PART IIA OF THE ENVIRONMENTAL PROTECTION ACT 1990

ST LEONARD'S COURT

DECISION DOCUMENT

Environment Agency

November 2005

CONTENTS

1. Introduction

1. This document (known hereafter as the decision) is the decision of the Environment Agency (the Agency) as to whether to issue a remediation notice in respect of land at St Leonards' Court (SLC) and as to the contents of that notice. This decision is made in the light of the consultation process initiated under s. 78H(1) of the Environmental Protection Act 1990 (EPA). Responses were received from the potentially appropriate persons (PAP) on 16th April 2004 [Woolwich Homes Limited (Woolwich)], on 21st April 2004 [Crest Nicholson Residential Limited (Crest)] and on 23rd April 2004 [Redland Minerals Limited (Redland)]. These are known as the first responses in this document, which takes account of them.

2. A draft of this decision and a draft remediation notice were sent to all who had initially been consulted, including Woolwich, Crest and Redland on 20th December 2004. Responses were received from the potentially appropriate persons (PAP) on 31st March and 28th July 2005(Crest), 18th March 2005 and 6th June 2005 (Woolwich) and 13th June 2005 (Redland). These responses, known as the second responses, have been taken into account in making this decision

3. Glossary of terms and acronyms used in this decision:

AP	Appropriate person
Beechgrove	Beechgrove (Sandridge) Management Limited
BHR	Bostock Hill & Rigby

Chemfix	Chemfix International Limited, advisers to Crest
Circular	Annex 2 of the Department of the Environment, Transport and Region's Circular 02/2000
Consultation	Document initiating the consultation process under s. 78(1) EPA
Crest	Crest Nicholson Residential Limited
DAC	Davies Arnold Cooper
DDD	Draft decision document
EA	Environment Act 1995
EPA	Environment Protection Act 1990
First responses	Responses as set in paragraph 1 from Crest, Woolwich and Redland received in April 2004
Guidance	Annex 3 of the Department of the Environment, Transport and Region's Circular 02/2000
HCC	Hertfordshire County Council
JF	The Jersey Farm landfill site and lagoon
JT	Jenny Thomas, Agency employee
MM	Mott MacDonald
MR	Malcolm Roberts, former Agency employee
Notice	The remediation notice
PAP	Potentially appropriate person
Redland	Redland Minerals Limited
ROD	Record of determination by St Albans District Council – 12th June 2002.

SA	Salvation Army
SADC	St Albans District Council
Second responses	Responses as set out in paragraph 2 from Crest, Woolwich and Redland to the draft decision document
SLC	St Leonard's Court
SPL	Significant pollutant linkage
TVW	Three Valleys Water
TW	Thames Water
TWA	Thames Water Authority
Water Regulations	The Water Supply (Water Quality) Regulations 2000 (SI 2000 No: 3184)
Regulations	The Contaminated Land (England) Regulations 2000 (SI 2000 No: 227) as amended by the Contaminated Land (England) (Amendment) Regulations 2001 (SI 2001 No: 663)
Woolwich	Woolwich Homes (1987) Limited
WA	Water Act 2003
WRA	Water Resources Act 1991
ug/l	equates to mg/m^3 in a liquid sample

2. Structure of this decision

4. The decision considers:

- the background to the matter,
- the determination of SLC under Part IIA of the EPA 1990 and its designation as a special site,
- the five stages to determine liabilities for remediation in accordance with Annex 3, Chapter D, Part 3 of the Guidance:

  1. Identifying potential appropriate persons and liability groups
  2. Characterising remediation actions
  3. Attributing responsibility between liability groups
  4. Excluding members from a liability group
  5. Apportioning liability between members of a liability group

- The Remediation Notice (the Notice), including any specific issues raised by the first and second responses in relation to the detailed provisions of the Notice.
- any specific issues raised by the first responses and second responses of Crest and Redland not already dealt with and
- finally, the decision making process.

The key decisions are set out in bold type in the document and appear together at section 9.

3. Documentation

5. With this document are served three indices listing documents supplied with the initial consultation and any documents subsequently taken into account:

- Relevant documents,

- Reports and
- Planning documents.

6. In the consultation document reference was made to the documents supplied to each PAP. As stated in the consultation document, (1-6) refers to the sixth document as set out in index 1, (2-11) to the eleventh document as set out in index 2 and so on. The same system of referencing will be used in the decision. The decision should be read in the light of the consultation initiated on 10th October 2003, the responses received and the documents supplied, including the documents supplied with the penultimate draft of this decision on 20th December 2004. The indices include those documents supplied to the PAPs after the original consultation document was served and correspondence passing between PAPs and the Agency since then.

7. In making this decision the Agency has had regard to:

- The factual material set out above
- The initial representations of the PAPs (Hammonds letter of 14th February 2003 (1-166), Lafarge's representations of 7th April 2003 (1-173), Taylor Waltons' letter of 6th December 2002 (1-144) and Allen and Overy's letter of 31st January 2003 (1-162).
- The first and second responses
- Part IIA EPA

- The Contaminated Land (England) Regulations 2000 (SI 2000 No: 227) (the Regulations)
- The Contaminated Land (England) (Amendment) Regulations (SI 2001 No: 663)
- Annexes 3 to 6 of the Department of the Environment, Transport and the Regions Circular 02/2000 (the Guidance)
- Annex 2 of the Department of the Environment, Transport and the Regions Circular 02/2000 (the Circular)
- Annex 1 of the Department of the Environment, Transport and the Regions Circular 02/2000
- The provisions of the Human Rights Act 1998
- Decided authorities on the meaning of "knowingly permitting"

4. Background

4.1 History of contamination and development at SLC

8. Bromate and bromide in the chalk aquifer in the vicinity of Hatfield, Hertfordshire, originate from the site of a former chemical works in Sandridge that operated from 1955 until approximately 1980, now called St Leonard's Court (SLC), as shown edged red on plan 1 attached hereto. Raw materials including bromine, red and yellow phosphorus and caustic soda were processed into various products including ceta-stearyl bromide and other organobromine compounds, sodium and potassium bromate and zinc bromide. Chemical manufacture ceased in or around 1980 and SLC

was redeveloped as high-density housing from 1985 to 1987. Appendix 4 of report 2-9 sets out a list of chemicals used or produced at SLC.

9. The contamination of the groundwater with bromate and bromide was first discovered by Three Valleys Water (TVW) in late May 2000 when it was testing groundwater in preparation for implementation of a new limit (which came into force in December 2003) of 0.01mg/l for bromate in drinking water under the Water Supply (Water Quality) Regulations 2000 (SI 2000 No. 3184) (the Water Regulations)

10. Since May 2000, TVW's groundwater abstraction at Bishops Rise, Hatfield has been closed and restrictions have been placed on the use of three private supplies at Nashes Farm, Capps Cottages and the Home Office PSDB establishment. This was because bromate levels were in excess of the limit prescribed in the Water Regulations. At a second TVW groundwater abstraction at Essendon rising concentrations of bromate are restricting its use such that the water abstracted has to be blended with other uncontaminated water.

11. In addition, public supply boreholes operated by Thames Water (TW) in the Middle Lee Valley between Ware and Turnford, some 20km from SLC, have shown concentrations of bromate up to 67μg/l.

12. The source of this contamination is the former chemical works at Sandridge.

13. SLC is now a residential development consisting of houses and communal open space. Each house is let on a long lease whilst the freehold remains with Beechgrove.

4.2 Chemical terminology

14. This section describes the properties of bromate, bromide and the organic chemicals that occurred at SLC, and defines some associated chemical terms. Chemical symbols for some of the substances discussed are given in brackets.

15. Bromides (Br^-) are a class of chemicals similar to chlorides (Cl^-), of which the most familiar example is common salt, sodium chloride (NaCl). Particular bromides, such as sodium or potassium bromide (NaBr or KBr) consist of a negatively charged atom of bromine (a negative ion, or anion) combined with a positively charged atom (a positive ion, or cation) of sodium (Na^+) or potassium (K^+). Sodium and potassium bromides are white crystalline solids, highly soluble in water, similar to common salt. When dissolved in water the bromide negative ion separates from the accompanying positive ion. It is this free bromide ion which is measured by chemical analysis. Hence, in the dissolved state it is appropriate to talk about 'bromide' rather than specifying it as for example, 'sodium bromide'.

16. The above description applies equally to bromates, the difference being that the bromate negative ion (BrO_3^-) consists of one atom of bromine combined with three atoms of oxygen. If the bromate ion loses the oxygen atoms (a process known as

reduction) it becomes a bromide ion. This is the process by which bromate could be converted to bromide in the environment. The reverse process of formation of bromate from bromide is highly unlikely to occur under any conceivable conditions within soil, groundwater or surface water in the UK.

17. An organic chemical (or compound) is broadly one which contains carbon, derived from living organisms or man-made (e.g. plastics). Other chemicals, including sodium or potassium bromate and bromide are described as inorganic. The organic chemicals known to have been present at SLC are likely to have been mainly liquids. Brominated organics or organobromine chemicals are organic chemicals which contain bromine. Properties of organic chemicals which differ from those of bromate and bromide and are relevant to the circumstances of SLC are:

- Lower solubility in water
- Characteristic odour
- Tendency to volatilise
- Tendency to decompose in the soil into other organic chemicals and, ultimately, to inorganic chemicals.

In addition, many organic chemicals are unacceptable in drinking water at concentrations two orders of magnitude lower than the current limit for bromate.

4.3 The ground and water beneath SLC

18. Immediately beneath SLC, to a depth of 3-5m, the ground comprises sands, grave ls and clays in discontinuous layers. Underlying these is chalk of which the top layer, up to 6 m thick, is weathered to a soft, clay-like consistency described as 'putty chalk'. Putty chalk and clays are highly porous (i.e. will hold a lot of water) but have low permeability (i.e. water cannot easily flow through them). The water table, which varies with time and location, is typically 2-5m below ground level at SLC.

19. Beneath the putty chalk at, and downgradient of, SLC the chalk consists of relatively hard blocks (referred to as the chalk matrix - typical dimensions 0.1-0.5m) which, like the putty chalk, have high porosity and low permeability. These blocks are separated by cracks ('fissures'). This material can be loosely described as 'blocky chalk'.

20. The water in soil or rock is contained in spaces (pores or fissures) between the solid particles. Above the water table these spaces are generally only partially filled with water, which is held in place by capillary suction forces but moves downwards when rainwater soaks into the ground. Very small pores, such as those in clays, the putty chalk and the matrix of the blocky chalk do not drain under gravity. Below the water table the spaces are full. Where these spaces are large and interconnected (e.g. in gravel, or in fissures in the blocky chalk) the water in them can move easily. Where they are small, as in the pores of the clay, putty chalk or the blocks of the blocky chalk, it can move only very slowly.

21. It is helpful to distinguish three locations for dissolved contaminants (e.g.bromate or bromide) in the land beneath SLC:

(a) In the pore spaces above the water table. In the case of SLC, this means the fine pores in the putty chalk or the pores in the overlying mixture of clays (fine pores) and sands or gravels (larger pores).

(b) In the pore spaces below the water table. In the case of SLC this largely means the fine pores in the putty chalk or in the blocks (matrix) of the blocky chalk. The bromide in fine pores in locations (a) and (b) can move from these into adjacent pores or fissures only very slowly (i.e. over years).

(c) In the fissures below the water table. Because the fissures form a fairly continuous network and are large compared to the chalk pores, water flows through them much faster than through the pores. It is this flow which allows groundwater to travel long distances and which provides the flow to abstraction boreholes.

4.4 Determination and designation of SLC under Part IIA EPA including consideration of the validity of the SPLs

4.4.1 SLC as contaminated land

22. On the 20th June 2002, St Albans District Council (SADC) notified the Agency that SLC had been identified by them as contaminated land under Section 78B(1) (EPA) (1-133).

