





## REMEDIATION STRATEGY – ISSUE 1, JANUARY 2004

### BEDWAS COLLIERY RECLAMATION SCHEME

#### Summary

This statement was prepared to provide an overview of the proposed strategy for the design of remedial works, in relation to contamination issues. Powerscreen International owns the majority of the site landholding. Caerphilly County Borough Council (CCBC) / Parsons Brinckerhoff Ltd (PB) are assessing this land as part of a larger reclamation scheme of the former Bedwas Navigation Colliery surface, with a view towards purchase of the Powerscreen International landholding. The Welsh Development Agency (WDA) may provide funding for the development-led elements of the remediation. The future site development will be a mixed use determined by CCBC. The Council have initiated discussion on potential after-uses with the Bedwas and Trethomas Community Liaison Group. The final development will be the subject of an Outline Planning Application in late 2004. The purpose for providing the strategy prior to outline planning is to obtain Environment Agency views on the sensitivity of the aquifers, which will determine the apportionment of costs and liability of the site in its current and future use. The site is mentioned in the Environment Agency LEAP document. Comments are welcome on the proposed strategy.

#### Site Location and Description

The site is located approximately 2.5 km north east of Caerphilly, Mid Glamorgan (Figure No. 1). The National Grid Reference for the centre of the site is ST 176 893. The 31.6ha study area comprises a series of plateau areas on the lower flanks of Mynydd y Craig above the village of Trethomas. The site topography comprises a southerly sloping hillside falling from 150m to 75m AOD across the site. The River Rhymney is present offsite at around 50m AOD in the valley bottom.

The former Bedwas Colliery occupied the central plateau area of the site, with the former coking ovens, Benzole and by-products plant to the east. Old railway lines and rail sidings run west to east across the site. The surrounding area includes colliery tips, residential properties, allotments and farmland. The site is unmanned and derelict remaining in the ownership of Powerscreen International, Forest Enterprise and Railways Paths Limited. A public footpath runs through the site.

The buildings associated with the colliery, coking works and by-product plant have largely been demolished, although some retaining walls, structure bases and foundations still remain. A number of more recent above ground concrete tanks are also evident on the site. Surficial materials are mainly soft cover with approximately 5% hard cover. Overhead power lines, gas mains and other services cross the site.

It is proposed that CCBC in conjunction with the WDA are to develop the site along with re-profiling of adjacent colliery tips. The site will comprise a mixed use development of:

- Residential
- Commercial (B1/B2) Use
- Leisure/Public open space
- Educational facility

Although outside the study area, CCBC have development proposals for a link road from Newport Road to the site.

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## **Geology, Hydrogeology and Hydrology**

The site is situated on made ground over variable Glacial Drift and Upper Coal Measures (Grovesend and Hughes Beds). The site lies on the northern limb of the Caerphilly Syncline, with the dip of the strata southwards at between 10 and 20 degrees. The worked Mynyddislwyn coal seam underlies the site. The strata thicknesses in the area are confirmed as follows: -

- 0.0 – 24.8m Made Ground comprising colliery spoil
- 0.0 -9.90m Glacial Drift comprising sands and gravels and sandy clays
- 700m Coal Measures comprising sandstones, mudstones and coal

Both shallow and deep mining operations have been carried out at this site from roman times until closure of the Colliery in 1985. Shallow pillar and stall workings, exploiting the Mynyddislwyn coal seam exist below the southernmost section of the site, whilst the Bedwas Navigation Colliery shafts exploited the deeper seams descending to over 700 m.

The Glacial Drift and the sandstone units of the Upper Coal Measures are minor aquifers. Shallow groundwater is contained within the drift as a continuous water body. The groundwater levels within the sandstone units are typically around 10 m below the shallow groundwater present in the alluvial strata.

Four licensed groundwater abstractions for industrial use are located in the Rhymney Valley around 800 m to the south of the site.

The site is located within the valley of the River Rhymney on the south sloping hillside above the river located around 900 m to the south of the site. A number of surface water streams and drainage culverts discharge water to the south and are likely to discharge into the river. In addition surface water runoff from the managed spoil tips to the north of the site is routed via the Quarry lagoon and a culvert beneath Navigation Street and discharges directly into the river.

The River Rhymney is classified by the Environment Agency as surface water quality B (good). In addition the Environment Agency's LEAP for the Eastern Valleys Area indicates that the River Rhymney is noted as a salmonid river with catches of salmon and sea trout recorded.

