BELFAST SEWERS PROJECT

Adam Green - Atkins Tunnelling

Scheme Overview

- New stormwater interceptor Tunnel Scheme within Belfast City Centre to alleviate flooding and divert storm water flows from existing water courses.
- Diversion of 1.5M m^3 of stormwater to a new screening facility within existing Duncrue Wastewater Treatment Works.
- Atkins appointed 8th July 2003 by DRD Water Service on a Project Management contract.
- Atkins team includes AMEC for Tunnelling Expertise and Construction Techniques.

Alternative Strategy- Tunnels

- Alternative Strategy accepted due to Team having all required skills to define the solution.

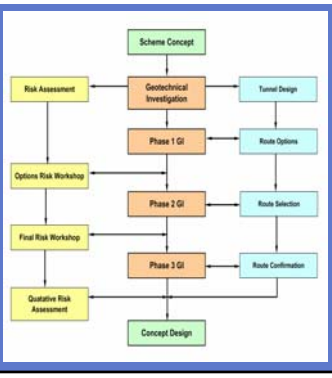
The appointed Project Manager undertakes:

- Primary responsibility for definition of the Works (provide a 70-80% design to the Contractors);
- Manages all 3rd Party interfaces; land, property, traffic, compensation etc;
- Competitively tenders the Works to the market on ECC Option C (Target Cost) Contract Conditions.

Delivery Benefits

- Places risk and applies focus of the respective skills of the Project Manager and Contractor to those areas of the Project which are best managed by each party;
- Utilises **PM** skills: modelling, design, geotechnical, constructability, traffic and environmental management, land and property / structural engineering;
- Utilises **Contractor** skills: design / construction of tunnel lining, shaft construction, structural design of RC elements;
- Provides a well defined scope of works to be costed – ensures cost competitiveness from the market;

Phased Design Development



Development of Geotechnical Investigation;

- Identification
- Investigation
- Detailed Investigation

Phase 1- Identification

Identify Existing Geotechnical Environment and Hazards

- Desk Study
  - Contaminated lands
  - Historic geological records
  - Existing land use (utilities/buildings/planned development)
  - Archaeological
- Borehole Record Search
- Procure GI contractor

Tunnel Design

- Develop tunnel route options
- Tunnel design criteria

Stormwater Tunnel Route Criteria

- Shafts located to intercept major storm overflows
- Tunnels to be driven in more favourable tunnelling strata
- Construction to avoid existing piled building foundations and road infrastructure
- Shafts and tunnels located to minimise construction, traffic and environmental impacts

Geology

The typical geology of the area, in sequence, comprises:

1. **Made Ground**
2. **Alluvium (including Sleech, Estuary Clay, Peat)**
3. **Glacial Deposits (Boulder Clay, Sands and Gravels)**
4. **Intrusive Dykes and Sills**
5. **Mercia Mudstone**
6. **Sherwood Sandstone**

Geotechnical- Hazards

- Methane – Landfills, Sleech, Peat
- Boulders – Glacial Deposits
- Mixed Face Conditions – Alluvium, Sleech, Glacial
- Running Sands
- Igneous Intrusions – No Warning
- River Flooding
- Buried Channels – Bedrock
- High Sulphate Content – Peat, Sleech
- Future Development – route sterilisation
- Unexploded Munitions – 1941
- Services
- Heritage Sites

Phase 2- Investigation

Investigate Geotechnical Conditions and Specific Hazards

- Under take intrusive ground investigation
- Additional Specific Desk Studies
  - Ground-borne noise and vibration assessment
  - Unexploded Ordnance
  - Manmade Obstructions (piles/foundations/underground structures)
  - Settlement assessment

Tunnel Design

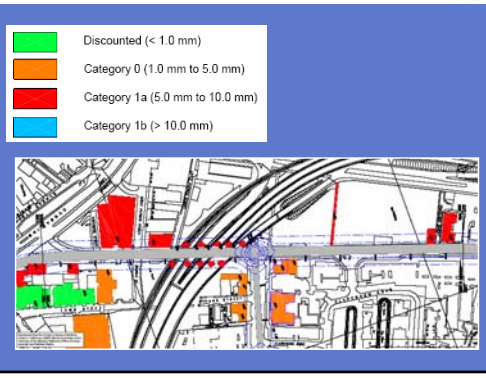
- Confirm final tunnel alignment (horizontal and vertical)
- Confirm shaft locations

Ground Settlement Assessment

Key Activities:-

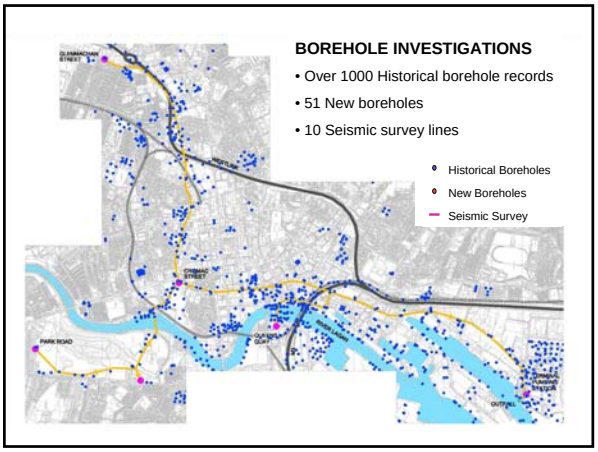
- Modelling of tunnelling induced ground settlement
  - 3 stage approach to settlement assessment
- Walkover Survey and Visual Assessment of Properties
- Desktop study of Existing Structures
- Establishment of existing foundation types along tunnel route

