate to the ground will be captured and discharged off site. The probability of a change to long-term surface water flows is considered to be '***medium***'. However as the magnitude of impact on existing flow patterns is '***mild***', this is considered to be a potentially '***low***' impact.

6.91 It is considered that the potential impact on the surface water flow quantities arising from the proposed development is negligible and, as such, it is not considered further.

## Potential Impacts on Groundwater

6.92 Given the hydrogeological setting, it is considered that the proposed development has the potential to impact on groundwater in terms of both the groundwater quality and the groundwater flow regime. These are considered separately below.



### *Groundwater Quality*

6.93 During the development and operation of the site there is a risk of groundwater pollution from the following potential sources:

- accidental spillage of fuels and lubricants by construction plant placing the inert fill and other operational procedures;
- increase in suspended solids and potential for contaminated runoff entering groundwater during development of the site; and
- rogue loads of contaminated material being deposited at the site.

6.94 It is considered that without mitigation the probability of occurrence of spillage of fuels, lubricants and other potentially contaminative liquids is '***medium***' due to the area of the site and number of vehicles that will be using the site and the magnitude of impact is '***moderate***'. Therefore the overall risk to groundwater, without mitigation, is '***medium***'.

6.95 It is considered that without mitigation the probability of occurrence of an increase in suspended solids and potential for contaminated runoff entering groundwater during operation of the facility is '***medium***' to '***high***' due to the time frame over which this may occur and the potential for infiltrating rainfall to mobilise fines in loose backfilled materials and carry them toward the groundwater body (much of the imported fill will be high in silt / clay content). As the magnitude of impact is '***mild***', the overall risk to groundwater, without mitigation, is '***low***' to '***medium***'.

6.96 Without mitigation the probability of occurrence of a rogue load which may have the potential to contaminate groundwater at the site is '***medium***' and the magnitude of impact is considered to be '***moderate***' depending on where the rogue load is deposited. The overall impact is considered to be '***medium***'.

### *Groundwater Flow / Recharge*

6.97 Without mitigation, or consideration of operational procedures, infilling the void on the quarry floor with low permeability inert fill material has the potential to create a low permeability zone. This could alter the groundwater flow pattern around the site, leading to higher groundwater levels up gradient of the site and lower levels down gradient of the site. Without mitigation the probability of occurrence is '***medium***' and the magnitude of impact is '***mild***'. Therefore the overall risk to groundwater, without mitigation, is '***low***'.

6.98 With reference to the potential impact on groundwater flow, the regional permeability of the aquifer is described as being moderate to high with flow along faults and fissures; however the local permeability in the quarry is low with little groundwater seepage through the quarry face. It is not envisaged that the infilling with inert soil material will influence the regional groundwater flow towards the River Slaney, and some runoff shed from the proposed restoration landform will infiltrate to form groundwater recharge down gradient of the fill maintaining aquifer recharge and regional groundwater flow towards the River Slaney. Without mitigation the probability of occurrence is '***medium***' and the magnitude of impact is '***mild***' and therefore the overall impact on groundwater flow is therefore considered to be '***low***' as limited local groundwater recharge will be maintained in the quarry.



## Summary of Potential Impacts

6.99 A summary of potential impacts without mitigation measures is presented in Table 6-8 below:

Table 6-8
Summary of Unmitigated Risk and Magnitude of Potential Impacts at Brownswood

| Potential Impact | Spatial Impact, Duration, Direct/Indirect | Probability of Occurrence | Magnitude of Impact | Significance of Impact | Mitigation Required? |
|---|---|---|---|---|---|
| **Groundwater Quality** | | | | | |
| Spillages of fuel | Local, Short Term, Direct | Medium | Moderate | Medium | Yes |
| Release of suspended solids | Local, Long Term, Direct | Medium to High | Mild | Low to Medium | Yes |
| Rogue load of contaminated material | Local, Short Term, Direct | Medium | Moderate | Medium | Yes |
| **Groundwater Flow / Recharge to Aquifer** | | | | | |
| Impermeable barrier to groundwater flow | Local, Long Term, Direct | Medium | Mild | Low | No |

| Potential Impact | Spatial Impact, Duration, Direct/Indirect | Probability of Occurrence | Magnitude of Impact | Significance of Impact | Mitigation Required? |
|---|---|---|---|---|---|
| Reduction in recharge to aquifer | Local, Long Term and Direct | Medium | Mild | Low | No |
| **Surface Water** | | | | | |
| Release of suspended solids | Local, Short and Long Term, Direct | Medium to High | Moderate | Medium to High | Yes |
| Surface water flow | Local, Long Term, Direct | Medium | Mild | Low | No |