23. The reasons for that decision were set out separately in a Record of Determination that Land is Contaminated Land (ROD) adopted by SADC through the appropriate cabinet member on the 12th June 2002 (1-132). The ROD identified four SPLs as follows:

Source	Pathway	Receptor
1. Bromate in soil & unsaturated zone	Unsaturated zone	Controlled waters
2. Bromate in soil & unsaturated zone	Unsaturated zone & groundwater	Potable abstraction boreholes
3. Bromide in soil & unsaturated zone	Unsaturated zone	Controlled waters
4. Bromide in soil & unsaturated zone	Unsaturated zone & groundwater	Potable abstraction boreholes

24. Contaminated land is defined in S78A(2) EPA as:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused".

25. According to Chapter A of Annex 3 of the Guidance, for land to be determined as contaminated a pollutant linkage must be identified (paragraph A.17 of the

Guidance).

26. The following is the basis for the significant pollutant linkages (SPL) initially determined by SADC at SLC:

(a) Contaminants: SLC was used for the manufacture of a range of organic and inorganic bromine compounds. The ROD records two contaminants at SLC namely, bromate and bromide which are present in the ground above the water table.

(b) Pathways: Both bromate and bromide are:

- soluble in water and
- therefore, have the potential to leach into the groundwater below SLC and then to be carried by the groundwater beyond SLC.

The ROD records two pathways: (a) the unsaturated zone and (b) the unsaturated zone and groundwater.

Atkins, consultants to the Agency, have shown the significance of such pathways by applying the ConSim mathematical model to data arising from site investigations in August 2000 and November 2001 (3-24).

(c) Receptors: According to the ROD, the receptor, the groundwater, is controlled waters. Controlled waters under s. 78A(9) EPA has the same meaning as in Part III of the Water Resources Act 1991 (WRA) except as amended by s. 86(2)(f) of the Water Act 2003 (WA) – i.e. it includes "any waters contained in underground strata" within the definition of controlled waters.

4.4.2 SLC as a special site

27. Under regulation 4(2)(c) of the Water Regulations a water supply company cannot supply water for human consumption if it contains substances of the concentrations or values outside the parameters listed in tables A and B in Schedule 1. Bromate is listed in table B and the concentrations of bromate in groundwater attributable to SLC exceeded the concentrations set out in that table.

28. Under regulations 2(1)(a) and 3(a) of the Regulations, contamination which affects the wholesomeness of the drinking water is a trigger for designating contaminated land as a special site. Where contaminated land is designated as a special site the Agency becomes the regulator in place of the local authority.

29. Therefore, the Agency assumed responsibility as the regulator for SLC on the 8th of August 2002. The Agency is under a strict duty under s. 78E EPA in that:

"*where-*

(a) any land has been designated as a special site …

the enforcing authority [the Agency] shall … serve on each person who is an appropriate person a notice ..,"

(emphasis as underlining added)

4.5 Reconsideration of the validity of receptors within the SPLs as determined by SADC

30. During the Agency's consideration of SLC, the consultation and the representations received from the PAPs a question arose over the validity of *"potable abstraction boreholes"* as a receptor within the terms of the Guidance. In other words, are the potable abstraction boreholes within paragraph A.13(b) of the Guidance: that is, are *they "controlled waters which are being or could be polluted by a contaminant"*?

31. The issue the Agency considered was whether the words *"potable abstraction boreholes"* are describing "controlled waters" which are being polluted. On their ordinary meaning the words do not. The SADC determination relating *to "potable abstraction boreholes"* does not describe controlled water but an engineered feature namely a borehole. If the SPL were to *say "groundwater reaching potable abstraction boreholes"* the identification of the SPL would be correct. However, once the water is abstracted from the borehole and arguably once it is even in the borehole as opposed to contained in the underground strata, it ceases to be controlled waters.

32. An abstraction borehole is a location at which water is abstracted and is, therefore, not controlled waters. Given that it is not controlled waters within the meaning under the WRA and as amended by the WA it cannot fall within the meaning of receptor.

33. In reaching this conclusion, the Agency has had regard to paragraph C.15 of the Guidance. The Agency is not satisfied that it would be appropriate to designate SLC under Part IIA based on the SPLs which have the potable abstraction boreholes as receptors. The Agency does not consider they meet the definition given.

34. Therefore, *"potable abstraction boreholes"* as the receptor of the SPL are outside the wording of the Guidance. The Agency's position is that it is no longer relying on the *"potable abstraction borehole"* SPLs. There is no reference to them in the remediation notice. However, it is appropriate to maintain the groundwater as a pathway in the remaining SPLs.

35. Any reference to the SPLs below is a reference to the groundwater SPLs and not the borehole SPLs. Individually they will be referred to as the *"bromate SPL"* and the *"bromide SPL"*.

5. Determination of liability to carry out remediation in accordance with Part IIA EPA and the Guidance Annex 3

Chapter D.

36. The notice sets out four assessment actions to be taken to assess the bromate SPL and one assessment action to assess the bromide and bromate SPLs. The reasons for specifying these assessment actions are set out below at section 7.

37. The decision will now go on to apply the procedure as set out in the Part 3 of Chapter D of the Guidance to determine who is liable to carry out the remediation actions specified in the notice. The next paragraphs therefore consider the principal arguments for each PAP being an appropriate person (AP).

5.1 The first stage: identification of appropriate persons and liability groups

5.1.1 The Definition of an appropriate person

38. S. 78F(2) EPA states that:

> *"… any person … who caused or knowingly permitted the substances … by reason of which the contaminated land in question is such land to be in, on or under that land is an appropriate person."*

39. Paragraph D.5(a) of the Guidance defines such a person as a potential Class A person.

5.1.2 Knowingly permit and the case law

40. Paragraph 9.12 of the Circular states,

> "*In the Government's view, the test [of knowingly permitting] would be met only where the person had the ability to take steps to prevent or remove that presence and had a reasonable opportunity to do so*."

41. As suggested by paragraph 9.15 of the Circular, the Agency has also taken into account the relevant case law indicating how the phrase, knowingly permit, has been interpreted in similar statutory contexts.

42. The Government's analysis is confirmed in case law such as *Bromsgrove District Council v Carthy and Another* [1975] 30 P & CR 34. In deciding whether an occupier could be held to be permitting gypsies to be on his land, regard had to be had to what steps he might reasonably have taken for their removal and that it was prima facie for the justices to decide as a matter of fact what steps were reasonable or unreasonable in a particular situation (see also *Schulmans Incorporated Limited v National Rivers Authority* [1993] Env LR D1). Therefore, to show that a PAP knowingly permitted the presence of bromide/bromate the Agency must show that:

(a) The PAP knew about the presence of bromide/bromate and

(b) in the light of that knowledge, the PAP failed to do something which they could reasonably have done to prevent the bromide / bromate remaining under the land and in contact with the groundwater.

These two considerations are referred to hereafter as the knowingly permit test

5.1.3 Potential Class A persons

43. The Agency considered the following as potential Class A persons. They are considered in this decision in the following order:

Current owners/occupiers of houses at SLC

Beechgrove

The Salvation Army (SA)

Woolwich

Redland

Crest

5.1.3.1 Current owners/occupiers of houses at SLC

44. The current owners/occupiers of SLC may have purchased their leasehold interests from the freeholders, Beechgrove, or previous leaseholders of their properties.

45. The current owners/occupiers stand in the same position as Beechgrove since they did not cause the pollution and would have found out about the contamination only at the stage of identification of SLC as contaminated land by SADC.

46. **This decision determines that the current owners/occupiers are not a Class A person by virtue of not causing or knowingly permitting the pollution for either SPL.**

47. Whilst the current occupiers occupy land at SLC under a leasehold interest and are potentially a Class B person a Class A person has been identified for both SPLs so there is no need to invoke s. 78F(4) EPA (see also paragraph 9.16 of the Circular) and, in any event, a Class B person cannot be held liable for pollution of controlled waters (s. 78(J)(2) EPA).

5.1.3.2 Beechgrove (Sandridge) Management Limited

48. Beechgrove acquired the freehold of SLC from Woolwich on 18th January 1989 and is still the freeholder. Beechgrove's shareholders are the leaseholders of the individual properties at SLC [see letters from Allen & Overy to Agency dated 31st January 2003 paragraph 6 (1-163), Beechgrove's solicitors' (Taylor Walton) letter to Agency dated 6th December 2002 (1-144), Hammonds to Agency dated 25th July 2003 (1-211) and transfer of 18th January 1989 (1-123)].

49. As such, Beechgrove did not cause the pollution. Neither did it knowingly permit the contamination. Beechgrove did not know of the contamination of SLC and have only discovered this through the determination by SADC. Paragraph 9.13 of the Circular addresses this point. It states that if an owner or occupier of land is notified by the local authority that the land is contaminated this does not trigger the knowingly permit test [see TW's letter to Agency of 6th December 2002 (1-145)].

50. This decision determines that Beechgrove is not a Class A person by virtue of not causing or knowingly permitting the pollution for either SPL.

51. Whilst Beechgrove is an owner of land at SLC and is potentially a Class B person a Class A person has been identified for both SPLs so there is no need to invoke s. 78F(4) EPA (see also paragraph 9.16 of the Circular) and further a Class B person cannot be held liable for pollution of controlled waters (s. 78(J)(2)).

5.1.3.3 Salvation Army

52. The Salvation Army (SA) owned a strip of what is now SLC occupying the space between the offices and laboratories and the long straight north east boundary (see plan D.1140, the plan to 3-1).

53. Crest purchased this area from the SA on 18th November 1983 [see page 1 of letter from Hammonds to the Agency dated 14th February 2003 (1-167)].

54. The SA does not have any record of having owned this strip of land [see letter from the SA to the Agency dated 30th May 2003 (1-185)].

55. No record exists of any activity carried out by the SA at SLC.

56. This decision determines that the SA is not a Class A or B person because, respectively, it did not cause or knowingly permit pollution nor can the SA be liable as a Class B person for pollution of controlled waters (s. 78(J)(2)).

5.1.3.4 Woolwich

57. Woolwich, now dormant, loaned funds to Crest to finance the development of SLC. In addition, it owned the freehold of SLC from 12th November 1986 until 18th January 1989 when the freehold was transferred to Beechgrove [see letter from Allen & Overy dated 31st January 2003, paragraph 6 (1-163) and transfer between Crest Homes PLC (1), Crest Estates Limited (2) and Woolwich Homes Limited (3) dated 12th November 1986 (1-116)].

58. Woolwich took no practical part in the development of SLC [see Joint Venture Agreement between Crest Estates Ltd (1), Crest Homes (Chiltern) Ltd (2), Crest Homes PLC (3) and Woolwich Homes Limited (4) of 29th October 1986 (1-112)].

59. Woolwich did not therefore cause the bromide or bromate, by reason of which SLC is contaminated land, to be in, on or under that land since it did not carry out any polluting activities.

60. There is the potential to argue that Woolwich could have knowingly permitted the bromide, by reason of which SLC is contaminated land, to be in, on or under that land. It was the freehold owner of SLC for over three years and purchased the land knowing of the contamination. Whilst it may not have had any control over the development of SLC it was still the freeholder and chose, through negotiating the agreement of 29th October 1986, to give responsibility to Crest to develop SLC. Paragraph 9.12 of the Circular may apply in that Woolwich had the ability to take steps to prevent or remove that presence and had a reasonable opportunity to do so [see Allen & Overy's letter of 31st January 2003 paragraphs 21 – 24 (1-163)].

