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THE DECONTAMINATION OF A DISUSED GAS WORKS SITE

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Summary

This paper describes work carried out at a site which was to be cleared prior to its use for erection of a large retail superstore together with its adjacent car park A preliminary site investigation indicated that contamination, especially by tar, was widespread and that numerous underground pipes and tanks were also present During site clearance approximately 10,000 m^3 of contaminated solid material was removed and deposited in two licensed landfill sites 25 km and 40 km from the gas works Liquid tar was adsorbed onto contaminated solids prior to disposal A below-ground gas holder was used as a holding tank for contaminated aqueous liquids to enable suspended solids and immiscible organics to separate After removal of contaminated material the site was covered with clean, crushed and compacted stone having known geotechnical characteristics

Introduction

In industrial countries, expecially the U K , there is increasing need to re-utilise the derelict land which has originated from the demise of certain manufacturing processes or from disposal of wastes from these and other currently operating industries Examples of processes which have given rise to derelict land include steel making, chemicals manufacture and the carbonisation of coal to produce town gas

In the U K there has been considerable interest in the re-use of coal production gas sites since often these, as a result of urban expansion, are now situated in prime positions close to town centres Many such sites have become available due to replacement of coal gas by methane from the North Sea in recent years However, the re-development of such sites poses problems since invariably they are contaminated to a greater or lesser degree by materials originating from the gas-making process The contaminants could give rise to health hazards in the short term to workmen engaged in the redevelopment and in the long term to people working or living on the site In addition, smells due to presence of contaminants could cause environmental nuisance while other contaminants may attack and degrade building foundations

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A comprehensive survey of the problems associated with the redevelopment of gas works sites has been made by Wilson and Stevens [1] The principal contaminants are usually tars, phenols, cyanides, elemental sulphur and sulphates In addition to chemical contamination there may be problems due to the presence of massive concrete foundations as well as underground pipes and tanks which still contain appreciable quantities of contaminated liquids including tar Prior to any site clearance being undertaken it is now normal practice to carry out a site survey to ascertain the extent of such problems so that appropriate remedial action can be taken

This paper describes work carried out at a site in the Midlands of England which was to be developed for a large retail superstore together with its adjacent car park

Description of site

The site is a level, irregularly shaped piece of land approximately 130 m by 100 m, divided into two roughly equal sections by a brick wall (Fig 1)

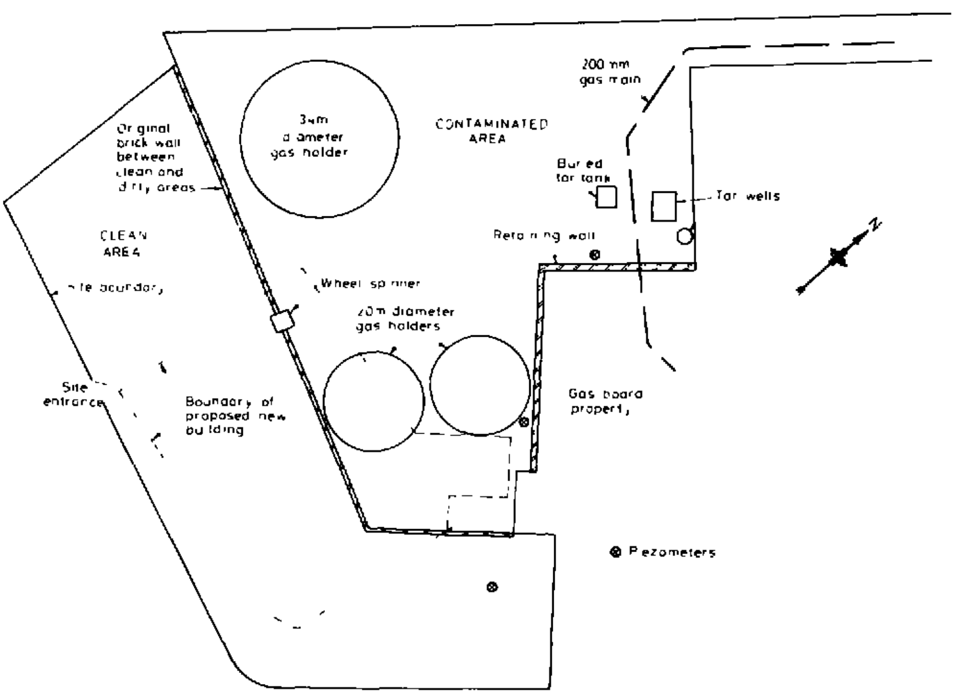

Fig 1 Plan of gas works site

The section to the south of this wall had previously been occupied by buildings used by the local technical college but these had been demolished to ground level, their cellars being filled in with demolition rubble The area north of the wall had been occupied by buildings associated with the gas works, which again had been demolished However, it was still possible to distinguish the retaining walls of two gas holders which were 34 m and 20 m in diameter, respectively Visual inspection of the site showed signs of blue complex iron cyanides known as "blue billy" on isolated surface areas, which were derived from gas purification processes normally used in the industry In addition, underground concrete tar tanks filled with a mixture of tar and rubble were visible on the northern edge of the site An area outside the development site boundary, which was to be retained by the Gas Board as a car park, and also a large operational holder were not to be redeveloped although they formed part of the original gas works site

