

## 12 SOILS, GEOLOGY AND HYDROGEOLOGY

### 12.1 Introduction

This section will describe the existing geological and hydrogeological environment. The likely significant impacts for both construction and operation of the proposed pipeline prior to mitigation are described in this section of the EIS. The mitigation measures are described in Section 12.4 and the residual impacts after the proposed mitigation measures have been implemented are described in Section 12.5.

### 12.2 Study Area

This assessment covers the soils and geology that occur within the proposed pipeline corridor and which have the potential to be directly impacted by the proposed pipeline.

The groundwater body along the proposed pipeline corridor is the Dublin Urban waterbody (EA\_G\_005). The study area for this EIS, will be focused on the assessment of potential impacts on groundwater near the proposed pipeline corridor.

### 12.3 Assessment Methodology

The existing geology is described in terms of the bedrock geology, overburden geology and hydrogeology. It was prepared using available published literature for the site area which included:

- Groundwater Protection Scheme for County Dublin (on Geological Society of Ireland (GSI) website [www.GSI.ie](http://www.GSI.ie))
- Geology of Meath - Sheet 13 (McConnell, B et al., 2001)
- Geology of Kildare-Wicklow - Sheet 16 (McConnell, B et al., 1994)
- General Soil Map of Ireland - Second Edition 1980 (Gardiner, M.J and Radford, T, 1980)

The impact assessment section was prepared having regard to 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (Ireland, Institute of Geologists of, 2013).

Following the compilation of data and information on the existing environment, the details of the proposed development were reviewed to identify potential impacts on geology and hydrogeology.

### 12.4 Existing Environment

#### 12.4.1 Overburden Geology

Soil mapping by Teagasc shows that the pipeline corridor and surrounding area is underlain predominantly by made ground with minor areas of Grey Brown Podzolic soils, mainly in the north of the study area between Santry and Dublin Airport. The Podzolic soils are derived from the underlying limestone and shale tills and have generally poor drainage. These superficial soils are underlain by glacial till within the Dublin area which is commonly referred to as Dublin Black Boulder Clay as indicated on Figure 12.1. Teagasc has mapped the sub-soils as being predominantly tills derived from the underlying Carboniferous limestone. The GSI mapping shows that the Alfie Byrne Open Space area of the city is underlain by estuarine silts and clays.

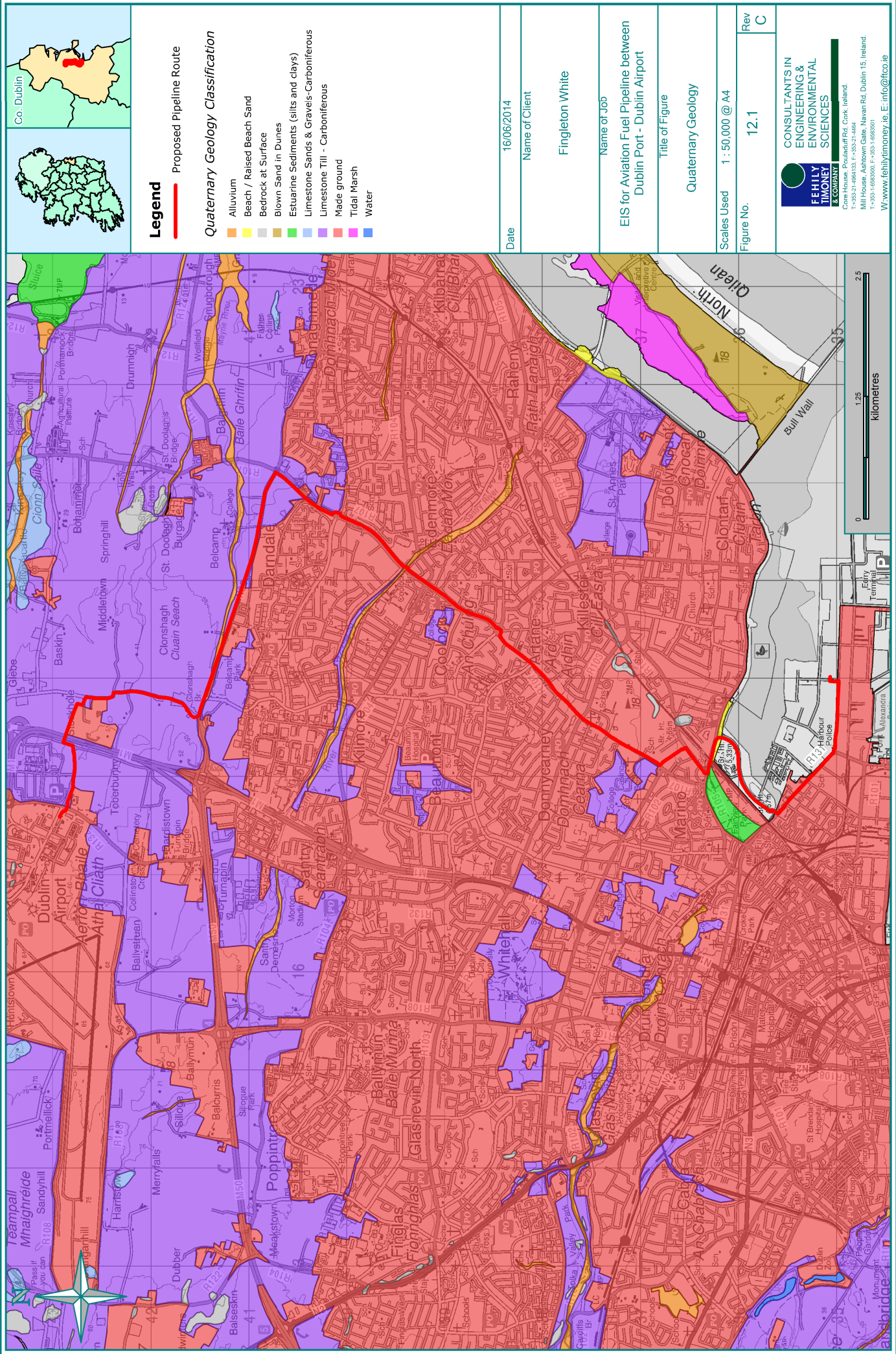
Recent site investigation trial pits at the Tolka and Santry rivers encountered made ground and gravelly clay soils to at least 2m depth in these areas.