61. In the consultation the Agency considered whether Woolwich knowingly permitted the contamination of the land and was a member of the liability group for the bromide significant pollutant linkage (SPL). In its first response, Woolwich disagreed with any arguments that it was a knowing permitter. Woolwich also argued that they should be excluded from the liability groups under a later stage in the sequence in any event. In this decision the Agency agree that Woolwich should be excluded at the later stage. Therefore, it is not necessary in this decision to examine and determine the argument that Woolwich knowingly permitted the pollution because it would be superfluous to do so in light of the conclusions reached

in applying the exclusions tests. The Agency will concentrate on the application of the exclusion tests for Class A persons and, more particularly, test 1 in paragraphs D.47 to D.50 of the Guidance (see section 5.4.2.1). For the purposes of this stage of the tests, it will be taken that Woolwich is a class A person for the bromide SPL although the Agency's position is that this is not necessarily the case.

5.1.3.5 Redland

62. The company now called Redland has been known as:

- prior to 3rd January 1966 FW Berk & Company Limited,
- from 3rd January 1966 Berk Limited,
- from 29th March 1977 Steetley Chemicals Limited,
- from 31st December 1986 Steetley Berk Limited,
- from 20th April 1988 Steetley Minerals Limited and
- from 1st November 1993 Redland Minerals Limited.

Any reference to Redland in this decision is also a reference to these previous identities.

63. Redland manufactured bromine-based chemicals, including sodium and potassium bromate, at SLC from approximately 1955 until about 1980. It was during this period that leaks and spills led to the chemicals entering the soil. Redland, therefore,

caused bromate and bromide, by reason of which SLC is contaminated land, to be in, on or under that land since it carried out polluting activities [Paragraph 2 of SADC planning permission of 19th April 1955 (3-1) and notes of interview with former Redland employee (1-125)].

64. This decision determines that Redland is a Class A person by virtue of causing the pollution for both SPLs.

5.1.3.6 Crest

5.1.3.6.1 Chronology of Crest's involvement with SLC

65. In August 1983 STATS produced, for Crest, an interim report, ref 83/3105 (2-2), on their first site investigation. Soil samples were taken at up to 3 depths, 0.5, 1.0 & 1.5m, from each of 5 boreholes. Boreholes 1 and 5 were in the front yard area used for storage of products & raw materials in drums, borehole 2 was in the area used for bromide manufacture, and boreholes 3 and 4 were in the area used for bromate manufacture. Bromate was not found above the detection limit of 20mg/kg.

66. Bromide occurred at 1000-2200mg/kg in boreholes 3 and 4, and at 100-500mg/kg in most samples from the other boreholes. No attempt was made at the time to compare these concentrations to natural background values, which have been shown by more recent investigations [Komex, October 2000 (2-22), Table 2, borehole MW001:

Atkins, December 2002 (2-24), Table 7.1, boreholes SLC01 and BH11)] to be of the order of 5mg/kg or less

67. Crest purchased part of SLC from Redland on 22nd September 1983 and the remainder from the SA on 18th November 1983 [see Hammonds' letter of 14th February 2003 (1-166)]. Crest, at paragraph 5.2 of its second response, state that a second STATS report, 83/3105A (2-3), was not available until Crest were committed by exchange to the purchase. There is no copy of the contract in the documents so the date given by Crest is taken as correct.

68. STATS second report, 83/3105A (2-3), dated September 1983, covered further work on the samples taken in the August investigation. It confirmed that the majority of bromide in the soil was water-soluble, in accordance with expectations from basic chemical knowledge.

69. Subsequently, between December 1983 and August 1986, a series of reports (2-4 to 2-20) recorded the findings of physical investigations of the SLC site and a parallel series of investigations of the site hydrogeology using mathematical models supported by groundwater sampling.

70. On 1st February 1984 planning permission was granted to Crest by SADC for 30 houses plus outline permission for office accommodation (3-10 and 3-11). Crest demolished the Redland buildings and hardstandings in March-April 1984 and SLC

was then left open to rainfall until hard surfacing in connection with the redevelopment was completed some time between November 1986 and October 1987 (see Crest second response paragraphs 5.4 and 5.44).

71. Crest did not proceed with the development permitted in February 1984, and submitted fresh applications for 70 houses on 10th December 1985 and for 66 houses on 20th March 1986. Permission for the latter was granted on 25th July 1986 (3-14 and 3-16), after which Crest commenced development.

72. By 17th September 1986, Crest had removed the soil at SLC to a depth of approximately 1m over much of SLC and deeper in the most contaminated areas [see letter dated 17th September 1986 from Chemfix to SADC (1-108) and letter dated 30th October 1986 from Chemfix to TW (1-113)].

73. Development of SLC into the housing that exists today was completed by late 1987 [see aerial photo, 11th October 1987, which shows construction of houses at SLC complete, possibly with some continuing work to finish off the landscaping and paved areas (1-121)].

74. Crest agreed to contribute to the cost of groundwater monitoring although the monitoring did not include bromate [see internal SADC memo dated 7th July 1986 (1-103)].

5.1.3.6.2 Are Crest a Class A person for the bromide SPL on the basis of causing or knowingly permitting?

5.1.3.6.3 Causing (bromide)

75. The Agency has considered Redland's argument that Crest is a causer. However, Crest did nothing to introduce the bromide, by reason of which SLC is contaminated land. They are not, therefore, a causer.

5.1.3.6.4 Knowingly permitting (bromide)

76. The Agency's case is that, in accordance with paragraphs 9.8-9.15 of the Guidance and the relevant case law, Crest satisfy the knowingly permit test because they knew of the presence of bromide in the land and groundwater, had the ability to take steps to remove that presence, had a reasonable opportunity to do so, and did not do so.

77. **Accordingly, this decision determines that Crest is a Class A person by virtue of knowingly permitting the pollution for the bromide SPL and is a member of the liability group for the bromide SPL.** The arguments supporting this conclusion are set out below.

78. What, therefore, follows is an analysis of the two elements of the knowingly permit test as set out in section 5.1.2: knowledge of the bromide and failure to do something

which Crest could reasonably have done to prevent the continued presence of bromide under the land both above and below the water table.

(a) Knowledge of bromide

79. Crest knew of the possible presence of bromide because it was aware of the history of chemical manufacturing, and also from analyses of soil and groundwater during site investigations commissioned for Crest.

Crest's knowledge of previous site manufacturing operations can be gleaned from the following letters:

- Letter from SADC to DAC, solicitors for Crest acting in the purchase from Redland, dated 7th July 1983 (1-38);
- Letter from DAC to SADC dated 12th July 1983 (1-39) and
- Letter from SADC to DAC dated 15th July 1983 (1-40)].

80. Crest knew about the presence of bromide before purchasing SLC as a result of the STATS site investigation report no 83/3105 of August 1983 (2-2). Crest also gained more knowledge about the presence of bromide from further reports (see 2-3, 2-4, 2-5, 2-13, 2-14, 2-18 and 2-19). In particular, Crest had the knowledge that high bromide concentrations occurred at depths well below the depth of approximately 1.5m from which most samples were taken during investigations - see results from

boreholes 1-3 drilled in March 1984 (2-9, Fig. A3.1), and borehole C1 drilled in January 1985 [Chemfix, March 85 (2-14, page 3, Table 1)].

81. Crest knew of the potential for groundwater contamination by bromide (see 2-2, 2-5, 2-9, 2-11, 2-13 and 2-14). It should be noted that in the Chemfix report of May 1984 (2-8) the focus of the modelling was specifically on bromide. In their March 1985 report (2-13) Chemfix recognised that, *"essentially the whole site is contaminated by inorganic bromides"* which *"most likely continue down into the chalk below the water table"* and *"are associated entirely with the water phase"*. The consideration of bromide by Chemfix demonstrates that it was considered a material polluting substance, requiring consideration, during the period of Crest's ownership of SLC.

82. In addition, there is correspondence in which Chemfix and TWA discuss the presence of bromide at SLC (see 1-39 to 1-119).

(b) Failure to do something which Crest could reasonably have done to prevent the continued presence of bromide under the land both above and below the water table

83. Crest took action only to the limited extent of testing for bromide and removing 1m or so of soil from the majority of the contaminated area. In the light of the knowledge available to them, the Agency considers that, after purchasing SLC, it would have been reasonable for Crest to have:

- removed more of the bromide-contaminated soil; and
- instituted a scheme of scavenge pumping to reduce the contamination of groundwater by bromide.

84. These actions should be considered not in isolation but as a package of measures which, if each had been applied in some degree in conjunction with the other, would have been both reasonable and effective.

85. Moreover, as previously highlighted, in March and April 1984 Crest demolished the buildings and hardstanding at SLC. Although this action in itself did not result in the bromide remaining in or under the land for any greater period of time than would otherwise have been the case, it did allow the bromide to be washed into the soil, making it harder to remove. Leaving SLC open was, therefore, an important part of the background against which Crest's other actions should be considered. It should be noted that Crest's objectives for removing the buildings and hardstanding, which were safety and de-rating (Crest's second response, paragraph 5.5), could have been achieved while maintaining most of the impermeable cover.

86. The Agency's view of Crest's argument in its first and second responses that the above actions either were not feasible or not a reasonable expectation is considered below under the following subheadings:

a) Practicality;

b) Effectiveness i.e. would the action have made a material difference to the current plume and/or soil contamination;

c) Relationship to normal good practice at the time;

d) Relationship to the requirements of the regulators;

e) Need for permits which were unlikely to be forthcoming.

87. Supplementary points under items (c) and (d) which are not directly related to soil removal and scavenge pumping are addressed in two subsequent sections of further comments.

88. In considering Crest's arguments this decision draws on evidence from Jenny Thomas (JT), Groundwater Quality Technical Specialist, who had direct knowledge of the circumstances applying to SLC between 1983 and 1986. Her statement, which she produced after Crest had made their first responses, was served with the DDD. Reference to Mrs Thomas' statement are made using her initials followed by the paragraph number (e.g. JT23, JT42 and so on).

5.1.3.6.4.1 Removal of more soil by Crest

(a) Practicality of additional soil removal

89. JT40 and 42 express the view that there were no insuperable obstacles to deeper excavation if it had been shown to be necessary. JT39 includes a recollection that some excavation to the chalk was carried out in the vicinity of the former sumps where contamination of soils was believed to be greatest.

(b) Effectiveness of additional soil removal

90. The decision considers this in relation to the quantity of bromide left at SLC by Crest, the mobility of the bromide left at SLC by Crest and the recontamination of soil by rising contaminated groundwater.

- **Quantity of bromide left at SLC by Crest**

91. It is the Agency's case that Crest could have removed a considerably greater quantity of bromide. The significance of the quantity of bromide that Crest left in the ground at SLC can be assessed by comparing it to the quantity of bromide in the current plume.

92. Attached to this decision are two appendices, numbered 1 and 2. The first is a calculation of the extent to which the deeper excavation referred to in paragraph 5.47(a) of Crest's second response necessitates a reduction in the Agency's estimate of the bromide remaining in the ground at SLC. The second, in response to

paragraph 5.51 of Crest's second response, estimates the quantity of bromide that could have been removed by extending the excavations 2m into the putty chalk.

93. The report, The Sandridge/Hatfield Bromate Pollution Investigation (2-30, page 39), compiled for the Agency in early 2001 by its employee, Malcolm Roberts (MR), estimates the quantity of bromide remaining in the unsaturated zone in 1986, following removal of the upper soil layers, to have been 5129 – 11729kg. The significance of this quantity is put into context in the Report of the Flow Study Group, Phase 1, February 2002 (2-38, page 54) where it is noted that it is of the same order as the quantity of bromide (2651 – 13256 kg) currently contained in the plume between Sandridge and Hatfield (taking into account only the mobile groundwater in the chalk fissures, and assuming a plume depth of 30m). The quantity of bromide that remained above the water table at SLC and was removable by excavation at the time it was developed by Crest, therefore, had the potential to significantly increase bromide concentrations in the plume between Sandridge and Hatfield. What could have been achieved by removal of all the soil to a depth of 4m, the depth assumed in MR's estimate (2-30, page 39), was removal of bromide sufficient to form a bromide plume similar in size and concentration to the currently existing plume between Sandridge and Hatfield.

