

## Wellwood, North Dunfermline — Mine Workings Consolidation

**Client:** I&H Brown  
**Designer:** David R Murray & Associates  
**Value:** £1.5m  
**Period:** Nov 2016— June 2017

This contract was undertaken to treat extensive shallow mine workings on a greenfield site at Wellwood, North Dunfermline in advance of the infrastructure works for the first phase of a large development of up to 1100 new homes with a new primary school and a commercial development area.

Multiple worked coal seams and recorded mine entries are present throughout the site which resulted in treatment of workings being required to depths ranging from 8 to 40 metres BGL. Treatment designs and specifications were provided by designer David R Murray & Associates, who also supervised the site works. Treatment grids were designed on a 3.5m hole spacing.

Overhead power lines running through the site necessitated the use of angled drilling to treat the workings beneath the associated exclusion zone. Whilst all our drilling rigs can accommodate angle holes, specialist Casagrande C6 geotechnical drilling rigs with versatile kinematics were required able to complete the more difficult drilling angles of up to 55°.



All drilling, grout mixing & pumping plant and ancillary equipment was resourced from our specialist in-house plant fleet based at our Grangemouth depot and during peak activity up to 13 rotary percussive drilling rigs were resourced to site with over 40 personnel working between drilling and grouting operations.

The main elements of work included;

- **Mineworkings Treatment**
  - ◇ 7,100 boreholes drilled (161,510 metres of drilling)
  - ◇ 45,000 tonnes of grout pumped (8:4:1 PFA/Sand/OPC)
  
- **Mineshaft Treatment**
  - ◇ Two recorded mineshafts located and treated (25m depth)

## Wellwood, North Dunfermline — Mine Workings Consolidation (Cont'd)

- Drill holes were cased with 101mm OD rotary percussive steel casing which was sealed into rock head followed by drilling a 75mm open hole to the workings to facilitate insertion of grout injection tubes. Use of steel casing was a specified requirement in the design.
- A mixture of water and air flush was used depending on the nature of the underlying geology. Water flush was used near to existing residential areas in order to prevent the possibility of mine gas migration.
- A perimeter was formed in heavily worked areas where there was a risk of grout loss outside the site boundary. Larger diameter holes were drilled to allow injection of gravel or sand.

### Grout Production

- Grout was mixed using a Bellmix continuous mixer capable of mixing up to 80m<sup>3</sup>/hr with cement being fed from a 30 ton horizontal silo which was refilled as often as twice a day.
- The grout plant was able to produce up to 600 tonnes of mixed grout on a daily basis, with 20 articulated lorry loads of PFA and sand delivered to site per day. PFA was delivered in bulk from Fiddlers Ferry power station near Warrington
- A grout mix of 8:4:1 PFA/sand/OPC was used for infill holes.



- Owing to the large pumping distances required to access some treatment areas on the site (up to 750m), a central re-mixing and pumping station was established with an agitation tank and trailer mounted concrete pump to maintain a homogenous grout mix and to prevent settlement in the grout lines.
- A total of 6 no. grout distribution pumps were used during peak production allowing for multiple areas of the site to be grouted simultaneously.
- The use of multiple pumps also reduced down time when testing completed areas. One pump/line being assigned to the testing while the other pumps continued to service other treatment areas.