METROLINK

Integrated Transport. Integrated Life.

# A19.6 Historical Inflows

**Appendix 19.6 Historical Inflows (Summary Table)**

Summary of groundwater observations from underground construction case histories in Dublin/ Kildare.

| Project (Ref.) | Project details | Ground profile / depth to base of stratum (mbgl) | Pumping test information | Observations |
|---|---|---|---|---|
| Custom House Docks, 1988 (1). | Excavation depth of 7.5 mbgl.<br><br>Anchored sheet pile wall seated in glacial till. | Made Ground / 6<br>Gravels / 10<br>Glacial Till / 12<br>Bedrock<br>Groundwater / 2-4 | Two well pumping tests carried out from separate wells for 24 hours with further 24-hour recovery period. Drawdown of 4m achieved in one well (predominantly in gravel), with predicted radius of influence of 700m and calculated k = 1x $10^{-5}$ to 1x$10^{-7}$m/s. | Maximum recorded tidal variation of site area was 0.5m, compared with 4.5m in adjacent docks, suggesting reasonably water-tight river and dock walls and low permeability silt or clay in the bed of the docks and river.<br><br>Required drawdown achieved by a combination of wells and local sumps. Dewatering of contaminated made ground allowed removal of dry material to disposal area. Maximum tolerable groundwater drawdown of 1.5m at the Custom House agreed with OPW and breached only once. |
| Brewery Road Water Main Tunnel, 1994 (2). | 1km long, 1500mm diameter tunnel (predominantly in rock) with 5 No. access shafts.<br><br>35m length of tunnel in “drowned valley”. Pre-treatment by permeation grouting from surface and grout injection from face following forward probing to identify gravels. | Stream deposits (locally) / -<br>Glacial Till / -<br>Bedrock (granite) / - | - | Water flows in shafts were somewhat unpredictable, with low inflows in strong granite and increased flows where the rock was weathered. This was most notable in poor rock under the Brewery Stream where the ingress increased substantially. |
| Jervis Street Shopping Centre, 1995 (3). | Site area 0.9ha.<br>Excavation depth of 5.5m to 7.3mbgl.<br>Bored secant piled wall. Male piles toed in 0.75m to 1.5m into rock, female piles toed in 0.5m.<br>Excavation of centre of site commenced during installation of secant piled wall with restriction that groundwater in gravels did not drop by more than 1m. | Made Ground / 3.2<br>Alluvium / 3.3<br>Gravels / 5.5<br>Glacial Till / 6.3<br>Weathered rock/ 6.8<br>Intact rock<br>Groundwater / 3.2 (0mOD) | One pump well in rock and two observation wells in gravel.<br><br>Groundwater lowered by 4.4m by pumping at 68l/min.<br><br>Minimal effect on water level in gravels due to presence of glacial till below gravels. | Groundwater lowering achieved by pumping locally from sumps near formation level. No attempt to reduce water table across the site. Pumping (typically from 4-6 pumps) was intermittent due to the nature of the weathered rock. Groundwater level maintained successfully to allow all construction in the dry.<br><br>Water level drawdown in the rock was between 1m and 4m shortly after pumping began. As all adjacent structures on piled foundations to rock, no implications for building damage. Water levels in gravels generally remained relatively steady with 0.5m to 1.0m drawdown. |
| Jervis Street Shopping Centre, 1995 (4). | As above plus: significant groundwater inflow noted during sheet pile wall and excavation trial, led to decision to adopt secant piled wall with cut-off in rock; contingency plan to recharge gravels | As above | As above | Generally, groundwater level in gravels noted to be in hydraulic continuity with bedrock, with the exception of 3 No. piezometers which showed drops of up to 4m. |

