4.0 SOILS & GEOLOGY

4.1 Introduction

This section describes the underlying bedrock of the Dublin Bay area, and the soils that overlie it. There is a large area of infilled land in the Bay, which is also discussed below.

4.2 Existing Environment

This section outlines the baseline or existing soils and geology environment within the study area. This essentially spans the Dublin Bay area; the soils and geology of this area have been influenced greatly by the coastal regime in this area.

4.2.1 Bedrock Geology

There are two dominant bedrock types underlying the S2S route, limestone to the north and granite to the south. The landscape of Dublin has been largely defined by the bedrock formations of the area. The more easily solubilised, less resilient limestone has eroded gradually, leaving a well-defined bay. The bay is restricted to the north and south where the limestone meets more resistant rocks (granite to the south and shale and conglomerate to the north). Figure 4.1 shows the bedrock geology of the area.

The changes in the bedrock geology are fault controlled to the south of the Bay. A large fault, known as the Rathcoole Fault forms the southern margin of the basin, where there is an unconformity between the granite and the limestone (Figure 4.1). To the north of the Bay, there is a natural succession from the muddy limestones to the north into the Calp limestone around the area of Sutton Cross.

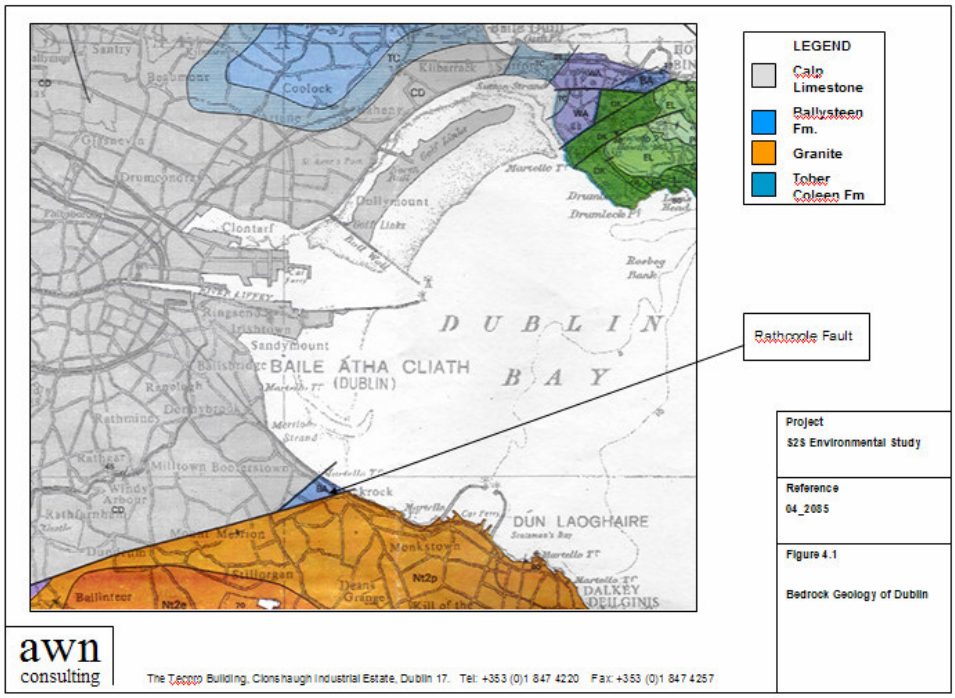

Figure 4.1 Bedrock Geology of Dublin

Ballysteen Formation

The bedrock underlying the section of S2S from Sutton Cross to where the route meets the coast at Sutton is comprised of muddy limestones, known as the Tober Coleen Formation. This bedrock is a mixture of calcareous shale and limestone conglomerate. There are no outcrops along this section of the route.

Calp Limestone

Much of Dublin is dominated by rocks of Carboniferous age. During the early Carboniferous period, the eastern part of Ireland underwent uplift and erosion. Following this, there was a period of general subsidence in the area.

This subsidence permitted the sea to invade the lower ground from the south during the Carboniferous age [1]. Continued subsidence resulted in shallow and then deeper marine sediments accumulating across most of Dublin City and County.

The depth of the sea and type of seabed varied from place to place, as did the rate of sedimentation and so a variety of carbonate sediments were produced in the area.

The Calp limestone, which covers most of Dublin was deposited in the basins that formed over 300 million years ago [1]. Thick sequences of muds and muddy limestones accumulated in the basins, sometimes showing graded bedding. The Calp Limestone itself is comprised of dark grey, fine-grained, graded limestone with interbedded black, poorly fossilised shales.