## **Site history**

The history of the area was charted from the late 1800's and revealed that the site was originally farmland with spring lines. Several adits and pits were in existence on site mining shallow coal. Records denote the Bedwas Navigation Colliery Company commencing in 1909 with two shafts. The pit was nationalised in 1947 and in the final years supplied coal for the Llanwern steelworks. It was closed in 1984-5 and the shafts were filled and capped. The resultant discard of colliery spoil was tipped on the hillside northwards for two miles. The tips were re-profiled in the 1980's for safety reasons. A redundant transformer station and two former fuel storage locations were associated with the colliery.

British Benzol and Coal Distillation Ltd formed a coke and By-products Plant in 1929. 35 coke ovens were in operation and the gas produced supplied Newport after being cleaned in purifiers at Newport. 53 ovens were in operation in 1971 and the plant covered 2.37 hectares. The by-products produced were ammonia, naphtha, benzol, pitch, sulphuric acid, tar and creosote and, latterly, benzene and toluene.

The by-products were formed in process plant in the central benzol plant area covering 1.62 hectares. The products were refined from the gas condensate taken via pipe work from the

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coke ovens. Engineering plans of the tanks and process areas are shown on Figure 2, however pipe work runs are unavailable. Anecdotal evidence from former employees and maintenance workers proves the tanks and pipe works to have been above ground and that five culverts outfall to the River Rhymney. Asbestos products were part of the plant and placed in the tip. A tunnel walkway exists for former employees to gain access to the plant from Llanfabon Drive.

The main processes involved the following:

Tar	-	Tar coolers
	-	Tar separating tanks
	-	Water treatment plant
	-	Tar tanks
Sulphuric Acid	-	Sulphuric acid scrubbers
	-	Ammonia sulphate shore
	-	Sulphuric acid storage tank
Benzol	-	Benzol scrubbers
	-	Wash oil tanks
	-	Gasholder
	-	4 condensers
	-	Benzol tank
	-	Distillation process
	-	Benzol, toluene and solvent naphtha tanks

Following cessation of production in 1984, the site was demolished. The demolition rubble and limited tar deposits were placed in a COPA licensed 0.93 ha. landfill during a 12 year period of infilling, which was designed to operate as a 'dilute and disperse' facility. A total of 2,500m<sup>3</sup> was licensed for disposal. It did not incorporate an engineered base and had a 1m restoration cover of subsoil. No current Waste Management License exists for this facility in the Environment Agency or CCBC records. Figure 2 records the historical structures, exploratory holes and services.

### **Initial Conceptual Model**

For the investigation phase, the site use was defined for future mixed-use development. The main receptors were 'controlled waters' (surface waters, aquifer or R Rhymney), property and humans. Allotments exist offsite to the south of the site. No ecological sites of significance or protected species were recorded at site.

Potential pathways are: -

- Inhalation, ingestion, contact, vapour movement with or from aqueous, tarry or solid sources of contaminants in the made ground, underground tanks, pipes and underlying strata.
- Unrestricted leaching of sources of contaminants from the soils and perched waters to the surface watercourses, River Rhymney or to the aquifers.
- Attack on services and buildings, combustion and explosion risk.

### **Site Investigations**

Site characterisation studies and investigations have been completed as follows: -

- Geological and Mining Report, Johnson Poole and Bloomer, November 1990.
- Feasibility Study, Rhymney Valley DC, 1991.

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- Feasibility Study – Stage 2, CD Gray Associates, 1991. (17 sampling points)
- Report on Ground Contamination, Keltecs, January 1991. (30 sampling points, 1989)
- Preliminary Investigation Report, Rust Environmental, 1995.
- Main Site Investigation and Risk Assessment, Rust Environmental, 1996. (95 sampling points)
- Ecological Walkover Survey, Hyder Consulting, 2002.
- Supplementary Ground Investigation, Parsons Brinckerhoff Ltd, 2003. (320 sampling points)
- Third round of groundwater monitoring, Parsons Brinckerhoff Ltd, Nov. 2003.