### 12.4.2 Bedrock Geology

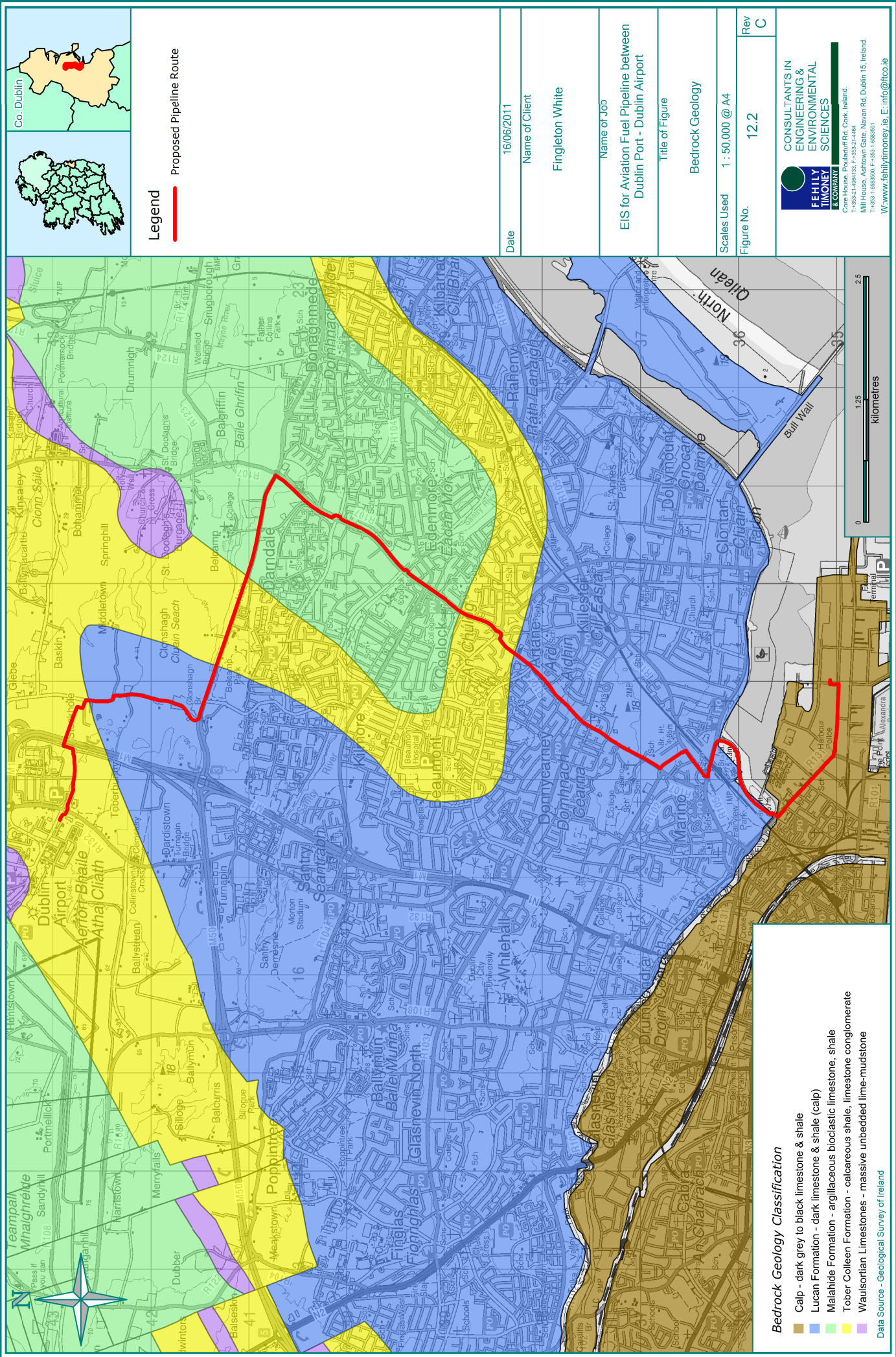
Figure 12.2 shows a summary of the bedrock geology of the pipeline corridor and surrounding area. The survey "*Geology of Kildare-Wicklow*" (GSI, 1994) and "*Geology of Meath*" (GSI, 2001) are the reference source for the description of the bedrock geology of the region.

The GSI 1:100,000 scale bedrock geology maps (Sheets 13 and 16) show that the extreme south of the proposed pipeline corridor, around Dublin Port, is underlain by the dark grey to black limestone and shale of the Calp Formation. Moving north, the area between Alfie Byrne Road and Artane is underlain by Carboniferous limestone and shale of the Lucan (Calp) Formation. Further north, a short section (approximately 0.7km) of the route between Artane and Coolock is underlain by calcareous shale and limestone conglomerate of the Carboniferous Tober Colleen Formation. This passes northwards into argillaceous limestone and shale of the Malahide Formation between Coolock and Darndale. Moving west, the proposed pipeline corridor encounters another short section (c. 1km) of the Tober Colleen Formation followed by the Lucan Formation and again back into the Tober Colleen Formation near Dublin Airport.