At this time erosion was also occurring in the Leinster Massif, which is the underlying geology of south Co. Dublin and the Wicklow Mountains. Some clasts and boulders from there were deposited in the Calp Limestone.

There are a number of faults in the Calp limestone. However, the area of the proposed S2S route itself is unfaulted, with the exception of the fault that creates the contact between the Leinster Massif (granite) and the Calp limestone, i.e. the Rathcoole Fault.

There are no evident outcrops of Calp limestone bedrock along the S2S route close to the shoreline.

Ballysteen Formation

There is a small wedged shaped section of bedrock between the Calp Limestone and the Rathcoole Fault that is part of the Ballysteen Formation. This is comprised of clean calcarenitic limestones, which can be muddy and finer-grained in places. There are no bedrock outcrops along this section of the route, which spans the area between the Martello Tower at Booterstown and Blackrock DART station.

Leinster Massif (Granite)

The Leinster Granite batholith (a large igneous intrusion) stretches from Blackrock to New Ross, consisting of five plutons, or intrusions. The proposed S2S is situated on the Northern Pluton, which is a rounded body with a broadly concentric internal zonation of granite types [1]. The Northern pluton was intruded as a diapir (a mobile mass piercing and rising through the crust under buoyancy) [1].

The granite type, which underlies the route along the southern section, is known as Type Nt2e. This is a type of granite with microcline phenocrysts (large mineral crystals) [1]. A further description of the formation of this rock type can be seen in the Geology of Kildare – Wicklow (Sheet 16) [1]. There are no major faults, fractures or unconformities underlying the area.

South of the Rathcoole Fault, intermittent granite outcrops can be seen along the coastline. These are weathered outcrops, with minor fractures and cracks. Prominent outcrops can be seen at Blackrock DART Station, Maretimo, along the front of Brighton Vale/Martello Tower and at Sandycove. Of these, the proposed route directly rests on the outcrops at Maretimo and Brighton Vale/Martello Tower.

Generally, the profile of the bedrock along the route can largely be described as being similar to a bowl in shape, with the depth to bedrock being up to 5m below ground level at either end of the route (towards Sutton and Sandycove) and as one moves towards the city centre from either end of the route, the depth to bedrock generally increases, with the exception of the occasional outcrops encountered, and reaches up to 30m below ground level along the Rinsgend/East Wall section.

4.2.2 Quaternary Geology

The Quaternary geological period extends from about 1.5 million years ago to the present day and can be sub-divided into the Pleistocene Epoch, which covers the Ice Age period and which extended up to 10,000 years ago and the Holocene Epoch, which extends from 10,000 years ago to the present day.

The Pleistocene Epoch in Ireland began when there was a significant cooling of the Earth's climate, and was characterised by alternating extended periods of very cold conditions, during which time much of the country was covered by an ice sheet [1]. These colder periods were interspaced with warmer periods, known as interglacials, which lasted for approximately 10,000 years at a time. It is under debate whether or not the last glacial period is over, or whether we are in the middle of another interglacial period.

Ice sheets that influenced the Dublin Region were from the Midlands and the Irish Sea Basin. Ice from the Midlands and the Irish Sea Basin vied with each other for the occupation of the coastal area north of Kilcoole, including much of the area Dublin City covers today.

As the ice travelled over the ground, it eroded underlying bedrock and formed, within and beneath the ice sheet, a sediment, which consisted of particles with a massive size distribution, from clay particles to boulders. This material has been labelled glacial till or boulder clay and is the most widespread sediment type in Ireland. Glacial till can range in thickness from less than 1m thick to tens of metres thick.

The Quaternary deposits in the South Dublin area are quite uniform in composition. They consist of tills derived and gravels, deposited by the ice sheet from the Irish Sea Basin. The till may contain shells dredged from the floor of the Irish Sea.

Most of the Carboniferous rock, i.e. the limestone, forms low ground, and is covered by a thick layer of Quaternary sediments.

The deposits along the northern section of the Bay are predominantly sand overlying gravels and clay. The Dublin Bay Project Environmental Impact Statement shows that in Sutton Creek and the Sutton foreshore, the quaternary deposits comprise approximately 4 m of sand, overlying a mixture of sand and clay [2]. As one moves along the route towards the city centre, the depth of the deposits increases and depths of 10m or greater, of sands, gravels and estuarine muds have been recorded in Ringesend and East Wall.