The most recent investigation used a combination of targeted and judgemental sampling. Principally the outlying colliery surface was assessed as green field as limited contaminative processes had taken place. The investigations in total have provided a 95% confidence of having found a hotspot of 0.002% of the total site area. For the brownfield area of interest (Benzol plant, coking plant and tip), the investigations have provided a 95% confidence of having found a hotspot of 0.004% (138m<sup>2</sup>) of the site area. No sampling points were completed where services run. Sampling points were also located around the site edge to look at migration potential. A geophysical survey of the licensed tip, bench scale biotreatability trials and a CCTV survey of the culverts were completed.

Laboratory testing was based on determinants for a coal carbonisation and benzene distillation suite with additional analytes for surface / ground waters, PCB's for the transformer compound, asbestos and loss on ignition.

A total of 62 rotary boreholes, 61 shell and auger boreholes, 12 window samplers 169 trial pits and 17 trial trenches were completed. Chemical and geotechnical testing were carried out on selected samples. Chemical testing comprised soils, leachates and waters totalling over 650 tests.

The Made Ground across the site generally comprised the following types of material:

- Shale tailings (colliery spoil);
- Demolition material; and,
- Made Ground associated with the Licensed Tip.

Made Ground was encountered in the majority of excavations as expected for the colliery site. The thickness of Made Ground ranged from 0.1 to 27.6m thick with an average of 3.4m.

The Made Ground typically comprised brown sandy gravels of sandstone and mudstone to brown clayey gravelly cobbles of sandstone and mudstone. Building material / demolition rubble was visibly evident within many of the trial pits and trenches.

The glacial drift of clays and sands and gravels were proved overlying the sandstones coals and mudstones of the Coal Measures.

Visible evidence of asbestos was not common across the site with only possible identifications recorded in the field. Visual evidence of contamination ranged from a hydrocarbon sheen on waters, tarry residues coated on soil material to unidentified material, with a gel type consistency. Odours characteristic of contamination in the ground ranged from that typical of solvents, hydrocarbons, cresol and naphtha.

Monitoring of groundwater installations indicated no free product, although product was noted in several trial pits. Groundwater was encountered in 75% all boreholes completed as groundwater monitoring installations. Of the 83 groundwater monitoring installations, no groundwater samples were recoverable from 20 installations due to the dry conditions during the two rounds of groundwater monitoring and sampling undertaken in January and February 2003.

A multi layered groundwater regime is evident beneath the site with a continuous shallow groundwater system present in the drift deposits and a deeper groundwater system present within the underlying Coal Measures. Perched water is also present within the Made Ground at a number of locations either due to low permeability materials or buried structures. In general however the Made Ground appears to be fairly permeable with many of the trial pits dry during the investigation. The shallow groundwater system within the drift deposits generally flows towards the south and southeast and also shows evidence of interaction with surface water drainage. Across the majority of the site the shallow and deep groundwater systems are not in hydraulic continuity due to the upper weathered nature of the Coal Measures strata. However, in some locations there appears to be hydraulic connection, potentially via deep foundations. The deep groundwater flows offsite towards the south and is likely to discharge into the River Rhymney as base flow.

Gas and vapour monitoring recorded generally gas free conditions with isolated records of CH<sub>4</sub> and CO<sub>2</sub> along with vapours above 50ppm

The site investigations reconfirmed the geology as per the initial conceptual model with no significant variations. The groundwater has been characterised more fully. Areas of concrete foundations, structures and hard cover were estimated and quantified for feasibility of re-use.

Anecdotal information obtained during the investigation indicated that tanks in the benzol plant were situated above ground, which provides a greater degree of surety on the background information previously reviewed.

Several hazards were identified in the site soils, mainly associated with the former benzol plant. These comprise organic species, (such as PAH, BTEX, and TPH), asbestos, arsenic, lead, organic vapours and carbon dioxide, and combustible materials.

The tip appears to be greater in volume than the COPA licence indicates, comprising approximately 15,000m<sup>3</sup> of material across a wider extent than previously anticipated.

The shallow aquifer within the drift/made ground beneath the process area contains free phase oils and a dissolved phase component. The deeper aquifer within the sandstone is only elevated in discrete areas with free phase and dissolved phase components, although is less well defined. None of these areas are shown to migrate off site.

Asbestos, lead and arsenic are also located in outlying areas associated with the colliery complex. The dredgings from the quarry lagoon sediments reveal a low pH environment and elevated metal content. The waters ponding on this area are also acidic.

Surface waters entering the site are typically clean, however the run-off from the quarry lagoon and the benzol plant shows elevated concentrations of metals above relevant environmental water quality objectives for river water receptor.

