



**METRO NORTH
ORAL HEARING**

PROOF OF EVIDENCE

Fergal Callaghan

Hydrology

Thursday 23rd April 2009

Metro North Oral Hearing
Supplementary Proof of Evidence

Groundwater

23 April 2009

Dr Fergal Callaghan.

1.0 NAME, QUALIFICATIONS AND ROLE IN PROJECT

1.1 I, Dr. Fergal Callaghan, hold a 2.1 honours degree of Bachelor of Science in Chemistry (1991) from the University of Limerick, where I majored in Environmental Chemistry and a Ph.D. in Environmental Engineering from the University of Birmingham (1998). I am a graduate member of the Chartered Institute of Water and Environmental Management (CIWEM), a member of the IChemE Water Group, a Member of the International Water Association (IWA), a Member of the European Water Association (EWA), a Member of the Royal Society of Chemistry (MRSC), an associate member of the Institute of Chemical Engineers (AMIChemE), a member of the IChemE Environmental Protection Subject Group (EPSG), and a Member of the Institute of Environmental Management and Assessment (IEMA) and am currently on the Irish Committee of this Organisation. It is a requirement of membership of these organisations that I am active in the field of professional water science and engineering and satisfy their requirements with regard to level of qualifications and experience.

1.2 My role on the Metro North project was to complete an assessment of the impacts of the scheme on surface water and groundwater.

2.0 EXPERIENCE

2.1 I have been active in the field of water science and engineering for 18 years, the last 12 as an Environmental Consultant. I have considerable experience with respect to the assessment of impacts on the groundwater and surface water environments.

2.2 My recent experience includes:

2.3 Preparation of Water EIR for Docklands Station (2006)

2.4 Preparation of water quality assessments for LUAS (2005-2006)

2.5 Water impact assessments for British Rail projects (1997 – 1998)

- 2.6 Water quality impact assessment for rail lines in Berkshire area (1991-1992)
- 2.7 Numerous groundwater contamination and impact assessments (2000-2008)
- 2.8 Groundwater contamination assessment, rail line construction (2008)
- 2.9 Groundwater contamination and remediation, Docklands, Dublin (2001-2002)
- 2.10 Larbre Park Waste Facility Oral Hearing, groundwater impacts (2006)
- 2.11 Road Scheme Surface and Groundwater Assessments(N17, N15, N11,R161)

3.0 **GENERAL INTRODUCTION**

- 3.1 AWN Consulting Limited was requested by The Inspector on 15/4/2009 to present supplementary evidence on the following:
- 3.2 **Groundwater Flow Direction:** General groundwater flow pattern along the route.
- 3.3 **Areas of Significance with Respect to Groundwater:** areas where significant groundwater may be impacted or encountered.
- 3.4 **Groundwater in the Soil;** areas where significant groundwater may be present in soil (overburden)
- 3.5 **Historical Groundwater Monitoring Data;** (Metro North and other data)
- 3.6 **Groundwater Monitoring Regime;** (proposed)
- 3.7 **Impact of Stop Box Structures on Groundwater Flow;** is there the possibility of elevating groundwater?
- 3.8 **Impacts on Trees – Impact on Sap?**

4.0 GROUNDWATER FLOW DIRECTION

- 4.1 At a regional scale, groundwater flow direction in the bedrock in County Dublin is generally in an easterly direction, with close correlation in Dublin City associated with topography (elevated ground to the north and south of the city centre) and with the River Liffey, leading to a more south/north flow direction. Groundwater flow direction in the bedrock is therefore generally likely to be at a slight angle to the route of Metro North. From Belinstown to the Airport groundwater flow in the bedrock is from south to north, and is generally from north to south from the Airport south to the Liffey, and again is from south to north from St. Stephens Green towards the Liffey.
- 4.2 There is likely to be little groundwater flow in much of the overburden along the route, as this is comprised largely of glacial till. Groundwater flow direction in the overburden tends to follow gradient, monitoring data indicates that for much of the route the direction of flow generally follows the route of Metro North (which is generally downhill from the Airport towards the River Liffey and downhill from the Airport to Belinstown). The Liffey exerts local influence on flow direction, which generally becomes more easterly in direction in the vicinity of the Liffey. Localised flow patterns may exist in some highly permeable areas such as gravel beds. Localised flow patterns towards other watercourses (mainly the Tolka and Broadmeadow/Ward) also manifest, with some localised south to north flow in overburden close to the Tolka and the other rivers encountered.
- 4.3 Groundwater flow in bedrock and in much of the overburden is limited due to low bedrock porosity and overburden material being mostly comprised of glacial till.
- 4.4 Some overburden with higher permeability is present (Parnell Square, O'Connell Bridge, Mater).