Coal gas had been produced on the site since about 1850 but no detailed plans were available which would show the various alterations to the plant which undoubtedly occurred during the intervening years However, one plan dated 1950 suggested that a further gas holder, 20 m in diameter, not now visible, existed at that time

Preliminary site investigation

An inital site investigation was conducted in two phases, both of which involved the excavation of trial pits to a depth of approximately 2 5 m The first phase of this investigation, carried out jointly by Soil Investigation Services of Stanford, Lincolnshire and ABC Testing under the supervision of Kenchington, Little and Partners, suggested that the site was heavily contaminated in places by tar and also cyanides, especially in the neighbourhood of the still visible 20 m gas holder base In addition, it was learnt that this holder had not been cleaned out thoroughly but had been simply filled with demolition rubble and contaminated material when the site had been cleared The larger holder (34 m diameter) had also been filled with rubble from the demolished college buildings

During early October 1983 immediately prior to commencement of site clearance a more extensive investigation was carried out by staff from the Harwell Laboratory Fifty-one trial pits were dug on a 10—15 m grid These showed that high levels of contamination, especially tar, were present over much of the area occupied by the gas works, and that numerous large diameter cast iron pipes were buried beneath the surface In addition, some limited lateral spread of contaminants had occurred into the "clean" area formerly occupied by the college buildings

The trial pits also showed the presence of 2—2 5 m of sandy silts above underlying clay The coarseness of the sandy silts increased with depth and a thin layer of water-bearing gravel existed just above the clay Some groundwater infiltration was therefore apparent A limited amount of analysis was performed on both solid and liquid samples taken from some of the pits Typical analyses are given in Table 1

Pits 16 and 18 and also 28 and 29 were within the area of the 34 m and

20 m holder bases, respectively. The preliminary investigation showed that these holder bases were filled with water but as contamination levels in the water were not too high, discharge at a slow rate to foul sewer would be acceptable

TABLE 1

Typical analyses of solid and liquid samples taken

Apart from pH, results on solids are expressed as μg/g while those on liquids are as mg/l

	Solids					
	Total CN	Phenol	Toluene extractable material	pH		
Pit 1 (surface)	4,000	45	4 000	5 0		
(0 5 m)	100	5	8,000	3 7		
Pit 7 (1 0 m)	45	2	14,000	7 3		
Pit 9 (1 0 m)	170	2	9,000	7 2		
	Liquids					
	CN	SO_4	NH_4	TOC	Phenol	pH
Pit 7		810	150	33	0 11	7 7
Pit 16		1700	10	140	0 27	7 6
Pit 18	<0 05	1700	12	150	0 28	8 0
Pit 28	<0 05	170	7 8	48	0 13	7 8
Pit 29	<0 05	70	12	75	0 24	7 8

The contamination levels in the solids were above licence concentrations allowed for direct disposal of materials removed from the site at a local land-fill site Therefore a landfill licenced to accept such material was located but this was situated approximately 25 km from the site Unfortunately this landfill was not licensed to accept any liquid tarry waste so an additional landfill which was licensed to accept this material was used some 40 km from the site

Site clearance

Before clearance started a tank having a capacity of 45,000 l was installed on the site to act as a temporary storage vessel for contaminated liquid encountered during the work This enabled decisions as to the most suitable disposal route to be deferred while awaiting analytical results Although some samples were sent to the Harwell Laboratory for analysis during site clearance, a mobile laboratory was set up on site which enabled a range of sample analyses to be performed rapidly A wheel spinner and washing facility was installed to prevent contaminated material from being carried on to public roads by the removal lorries

As can be seen in Fig 1, the retail store was to be built mainly on the "clean" area although it extended partly into the "dirty" area originally occupied by the gas works. The car park was to occupy the remainder of the "dirty" area As a consequence of preliminary chemical and geotechnical investigation it was decided to remove all the material beneath the designated building area down to the underlying clay and to replace this with crushed rock and compacted sub-base, so that the development would take place on uncontaminated material having known geotechnical characteristics

Removal of uncontaminated material commenced during the last week of October using an Akerman H9B excavator It was confirmed that some lateral contamination extended approximately 5 m into the "clean" area but was confined to the coarse gravel layer above the clay This material was separately removed to the licensed landfill while the uncontaminated material was transported to the local landfill site.