CCTV inspections revealed several large diameter culverts beneath the site, which represent direct pathways to the River Rhymney via the two site outfalls.

### **Refined Conceptual Model**

The site use was defined as future mixed-use development. The main receptors were 'controlled waters' (surface waters, aquifer or R Rhymney), property and humans. Allotments

exist offsite to the south of the site. No ecological sites of significance or protected species were recorded at site.

Hazards / sources were identified in the site soils, mainly associated with the former benzol plant and tip area. These comprise organic species, (such as PAH, BTEX, and TPH), asbestos, arsenic, lead, organic vapours and carbon dioxide, and combustible materials. The shallow aquifer within the drift/made ground beneath the process area contains free phase oils and a static dissolved phase component. The deeper aquifer within the sandstone is only elevated in discrete areas with free phase and dissolved phase components.

Potential pathways are: -

- Inhalation, ingestion, contact, vapour movement with or from aqueous, tarry or solid sources of contaminants in the made ground, underground tanks, pipes and underlying strata.
- Unrestricted leaching of sources of contaminants from the soils and perched waters to the surface watercourses, culverts, River Rhymney or to the aquifers.
- Attack on services and buildings, combustion and explosion risk.

A summary conceptual model drawing is produced as Figure 10.

### **Risk Assessment**

Risk-based assessment utilised qualitative and quantitative methodologies, including the use of generic guideline values, modeling of soil vapours within the subsurface, and contaminant transport and degradation in the saturated zone. Where available, the results were compared against CLEA guideline values and other risk-based guidelines. Groundwater assessment is undertaken in a tiered approach in accordance with Environment Agency R&D Publication 20 ("Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources"). Groundwater quality has been initially screened with reference to both Environmental Quality Standards (EQS) for salmonid fish and EC Drinking Water Standards for comparative purposes due to the proximity of the Afon (River) Rhymney and the presence of a Minor Aquifer beneath the site. Surface water assessment has been initially screened with reference to EQS for salmonid fish due to the rapid flow of surface water across the site towards the Afon (River) Rhymney.

A 'suitable for use' approach was adopted, in line with the proposed mixed-use development for the study site.

An assessment has been made of the degree of contamination present and the likelihood of there being a 'significant pollutant linkage' in accordance with the Environmental Protection Act 1990. Consideration was also given to other relevant legislation, including the Water Resources Act 1991, Waste Management Licensing Regulations 1994, and the Water Act 2003.

The assessment determined the risks of hazards present on site affecting receptors via pathways for the following generic uses:

- Existing Use and Future Commercial Use;
- Future residential use;
- Future schools and playing fields; and
- Future public open space.

The main 'drivers' for remediation are the impact on 'controlled waters', human health and property from the soils, liquids and waters present at the site, resulting in the largest component of remediation required. There is also a small, but significant, cost implication

between remediation for commercial use and that for residential/open space/educational facility.

### **Environmental Improvement Strategy**

This strategy has been formulated to reduce the potential liabilities under the Environment Act 1995 S57 Part IIA and to ensure the site is suitable for mixed - use development. Consideration of other legislative frameworks has been taken into account in this assessment. These are the Water Resources Act 1995, the Waste Management Licensing Regulations 1994, and the Water Act 2003.

Risk derived site action values have been used to assess human health risk from soil contaminants in the upper 1.0m. A tier 3-risk assessment has been completed with reference to the Environment Agency R & D Publication 20 'Methodology for the derivation of remedial targets for soil and groundwater to protect water resources'. Soil and groundwater action values have been derived to be protective of the River Rhydney from the leachable components of PAH, BTEX and TPH.

Site action values for soil and groundwater will be proposed during remediation design phase, masterplanning of the development and after discussions with Environmental Health and Environment Agency.