6.100 Review of Table 6-8 indicates that if no mitigation measures are incorporated into the quarry backfilling operation, there is potential for the site to have an adverse impact to the aquifer by locally polluting groundwater and creating a low permeability zone to impact groundwater flow. The impacts are all local, but range from short-term to long-term. It is considered that if the identified potential impacts on either groundwater quality or groundwater flow were all to occur there would be a cumulative effect, which would increase the significance of the impact.

6.101 Similarly, surface water runoff from the quarry backfilling operation at the site has the potential to cause adverse and direct impacts on the River Slaney beyond the western site boundary.

6.102 It is therefore recommended that the mitigation measures outlined in the following section are incorporated to reduce the potential adverse impacts on groundwater and surface water as outlined above.



## Do Nothing Scenario

6.103 Were the proposed backfilling of the application site not to proceed as envisaged, it is unlikely that a portion of the land at least could ever be put to productive use and that it would remain as a scar on the landscape. Ongoing vigilance will be required to ensure no potential contaminating activities occur on or in the vicinity of the quarry floor at the site.

# MITIGATION MEASURES

6.104 Proposed mitigation measures required to reduce the potential adverse impacts to acceptable levels are identified in this section. These measures either reduce the likelihood of an event occurring, or reduce the magnitude of the consequences should the event occur. It should be noted that several of the mitigation measures proposed would have a positive effect on more than one potential impact.

## Proposed Mitigation Measures

6.105 In order to mitigate against the risk of pollution to groundwater and surface water occurring during operation of the site, the following management measures will be included:

- wherever possible a traffic management system will be put in place to reduce the potential conflicts between vehicles, thereby reducing the risk of a collision;
- a site speed limit would be enforced to further reduce the likelihood and significance of collisions;
- all plant would be regularly maintained and inspected daily for leaks of fuels, lubricating oil or other contaminating liquids/liquors;
- refuelling of vehicles would either be undertaken on the sealed hardstand area adjacent to the maintenance shed or from a mobile double skinned fuel bowser in order to minimise the risk of uncontrolled release of polluting liquids/liquors;
- maintenance of plant and machinery would be undertaken in the existing covered workshops or off-site, as appropriate, to minimise the risk of uncontrolled release of polluting liquids;
- spill kits will be made available on-site to stop the migration of any accidental spillages, should they occur (see Appendix 6-3 for details of spill kit);
- the flooded quarry void will be dewatered prior to the inert soil material being deposited to minimise the mobilisation of fines;
- the provenance of imported waste (inert soil) loads should be recorded and be visually inspected at the site in accordance with a detailed Material Acceptance and Handling Plan. Where possible, imported soils should be tested to confirm they are inert prior to deposition at site and
- diverting all surface water run-off collected in sumps via new settlement ponds / mobile silt trap and hydrocarbon interceptor tanks prior to discharge to surface watercourses in order to reduce the concentration of potential suspended solids and any hydrocarbons in the discharge.



6.106 These measures would reduce the potential impact of:

- spillage of fuels and lubricants from '*medium*' to '*low*';
- increased suspended solids and contaminants in surface water discharges from '*medium to high*' to '*low';* and
- contamination from rogue loads from '*medium*' to '*near zero*'.

## Residual Impacts

6.107 A summary of the proposed mitigation methods, together with the predicted effects and residual impacts is presented in Table 6-9 below.

6.108 An examination of Table 6-9 confirms that there are no significant residual impacts with respect to groundwater and/or surface water provided the appropriate mitigation measures are implemented. It is therefore considered that the siting of an inert recovery facility in this location is acceptable and that there will be no significant impact on groundwater and/or surface water.

## Interactions

6.109 Surface water discharges from the site around the void being infilled will be maintained during the backfilling of the quarry void to provide for water management.