94. In paragraph 5.48 of its second response, Crest counter this argument by stating that MR "*seriously under-estimated the quantities of contamination removed and seriously over-estimated the quantities of contamination remaining.*". Their three

arguments supporting this statement in paragraphs 5.47 and 5.49 are considered below.

(i) Paragraph 5.4.7(a) of Crest's second response (bromide removed by deeper excavations

95. MR "*…did not take account of the more heavily contaminated area removed to depths greater than 2.5m*".

96. Crest have not provided any records of the areas in which removal exceeded 1.5m. Further, JT39 acknowledges that in the sump locations excavations exposed the chalk but that "*most of the excavation was shallow*". Recent evidence of the extent of this removal is given by the depth of strata described as 'made ground' in the logs of boreholes drilled in the investigations by Komex and Atkins (2-22, Appendix 2 and 2-24, Appendix C, respectively). It is between 2.0 and 2.95m in three locations, MW 2 and 3, and SLC7. Elsewhere, it is generally in the range 0.4-1.5m

97. On the assumption that the localised deeper excavation was to a depth of 4m below ground over a total area of 300m^2, an appropriate reduction of MR's estimate to take account of the localised deeper excavation carried out by Crest can be made. The calculation, in appendix 1, gives a figure of 1950kg. Subtraction of this figure from MR's estimate of 5129 - 11729kg reduces it to 3179 - 9475kg. This range remains

of the same order of magnitude as the 2561 -13256kg quoted above for bromide in the plume.

98. Accordingly, even if allowance is made for deeper excavation the amount of bromide that could have been removed is significant.

(ii) Paragraph 5.47(b)) of Crest's second response (remaining soil concentrations lower than assumed by MR).

99. Crest state that *"., Mr Roberts wrongly assumed that the contamination of the zones of materials left in situ was the same of the contamination of the closest zones which had materials excavated and removed."*

100. Crest support their contention that the remaining material was less contaminated than assumed by MR by asserting that he "*gives no credit to the skills and professionalism of those involved …whose aim was to detect and remove the more contaminated material and leave in-situ the less contaminated material."*

101. The conclusion in paragraph 3 of the Chemfix report of March 1985 (2-13) is relevant to this assertion. It states that, *"These inorganic bromides.…..have no smell.*" and "*cannot be detected by simple observation*" It follows that, in relation to bromide, the observations of a site chemist on the odour and appearance of the soil are not relevant, and the only valid evidence that the remaining soil had low

concentrations would be a chemical analysis of soil from the base of the excavation. Therefore, the presence of a chemist could not have enabled detection of greater or lesser concentrations since chemical analysis would have been needed not simple observation during soil removal.

102. Some analyses of samples from the base of the excavation have now been disclosed by Crest in appendix 2 of their second response in the form of reports from Vintec Laboratories dated 26th – 28th August 1986. This is some of the evidence that was sought by JT in the autumn of 1986 (see JT41). Had it been provided at that time it would have allowed JT to determine what further information was likely to be necessary. It shows that in 60% of the locations sampled the concentrations exceed 300mg/kg (i.e. significantly above the level of 4mg/kg, the usual background level. The accompanying 'Statement of Quality' dated November 1986, also forming part of appendix 2 to Crest's second response, refers to a "*Target concentration of Bromides of 300mg/kg.*." and states that, "*Where a sample showed greater levels then additional excavation was carried out…*". However, there is no information provided in that Statement of Quality of what additional excavation was done, or that chemical tests were carried out to show the bromide remaining in the base of the excavation.

103. Accordingly the Agency gives little weight to the paragraph 5.47(b) of Crest's second response.

(iii) Paragraph 5.47(c) of Crest's second response (gravel layer relatively uncontaminated).

104. The paragraph makes the same point as paragraph 5.47(b), that Roberts over-estimated the contamination of the soil left in-situ, by reference to the relatively low concentrations of bromide in the gravel layer underlying parts of SLC. Crest state that,

> *"It is therefore not correct to assume, as Mr Robert does, that this gravel layer is equally contaminated as some areas of made ground above."*.

105. The existence of a gravel layer of thickness 1.4 - 4.2m with its base some 3.5 - 4.5m below ground level was deduced from the logs of STATS boreholes 1-3, [(STATS report May 1984, Appendix 2, Figs A2.1 to A2.3 (2-9)] and Chemfix borehole C1 (Chemfix report March 1985, following page 5 (2-14)]. Boreholes drilled in the Komex (2000)(2-22) and Atkins (2001)(2-24) investigations show that the gravel layer varies in thickness and depth below ground and is absent in some parts of SLC [e.g. in boreholes SLC 1, 3, 6, 7 and 8 (2-24, Appendix C) and MW3 (2-22, Appendix 2)]. This is illustrated in the Atkins report of December 2002, Vol 1, Figs 16 and 22 (2-24).

106. The conclusion that the gravel was less contaminated than the overlying soils derives from the data for the STATS boreholes 1 and 2 (2-9, Appendix 3, Figs A3.1

and A3.2) and the Chemfix borehole C1 (2-14, page 3, Table 1 and borehole log following page 4), all in areas of high contamination. The data from STATS borehole 3 (2-9, Appendix 3, Figs A3.1 and A3.2) , in a less contaminated area, does not show lower bromide concentrations in the gravels. It should be noted that, as illustrated in the analysis in the Chemfix report on borehole C1 (2-14, page 3, Table 2), the lower concentrations in the gravels appear to result from the fact that the bromide is dissolved in the soil moisture, and that the gravels have a lower moisture content than the clays and putty chalk. Therefore, the decrease in the gravels cannot be construed as a decline in concentration with depth.

107. It may also be noted that even the 'limited' bromide concentrations in the gravels were far in excess of off-site values which are probably of the order of 2-5mg/kg (e.g. see data for the offsite boreholes BH11 and BH12 drilled for Atkins in Nov 2001 (2-24, Vol 1. Table 7.1)].

108. The Agency accepts that Crest's point in paragraph 5.47(c) of its second response has some validity in relation to boreholes 1 and 2 and C1 (C1 was within 2m of borehole 1 as noted in the Chemfix March 1985 report on further modelling studies, 2-15, page 4). However, it should be judged against the following facts.

(i) It is not valid in the less contaminated locality of STATS borehole 3.

(ii) As noted above, in some places the gravel layer was thin or non-existent.

(iii) MR calculated on the basis of a relatively conservative assumption that contamination extended to 4m below ground level. The evidence from the STATS boreholes 1-3 and the Chemfix borehole C1 is that, in the contaminated localities around boreholes 1 and 2 at least, contamination extended well below the 4m depth (8.0m in borehole 1, 6.0m in borehole 2, and 5.4m in borehole C1) assumed by MR and, in some cases, the concentration was higher at this depth than at the surface [2-9, Appendix 3, Figs A3.1 and A3.2]. MR's estimate would have been higher if it had allowed for this deeper contamination.

109. Accordingly, the Agency does not consider Crest's point in paragraph 5.47(c) is well supported by the limited data relating to the gravel layer, and tends to be nullified by the evidence of higher concentrations of bromide at depth which MR did not take into account in his estimate.

110. In relation to this deeper contamination, Crest maintain, at paragraph 5.51 of its second response, that,

"*little would have been gained by, say, generalised removal of a 1 or 2 metre band of chalk over the extent of the site at the top of the putty chalk.*"

111. There is no firm basis for this statement. Bromide concentrations in the putty chalk were comparable to those at the surface (see STATS boreholes 1-3 and Chemfix borehole C1). Based on this assumption, appendix 2 gives an estimate of the quantity of bromide that would have been removed by the excavation of 2m of putty chalk as 7168kg which is clearly significant in relation to the estimate given above of the quantity of bromide in the current plume.

112. In summary, Crest's responses at paragraph 5.47(a) - (c) do not invalidate the Agency's argument that removal of the quantity of bromide left in SLC by Crest could have materially decreased concentrations in the plume. The Agency does not, accept Crest's criticism of MR in paragraph 5.48 of its second response that he overestimated the quantity of contamination remaining at SLC after excavation by Crest.

- **Mobility of bromide left at SLC by Crest**

113. At paragraph 5.49 of its second response Crest argues that removal of more soil would not have been effective since the bromide in the clay (which constituted a significant proportion of the soil) would "*be far less mobile and less likely to migrate further*". At paragraphs 5.52 and 5.53 a similar argument is advanced in relation to bromide held in the chalk matrix and the putty chalk, supported by the statement that, "*the bromide now under SLC has remained static under the site for a minimum of 20 years*". The Agency do not understand these arguments since it is

precisely this bromide, left by Crest in the clays and putty chalk, which is continuing to give rise to the plume, thereby demonstrating that it is sufficiently mobile to give rise to serious pollution of groundwater. Its removal by Crest would, therefore, have been effective in the long term in reducing the contamination of the groundwater in the chalk fissures, contrary to the conclusion reached by Crest in paragraph 5.53 of its second response.

- **Recontamination of soil by rising contaminated groundwater**

114. Crest argue in paragraph 4.15 of its first response and paragraphs 5.54 - 5.57 of its second response that replacement of the contaminated soil with clean fill would have resulted in recontamination of the clean fill. The Agency takes this to mean that when the water table rises, normally in the winter, contaminated water from the chalk fissures would fill the pores of the overlying clean soil. When the water table falls some of this water would remain in the pores, held by capillary action. Thus, a sample of the 'clean' soil or made ground taken from the zone that was temporarily below the water table will contain some contaminant as a result of the contaminated water held in its pores. This is merely a redistribution of contaminant that had already reached the groundwater and not a source of new contamination.

115. The Agency does not, therefore, accept that, from the point of view of groundwater protection, this recontamination process would have nullified the benefits of

removing more contaminated soil and replacing it with clean fill. The quantity of contaminant at SLC would still have been materially reduced.

116. By way of comment, the recontamination of clean replacement soil would not of itself have lead to SLC being determined to be contaminated land under Part IIA EPA 1990 had all other contaminants been removed by excavation. This is because it would have been contamination of the land by a substance from the ground water rather than pollution of the controlled waters by a substance present under the land - see paragraphs A.36 to A.39 of the Guidance.

(c) Good practice in relation to soil removal

- **TWA guidelines for contaminated soils**

117. JT 37 refers to the expectation in the TWA guidelines that soil with a high water pollution potential would be removed. The need for additional excavation of soil would have normally been assessed by analysing the soil left in the site following removal of the most contaminated material. This information was not provided by Crest at the time (see JT41). Some such information, reports from Vintec Laboratories, formed part of appendix 2 of Crest's second response but it is incomplete in that it merely demonstrates the need for further investigation. There are no records of the location and depth of any additional excavations, or of any

chemical tests of the soil left in-situ to demonstrate that all the soil in which bromide exceeded a specified concentration had been removed.

118. It is unclear why this information was not provided to JT at the time of the site remediation.

119. As already noted, the presence of a chemist at SLC during excavation of contaminated soils was not a substitute for analysis of the soil. Odour and appearance would assist the on-site chemist in detecting organic contamination. The Chemfix report of March 1985 (2-13)) records that, "*As a control six samples that were judged clean* (presumably by appearance and odour) *were also analysed*" (final paragraph on page 2 of 2-13) and notes that, "*the levels* (of bromide) *in the control samples are similar to those in the suspected ones*" (paragraph 3 on page 2 of 2-13). In other words, bromides cannot be seen or smelt, and the presence of organics, which, in contrast, often could be seen or smelt, was not a reliable guide to the presence or absence of bromides.