TYPICAL DRAWING SHOWING EXTENT OF WALK THROUGH SURVEY - CATEGORIES



Geotechnical Investigations

- 51 Boreholes
  - 1220m of Cable Percussive Hole
  - 250m of Rotary Cored Hole
  - 1830 Soil Samples
  - 52 Core Samples
  - 426 Chemical Test Packages
  - 2 Photographic / Acoustic bore hole logs
- 12 CPT (Cone Penetration Tests)
- 2852m of Shear Wave Seismic Investigation
- Site Investigation Contractors
  - Glover Site Investigations Ltd (Principle Contractor)
  - Robertson GeoLogging Ltd
  - Lankelma Cone Penetration Testing Ltd
  - Zetica [Geo-Services International (UK) Ltd]



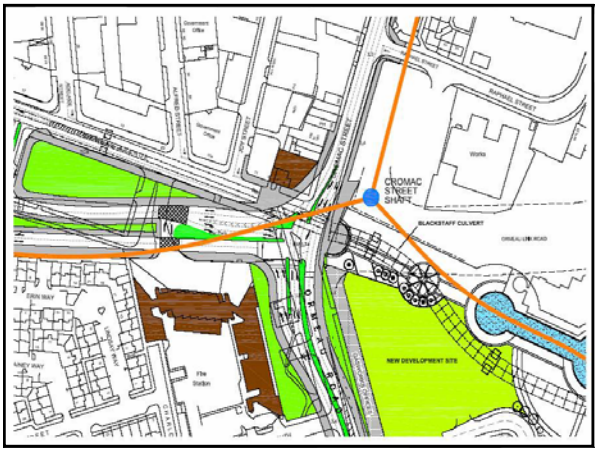
Phase 3 – Detailed Investigation

Investigate Specific Geotechnical Conditions and Hazards

- Additional focused ground investigation
  - Seven further percussive and rotary boreholes
  - Seismic survey

Tunnel Design

- Confirm final tunnel design solution

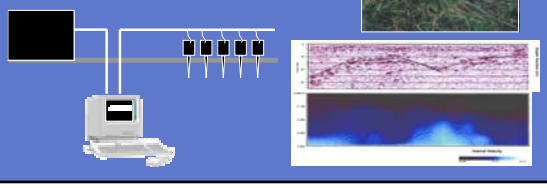


Geophysical Investigations

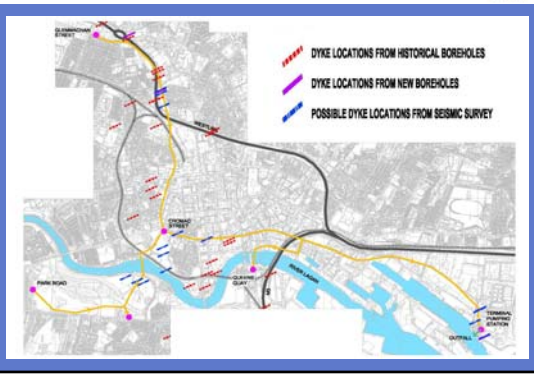
Aim:

- Determine depth to bedrock
- Determine location of intrusive material

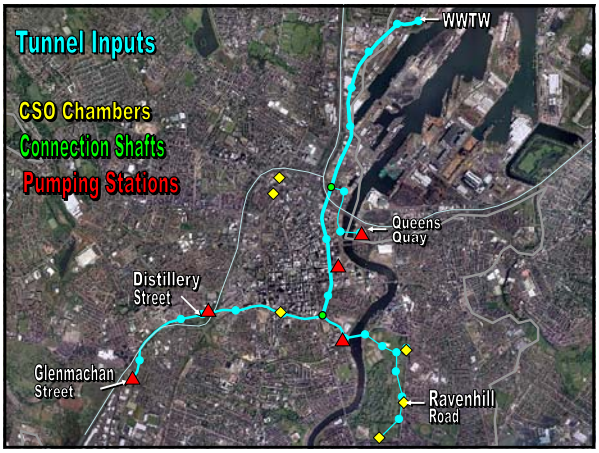
- Shear wave seismic reflection
- 3 locations within Belfast
- 10 Survey Lines



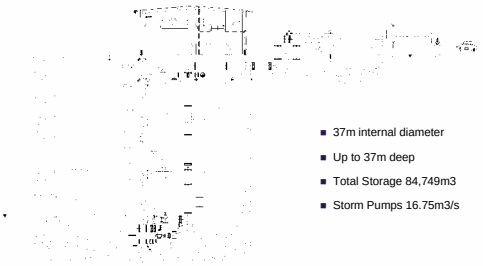
Dolerite Dyke Locations



Route Geology



Terminal Pumping Station



- 37m internal diameter
- Up to 37m deep
- Total Storage 84,749m3
- Storm Pumps 16.75m3/s

Final Design Solution

- Development of a detailed project ground model to assist in tunnel design and cost development
- Full Cost Plan including risk provision, contingencies proposal for final tunnel route option
- Primavera P3 Construction Programme of Stormwater Management Works
- Provides Water Service with robust cost, risk profiles for the final tunnel design solution

Summary

- Phased Investigation enabled the Geotechnical Investigation to Target high risk areas during the design
- Detailed package of Geotechnical information available from third parties and design team to enable contractor's to accurately price contract works and include appropriate risk allowance
- Provide DRD Water Service with a robust target cost

Belfast Sewers Project
21st CENTURY INFRASTRUCTURE

QUESTIONS

Water Service

Department for Regional Development

ATKINS