Boreholes undertaken during site investigations for the nearby Metro North and Metro West projects show that the bedrock is typically at a depth of 20 m to 40 m to the south of Dublin Airport. The strata in this area typically comprises of a thick cover of glacial till (boulder clay) overlying weak mudstone or strong limestone. Experience of other projects in the Dublin region along with information provided on the GSI geotechnical database suggests that ground conditions will be broadly similar over the entire route although variations will occur in overburden thickness and consistency in addition to bedrock type.







### 12.4.3 Structural Geology and Topography

The bedrock in this area was deposited within the low-lying Dublin Basin. Although the basinal deposits were subject to some structural effects of the Caledonian Orogeny, this has resulted in very little deformation or faulting of the study area and there are no faults recorded within the study area.

### 12.4.4 Hydrogeology

The groundwater section of the GSI website classifies the underlying limestone and shale of the Calp, Lucan and Malahide Formations as a Locally Important Aquifer (LI) which is moderately productive in localised zones. The Tober Colleen Formation is classified as a Poor Aquifer (PI). The aquifer classification in the area is shown in Figure 12.3.

The site is characterised by hard cover (concrete or tarmacadam) over much of the pipeline corridor which overlies low permeability made ground or glacial till and this is reflected in the rapid run-off and low surface water baseflow in the area.

The bedrock aquifer generally lies within the underlying limestone and shales. The rocks are confined or sealed by the very low permeability of the overlying tills and this may potentially result in semi-artesian groundwater pressures and a piezometric surface which is close to ground level.

A perched aquifer may exist within the glacial till, however due to the low permeability of the strata, groundwater inflow was often not observed during site investigations. For example, groundwater monitoring of standpipe installations for the Metro North Depot Scheme at Dardistown approximately 1km west of the proposed pipeline corridor near Dublin Airport, observed highly variable standing groundwater levels, typically between 1 m and 10 m below ground level, however it is unclear whether these readings represent a perched water table within the glacial till or semi-artesian water pressure from the underlying bedrock aquifer.

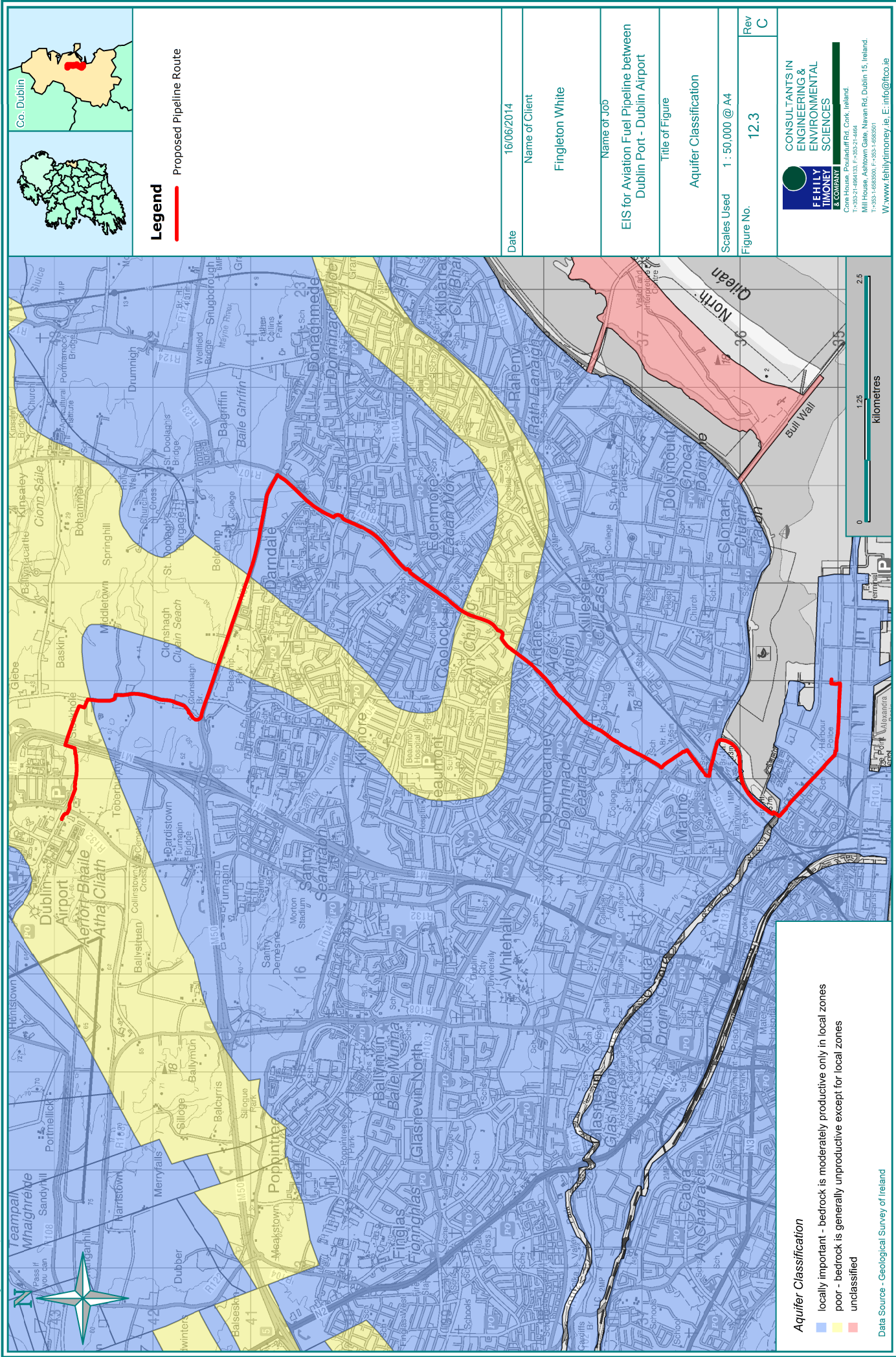
Groundwater flow direction along the pipeline corridor is likely to be towards the east, however local variations in direction will occur, particularly within the shallow groundwater which will be locally influenced by topography and surface water features.