(d) Requirements of regulators in relation to soil removal

120. This is considered in relation to the amount of soil that could have been removed. The correspondence with TWA on soil removal reviewed below should be seen in the light of comments later on the weak regulatory position of TWA.

121. Removal of soil to a greater depth than 1m was first mentioned in TWA's letter to Chemfix of 17th August 1984 (1-62, second page, penultimate paragraph). TWA's letter of 4th December 1984 (1-68) then emphasises that,

"*it would be wise to excavate virtually down to the Chalk surface in the most contaminated areas i.e. most of the area marked red on the S.T.A.T.S plan, with more limited excavation elsewhere."*

A letter from Chemfix to SADC dated 17th September 1986 (1-108) states that excavation of contaminated soil had been completed. Following a meeting between Chemfix and TWA on 22nd October TWA then commented, in a letter from JT to Chemfix dated 19th November (1-117) 1986, that:

"…it is difficult to judge how significant the removal undertaken is without some indication of the levels of contamination which still remains on the site. … Remaining contaminated material may be further leached since some permeable areas, of trees and grass are still shown on the revised plan".

As noted above from JT41, it would appear that any information (e.g. that dated August 1986, in Appendix 2 of Crest's second response) held by Crest on the concentrations of bromide in soil at the base of the excavations had not been provided to TWA.

122. Crest's conclusions in paragraph 5.17 of its second response on the "*thrust*" of Mr Flavin's (JT's colleague at TWA) advice are at odds with JT44 that, "*there was concern regarding the possible effects of the organics on groundwater down-gradient.*" This is borne out by BHR's letter of 15th August 1986 (1-83, last

paragraph) which advocates "*ongoing monitoring*". In addition, SADC's internal memorandum of 2nd October 1985 (1-84, last paragraph) recommends monitoring for five years and SADC's letter of 18th November 1985 (1-85) states, "*Thames Water are not completely satisfied that this contamination [downstream pollution] will not occur …*" All of this does not equate with pollution downstream being unlikely. Mr Flavin sets out a programme for monitoring in his letter of 11th February 1986 (1-93), over six months after his letter of 24th June 1985 (1-76). However, it is this 1985 letter (1-76) upon which Crest rely for the "*thrust*" of his views.

123. Crest, at paragraph 5.18 of its second response, states that Mr Flavin's ultimate views on soil removal are not acknowledged by the DDD. There is no documentation to show what Mr Flavin's ultimate views on soil excavation were. The quotation in paragraph 5.17 of Crest's second response does not articulate Mr Flavin's views and the letter of 24th June 1985 (1-76) from which the quotation is taken relates to SADC's responsibilities for water quality in private potable abstractions.

124. Crest maintain at paragraph 5.11 of its second response that the DDD did not acknowledge that Crest removed more soil than originally proposed. JT39 does acknowledge this.

(e) Need for permit for additional soil removal

125. Removal of soil to a greater depth might have required a change in the planning permission issued by SADC on 25th July 1986 (3-14) which specifies, in condition 9:

"*Prior to the commencement of building works on site those parts of the site which are contaminated by chemical pollution shall be treated and soil removed in accordance with the recommendations of St Albans Testing Services third report dated November 1983 and shown on Crest Homes WT122 dated February 1986. All soil to be removed shall be safely disposed in a manner acceptable to the appropriate authorities.*"

JT42 records JT's view that the planning authority would have been unlikely to object to an amendment of this condition to

require deeper excavation if this had been shown to be necessary.

5.1.3.6.4.2 Conclusion on removal of more soil by Crest

126. The conclusions of this section are:

(a) There were no insuperable practical obstacles to deeper excavation at SLC.

(b) Removal of more soil had the potential to be effective in reducing the extent and concentration of the current plume. The quantity of bromide that could have been thus removed was comparable to the quantity in the current plume.

(c) Considerations of mobility of bromide in the soil, and recontamination of clean replacement fill by contaminated rising groundwater do not detract from the above conclusion on the effectiveness of deeper excavation.

(d) Crest failed to comply with best practice, as stated in TWA guidelines, in determining whether the quantity of soil removed was adequate to prevent pollution of the aquifer. In particular they failed to provide the data which would have enabled TWA to form a view on this point.

(e) There is no clear evidence that TWA, the relevant regulator for aquifer protection, approved Crest's actions.

(f) It is likely that SADC would have issued any change in the planning permission necessary to permit deeper excavation.

127. It is the Agency's position that Crest had the opportunity to remove more contaminated soil and received requests and encouragement from TWA to do so or, at the very least, to demonstrate that their excavation operations complied with good practice. It is likely that any necessary change in the planning permission

would have been forthcoming. The Agency cannot be precise as to exactly how much more soil should have been removed, but it is clear that removal of more soil would have materially reduced the amount of bromide remaining under SLC.

5.1.3.6.4.3 Scavenge pumping

128. As with the removal of more soil this document considers the feasibility of scavenge pumping according to items (a) to (e) in section 5.1.3.6.5.

(a) Practicality of scavenge pumping

129. JT48 expresses the view that there were no insuperable practical obstacles to scavenge pumping.

129. Dealing with each of Crest's arguments on this point:

- **Transfer of pollutants downgradient by scavenge pumping**

131. Paragraph 4.14 of Crest's first response states,

"*pumping to waste would probably have transferred the contaminated groundwater down catchment, and hence would have led to an increase in the concentrations of contaminants elsewhere in the aquifer or drainage system*".

Crest reiterates this in its second response at paragraph 4.3 and concludes, "*It is therefore unreasonable to expect Crest to have instituted it*".

132. Paragraphs 8.13 and 8.14 of the second response enlarge on the problems arising from the transfer of polluted water obtained by scavenge pumping to somewhere else further down the river/drainage system.

133. The Agency do not accept that the transfer of pollutants down the river/drainage system would have been a significant obstacle to scavenge pumping.

134. Because there are no rivers or streams in the locality of SLC the only means of discharging the scavenged water would have been to foul sewer or to the surface water drainage system. Water carried by the latter discharges to a soakaway lagoon at Jersey Farm, thereby returning the water to the aquifer and thus negating any benefit of the scavenge pumping. Discharge to foul sewer was, therefore, the only viable option.

135. The practicality of discharge to the foul sewer would have depended on:

(a) whether the sewer could physically carry the volume of scavenged water;

(b) the effect of the water and its contaminants on the operation of the sewage works;

(c) the effect of any contaminants, principally bromide, remaining in the sewage works effluent on the River Colne, which would have received that effluent.

136. Points (a) and (b) would have been addressed under an application for consent to discharge to the foul sewer. The possible issue under (c) would have been the formation of brominated organic compounds in water abstracted for public supply during treatment by chlorination. This is borne out by the reference to "*potential generation of brominated haloforms*" in the letter from BHR dated 15th August 1985 (1-83). However JT's recollection (see JT48) is that this was not of undue concern at the time.

- **Need for access to land occupied by third party for scavenge pumping**

137. Crest describe the practical difficulty of involving a third party in a scavenge pumping scheme in its second response at paragraphs 8.9 - 8.12. The issues were the right of access and the effect of the pumping in drawing pollutants under the land.

138. Although no legal powers were available to Crest to go onto a third party's land it was open to Crest to negotiate a private access agreement with landowners near

SLC, as they did for the off-site monitoring borehole. There is no evidence that they ever explored this option.

139. The most effective locations for scavenge pumping would have been those where the groundwater was already contaminated. The effect of the pumping would have been to ultimately reduce this contamination. The Agency, thus, gives little weight to the issue raised in paragraphs 8.9 and 8.12 of Crest's second response that scavenge pumping could have added to the pollution present beneath the land of a third party.

140. However, more fundamentally, it should be noted that, while access to a third party's land would have been needed to remove the existing bromide plume downgradient of SLC, pumping on the land under Crest's control at SLC, as suggested by the words *"at the site"* in the TWA letter of 17th August 1984 (1-62, 4th paragraph from end), could have prevented any bromide in the soil and groundwater at SLC from entering the downgradient plume. The downgradient plume would then have been isolated from the bromide source and would have started to reduce by dilution with uncontaminated groundwater. Crest could have carried out scavenge pumping at SLC.

- **Technical difficulties of scavenge pumping**

141. Paragraph 8.11 of Crest's second response mentions the technical investigation that would have been necessary to "*ensure that the scavenging pumping was capable of drawing the full extent of the plume into the borehole or boreholes ultimately used*". The Agency recognise that investigation would have been needed, but point out that total capture of the plume was not essential. A scheme which drew in only a proportion of plume could have effected significant reductions in the contamination of the groundwater downgradient of SLC.

(b) Effectiveness of scavenge pumping

142. Scavenge pumping would remove contaminated water from the fissures in the blocky chalk. Clean groundwater flowing into theses fissures would, in its turn become contaminated by diffusion of bromide from the pores of the chalk. Crest's point, in paragraph 8.15 of its second response, that,

"*The bromide in the putty chalk and in the matrix of the blocky chalk would not be drawn in by such a scheme.*"

is not accepted by the Agency (see paragraph 113) dealing with the mobility of bromide in the clay and putty chalk). Sustained scavenge pumping over a prolonged period would have provided a means of gradually removing contamination from the pores.

143. Accordingly, the Agency does not accept Crest's argument in paragraph 11.1 of its second response that scavenge pumping would have made no material difference to the level of bromide remaining at SLC.

(c) Good practice in relation to scavenge pumping

144. JT47 and 61 - 83 describe the policy and regulatory framework in the early 1980s, knowledge of scavenge pumping at that time, and two examples of its use in the Thames catchment prior to its discussion in relation to SLC. The Agency accepts Crest's comment at paragraph 8.16 of its second response that there are differences (as acknowledged in JT81 - 82) between these examples and the situation at SLC but considers the examples are, nevertheless, relevant in demonstrating the potential of the technique of scavenge pumping

145. The acceptability of scavenge pumping as a technique is confirmed by the letter of 15th August 1985 (1-83) from BHR, in which they, presumably applying their knowledge of current best practice, warn a potential purchaser of SLC of an "*ongoing monitoring and control liability on the owners of the site*" and confirm the desirability of investigating scavenge pumping to minimise this liability as follows:

"I would endorse Mr Flavin's suggestion of a groundwater scavenging scheme as a means of complete restoration of the site although disposal of the scavenged water would be difficult. It is essential that high levels of bromide are eliminated from

potable water since the potential generation of brominated haloforms is considerable."

A further observation that may be made on this letter is its acceptance that the site owner would become liable for all pollution emanating from the site currently and in the future.

(d) Requirements of regulators in relation to scavenge pumping

146. Scavenge pumping was first mentioned in TWA's letter to Chemfix of 17th August 1984 (1-62). It also highlights that the EEC Drinking Water Directive (80/778) guide levels for organic compounds are exceeded. TWA in its letter of 4th December 1984, written by Mr Flavin, (1-68) states that the groundwater immediately below SLC is grossly contaminated with organic compounds, that local private abstraction boreholes are not contaminated, and that the demolition of SLC may have exacerbated infiltration. In the same letter TWA goes on to "*advocate*" scavenge pumping at the downstream end of SLC and Mr Flavin states,

"*I would envisage that discharge to the foul sewer would be acceptable though this would obviously depend on the quantity and quality of the groundwater abstracted."*

147. TWA then appears to reconsider its position (as to which see paragraph JT45) since in his letter of 21st June 1985 (1-75) Mr Flavin states that,

"the idea of a groundwater scavenging scheme …… is one which I would still ideally like to see employed" but refers to, *"the legal complications of responsibility"* such that, *"it therefore appears that such a scheme is unlikely to be practicable"*.