A second Akerman excavator was brought in to work on the contaminated gas works area It rapidly became apparent that contamination, mainly due to tar, was extensive, especially beneath the large cast iron pipes which had linked the ovens with the purifier and gas holders The 20 m diameter holder mentioned previously was located and excavated It was found to be approximately 6 m deep and had a domed base formed from the underlying clay which had then been covered by brickwork The surrounding "ditch" contained narrow concrete buttresses to prevent the sides of the holder from penetrating into the clay (Fig 2) The water in the holder showed only fairly low levels of dissolved contaminments (TOC 35 mg/l, phenol 0 7 mg/l and ammonia 11 mg/l) but was covered by a thin layer of tar The tar was removed by pumping the water into the second 20 m holder which still contained rubble and earth Tar-free water could be removed from this to sewer by pumping from a sump dug in the rubble This treatment also served to remove suspended solids from the water Considerable quantities of tar which were present in the ditch at the base of the holder were removed by the excavator after adsorbing the tar on dry but contaminated solid material from elsewhere on the site. The holder was filled with crushed rock followed by sub-base

The concrete tar tank (Fig 3) on the northern boundary was then decontaminated. This structure consisted of several interconnected chambers having a total volume of about 60 m^3 Two skips were originally filled with tar but these posed transport problems since the contents had a low viscosity. The remainder of the tar was therefore adsorbed on to contaminated solid material as above. A smaller tar well having a depth greater than 5 m and a buried 20 m^3 steel tank containing tar were later found in this area of the site. They were decontaminated using the same method. Considerable care was needed not to fracture a "live" 200 mm high pressure gas main close to the tar tanks Contaminated material from around this pipe was re-

Fig 2 Excavated gas holders

Fig 3 Tar tank

moved by hand digging Many of the numerous gas pipes exposed during the site clearance work were checked by officials from the local Gas Board before removal to confirm that they did not still contain gas

The 34 m diameter gas holder base would be under the proposed car park so that complete removal of the contents were not considered to be necessary After breaking down the retaining walls to 1 m below final level using a concrete breaker, 1 m of the rubble fill was removed and replaced by sub-base after lowering the water level in the holder by pumping to sewer

The remaining 20 m diameter holder base was thoroughly cleaned out The design was similar to the buried holder base which had earlier been excavated, being about 6 m in depth Most of the water contained in it was pumped to sewer but the water at the base again had a high suspended solids content together with tar Since no large convenient settling tank was available this was removed from the site by tanker by local waste disposal contractors Approximately 60,000 l of contaminated liquid was removed in this manner

Contaminated solids were then removed from the remainder of the site to a depth of 1 m In some areas where areas of high contamination were encountered a greater depth was removed, these areas were found particularly under buried pipes During the whole operation approximately 10,000 m^3 of contaminated solids together with a few cubic metres of liquid tar were removed and deposited in licensed landfill sites Approximately 14,000 m^3 of crushed rock and sub-base were required to replace the contaminated and clean solids which had been removed and to bring the site up to final level Site clearance took approximately one month to complete

Finally a concrete wall was formed along part of the northern boundary to prevent any ingress of contaminants from the part of the site still retained by the Gas Board into the now decontaminated area Three piezometers were installed in the cleaned area close to this concrete wall to enable long-term monitoring of ground water to be undertaken

Discussion

1 The extent and degree of contamination at this site was somewhat greater than had been suggested in the original survey, with the result that eventually about 10,000 m^3 of solid contaminated material was removed The main contaminant was tar containing some phenols, although complex cyanides were also present, mainly on the surface of the site

2 The spread of contamination throughout the site was aided by the nature of the geological formation, i e , 2—2 5 m of permeable sands/silts above underlying clay. The spread of contamination was more marked than at other gas work sites investigated by the Harwell Laboratory

3. Although considerable volumes of water were present in buried gas holder bases, tanks and pipes on the site the level of dissolved contaminants, e g , phenol, ammonia and total organic carbon, was not high This allowed

discharge at acceptable pumping rates to a foul sewer which fortunately ran close to the site During site clearance it was possible to use one of the gas holder bases successfully as a settling lagoon for removal of suspended solids and separation of tars

4 The contents of tar tanks and well were adsorbed on dry, chemically contaminated solids present on the site, which were then transported by normal lorries to licensed landfill sites

5 Numerous large buried pipes and tanks whose position was not shown on available site plans were encountered Contamination was very marked around and underneath such pipes It is probable that liquid spillages seeped through disturbed ground around these when the plant was operational

6 Massive concrete and/or brick foundations were widespread, which required the use of mechanical concrete-breakers before the broken material could be removed from the site Sulphate attack on concrete was obvious in many areas

7 During the clearance, analysis of waters encountered on the site was required fairly frequently to check that they were suitable for discharge to foul sewer Mixing of waters of varying purity was practiced in order to reduce the overall level of contaminants in the liquid waste stream to acceptable concentrations in the sewer For the solid materials on site, once the concentration range of major contaminants had been confirmed, little further analysis was required Contaminated material could be readily identified by appearance and its distinctive odour drawing on experience gained at other similar sites

References

1 D C Wilson and C Stevens, Problems arising from the redevelopment of gas works and similar sites, AERE-R 10366, 1981, obtainable from H M S O , £11 00