Table 6-9
Summary of Mitigation and Residual Impacts

| Potential Impact | Spatial Impact, Duration, Direct/Indirect | Probability of Occurrence | Magnitude of Impact | Significance of Impact | Mitigation Required? | Mitigation Measures | Mitigated Probability of Occurrence | Mitigated Magnitude of Impact | Residual Magnitude of Impact |
|---|---|---|---|---|---|---|---|---|---|
| **Groundwater Quality** | | | | | | | | | |
| Spillages of fuel | Local, Short Term, Direct | Medium | Moderate | Medium | Yes | Traffic systems, maintenance, bunding and spill kits | Low | Moderate | **Low** |
| Release of suspended solids | Local, Long Term, Direct | Medium to High | Mild | Low to Medium | Yes | Minimisation, management, and waste placement measures | Low | Mild | **Low** |
| Rogue load of contaminated material | Local, Short Term, Direct | Medium | Moderate | Medium | Yes | Record waste provenance, visual inspection and testing of waste loads | Negligible | Moderate | **Near Zero** |
| **Groundwater Flow / Recharge to Aquifer** | | | | | | | | | |
| Impermeable barrier to groundwater flow | Local, Long Term, Direct | Medium | Mild | Low | No | - | - | - | - |
| Reduction in recharge to aquifer | Local, Long Term and Direct | Medium | Mild | Low | No | - | - | - | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Surface Water** | | | | | | | | | |
| Release of suspended solids | Local, Short and Long Term, Direct | Medium to High | Moderate | Medium to High | Yes | Surface water management measures and treatment | Low | Moderate | **Low** |
| Surface water flow | Local, Long Term, Direct | Medium | Mild | Low | No | - | - | - | **-** |

## Conclusions

6.110 The groundwater and surface water regimes at the application site have been assessed with reference to information held by the Geological Survey of Ireland, the Environmental Protection Agency and others. This information has been supplemented with site specific investigation information.

6.111 The potential impacts of the proposed development upon hydrogeological and hydrological environment have been identified and assessed, and where appropriate, mitigation measures have been incorporated into the design of the development.

## Monitoring

6.112 A number of measures are proposed in order to monitor any potential impact of the proposed recovery operations on groundwater or surface water.

### *Groundwater Monitoring*

6.113 At the present time, it is envisaged that groundwater sampling and testing will be undertaken on a bi-annual basis at the 4 No. groundwater monitoring wells. Groundwater levels in the wells will also be recorded on a bi-annual basis. The existing groundwater monitoring well locations are shown on Figure 6-1.



6.114 Groundwater samples will be tested for a range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site. The groundwater quality in the monitoring wells will be tested for the following parameters:

- BOD mg/l
- pH pH value
- Suspended Solids mg/l
- COD mg/l
- Total Coliforms cfu/100mls
- Ammonia mg/l $NH_3$-N
- Nitrate mg/l $NO_3$
- Nitrite mg/l
- Oils, Fats & Grease mg/l as P
- Ortho Phosphate
- Ortho Phosphate mg/l as P
- TPH mg/l
- PRO mg/l
- DRO mg/l

6.115 It is currently envisaged that the existing groundwater monitoring regime will remain in place for the duration of the quarry backfilling and restoration works. Groundwater sampling and monitoring will continue as long as backfilling activities continue and for a short period thereafter.

## *Surface Water Monitoring*

6.116 Surface water at the site is currently tested for a range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site.

6.117 It is envisaged that surface water sampling and testing will be undertaken on a bi-annual basis (i.e. six monthly) basis at any temporary surface water features which may either be created or form naturally at low points within the application site.

6.118 Surface water sampling and chemical testing will also be undertaken at the discharge from the proposed silt trap and oil interceptor, immediately upstream of its connection to the water holding tank and the existing drainage network which leads to the River Slaney discharge, sample Location SW1. Further surface water sampling and chemical testing will also be undertaken in any temporary sumps which may be constructed and used during the restoration process, sample Location SW2. The proposed surface water monitoring location SW1 is shown on Figure 6-1 with an indicative location for SW2.

6.119 Surface water samples will be tested for a wide range of physical and chemical parameters in order to assess water quality and detect possible contamination at the site.

6.120 It is currently envisaged that the surface water monitoring regime will remain in place for the duration of the quarry backfilling and restoration works and for a short period thereafter.

# FIGURES

# APPENDICES

**Appendix 6-1**
**Drillers Borehole Construction Records**

**Appendix 6-2**
**Water Quality Results**

**Appendix 6-3**
**Spill Kit Details**