The GSI online database for groundwater wells contains approximately 15 wells within a 2 km radius of the proposed pipeline corridor as indicated on Figure 12.4. In addition to these wells, a spring is recorded at Saintdoolaghs near Balgriffin, approximately 1km north of the pipeline corridor at the eastern end of the Malahide Road. The wells were drilled between 1988 and 1998 and vary in depth between 6.5 m and 122 m with generally good yields of typically 100 and 300 m<sup>3</sup>/d. It should be noted that additional wells are likely to exist in addition to those recorded on the GSI well database.

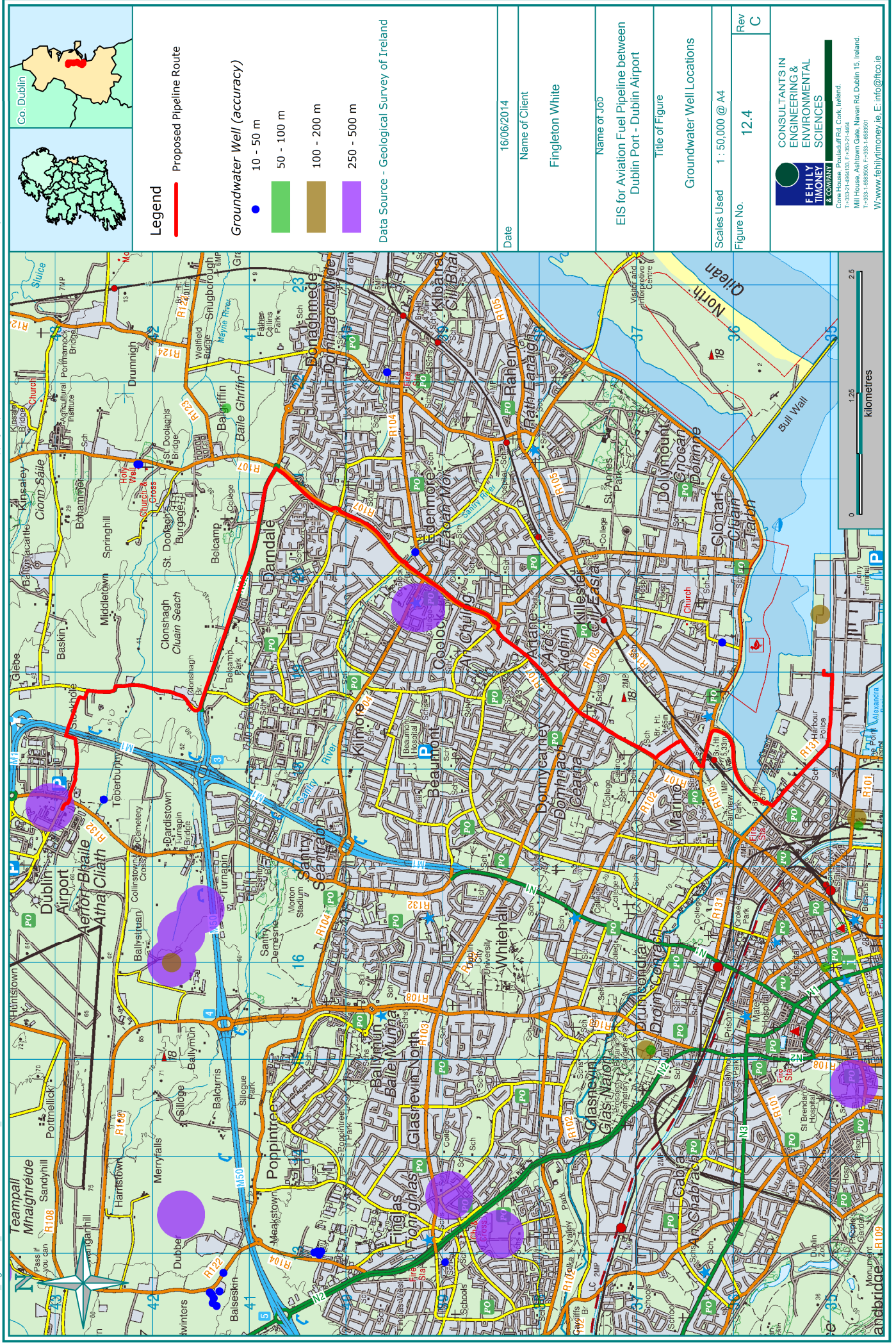
### 12.4.5 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The factors used in assessing groundwater vulnerability include subsoil type and thickness as indicated in Table 12.1. The GSI procedure whereby groundwater protection is assessed is outlined in the EPA-GSI publication '*Groundwater Protection Schemes*' (DELG/EPA/GSI, 1999). The GSI classifies the site as mainly "Low Vulnerability" due to the relatively thick cover of low permeability glacial till in the area as shown in Figure 12.5. Part of the area between Artane and Marino, close to the southern end of the proposed pipeline corridor, rates as "Moderate" to "Extreme", which suggests that shallow bedrock may exist in this area.