148. In addition, this letter shows he did not have details of the latest proposal for excavation and so does not represent his approval of the scheme to decontaminate. Chemfix respond in their letter of 26th July 1985 (1-82) by arguing that there is little more that they can do in view of the

"present state of art knowledge" and they believe that, "*their approach, presentation and interpretation does reflect present state of the art knowledge and application in dealing with both groundwater quality and pollution at this site*".

149. The context of TWA's comment on practicability in their letter of 21st June 1985 (1-75)makes it clear that their reservations centred around access and finance. These were not insuperable difficulties.

150. Crest appear to take the view that TWA rejected scavenge pumping (paragraphs 4.1 and 8.6 – 8.7 of their second response). TWA's letter of 24th June 1985 (1-76)

refers to protection of private water supplies not the whole aquifer. Therefore, it does not constitute evidence that TWA rejected scavenge pumping as a means of protecting the aquifer. Also JT45 does not accept Crest's view that TWA rejected scavenge pumping. She would have obviously discussed the matter with Mr Flavin and her view that scavenge pumping was an appropriate step to take is the best indication of TWA's attitude.

(e) Need for permit for scavenge pumping

151. A consent would have been required to discharge the contaminated water generated by scavenge pumping to foul sewer. JT48 states that TWA would have been likely to grant such a consent. Their interest in safeguarding groundwater quality provided an additional incentive for them to do so.

5.1.3.6.4.4 Conclusion on scavenge pumping by Crest

152. The conclusions of this section are listed below:

(a) There were no insuperable practical obstacles to scavenge pumping.

(b) Scavenge pumping had the potential to be effective in reducing the extent and concentration of the current plume. If carried out downgradient of SLC it would have reduced the downgradient contamination at the time and captured any

bromide which entered the fissure groundwater from the contaminated soils and pore water at SLC. If carried out at SLC it would have had little influence on the existing downgradient plume, but would have prevented bromide in and under SLC from being added to it.

(c) The principle of scavenge pumping as a means of controlling groundwater pollution was accepted as good practice in the early 1980s.

(d) The regulator responsible for aquifer protection, TWA, would have preferred Crest to undertake scavenge pumping.

(e) It is likely that TWA would have granted the necessary consent to discharge water from scavenge pumping to the foul sewer.

153. It is the Agency's position that Crest had the opportunity to carry out scavenge pumping at or downgradient of SLC because the practical, legal and administrative difficulties were not insurmountable; solutions were never really explored and it is likely that the necessary discharge consent would have been forthcoming from TWA. Moreover, it was a reasonable expectation that Crest should do so because scavenge pumping was an accepted technique at the time; TWA had expressed a preference for using it and it would have been a prudent step in relation to Crest's liability for all pollution emanating from the site.

154. Having dealt with the two measures that Crest could have carried out the Agency has the following views on good practice, the regulatory position at the time and the gravel layer.

5.1.3.6.4.5 Further comments on good practice

155. In paragraph 6.1 of its second response, Crest quote the view of Enviros' hydrogeologist Mr Cameron (expressed on page 4 of the report which forms Appendix 1 to Crest's first response) that, "*the site investigations and remediation activities 'were all in accordance with prevailing best practice' and were appropriate to addressing the areas of concern at the time*". It points out that Mr Cameron's hydrogeological career started in 1976.

156. The Agency considers there were significant failures of good practice by Crest, both as noted above in relation to soil removal and scavenge pumping, together with some more general failures listed below. Most of these are referred to in the statement of JT, whose hydrogeological career included direct involvement in the remediation operation at SLC.

157. The following are example of Crest not following good practice.

(a) Premature removal of hardstanding and buildings

158. Removing the buildings and hardstanding and leaving SLC open to leaching by rainfall for more than 2½ years, from April 1984 to at least November 1986 (see Crest second response paragraph 5.5 and 5.44) is discussed in JT50 - 54. The Chemfix report of February 1984, page 7 (2-7) specifically drew the attention of Crest to the role of hardstanding in limiting pollutant migration. The principle of maintaining cover for as long as possible in the course of developing a contaminated site was included in the TWA guidelines (see JT64). The removal of impermeable cover was a clear departure from good practice which significantly increased the potential of the site to cause groundwater pollution and thereby created a pressure on TWA not to require measures which might delay the reinstatement of cover in the course of development.

(b) The barrier layer

159. Crest note at paragraphs 5.34 and 5.35 of its second response that the barrier layer was a Building Control requirement and discuss the doubts expressed as to whether it was installed. The requirement in the Building Regulations approval of 24th June 1986 (1-102) was that, "*After excavation the site should be sealed using 100-150mm of Pulverised fuel Ash (PFA), though other materials such as Hoggin or Terram sheeting may be acceptable…*"

160. Historical evidence suggesting the barrier was not constructed is found in the lack of any reference in Chemfix's letter of 30th October 1986 (1-113), which simply

says, "*now being backfilled with a minimum of 1m of chalk*", or in Chemfix's Statement of Quality of November 1986 (item 2 in Appendix 2 of Crest's second response).

161. However, the most definitive evidence that the barrier was not placed is that the logs of 15 boreholes drilled by Komex and Atkins (2-22 and 24 respectively) showed no barrier of any sort. These recent site investigations have, thus, confirmed that a barrier layer was not put in place by Crest.

162. A barrier of compacted pulverised fuel ash would have served to:

- minimise upward migration of contaminants, either dissolved on in vapour form, from the underlying soil (important mainly in relation to organic contaminants which could vapourise and thereby enter houses on SLC);

- minimise penetration of rainwater which would carry contaminants downwards.

163. In relation to bromide, the absence of the barrier is significant in that it would have been a means of significantly reducing continued leaching of bromide into the aquifer. The failure to install it was, therefore, a failure of good practice, as well as being a failure of regulatory compliance.

(c) Quality of hardstanding constructed by Crest

164. In paragraph 5.49 of their second response, Crest refer to the effect of the houses and hardstanding constructed at SLC in preventing ingress of rainwater. In paragraph 7.4, they refer to revisions of the planning permission seeking and achieving the objective or obtaining a development "*less likely to allow water to penetrate into the ground*". While the final design may have been better than previous ones in this respect there is no evidence in the documents that this was an objective which was actively sought.

165. Moreover, this objective would have been more successfully achieved by a different design of the hard surfacing. Many of the roads, pavements and parking areas are constructed of block paving. The logs of the boreholes drilled by Atkins (see 2-24, appendix C, logs of boreholes SLC01, 02, 03, 07 & 10) show that the blocks are bedded in, and jointed with sand. They will therefore allow significant infiltration of rain water through the joints. Good practice in constructing a hardstanding to minimise infiltration would have been to place an impermeable membrane (e.g. polythene sheet) beneath the block paving, or to use hot-rolled asphalt or joint-sealed concrete instead of sand-jointed blocks.

(d) Monitoring boreholes

166. It should be noted that Crest chose not to act on the recommendation from TWA [letter to Chemfix dated 19th November 1986 (1-117)] that a second off-site

borehole should be installed further downgradient than the existing one. Paragraphs JT24 - 28 refer to discussions of off-site boreholes.

5.1.3.6.4.6 Further conclusions on good practice

167. In addition to the conclusions of good practice in previous sections on soil removal and scavenge pumping, Crest's operations failed to meet good practice at the time in respect of:

(a) Premature removal of impermeable cover;

(b) Failure to install the barrier layer required by the Building Regulations approval;

(c) Use of block paving on hardstanding areas at SLC instead of some less permeable form of surfacing;

5.1.3.6.4.7 Further comments on compliance with requirements of the regulators

168. This section examines the nature of the requirements of the regulators (TWA and SADC Planning, Building Control and Environmental Health). It then tests Crest's claim in paragraphs 2.4, 5.4, 5.32, 5.33, 5.39 and 5.40 of its second response that it complied with the requirements of the regulators additional to those discussed above.

169. It is designed to demonstrate what would have been the regulatory mindset of the time.

(a) Weak regulatory position of TWA

170. The requirements of the regulators should be seen in the light of paragraphs JT59 - 69 describing how the weak regulatory position of TWA prevented them from pressing Crest to take additional actions. The TWA regulatory position was significantly influenced by Crest's removal of buildings and hardstandings in March-April 1984 (see JT50 - 55). There is no evidence that TWA were consulted on the removal. They would certainly have advised against it. This action, once taken, placed TWA under some pressure to agree to development proposals, even if less than ideal, as the most rapid means of restoring hard cover to the SLC site.

171. Accordingly, the fact that TWA did not object to Crest's proposals does not mean they approved them but rather reflects their view, (see JT52 and 53) that continued negotiation for more extensive action, with the associated delay in restoring hard cover on the site, could be more detrimental to the aquifer than ceasing to press their objections to Crest's proposals. JT41, 45, 50 and 54 show that while TWA may have accepted Crest's actions they were not happy about Crest's failure to pursue other actions recommended by TWA.

172. The weak regulatory position of TWA is highlighted by the comment in SADC memorandum of 7th July 1986 (1-103).

(b) Initial consultation with TWA

173. In paragraph 5.4 of its second response Crest state that TWA,

"*appear not to have commented unfavourably on this application judging by their letter of 5th December 1983 …*"

174. This letter was from the team that dealt with consultations on planning applications. Mr Flavin in both his letters of 8th March 1983 (1-34) and a TWA internal memo dated 30th December 1983 (1-44) expresses reservations. It is likely that this apparent incompatibility resulted from poor internal consultation between the planning and pollution control functions of TWA. Indeed, the letter relates to sewage disposal not the risk of groundwater contamination.

(c) Differing requirements of TWA and SADC

175. There were different requirements in respect of human health (SADC Environmental Health) and protection of the aquifer (TWA). Effectively the documents comprise two parallel discussions relating to these separate interests which, however, overlap to the extent that SADC was responsible for the wholesomeness of private potable

supplies. The water regulator, TWA, expressed the desirability of two measures - soil removal and scavenge pumping - to protect the aquifer, as well as concern about the removal of impermeable cover from SLC. However their ability to insist on these measures, or address their concern, was limited. The human health regulator, SADC, focussed on the risk to future occupants of SLC, accepting the views of TWA on protection of the aquifer in relation to safeguarding the private potable supplies drawing on it. These separate roles are not clearly distinguished in Crest's second response. Evidence that Crest met the requirements designed to protect the health of future site occupants has no direct relation to the parallel consideration of protection of the aquifer.

(d) Approval of soil excavation

176. In para 5.31 of their second response Crest notes the approval of the excavation works by SADC in their letter of 15th October 1986 (2-111). However, as noted above, the interests of SADC were different from those of TWA. The TWA position (see JT41) was that they were not provided with sufficient data to assess the adequacy of the soil excavation.

(e) Retention of the gravel layer

177. Crest, in their second response, paragraphs 5.35 - 5.43, demonstrates that there was a broad agreement among consultants and SADC that the gravel layer should be

retained. In paragraph 5.40 they infer, from words in an internal SADC memo of 7th July 1986 (2-103), that TWA also supported its retention. They present this as justification for limiting the site excavation to no more than 1.5m in most parts of SLC (i.e. to the contaminated soils above the gravel layer). The Agency comment as follows on this argument:

(a) The evidence for a gravel layer from only four boreholes (already discussed in the section on 'Effectiveness of additional soil removal') is a relatively slender basis for the assumption that there was a continuous layer of gravel across the whole site, particularly as the type of glacial deposits which overly the chalk at SLC are known to be variable in nature. As already noted, recent site investigations have shown that it was neither continuous nor uniform in thickness across SLC.