| Project (Ref.) | Project details | Ground profile / depth to base of stratum (mbgl) | Pumping test information | Observations |
|---|---|---|---|---|
| | included but not required in practice; | | | |
| Marks and Spencer, Grafton Street, 1995-96 (5). | Excavation depth of 7.2m. Sheet pile wall driven to top of bedrock. | Made Ground / 3.3<br>Glacial Till / 5.4<br>Glacial Gravel / 8.8<br>Bedrock<br>Groundwater / 4.5 | - | Problems caused by the seepage of water into the site from the weathered top of the bedrock, which were solved by pumping from shallow wells and sumps (*). |
| Clarendon Street, 1996 (5). | Excavation depth of 6.0m. King post wall with toe at 7mbgl and lean mix concrete onto excavated vertical faces between king posts. Water seepage a concern. | Made Ground / 1<br>Glacial Till / 8<br>Bedrock<br>Groundwater / 4.5 | - | 2 out of 4 inclinometers recorded no movement. 1 inclinometer recorded 5mm of movement where the glacial till had been replaced locally by a water bearing gravel. It was found that except where the gravel was encountered, the water seepage was very small (*). |
| Schoolhouse Lane, 1995/6? (5). | Excavation depth of 5.5m. Contiguous bored pile retaining wall seated on bedrock. Significant water seepage was a concern | Glacial Till / 5.6<br>Glacial Gravel / 8.0<br>Bedrock<br>Groundwater / 4.2 | - | No measurable movement recorded. Observed seepage was insignificant, probably due to the low permeability of the glacial till (*). |
| Intel, Leixlip, 1995/6? (5). | Excavation depth of 8.5m. Contiguous bored pile retaining wall with 2m toe into bedrock. | Glacial Till / 5.3<br>Weathered rock/ 6.8<br>Intact rock<br>Groundwater / 5.3 | - | No measurable movement recorded. Presence of groundwater not covered in paper (*). |
| Site bounded by Westmoreland St., Fleet St. and College St., 1999 (6). | Excavation depth of 6.3m. Bored secant piled wall. Pile toes at -4mOD (1m into intact rock). | Made Ground / 4<br>Glacial Till / 6<br>Weathered rock / 7<br>Intact rock<br>Groundwater / 3 (1mOD) | - | Groundwater was pumped from sumps within the excavation. Standpipes around the site recorded no significant change in groundwater level. |
| Westin Hotel, College Street, 1999 (7). | Excavation depth of 6.3m. Bored secant piled wall. Male pile toed in at - 4mOD (1m into intact rock), female piles toed in at - 2.3mOD (0.3m into weathered rock).<br>Site lies 100m south of River Liffey, tidal influence on groundwater levels small (approx. 0.2m to 0.3m). | Made Ground / 4<br>Glacial Till / 6<br>Weathered rock / 7<br>Intact rock<br>Groundwater / 3 (1mOD) | - | Groundwater level falls by 0.7m from south to north towards River Liffey. Small decrease in groundwater level during basement works between 0m and 0.9m. Significant pumping was carried out both from sump pumps and from a submersible pump in a borehole near the centre of the site. The secant piled wall formed an effective cut-off. Rainfall affected groundwater levels. No tidal effect over a 24-hour monitoring period. |
| Dublin Port Tunnel, 2001/2 (8). | 56.6m diameter shaft, 28m deep, formed by 1.5m thick diaphragm walls, approx. 32.5m deep. | Made Ground / 2<br>Glacial Till / 25<br>Bedrock<br>Groundwater / 2 | - | High groundwater levels controlled by dewatering from wells around the shaft during excavation. |
| Dublin Port Tunnel, 2001/2 (9). | Construction of groundwater model for Dublin region using information gained during ground investigations for, and construction of, the tunnel. | Made Ground<br>Estuarine deposits<br>Glaciomarine sand and gravel<br>Glacial Till<br>Bedrock<br>(depth varies) | 4 No. pumping tests targeting the bedrock/ glacial till interface, limestone bedrock and estuarine gravels (2 No.). | The Dublin limestone is the primary aquifer in the Dublin region. Overlying glacial tills act as a confining unit to the limestone which produces almost artesian heads within that unit. The uppermost gravels, sands and silts are transmissive sediments draining the system |

| Project (Ref.) | Project details | Ground profile / depth to base of stratum (mbgl) | Pumping test information | Observations |
|---|---|---|---|---|
| | | | | towards the Irish Sea. Topography is the primary driving force behind the flow system in the study domain. Recharge is linked to the depth to which flow occurs in the limestone and is limited, ultimately, by rainfall into the system. Drawdown of 2mm to 6mm was predicted in the saturated limestone above the unlined tunnel during 8-hour nightly cessations of work (**). |
| Smithfield, 2003 (10). | Site area 1.2ha. Excavation depth of 10m. Anchored diaphragm wall (800mm thick) founded on bedrock.<br>Site lies 200m north of River Liffey.<br>Pumping from well in centre of site to dewater the gravels and sump pumping at base of excavation as necessary. | Made Ground / 3<br>Dense Gravels/ 14.8<br>Bedrock<br>Groundwater / 4 | - | Groundwater levels measured outside the diaphragm wall showed very little variation during the works, suggesting an effective cut-off was provided by the wall. Prior to start of construction groundwater levels were typically +0.8mOD. During subsequent dewatering the level dropped to about +0.2mOD and subsequently showed a small increase towards +0.3mOD. |

*Notes:*

*(*): Author concludes that: "Retaining walls in Dublin have often been designed with significant toe embedment in order to minimise water seepage. It has been found in practice that the seepage through the glacial clays is very small. However, significant seepage can occur through the top, weathered portion, of the bedrock".*

*(**): No published observations of groundwater drawdown measured during construction. However, it has been indicated that rapid reductions in head within bedrock occurred in response to relatively small initial inflow to openings during pumping tests and excavation of the tunnels. Recovery of head was rapid once the tunnel lining was constructed.*

**References:**


- (1): Higgins, J. and Mason, S. 1989. Geotechnical aspects of the redevelopment of the Custom House Docks area in Dublin. The Institution of Engineers Ireland.
- (2): Grant, J., McCarthy, D. and Sharkey, J. 1996. Construction of a water main tunnel at Brewery Road. The Institution of Engineers Ireland.
- (3): Long, M. and Murphy, B. 2003. Difficulties with ground anchorages in hard rock in Dublin, Ireland. Geotechnical and Geological Engineering 20: 87-111.
- (4): Dougan, I., Long, M. and Byrne, J. 1996. Geotechnical Aspects of the Deep Basement for the Jervis Street Shopping Centre. The Institution of Engineers Ireland.
- (5): Long, M. 1997. Design and construction of deep basements in Dublin, Ireland. Proc. XIV. ICSMFE, Hamburg, vol. 2, pp1377- 1380.
- (6): Long, M. and Brangan, C. 2000. A deep basement in weathered rock in Dublin. Eurock 2000, Aachen, Germany. German Geotechnical Society DGGT.
- (7): Long, M. 2002. Observations of ground and structure movements during site redevelopment in Dublin. Geotechnical Engineering Vol. 155, Issue 4, pp229-242.
- (8): Cabarkapa, Z., Milligan, G.W.E., Menkiti, C.O., Murphy, J. and Potts, D.M. 2003. Design and performance of a large diameter shaft in Dublin Boulder Clay. Foundations: Innovations, observations, design and practice.
- (9): Rooney, T.O. 2002. Hydrogeological, three-dimensional, numerical flow modelling of the Dublin Port Tunnel and region. MSc thesis.
- (10): Long, M. and Dhouwt, B. 2003. Behaviour of a diaphragm wall in dense gravels. Proc. Int. Conf. on Field Measurements in Geomechanics, FMGM"03, pp209-204.