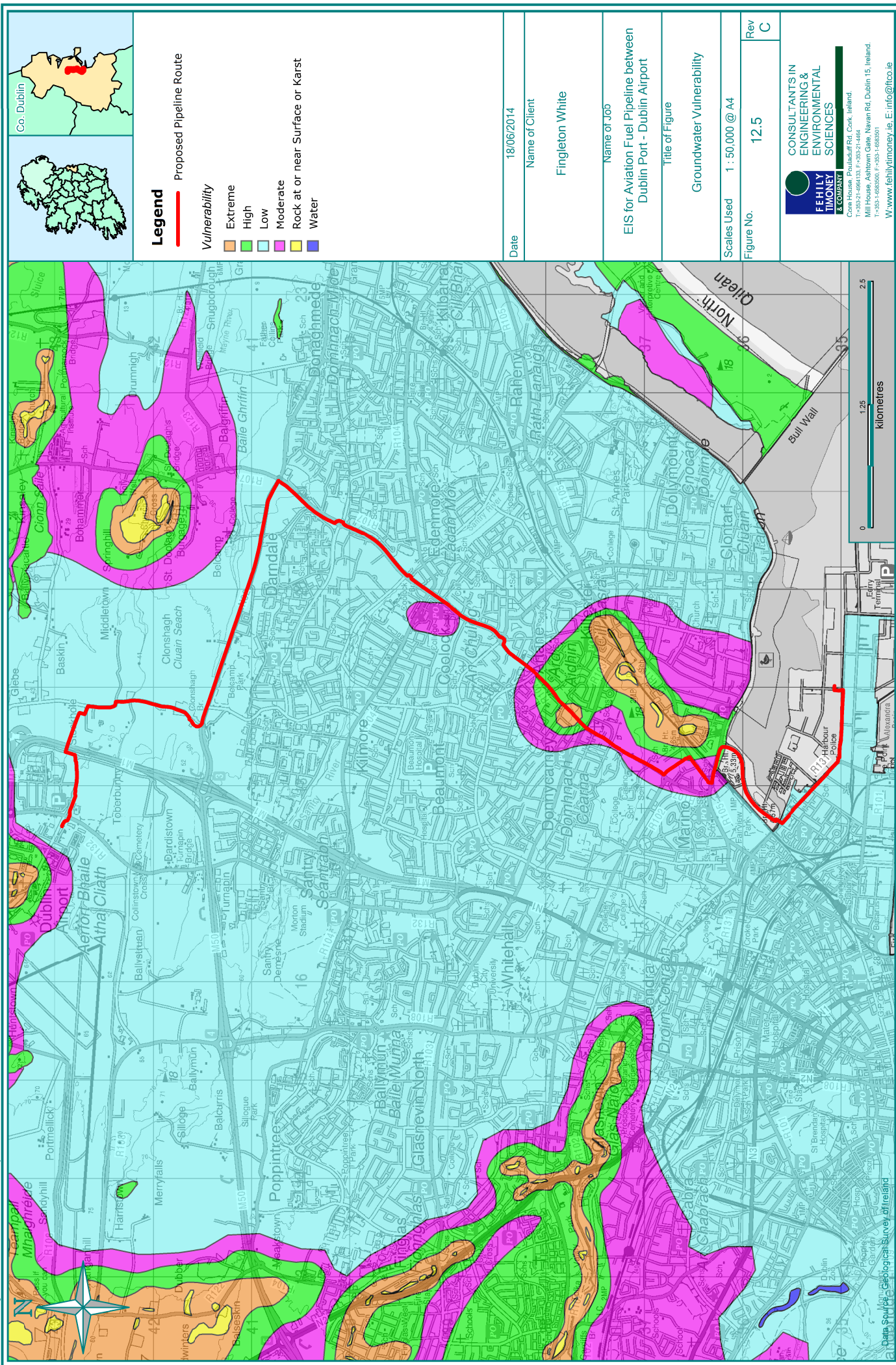














**Table 12.1: GSI Guidelines – Aquifer Vulnerability Mapping**

Vulnerability rating	Hydrogeological Conditions		
	<i>Subsoil Permeability (Type) and Thickness</i>		
	High Permeability (Sand/gravel)	Moderate Permeability (e.g. Sandy soil)	Low Permeability (e.g. Clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	>3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

**Notes:**

N/A = Not Applicable

#### 12.4.6 Geological Heritage and Economic Geology

There are no sites of geological importance along the pipeline corridor. The closest site of interest is the Feltrim quarry (Roadstone working quarry at 320300E 244400N), located approximately 1 km to the north east of the pipeline corridor. The GSI lists no other working quarries or pits close to the pipeline corridor.

## **12.5 Summary of Key Potential Impacts**

### 12.5.1 Construction Impacts (Direct & Indirect)

The key soil and geology impacts arising during the construction phase are associated with the excavation, handling and transporting of soil, subsoil and/or made ground.

The depth of excavation works will generally be limited to 1.5 m below the existing ground level unless local conditions dictate otherwise. Deeper excavations will be required at river crossings, where trenchless technology will be utilised to avoid the requirement for deep excavations and in instances where there is a requirement to go under existing services. The estimated total volume of material to be excavated and removed from site is approximately 15,120 m<sup>3</sup>, with a similar volume of backfill material being required for the pipe trench reinstatement (14,469 m<sup>3</sup>).

A number of potentially negative environmental impacts on soil and geology may arise as a result of the construction phase activities. These impacts can arise directly, as a result of site excavations, or indirectly, due to transfer of excavated material to off-site locations.

Potential direct impacts include the degradation and erosion of soil and/or subsoil in off road sections, the contamination of overburden due to construction activities and ground movement (impact on roads, footpaths and buildings) during or after construction.

Potential indirect impacts relate to the depletion of natural resources as a result of importation of granular backfill and lean mix concrete.

These impacts are discussed in more detail in the following sections.