(b) There is no evidence that the comment, '*the gravel bed…cannot…be relied on entirely*' in the SADC memorandum of 7th July 1986 (2-103), from which Crest (in paragraph 5.40 of their second response) infer the view of TWA, originated from TWA. Since the TWA remit did not include issues relating to the safety of future occupants of SLC it is more likely that TWA merely commented that the gravel bed contained silt and that SADC added the implication as to its reliability in preventing upward movement.

(c) Paragraph 5.39 of Crest's second response shows agreement by all parties quoted that the reason for retaining the gravel layer was its potential to limit upward

movement of contaminants (see JT38), thereby protecting future SLC occupants. The contaminants of concern in this connection were organic bromine compounds, because of their potential to form harmful and odorous vapours. This function has no relevance to the TWA interest of preventing downward movement of contaminants.

(d) Accordingly, because TWA had no reason to support the retention of the gravel layer, the Agency does not accept Crest's conclusion in paragraph 5.41 of its second response that TWA's view was "*far from the Agency's present position.*" and in paragraph 5.43 that, "*Everybody at the time thought there was some advantage in retaining it*".

(e) Because the gravel layer had no role in preventing downward migration of contaminants TWA had no reason to object to its removal. The benefit of preventing upward migration could have been achieved (as was, in fact, a requirement of the Building Regulations (1-102)) by the installation of a barrier layer following removal of contaminated soil. Had the Agency's position of complete removal of highly contaminated soils down to, and into the chalk been adopted the 'benefits' conferred by the gravel layer would have been largely irrelevant because much of the contamination beneath the gravel would have been removed. Moreover, any perceived benefits of the gravel layer could have been retained by replacing it after removal of the underlying chalk.

178. Based on the above points the Agency's view on the gravel layer is as follows:

(a) Removal of the gravel was a reasonable option which Crest should have considered. A more thorough appraisal at the time of both the evidence for the existence of the gravel layer, and of the alternative strategy of removing it in order to remove underlying contaminated chalk, would have shown that the principal benefit of retaining it was one of cost and time, which would have had to be balanced against the much more thorough decontamination which could have been achieved by removing it.

(b) It is not apparent that TWA supported retention of the gravel layer.

5.1.3.6.4.8 Further conclusions on compliance with requirements of the regulators

179. In addition to the conclusions in previous sections on soil removal and scavenge pumping, the following points can be made about Crest's actions and compliance with the requirements of the regulators:

(a) The only regulatory power available to TWA in the 1980s was to persuade SADC to include measures in the conditions attached to the planning permission allowing re-development. Even in this context, TWA were severely constrained in their ability to 'demand' any measures (which, in any case could have been done only via planning conditions, given their

limited legal powers at the time) by the fact that the site had been cleared of impermeable cover, thereby exacerbating the risk of groundwater pollution until such time as it was redeveloped. The scheme adopted by Crest was probably the best that could be achieved by TWA with the powers available to them, but that does not mean that they approved of it or considered it wholly adequate or that bromide did not have the opportunity to remove more contamination.

(b) The two regulators, SADC and TWA, had different interests relating respectively to human health (including wholesomeness of private water supplies) and protection of the aquifer. Approval expressed by SADC did not imply approval in respect of aquifer protection.

(c) There is no evidence that TWA supported retention of the gravel layer, and they had no reason to do so.

(d) At different times TWA suggested removal of contaminated soils down to the chalk over considerable areas of SLC, scavenge pumping, and installation of a second down-gradient monitoring borehole. Crest chose not to act on any of these suggestions.

5.1.3.6.4.9 Conversion of bromate to bromide

180. This section considers Crest's contention in paragraph 6 of its first response that,

> *"… it is likely that a proportion of the bromide now found originates from bromate which Redland spilt or otherwise allowed to escape."*

and a similar statement in paragraph 10.1 of its second response.

Section 78F(9) EPA reads,

> *A person who has caused or knowingly permitted any substance ("substance A") to be in, on or under any land shall also be taken to for the purposes of this section to have caused or knowingly permitted there to be in, on or under that land any substance which is there as a result of a chemical reaction or biological process affecting substance A.*

Crest argues that some of the bromide under SLC originates from bromate present at SLC at the time it was redeveloped by Crest. Therefore, applying s.78F(9) EPA such bromide is attributable to Redland who have therefore caused its presence and are thus a class A person in respect to it.

181. The Agency accepts the possibility of conversion of bromate to bromide, but does not consider that the bromide currently present at SLC has, to any material degree, originated from bromate present on SLC around 1986.

182. Possible evidence of localised conversion is present in Agency monitoring data (recorded in the Agency database which has been provided to the PAPs, and

illustrated in 2-23, Figs A2, A5, A3 and A6) showing high bromide concentrations in the absence of bromate in six boreholes at SLC (MW1, 2, 3 and 5, SLC1 and 2) and one downgradient (GW12) of SLC. However, the significance of this observation is reduced by the fact that all the on-site boreholes with this characteristic are located in the part of SLC where bromate was not produced or stored, and the principal contaminants from factory processes would have been bromides and organics (see 2-24, Atkins, Dec 2002, Fig 3). Apart from this observation, the Agency's reasons for its view that the reduction process has not created a material proportion of the bromide at SLC are summarised in the points (a)-(e) in this section which draw on a number of sources including monitoring of groundwater and surface waters by the Agency, and research carried out by WRc (see 2-44 and 45).

(a) An indicator of conversion of bromate to bromide in field conditions is a decrease in the ratio of bromate to bromide with time. Plume monitoring data shows no systematic decrease in bromate/bromide ratio with increasing distance (and therefore increasing travel time) from SLC (2–38 Fig 6.1). This suggests that large-scale degradation of bromate is not occurring in the groundwater.

(b) Similarly, on two occasions when bromate has been detected in the River Colne there has been no clear evidence of degradation with increasing distance downstream (and therefore increasing travel time) from the point of entry of the bromate. Any degradation has been masked by uncertainty about flows and the

composition of any incoming tributaries [see report by Vivendi Water Partnership, March 2002, (2-35) and samples taken by the Agency from the Ellenbrook and River Colne on 4 July 2002, recorded in Agency database (2-26)], suggesting that it was not occurring rapidly, if at all.

(c) Points (a) and (b) above have been confirmed by tests showing that bromate does not degrade when bromate-contaminated water is kept in laboratory conditions.

(d) Since January 2003 WRc has been undertaking laboratory studies, commissioned by the Agency, of the conditions under which degradation of bromate to bromide occurs (2-44 and 45). These have made it clear that at 10°C, a typical temperature of soils and groundwater, such degradation does not occur easily or fast, and requires the presence of organic compounds such as glucose as a food source for the necessary micro-organisms and the absence of oxygen (anaerobic conditions). Establishment of a microbial culture which degrades bromate at a significant rate has proved difficult. The possible limited reduction of bromate at SLC referred to above could plausibly be a consequence of the localised presence of sufficient organic compounds to provide the necessary food source.

(e) If degradation were occurring extensively at SLC it is hard to explain why significant concentrations of bromate were detected in the soils in 2001 (2-23),

some 21 years after the last possible date when leakage of bromate from the Steetley factory could have occurred.

183. Points (a)-(e) above suggest that for reduction of bromate to have contributed a significant proportion of the bromide currently present at and under SLC requires the assumption that a number of specialised conditions (e.g. presence of soluble organic chemicals, in the same location as bromate, in the absence of oxygen) would need to have been satisfied. It seems unlikely that the occurrence of these conditions at SLC was sufficiently widespread and prolonged, particularly following the selective removal of soils with the highest concentrations of organic contaminants (those which looked or smelled contaminated, as judged by the site chemist), for the process to have added significantly to the already large quantities of bromide present in the soil.

5.1.3.6.4.10 Conclusion on conversion of bromate to bromide

184. Despite paragraphs 10.1-10.4 of Crest's second response the Agency maintains its position that although the bromate to bromide process can occur it has not contributed materially to the levels of bromide currently present at SLC and in the plume. Crest is unable to point to any concrete evidence that a significant proportion of the bromide found in the soils above the water table at SLC in November 2001 is derived from bromate present at SLC when it controlled the site. The combination of factors set out above weighs against their contention.

5.1.3.6.5 Conclusion on Crest as a knowing permitter

185. Part of Crest's argument in paragraphs 9.1 and 9.2 of its second response is that what they did in the 1980s was best practice and it was not, therefore, a reasonable expectation that they should have done more. It refers, in para 2.1 of the second response, to the Agency viewing its actions *"with 20:20 hindsight"*. The Agency accept that a retrospective regime such as Part IIA involves an assessment of what could have been done at the time. However, too ready an acceptance of arguments such as Crest's that their actions were the best that could be expected at the time could lead to the result that few PAPs, in relation to historic contamination, will be found to be APs within the Part IIA regime by virtue of knowingly permitting the contamination. This would not appear to be the objective of the contaminated land provisions of the EPA or the Guidance. The Agency's assessment, with the insight of an officer who was directly involved with the matter at the time, JT, is that more could have been done by Crest within the hydrogeological science and techniques of the time, that TWA encouraged them to do so, and that they chose not to do so.

In summary, the Agency has shown above that:

(a) There were no insurmountable practical obstacles to deeper excavation at SLC and to scavenge pumping.

(b) These actions, particularly if taken together, had the potential to be effective in reducing the extent and concentration of the current bromide plume.

(c) Crest's actions were not in accordance with best practice at the time in a number of important respects.

(d) The weak regulatory position of TWA, who were responsible for protecting the aquifer, caused it to express its requirements as suggestions and requests rather than demands. Crest chose to take no action to meet these requirements.

(e) It is likely that a discharge consent in relation to scavenge pumping and, if considered necessary, a change in the planning permission to permit a greater depth of excavation, would have been forthcoming if requested by Crest.

(f) In the light of the specialised environmental conditions necessary for the conversion of bromate to bromide process to occur this has not contributed materially to the bromide currently present on and under SLC.

(g) The Agency concludes that Crest knew of the presence of bromide at SLC and had the ability to take steps and a reasonable opportunity to remove that contaminant.

186. The arguments put forward by Crest to the contrary have been considered and rejected. **Therefore, Crest are considered to be a Class A person for the bromide SPL.**

5.1.3.6.6 Are Crest a Class A person for the bromate SPL on the basis of causing or knowingly permitting?

5.1.3.6.7 Causing (bromate)

187. Crest did not carry out polluting activities at SLC which caused bromate, by reason of which SLC is contaminated land, to be in,

on or under that land since it did not carry out polluting activities.

188. At paragraph 12 of its second response Redland state Crest *"… should be held to have caused some of the contaminative substances to be "under" the land and made a Class A person for the purposes of the bromate and bromide significant pollutant linkages.*" Therefore, Redland argue that Crest caused some of the bromate at SLC. Redland's argument can be summarised as follows:

- It is established case law that it is permissible to have more than one person who caused a contravention of s. 85(1) WRA.
- The initial removal of soil and the fact that SLC was left uncovered after the removal of the hard standing increased the level of bromate in the receptor.

189. An AP is one who caused the substances by reason of which the land is contaminated to be in, on or under the land. Paragraph 9.9 of the Circular states,

"… the test of "causing" will require that the person concerned was involved in some active operation, or series of operations, to which the presence of the pollutant is attributable."

190. Redland appear to make the error of confusing the receptor with the definition of contaminated land (see paragraph 24 above for this definition). To reiterate, contaminated land is land in such a condition, by reason of substances in, on or under the land, that pollution of controlled waters is being, or is likely to be caused. The receptor is controlled waters (see paragraph 23 above). Paragraph A.13 of the Guidance introduces the concept of a receptor to assess the risk posed by contaminated land. Crest may have increased the contamination in the receptor by leaving SLC uncovered but did not cause the bromate to enter the contaminated land. The bromate was already *"in, on or under"* SLC by the time Crest bought it. Crest did not cause the bromate contamination.