4.2.3 Topsoil/Alluvium

The soil of Dublin is derived from glacial till of Irish Sea origin, with limestone and shale and is largely Grey Brown Podzolics. Grey Brown Podzolic soils, as shown on the Soil Map of Ireland [3], are usually formed from a calcareous parent material (limestone). The lighter-textured Grey Brown Podzolics are good all-purpose soils, while the heavier-textured members are highly suited to pasture production, responding well to manurial and management practices.

However, the coast of Dublin has a layer of alluvium overlying the topsoil, which is a result of the low-lying status of the city. This sequence of soils is only remaining in undisturbed areas of the coast. As Dublin is a very built-up city, much of the topsoil and alluvium have long since been removed.

4.2.4 Infilled/Reclaimed Land

A significant portion of Dublin city is built on reclaimed or infilled land. This reclamation began back in the 18th Century. Figure 4.2 shows the infilled sections of Dublin that the proposed route will cross. The North Docklands, was reclaimed between 1717 and 1729. A 1 km stretch of land between the city centre and the River Dodder was reclaimed by Sir John Rogerson between 1917 and 1927 [4].

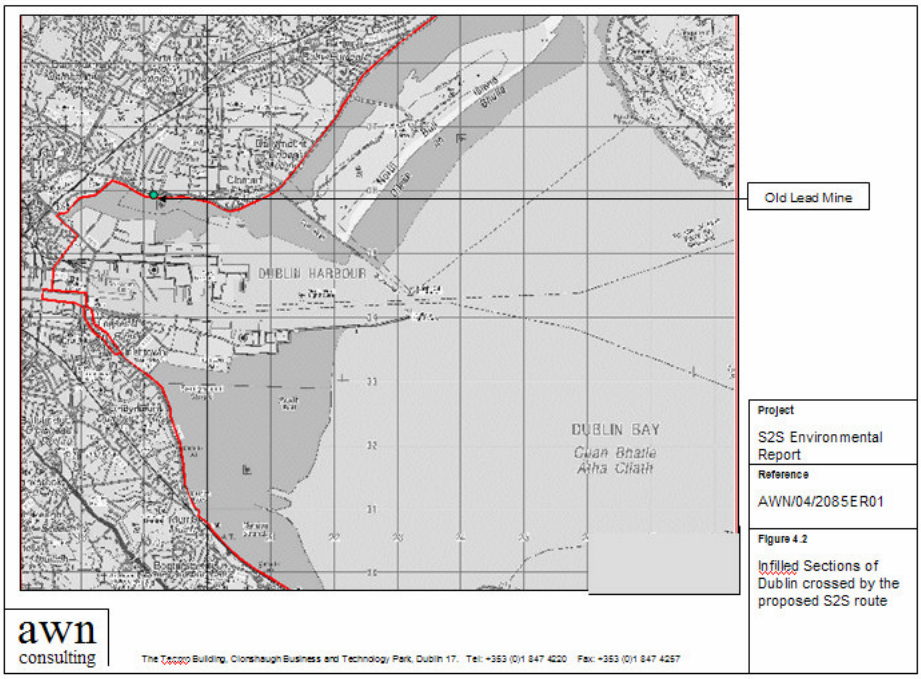

Figure 4.2 Infilled coastal areas along S2S route

North Lotts, and East Wall were reclaimed by the end of the 1750s. A bank was constructed along the present South Lotts Road by 1760 [4]. The area between these banks was gradually reclaimed together with adjoining areas of the Dodder Estuary. The dry dock between the Grand Canal Dock and the Dodder was filled in 1918.

Reclamation continued progressively in an easterly direction from the beginning of the 19th Century[4].

Traditionally the material used for reclamation in Dublin included construction and demolition waste, waste topsoil and municipal and industrial wastes.

The East Wall Business Park EIS shows the composition of the layers of fill and subsoil in the area [5]. The upper fill layer was reported to be between 4 – 6 m, overlying silt, gravel and stoney clay, overlying boulders at a depth of 13 m+. Bedrock was not encountered at the site.

4.3 Constraints

This section outlines any possible constraints the proposed route may have as a result of the existing bedrock and overlying subsoil and topsoil deposits.

4.3.1 Geological Heritage/Interest

There are two sites that have been identified by the Geological Heritage Programme of the Geological Survey of Ireland as of geological importance, which are possible constraints for the S2S route.

There is an old lead mine on the shore along Clontarf Road (Figure 4.2), opposite the junction of Clontarf Road and Castle Avenue. Nothing is visible on the surface at present; all of the structures are below ground.