#### 12.5.1.1 Degradation of Soil and/or Subsoil

Movement of HGV's during earthworks on off-road sections in the FAI/AUL sports grounds and reinstatement activities often gives rise to physical or chemical damage to soil and underlying subsoil. Increased compaction by construction plant destroys soil structure and reduces subsoil drainage, which in turn leads to waterlogging and increased runoff. It also restricts root penetration and reduces plant growth.

Placement of excavated soil in oversized temporary stockpiles may potentially result in damage to existing soil structure. Damage to soil or subsoil, should it arise, is generally irreversible. Natural soil and subsoil occurs only locally on the scheme, along the grassland amenity area.

In addition, where soil, subsoil or made ground are disturbed, excavated, and/or stored during construction, they are prone to erosion by surface water runoff. In the absence of any active management of surface water runoff during the construction phase of the proposed pipeline, there is potential for sediment laden surface water runoff to discharge to existing watercourses or existing road drainage systems.

#### 12.5.1.2 Contamination of Overburden and Groundwater

If contaminated soil, subsoil and/or made ground is encountered during the construction phase, the excavation, handling, transport and/or processing of this material could result in mobilisation of contaminants, increasing the extent or degree of contamination in surrounding ground. These impacts could be of short to long-term duration, depending on the local hydrogeological regime at the affected location. There is also the potential for impacts from a potential accident, spill or leakage of fuels and lubricants from plant and machinery during the construction phase.

#### 12.5.1.3 Ground Movement

Ground movements generated by the excavation of trenches and the effects of dewatering, have the potential to cause ground movement which could affect adjacent property or structures. In addition, the excavation and backfill of trenches can result in short-term or long term settlement of the backfill material or the underlying soils in areas of soft ground (both natural or man-made soils) which could result in damage to road pavements, footpaths, buried utilities, buildings and other structures.

#### 12.5.1.4 Importation of Backfill (Indirect Impact)

As described in Chapter 3 – Description of the Proposed Development, the trench will be backfilled with 300 mm of sand or pea gravel, then 700 mm of lean mix concrete to 200 mm below ground surface. The extraction of the granular material (gravel or crushed rock for aggregate, limestone for cement) will have indirect impacts on natural resources from the point they are excavated. Other indirect impacts will result from the transportation of the materials to the site. These include the potential for increased noise, traffic and air emissions. These impacts are dealt with in more detail in other chapters.

### 12.5.2 Construction Phase Impacts – Hydrogeology & Water Quality

During all phases of the construction of the proposed pipeline, certain activities have the potential to directly impact on the groundwater environment underlying the study area.

#### 12.5.2.1 Increased Groundwater Vulnerability

The reduction or removal of soil from the site has the potential to temporarily increase the vulnerability of the underlying aquifer. Given that the aquifer vulnerability in the study area is mostly low due to a thick cover of low permeability glacial till underlying the made ground, this increased impact on the bedrock aquifer is likely to be insignificant, particularly along the roads where excavation will be mainly within made ground. However, monitoring of groundwater levels in standpipes installed for the Metro West scheme has shown that a perched groundwater table may exist close to the ground surface within the made ground and glacial till. This perched groundwater will be more vulnerable to contamination, although any perched groundwater is likely to be localised in nature and is very unlikely to be used for abstraction purposes. Following construction, groundwater vulnerability will be reduced due to backfilling of the trench with 700 mm of lean mix concrete which will act as a barrier to the downward movement of contaminants from third party sources (surface spills and leaks).



In addition, there is the potential for contaminated surface water run-off to arise from open excavations and movement of materials during the construction phase, which if it enters groundwater could negatively impact on groundwater quality locally. Other sources of potential pollutants include:

- Leakages or spillages of fuels from construction vehicles at the temporary construction compounds
- Oil or other chemical spillages during refuelling or maintenance of construction vehicles
- Damage to other services including sewer network during excavation of the trench
- Suspended solids or chemicals from overburden soils which have been exposed to erosion during construction activities

Equally, however, the construction of the proposed scheme may potentially result in an improvement in the quality of the underlying aquifer in localised areas due to the removal of contaminated material if encountered.

#### 12.5.2.2 Dewatering Effects

The majority of excavations will be 1.5 m in depth and, given the low permeability of the glacial till soils, are unlikely to encounter strong inflows of groundwater within these soils. The main bedrock aquifer within the Dublin area is within the underlying limestone and shale bedrock which is at an anticipated depth of between 10 m and 30 m within the study area, except near Artane in the south where shallow bedrock may be encountered. However, groundwater monitoring for the Metro North Depot scheme at Dardistown, south of Dublin Airport, has encountered perched groundwater at shallow depths and therefore dewatering of excavations may be required locally, especially in areas where granular material is encountered, particularly within the made ground or adjacent to rivers. Given the shallow depth of excavation along the majority of the pipeline corridor, major dewatering will not be required.

The exception to this will be the reception/launch pits for trenchless techniques at river and stream crossings which may require sheet piling and/or local dewatering depending on the depth of excavation (typically 2–3m) and the permeability of the strata. Given that shallow groundwater flows are likely to be minor and excavation volumes small, any groundwater inflow will be controlled by drainage measures and sump pumps if required.

#### 12.5.3 Operational Impacts – Soils & Geology

During the operational phase of the proposed scheme, the potential direct impacts on soils and geology include a leak from the pipeline during the operational phase whereby contamination of the underlying soil may occur.

#### 12.5.4 Operational Impacts – Hydrogeology & Water Quality

In the unlikely event that aviation fuel was leaked during the operational phase, it could give rise to groundwater contamination. The environmental consequences of a fuel leak could potentially be significant in the absence of any mitigation, however given the low abstraction rate and predominantly low vulnerability of the underlying aquifer, the risk of any contamination entering a public water supply is deemed to be low. Additionally, it should be noted that Jet A1 fuel is a kerosene based fuel which has a low density and would therefore remain above the water table and would tend not to adhere to soil particles.