5.0 AREAS OF SIGNIFICANCE WITH RESPECT TO GROUNDWATER AND GROUNDWATER IN SOIL

- 5.1 Areas of significance with respect to groundwater – along much of the tunnelled route the structure is passing through low permeability bedrock, with fissure flow being the predominant groundwater feature.
- 5.2 Working from north to south, the first location where groundwater is likely to be intercepted is the portal where the route begins its entry to tunnel beneath the airport at Fosterstown.
- 5.3 The overburden within this area is generally impermeable glacial till, some perched groundwater is present but the retaining walls which will form the portal side walls will act as cut-off walls limiting any groundwater flow, so this area is considered of low significance.
- 5.4 Further to the south of the portal the tunnel will cross the bedrock/overburden interface, given that the overburden is generally impermeable glacial till the likely impacts are minimal, although some elevated groundwater heads may be noted at the surface of the bedrock, again this is considered of low significance.
- 5.5 Further to the south of the interface the tunnel will cross the Malahide Formation/Waulsortian Limestone Fault. Localised groundwater heads may be expected to be elevated along the fault and may lead to inflows to the tunnel, overburden is of low permeability, overall significance is considered low.
- 5.6 To the south of the airport, a similar pattern is evident, where the tunnel crosses the fault between Waulsortian Limestone and the Tober Colleen Formation (low to medium significance), and then where the tunnel exits the rock into the overburden (low significance)
- 5.7 To the south of the Dardistown Stop the tunnel crosses the fault between the Tober Colleen Formation and the Calp Limestone, again localised groundwater heads may be elevated along the fault but the overburden is impermeable (low significance).

- 5.8 The alignment next encounters groundwater as it runs through cut-and-cover through Ballymun and down to the DCU stop. The overburden along this section is glacial till and groundwater ingress is likely to be low and restricted to perched groundwater and some gravel lenses, in any case the walls of the cut and cover section will restrict groundwater movement and inflow (low significance).
- 5.9 The route crosses the bedrock/overburden interface south of the DCU stop, again given the impermeable nature of the overburden groundwater impacts are unlikely (low significance). Significant excavation will take place in Albert College Park to enable TBM's to be launched, however the trees in this area are rooted within the made ground and significant impermeable glacial till exists in the Park area, so this area is considered of low significance with respect to groundwater impacts.
- 5.10 The tunnel then proceeds in bedrock to pass under the River Tolka. Current data indicates that the Tolka lies in relatively impermeable glacial till, although localised alluvial deposits and sands/gravels are likely to be present. The possibility of hydraulic connectivity between the Tolka and the bedrock is considered unlikely but is possible (low to medium significance)
- 5.11 The tunnel proceeds to the Drumcondra Stop which will require construction and which crosses the overburden/bedrock interface, overburden is impermeable glacial till, with some gravels noted in the vicinity (low significance)
- 5.12 The tunnel then proceeds to the Mater Stop, ground conditions are more complex here, with sands and gravels and the tunnel crossing the bedrock/overburden interface. This area is considered of high significance with respect to groundwater
- 5.13 The Parnell Square Stop is the next on the route, and again this area is complex, with artesian conditions being encountered in the sands and gravels in this area, again this area is of high significance with respect to groundwater

5.14 The O Connell Street Stop is also an area where significant deposits of sands and gravels occur and this is also an area of high significance with respect to groundwater

5.15 The tunnel remains in bedrock through to its termination at St. Stephens Green, some sands and gravels are present in the area of the Green, although they appear to be capped by a layer of impermeable glacial till. Trees in this area will generally be rooted on the made ground (the glacial till being impermeable and unattractive to tree roots) so hydraulic connectivity between the overburden in which the trees are rooted and the gravels is extremely unlikely. Experience has shown that trees generally rely on recharge from rainwater to supply water requirements, rather than groundwater, and that the maintenance of a permeable surface around trees is the primary measure for ensuring a continued water supply to the root zone. This area is therefore deemed to be of medium to low significance.