The environmental improvement is to be achieved by removing or modifying the known significant contamination sources identified: -

- High soil concentrations of PAH, TPH and BTEX compounds associated with former product wastes having the capacity to leach to controlled waters;
- Areas of free phase (LNAPL) product and dissolved phase groundwater entering controlled waters in the Made Ground / shallow drift deposits (minor aquifer) and the sandstone (minor aquifer);
- Areas of free phase (LNAPL) product and dissolved phase groundwater polluting groundwater under the Water Resources Act;
- Vapours from the free product and soil waste in the process areas and licensed tip have the potential to significantly impact on future site users;
- High soil concentrations of PAH, TPH and BTEX compounds associated with former product wastes having the capability to directly be in contact with site users and impact human health;
- Dense carbon dioxide gas may enter basements and excavations, causing an asphyxiation risk;
- Risk due to inhalation of asbestos fibres, due to excavation and construction activities;
- Combustion risks in high calorific value soils, should infrastructure construction create an ignition source;
- Acidic / aggressive soils impacting on construction materials;
- Attack on new potable water supplies by soil chemical conditions;
- Soil contaminants (PAH, BTEX, TPH, Lead, Arsenic) located in isolated areas within the colliery surface coking plant and railway corridor, having the capability to impact human health through direct contact, ingestion and plant uptake.

The re-profiling of the tips by CCBC will also have an influence on the remediation perhaps by use of the material as cover, thereby influencing finished site levels. The hazards to be remediated are shown on Figure 6. Service corridors would need to be maintained especially in the Transco mains area.

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Several different remedial techniques are feasible to treat the materials and products identified. For soils it is likely that thermal desorption, incineration, bioremediation and excavate and replacement methods will be suitable. For ground waters, a combination of methods involving free product source removal and pump and treat would be feasible. Proper-engineered control of groundwater in the hillside will be required during soil removal and/or treatment operations.

The most beneficial, sustainable and cost effective remedial method would be a combination of soil treatment using bioremediation methods combined with excavate and replacement, product removal and groundwater treatment. Initially, excavation and disposal methods would remove the 'very high' concentration organic rich soils, combustible materials and high lead concentration soils. These areas of highly contaminated soils would be removed from site to a suitably licensed landfill. The areas of the tip, benzol plant and smaller outlying areas would be subject to bioremediation and the bioremediated soil would be placed and compacted where they would be suitable for future use, after removal of leachable components. A mobile plant licence would be required for this operation. This strategy would be more sustainable by reducing the export to landfill and reducing the import of 'clean' materials from quarried sources. It would further reduce the amount of lorry movements to and from this area on congested local roads. The impact of the new landfill directive on costs in relation to co-disposal is unknown at this stage

The remediation required for the proposed mixed use development will require a combination of the following:

- Soil treatment (bioremediation and excavate and replace);
- Free product (oils) source removal;
- Groundwater dissolved phase treatment or monitored natural attenuation.

An amount of separation to remove metal objects, asbestos and other materials will be required as well as limited removal of outlying hazards by excavate and disposal methods. Concrete is available in foundations to be re-used as fill materials following on-site crushing.

Remediation of the COPA 'Licensed tip' does not require negotiation of liabilities in respect of the Waste Management Licensing Regulations.

Chemical validation testing would be carried out at the sides of the excavations with samples taken in each excavation cell to confirm that the site action values have been achieved. Where action values are not achieved the excavation would be assessed on a statistical basis to define the significance of the individual results. Validation testing of materials in biopiles before during and after treatment would confirm end product chemical validation.

Product removal / groundwater treatment will require testing before during and after remediation treatment including rebound testing to ensure clean up criteria are achieved.

After validation of the excavated area, the areas will be left prior to re-profiling using colliery spoil.

The waste would be properly handled under the Duty of Care obligation under the Environmental Protection Act 1990. Remaining hard materials would be recovered and recycled as backfill materials if appropriate.

Future monitoring of the site is not a requirement as source removal and bioremediation verification negates this requirement, for soils and ground waters.

A comprehensive validation report following WDA guidelines would be compiled for the site works, taking account of any variations to the strategy and recorded outcomes.

## Control Measures

Dust suppression measures would be maintained together with noise control in line with current legislation. If necessary, the site would make use of odour suppression during the works to control the odours during removal of materials. The common elements of the environmental improvement works to be carried out are as follows: -

- Use of term Planning Supervisor to oversee the works.
- Use of contractors familiar with former coking works remediation for both remediation and supervision.
- Use of communications letters and liaison for public relations.
- Environmental and occupational monitoring of air, noise and dust.
- Final site level validation and verification.

All works would be completed with the agreement of the Environment Agency and local Environmental Health Officer. Segregating clean and dirty areas, in accordance with HSE Guidance, will control the site contamination.

The proposed site working hours subject to agreement with the authorities would be;

Mon - Fri        0800 - 1800hrs

Sat                0800 - 1300hrs

Specific haul routes for exported and imported materials would be agreed with the Local Authority Highways Dept and / or police.