There is a geologically important rock outcrop, situated approximately 45 m to the northwest of Blackrock Baths, which has been identified as an unusual geological phenomenon by the GSI's Geological Heritage Programme (Figure 4.2). It is an exploded breccia granite feature. The outcrop is situated against the seawards side of the sea wall at Blackrock. This will need to be taken into consideration when designing the route along this stretch.

4.3.2 Coastal Erosion and Deposition

Rising sea levels and increased storm frequency have led to an increased rate of erosion and the incidence of flood-related events (such as land incursion)[6]. A study carried out in the 1990s showed that over 1,500 km of Irish coastline was at risk from erosion, with 490 km needing immediate action [7].

As the majority of the proposed route rests on limestone rock, which is prone to a high rate of erosion, the likelihood of erosion along the Dublin coast was examined as a possible constraint for the route.

A large portion of Dublin Bay is protected from the sea by artificial constructions; seawalls and artificial promenades (e.g. at Sandymount). These structures prevent the sea from encroaching on the coastline any further, with the exception of during severe storms. The study in the early 1990s showed that the only section of Dublin that has an accelerated erosion rate i.e. greater than 0.5 m per annum, is the north side of the Howth Peninsula. Therefore, erosion of the Bay is not a constraint at present, but with continuing sea-level rise and increasing storm frequency and intensity, this may present a problem on a long-term basis.

A developing dune system to the south of Merrion gates is a potential constraint and the construction of the S2S along this section will be required to have no significant short or long term impact on the dune system.

4.3.3 Contaminated Sites/Reclaimed Land

There is a significant portion of the proposed route that will cross land that has been reclaimed from the Bay over the last two centuries. Traditionally the material used for reclamation in Dublin included construction and demolition waste, waste topsoil and municipal and industrial wastes. Any material excavated from this area may be contaminated.

There are two route options through the north city centre section of the route. The main option for this section of the proposed route (Option a) is along the following roads - East Wall Road, East Road, New Wapping Street and North Wall Quay.

The other option for this section of the proposed route (Option b) is along the following roads - East Wall Road, Church Road, Sheriff Street Lower and

North Wall Quay. There are a number of potentially contaminated sites along both routes of this section.

Previous industrial uses include a Plaster of Paris factory on Church Road. On East Road, an importer of asphalt, cement, plaster, an oil importer, a pharmaceutical manufacturing plant and a glue manufacturer. East Wall Road has had oil stores, manure and acid manufacturers, a chemical/varnish and dye manufacturer and road material manufacturer [8].

Sir John Rogerson's Quay has had the following potentially contaminating processes/factories; Oil storage, chemical and artificial manure manufacturers, coal stores, pharmaceutical product manufacturer and a sulphuric acid and fertilizer manufacturer [8].

Any sections proposed to be excavated in these areas should be investigated prior to construction work commencing to determine if contamination is present in the fill material.

On the south side of the city, the primary option for the route to go is via York Road, Pembroke Cottages and through Ringsend Park and Sean Moore Park. Ringsend Park was originally a landfill site of unknown material and has only a thin layer of topsoil.

The existing promenade along Strand Road was also infilled with landfill materials.

At Dun Laoghaire, there are a number of surface deposits or dumped material along the proposed route. These are located on the section of the route that leads under Coal Quay Bridge connecting Crofton Road to the Harbour. 2 no. deposits are located on the western side of the tunnel and 2 no. deposits on the eastern side. These deposits appear to be Construction and Demolition (C&D) waste. The deposit on the western side, closest to Coal Quay Bridge may contain hazardous material, including a tar spill.

It is proposed to build the route along the seaward side of the harbour wall to the east of the West Pier in the Old Harbour area. This may involve working from the seaward side of the wall. As the harbour has had industrial uses over the years (including chemical industries), sediment on the harbour floor may be contaminated. Disturbance of the sediment may lead to re-introduction of the contaminants into the environment (i.e. the water). Construction work should be carried out from the landward side insofar as is possible.

There is an option to direct the route in front of the West Pier Pumping Station i.e. the seaward side of the pumping station in an area known as the Gut. This passes a number of contaminated sites. The preferred option avoids this route, however a complementary route is considered as part of an overall redevelopment of the Gut and a contamination assessment of the material to be removed from this area would be required prior to any construction works taking place.

4.3.4 Excavation of Bedrock

Excavation of bedrock is not considered likely along the route.