Where the pipeline passes below the Tolka River, any leakage from the pipeline has the potential to enter the Tolka River which may eventually result in migration to the groundwater table. Given the low vulnerability of the aquifer at this location, it is not likely that hydraulic continuity between the Tolka and the aquifer exists, hence the risk to groundwater is low.

#### 12.5.5 Decommissioning & Re-validation Impacts

Mains water will be used in both the decommissioning (flushing out) and re-validation (hydrostatic testing) of the pipeline. The uncontrolled release of this potentially contaminated water to groundwater could result in pollution.

### 12.5.6 Do-Nothing Impact

In the event that the pipeline is not constructed, there will be no impact on the soils and geology and the condition of the soils, geology and groundwater in the area will remain unchanged.

## **12.6 Mitigation Measures**

This section describes the measures to mitigate or ameliorate the significant adverse impacts at during all phases of the proposed scheme.

### 12.6.1 Construction Mitigation Measures

#### *Soils and Geology*

The following mitigation measures will be implemented along the pipeline corridor to minimise potential impacts on soils and geology during the construction phase:

- Surface water runoff will be intercepted and diverted away from open excavations towards the nearest gully (on roadways) or to a temporary holding pond/tank (near river/stream) crossings
- There will be no stockpiling of material on-site. Excavated soil/material will be removed directly onto an awaiting truck for removal off site for recovery or disposal at an appropriate facility. The trench will generally be backfilled again on the day of excavation
- For off-road sections, granular material will be placed over exposed clayey subsoil or made ground, to prevent erosion of fines and/or rutting
- Where contaminated material is encountered, it will be left in-situ while testing to determine its characteristics is carried out. The material will be covered to minimise rainfall ingress. The material will be excavated and transported by a permitted waste contractor to an appropriate facility for treatment or disposal. All contaminated materials encountered along the proposed scheme will be excavated, stored, moved, disposed of or recovered in accordance with the requirements of the Waste Management Act 1996 as amended<sup>4</sup> and the Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects<sup>5</sup>
- Imported granular material will be sourced in accordance with an engineering specification to ensure that only clean, inert material is used which contains minimal fines content to reduce the risk of contamination, sedimentation and ground settlement
- All backfill material (sand/pea gravel and leanmix concrete) will be brought to each working area on an as needed basis and will not be stockpiled on site. This will prevent silt laden run-off. Lean mix will be pumped or poured directly from the truck into the trench
- To reduce the risk of soil, subsoil, made ground and/or groundwater contamination arising as a result of spills or leakages, a number of measures will be implemented during the construction phase of the proposed pipeline to control the storage and handling of fuels, lubricants and waste. These measures include, but are not limited to, the following:
  - Storing fuels, chemicals, liquid and solid wastes in appropriately bunded areas within the temporary compound(s)
  - Removal of all potentially contaminating materials as well as plant and machinery away from rivers/stream crossings to the temporary compound(s) at the end of each working day
  - Undertaking refuelling of plant, equipment and vehicles within the temporary compound(s)
  - Provision of spill kits at high risk sites.

Further details regarding the management of surface water runoff during the construction phase is provided in Chapter 13 - Surface Water Quality & Drainage of this EIS.



With respect to ground movements, given the limited depth of excavation, the expected low dewatering requirements and the backfilling of the trench with 700 mm of lean mix concrete, ground movement adjacent to the pipeline is expected to be minimal during construction. In locations where the pipeline passes very close to or beneath buildings, structures, rivers or railways, an appropriate monitoring regime will be put in place to ensure that there are no negative impacts.

Settlement of trenches will be minimised by using an engineering specification for 300 mm sand/pea gravel followed by 700 mm of leanmix concrete which will be compacted during and following placement. A maintenance period and regular inspections will ensure that any subsequent settlements are quickly identified and repaired.

#### *Hydrogeology & Water Quality*

The potential impacts associated with dewatering of excavations will be mitigated by avoiding unnecessary pumping and dewatering of excavations. Where necessary, drainage measures will reduce the need for dewatering and will avoid unnecessary drawdown of the water table outside of the excavations. Given the low permeability of the glacial soils and the relatively shallow depth of excavations, the effects of dewatering will be laterally confined to within a few metres of the excavations.

Where dewatering is required, no discharge will be made to drains or watercourses unless a discharge licence is obtained from the relevant authority. All water removed from excavations will be tested prior to discharge or will be tankered from site for disposal or treatment.

Although there will be no direct discharges to groundwater during the construction phase, potential impacts on the underlying groundwater aquifer will be mitigated, where appropriate, by implementing best practice on site. This will include, but not be limited to, the following:

- It will be a requirement that all chemicals, oils and fuels used during the construction phase will be stored in sealed containers on impervious bases within a bund of 110% of the storage capacity at the temporary construction compound(s). The bunded areas will be either double skinned or bunded to a volume of 110% of the capacity of the largest tank/container present or 25% of the total tank capacity within the bund (plus an allowance of 30mm for rainwater ingress). Filling and draw-off points will be located entirely within the bunded area(s). Drainage from the bunded area(s) will be diverted for collection and safe disposal off site by an appropriately licensed contractor. All storage tanks will have primary, secondary and tertiary containment. The integrity and water tightness of bunds and their resistance to penetration by water or other material stored therein will be confirmed prior to use as a storage area and checked regularly thereafter.
- Refuelling of vehicles will be conducted off-site away from the pipeline corridor at the temporary construction compound(s)
- Potentially contaminated water generated by construction activities will be collected onsite and discharged to a nearby surface water drain or foul water sewer (under agreement and licence from DCC or FCC). Effluent unsuitable for discharge will be tankered off site to an appropriate facility for disposal
- Drainage from bunded areas will be diverted for safe disposal off site.
- Any effluent generated by temporary on-site toilet facilities (portaloo type facilities) will be taken off site for appropriate treatment
- In the event that contaminated soils are encountered during the construction of the proposed scheme, run-off will be diverted, collected and removed off site for treatment and/or disposal.