6.0 HISTORICAL GROUNDWATER MONITORING DATA AND PROPOSED MONITORING REGIME

6.1 Little historical data exists for Dublin City due to the fact that the bedrock and overburden are generally impermeable and only locally productive, for this reason the groundwater has not been used as a resource to any great degree in the City.

6.2 A programme of monitoring of groundwater levels for Metro North has been undertaken over the period 2006 – 2008 and this programme of monitoring will be continued

6.3 The recorded levels are marked onto the Long Sections previously presented

6.4 At areas of low to medium significance with respect to groundwater the following is noted

6.5 The tunnel will pass beneath the Tolka, which is thought to be situated in largely impermeable overburden, but it is considered appropriate to conduct ongoing groundwater monitoring along 3 transects minimum (6 borehole locations)

- 6.6 Boreholes to be nested, in each ground stratum (made ground, estuarine deposits, sands/gravels, glacial materials, bedrock) and piezometers with data loggers installed, baseline conditions to be established prior to construction commencing, ongoing monitoring during construction and criteria to be agreed as to threshold and trigger values for changes in water level
- 6.7 St Stephens Green, similarly, 3 transects minimum, boreholes to be nested in each of the overburden strata, baseline date and trigger/action values to be agreed.
- 6.8 Weather station measuring temperature, rainfall, windspeed, evaporation to be installed and used to predict evapotranspiration and soil moisture deficit, tensiometer programme to be implemented in soils in the Green and cross reference with evapotranspiration calculations to identify any sudden divergence in values, which may indicate abnormal impacts on soil moisture:
- 6.9 At the areas of high significance with respect to groundwater, the following is noted:
- 6.10 Mater Stop – non-hydrostatic conditions indicated by very significant level differences between soil and rock water levels, potential for disruption of current groundwater regime. Proposed monitoring should include 3 transects minimum, wells nested as above, baseline to be defined, trigger and action values agreed.
- 6.11 Parnell Stop – sub artesian pressures and blowing encountered, hydraulic continuity exists between rock and sands/gravels, tunnelling across the interface likely to be complex. Proposed monitoring should include 3 transects minimum, wells nested as above, baseline to be defined, trigger and action values agreed.
- 6.12 O' Connell Bridge, hydraulic connectivity between bedrock, overburden and Liffey, 4 transects minimum, wells nested as above, baseline to be defined, trigger and action values agreed.

7.0 STOP BOX IMPACTS ON FLOW DIRECTION

- 7.1 Groundwater flow is generally close to parallel to the stop boxes, so the structure will not act as a significant barrier to groundwater flow
- 7.2 Further studies (as defined in previous section) will be required to determine if localised flow direction and pattern exist at Mater, Parnell and O' Connell Bridge
- 7.3 Dimensions of Stop Box are insignificant when compared with cross sectional area of over-burden deposits in these locations
- 7.4 Contractor is required to minimise any groundwater impacts, so Contractor may undertake hydrogeological modelling to predict possible groundwater elevation or depression in the vicinity of stop boxes.

8.0 **IMPACT ON TREES**

- 8.1 Trees present at St. Stephen's Green and Albert College Park
- 8.2 Albert College Park not considered at risk with respect to groundwater impacts due to impermeable nature of overburden
- 8.3 Some gravel deposits under St. Stephen's Green, considered prudent to conduct ongoing study to establish baseline conditions using evapotranspiration calculations and tensiometer study, risk of impact on trees is considered low.

END OF SUPPLEMENTARY EVIDENCE

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