4.4 Mitigation Measures

The Environmental Management Plan (EMP) will be implemented as part of the design, planning, construction and operational stages of S2S. In terms of geology and soils, the EMP will ensure that any issues are dealt with at an early stage of the development, and the avoidance or mitigation of any soils or geology impacts can be integrated into the overall design of S2S (See Appendix B of this report).

4.4.1 Geology

Any extensive ground excavations in the area of the lead mine at the junction of Castle Avenue and Clontarf Road will require consultation with experts (i.e. a member of the Mining Heritage Trust of Ireland), to ensure destruction of any features does not occur. As the proposed route only plans to upgrade and widen the existing cycle path and walkway, there should not be a need for specialist monitoring.

It is essential that the breccia granite outcrop at Blackrock is not in any way interfered with or built upon or over, nor is any of the outcrop to be excavated or damaged to make way for the route. This requirement is incorporated into the proposed design of S2S at this location. The outcrop should be bypassed or bridged at this point. During construction, any machinery based on the seaward size of the seawall should be kept away from the outcrop in order to ensure the rock is not accidentally damaged.

4.4.2 Beach/Dune Protection

The extent of footprint of S2S in the area south of Merrion Gates will need to be considered in terms of limiting the impact of the S2S on the dunes. However this consideration must also take cognisance of other issues. For example it is understood that the dunes pose a periodic threat to safety on the railway line and are periodically removed when they are in danger of overtopping the wall and encroaching on the track. The S2S could provide a barrier to prevent this occurring and also could also provide a support structure for the dunes.

4.4.3 Reclaimed Land

It is recommended that any infilled areas be investigated prior to excavation works being carried out to determine if contamination is present. It is not expected that significant volumes of contaminated material will be uncovered, but as the material type and origin is not known, further investigation of the material is advisable.

4.4.4 Contaminated Land

If any contaminated soil is generated during excavations, it will be placed in open topped containers (metal skips), which will prevent any contaminated material from coming into contact with uncontaminated soil. This soil will be disposed of to a licensed facility.

The dumped material by Coal Quay Bridge in Dun Laoghaire appears to be C&D waste. Some of this may be hazardous. Samples should be taken from these deposits to identify any potentially hazardous material. If found to be contaminated a licensed contractor will be employed to remove and dispose of the material at a licensed site under the Waste Management Act of 1996 and Section 5 of the Waste Management (Permit) Regulations of 1998. Any material removed from the site shall be carried out by a contractor licensed under the Waste Management (Collection Permit) Regulations 2001.

It is recommended that most of the work along the seawall at Dun Laoghaire Harbour be carried out from the landward side. This will prevent the disturbance of possibly contaminated sediments on the harbour floor and reintroducing them into the coastal waters.

4.5 Possible Impacts

4.5.1 Bedrock

Excavations at the junction of Clontarf Road and Castle Avenue may encroach on the lead mine site and damage the structures there however mitigation measures will ensure that the impact on the structure is not significant.

There is a possible impact on the bedrock outcrop at Blackrock, as the construction of the S2S route may permanently damage the rock outcrop by excavation work or by covering it with an impermeable surface. There may be a positive impact due to increased access to the formation and signage to provide information on the subject.

4.5.2 Subsoil

If excavations take place for the construction of S2S, particularly in the city centre, there is a possible impact of encountering contaminated material. However, mitigation measures outlined in the previous section addresses this possible impact.

4.5.3 Beaches/Dunes

Construction work will be required along the foreshore between Sandymount and Dun Laoghaire as much of the route will be on the seaward side of the existing sea wall. The remainder of the route will not involve work along the foreshore or in the intertidal zone.

There will be temporary construction work for weeks or months at a time. There is a significant potential to cause contamination of the marine sediments and beach deposits along this stretch, from fuels, oils, lubricants etc that will have to be stored on site, as the machinery will be in place for relatively long periods of time. There is a possible negative impact on the soil environment if mitigation measures are not properly implemented during construction on the foreshore (see detailed mitigation measures in Section 5.5.1).

4.6 Recommendations and Further Studies

The water section of this report presents measures that will be implemented during any construction work on the foreshore.

It is also recommended that signage that will be provided along the route contain information on the local geology of Dublin Bay, specifically the two areas of geological interest outlined in the baseline environment of this section.

There is a lack of data for the depth to bedrock along the route, particularly on the south side of Dublin. A full geotechnical investigation to determine at what depth the bedrock lies is recommended. The results of this investigation will allow the full impacts of working on the foreshore to be assessed and mitigated accordingly and

will determine the type of foundation that may be required and the type of machinery that may be utilized for foundation construction, along the route.