#### 12.6.2 Operational Mitigation Measures

The risk of potential soil or groundwater contamination during the operational phase of the proposed scheme will be reduced by the use of the protective measures which are in accordance with I.S. EN 14161:2011 – Petroleum and natural gas industries – Pipeline transportation systems (ISO 13623:2009 modified). These are outlined in Chapter 3 – Description of the Proposed Development and the Design Basis Report in Appendix 3.2.

A Safety and Environmental Impact Evaluation was undertaken by AMEC Environment and Infrastructure UK Ltd (AMEC) in October 2014 as part of a Safety & Environmental Impact Evaluation report. The conclusions of this study indicate that the risk of a pipeline leak/release occurring is 1 in 5,130 years, compared with a frequency of 1 in 32 years for a road tanker release/leak. Although the average spill size has the potential to be greater for a pipeline, this potential risk has been significantly reduced for this pipeline through a number of design considerations including the installation of four emergency shutdown valves. In the unlikely event of a leak, the valves will minimise the volume of fuel discharged. Although the environmental consequences of a pipeline release may be substantially greater than for a tanker release, the report concludes that there is a sound basis for proceeding to detailed design and construction planning. Table 12.2 gives a comparison of the various transportation options for the aviation fuel.

**Table 12.2: Comparison of Risks for Different Options<sup>6</sup>**

	200mm Pipeline			Road Tanker Transport	
	No intermediate Section Isolation Valve(s)	Single intermediate Section Isolation Valve at 4.5km or 11km	Two intermediate Section Isolation Valves at 4.5km and 11km	Projected 1500 MI/yr	Design 2700 MI/yr
Failure Frequencies	1 in 5,130 yrs	1 in 5,130 yrs	1 in 5,130 yrs	1 in 57 yrs	1 in 32 yrs
Failure Frequencies (yr-1)	1.95 x 10 <sup>-4</sup>	1.95 x 10 <sup>-4</sup>	1.95 x 10 <sup>-4</sup>	0.017	0.031
Average Spill rate (litres/yr)	37	25/27	14	51.1	91.9
Average Spill Size (litres)	193,524	128,788/138,834	74,795	2,950	2,950
Maximum Spill size (litres)	278,702	276,426	103,128	38,000	38,000

The likelihood of surface water contamination from the operation of the proposed pipeline is considered low. The depth of burial of the pipeline will be 1.2 m and the trench will be backfilled with 300 mm of sand and/or pea gravel, then 700 mm of lean mix concrete to 200 mm below ground surface. An additional leak detection system will be provided at the Tolka River Crossing and strategically positioned isolation valves will be incorporated to minimise the volume of fuel lost in the unlikely event of a leak. Emergency plans will be implemented in the event of a leak.

### 12.6.3 Decommissioning and Re-Validation Mitigation Measures

Mains water will be used in both the decommissioning (flushing out) and re-validation (hydrostatic testing) of the pipeline. This will be collected and removed off-site for disposal at an appropriate facility.

## 12.7 Assessment of Residual Impacts

This section describes any residual impacts that continue to exist when the mitigation measures have been put in place. The significance of the impact after mitigation (residual impact) is determined using professional judgement.



### 12.7.1 Construction Residual Impacts

- Degradation of soil and/or subsoil - implementation of the proposed mitigation measures identified to reduce soil degradation during the construction phase will ensure that the magnitude of impacts on the quality and function of soil will typically reduce from moderate - low for all soil types.
- Erosion of soil, subsoil and/or made ground - implementation of the proposed mitigation measures identified to reduce erosion during the construction phase will ensure that the magnitude of impacts on the quality of soil, subsoil and made ground will typically reduce from low to very low.
- Contamination of soil, subsoil and/or made ground - implementation of the proposed mitigation measures identified to minimise ground contamination during the construction phase will ensure that the magnitude of resultant impacts on the quality of soil, subsoil and/or made ground will typically reduce from low to very low.
- Management of excavated materials at off-site locations - any contaminated soil transferred to off-site recovery or disposal facilities presents a low level of environmental risk. Accordingly, the magnitude of any potential impact on soil and subsoil quality at off-site locations is likely to be low.
- Dewatering - implementation of the proposed mitigation measures identified to minimise the effects of dewatering during the construction phase will ensure that the magnitude of resultant impacts on the quality of the existing groundwater and surface water will reduce from low to very low.
- Groundwater Vulnerability - implementation of the proposed mitigation measures identified to minimise the effects on the groundwater vulnerability during the construction phase will ensure that the magnitude of resultant impacts on the groundwater vulnerability will reduce from low to very low.
- Ground Movement including settlement - provided that the impact mitigation measures outlined are put in place, this will ensure that the magnitude of resultant impacts on the ground during construction will reduce from low to very low.

### 12.7.2 Operational Residual Impacts

Once operational mitigation measures set out above the residual impacts from any leak event will be low – slight.

## **12.8 Monitoring**

Ongoing monitoring of the development will take place during both the construction and operational phase of the proposed pipeline. Pressure testing of the pipeline before operation will ensure the integrity of the pipeline. Automated leak monitoring and detection, as well as fortnightly visual inspections (as outlined in section 3) will ensure that any damage to the pipeline is identified at the earliest possible stage to ensure minimal environmental consequences.

## **12.9 References**

- EPA. *Guidelines on the information to be contained in Environmental Impact Statements*. s.l. : Environmental Protection Agency, 2002.
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