5.1.3.6.8 Knowingly permit (bromate)

191. Bromate was apparently of little interest or concern to either Crest or the regulatory authorities at the time Crest developed SLC. Only the STATS report of August

1983 [ref: 83/3105) (2-2)] tested for bromate and found no concentration above the detection limit. Although this limit was high compared to tests carried out recently it was reasonable according to the standards of the time. This means that the Atkins analyses were 2000 times more sensitive than those of STATS in 1983. Crest knew of the possible presence of bromate as a result of the general history of SLC and the STATS report of August 1983 (ref: 83/3105) (2-2) but the STATS report erroneously confirmed that bromate levels were negligible. The suspected presence of higher levels of bromate was only confirmed some seventeen years later. This was after Crest had sold SLC and came about when TVW, the water undertaker for the area, started to test the groundwater at its boreholes for bromate.

192. If Crest deliberately set test levels to avoid detecting problem substances they would have also done so for bromide and other substances rather than just for bromate which was not perceived to be a problem.

193. Given the information available to it, Crest did not knowingly permit the bromate, by reason of which SLC is contaminated land to be in, on or under that land since it did not know of the presence of bromate at SLC.

194. In paragraph 3 of its first response Redland argue that Crest had constructive knowledge of bromate. It backs this argument up at two paragraphs, both numbered 3 on pages 2 and 3 of its second response. By leaving SLC uncovered, according to Redland, Crest were negligent in the context of civil liability (paragraph 3 on page 3

of its second response) and that they should be regarded as having had knowledge of the presence of bromate. The basis for the assertion about civil liability is presumably the last sentence from the judgment quoted on page 3, "… *the legal conception of constructive knowledge, which is not a conception which, generally speaking, has any place in criminal law*."

195. The elements of the knowingly permit test are set out in section 5.1.2 above: knowledge of the presence of the pollutant and failure to do something which could reasonably have been done to prevent the pollutant remaining under the land and impacting on the groundwater.

196. The key question is therefore whether Crest deliberately refrained from acquiring, or negligently omitted to acquire, knowledge of the bromate. Crest's knowledge of the presence of bromate is described in paragraphs 79 to 82 above. The Agency does not consider such knowledge to be sufficient to satisfy the first limb of the knowingly permitting test. There is no evidence that Crest's failure to acquire knowledge of bromate was either deliberate or a result of negligence.

5.1.3.6.9 Conclusion as to Crest and the bromate SPL

197. For the reasons set out the Agency considers that Crest neither caused nor knew of the presence of bromate under SLC. Crest is therefore not an appropriate person in relation to the bromate SPL.

5.1.4 Conclusions as to Class A persons

198. There are three Class A persons to be considered in the next stage of the sequential decision making process set by the guidance. These are Redland, Crest and Woolwich.

5.1.5 Class B persons

199. Since Class A persons have been found for both SPLs there is no requirement to go on to seek to determine who may be Class B persons (paragraph D.12 of the Guidance). In any event it is not appropriate to designate class B persons in relation to pollution of controlled waters (s. 78(J)(2) EPA).

5.1.6 The liability group

200. Therefore, the liability group for each SPL is:

The bromide SPL: Redland, Crest and Woolwich.

The bromate SPL: Redland.

5.2 The second stage: characterising the remediation actions

201. The actions contained in Schedule 2 of the notice are assessment actions. These have been formulated bearing in mind that the ultimate remedial objectives in relation to SLC are:

(a) to prevent or minimise the continuing or future migration of contaminants from SLC by pumping and/or treating contaminated water from beneath SLC; and

(b) to improve the quality of localised areas of the aquifer further down-gradient to a quality sufficient for abstractions to be used with no treatment other than readily available dilution.

202. The specific remedial treatment actions which will enable the land and controlled waters to be effectively remediated to the required standards cannot yet be identified. This is because specific assessment actions are needed to characterise in detail the SPLs and to collect data to evaluate the likely effectiveness of remedial treatment actions. The notice therefore identifies a series of assessment actions that will enable remedial treatment actions to be specified in one or more subsequent remediation notices.

203. In accordance with paragraphs D.20 to D.23 of the guidance, the following is the assessment as to whether the actions in schedule 2 of the notice are single linkage actions (relate to one SPL) or shared actions (relate to more than one SPL) and the reasons for that assessment:

1A: Single linkage action. It only refers to the bromate in the bromate SPL.

1B: Single linkage action. It only refers to the bromate in the bromate SPL.

1C: Single linkage action. It only refers to the bromate in the bromate SPL.

1D: Single linkage action. It only refers to the bromate in the bromate SPL.

2E: Shared action. It refers to the bromide in the bromide SPL and the bromate in the bromate SPL.

204. The approximate cost of each assessment action following the numbering used in schedule 2 of the notice is as follows:

Ref	Action	Cost estimate (£)	Basis for cost estimate
1A	Estimate load of bromate in unsaturated and saturated zones beneath SLC	4800	12 days @ £400 per day
1B	Estimate rate of input of bromate to controlled waters from SLC	4800	12 days @ £400 per day
1C	Review scope for modelling the contaminant plume	10000	25 days @ £400 per day
1D	Monitor groundwater	20000	Charge rates of Agency monitoring contractors & laboratory for 33 locations, 2-monthly
2E	Monitor groundwater	9000	Charge rates of Agency monitoring contractors & laboratory for 11 locations, 2-monthly

5.3 The third stage: attributing responsibility between liability groups

205. There is one shared action, 2E, so paragraph D.99(b) of the Guidance applies to that action. An equal share of the cost of carrying out action 2E should be attributed to each liability group.

206. Therefore the proportion of the cost in which liability is attributed to each liability group is:

Bromate liability group (Redland):

- **100% of the cost of the assessment actions for the bromate SPL.**
- **50% of the cost of the assessment action for the bromide SPL.**

Bromide liability group (Redland, Crest and Woolwich):

- **50% of the cost of the assessment action for the bromide SPL.**

5.4 The fourth stage: excluding members of a liability group

5.4.1 Bromate Liability Group

207.The bromate liability group has only one Class A member so the fourth stage does not apply, in accordance with D.28(a) of the Guidance.

5.4.1.1 Nevertheless, did Redland make Crest aware of the presence of bromate?

208.In their representations Redland (paragraphs 6 – 14 of its first response) argued that they had made Crest aware of the presence of bromate and so should be excluded from the liability group under test 3, "Sold With Information" (paragraphs D.57 to D.61 of the Guidance). Although the exclusion test does not apply since Redland are the only member (paragraph D.41(c) of the Guidance) it is appropriate to make clear that the Agency do not consider that Redland had made Crest aware of the broad measure of bromate at SLC before the sale to them.

209.The only source of knowledge for Crest as to the presence of bromate at the time of purchase is the STATS report of August 1983 (2-2). Samples taken show that no bromate was measured above the detection limit of 20 mg/kg. No further investigations were, therefore, carried out. Redland did not provide any further information or suggest any further investigation was necessary and Crest was not, therefore, aware of the broad measure of bromate that has subsequently transpired.

210.Redland remain the only member of the bromate liability group.

5.4.2 The bromide liability group

211.The bromide liability group has three members, Redland, Crest and Woolwich. In accordance with paragraph D.28(a) of the Guidance as the liability group has these three Class A members paragraphs D.40 to D.72 of the Guidance (the exclusion tests) apply. This means that the exclusion tests are to be applied sequentially until either they have all been considered or there is only one member left in the group.

5.4.2.1 Test 1: excluded activities

This test only applies to Woolwich.

212.Paragraph D. 47 of the Guidance is relevant:

> *"The activities are ones which, in the Government's view, carry such limited responsibility, if any, that exclusion would be justified even where the activity is held to amount to "causing or knowingly permitting" under Part IIA."*

213.Paragraph D. 48 then lists the activities that may lead to exclusion from a liability group. One activity is:

> *"(a) providing (or witholding) financial assistance to another person (whether or not that other person is a member of the liability group), in the form of any one or more of the following:*
> *…*
> *(ii) making a loan or providing any other form of credit, including instalment credit, leasing arrangements and mortgages."*

214. It is key to note to the interpretation of paragraph D.48(a)(ii) is that it is designed as a form of catch-all provision. It uses the words "*any other form of credit including…*" The list of arrangements in paragraph D.48(a)(ii) is not meant to be exhaustive.

215. Paragraphs 2.13 to 2.17 of Woolwich's first response sets out the nature of the contractual arrangements between Crest and Woolwich. It reinforces these points in its letter of 6th June 2005. Woolwich purchased SLC as part of the lending arrangements. The nature of the agreement was such that Woolwich did not play an active part in the development of SLC (paragraph 4.10 of Woolwich's first response). It was not a conventional development partner in that there was no equal profit sharing and Woolwich received a fixed fee and small element of profit share (2% of gross profit). Moreover, the loan was paid back. This particular arrangement is not listed in paragraph D.48 of the Guidance.

216. Woolwich did become the freeholder of SLC. Woolwich in paragraph 2.1 of its letter of 6th June 2005 highlight that,

"*Having a legal interest for security purposes (e.g. a long lease as a mortgagee) is clearly not inconsistent with providing finance. Woolwich's title to the land was not merely security provided consequentially on the provision of credit. Title would not have been obtained but for the provision of such credit.*"

217. Further, Woolwich highlights through its examination of the finance arrangements at paragraph 2.2 of its letter of 6th June 2005 that it received considerably less money than Crest. Woolwich received a fee of £68,762 as compared to Crest's profits of £1,117,846. This difference in these figures show that Crest benefited financially to a much greater degree than Woolwich. In no circumstances were Woolwich to take a loss in the same way as Crest might have done if the development had been unsuccessful. Whilst there may have been profit sharing by no means was it an equal partnership. Woolwich's reward was seen as a fee.

218. However, Woolwich's acquisition of the freehold was no more than a device to provide the necessary financial assistance within paragraph D. 48(a) of the Guidance. As such, it falls within the definition of carrying "*such limited responsibility … that exclusion would be justified.*" Crest in its second response at paragraph 12.8 cite examples of those factors that they maintain show this is not the case in the sense that Woolwich took an active role in the development. The Agency acknowledges that the facts are not all one way – for example, Woolwich's comments on the floor do appear to go beyond a mortgagee's concerns. However, on balance, the Agency

consider that, taking all the information into account, this exclusion test does apply to Woolwich.

219. **Woolwich is excluded from the bromide SPL through the application of Test 1 and is no longer a member of the liability group.**

220. After application of Test 1, the remaining members of the liability group are Crest and Redland.

5.4.2.2 Test 2: payments made for remediation.

221. There is no evidence that payments for remediation were made between Crest and Redland and so no appropriate person benefits from this exclusion test.

5.4.2.3 Test 3: sold with information

222. Paragraph D.58 of the Guidance sets out the elements of the sold with information test:

(a) Sale of SLC between members of the liability group.

223. Crest bought the freehold of SLC from Redland on 22nd September 1983. The sale, therefore, took place between members of the

same liability group.

(b) The sale took place at arms' length.

224. The sale took place on the open market.

(c) Before the sale became binding, the buyer had information that would reasonably allow the particular person to be aware of the presence on the land of the pollutant in the SPL and the broad measure of that presence and that the seller did not misrepresent the implications of that presence.

225. By the time of the sale Crest had received the following documents:

(1) Letter dated 7th July 1983 from SADC to DAC warning of possibility of contamination by bromide (1-28) and

(2) Letter dated 15th July 1983 from SADC to DAC giving further details of the processes carried out on SLC and warning of the likely need for a site survey (1-29)

226. Before it bought SLC from Redland on 22nd September 1983 and from the SA on 18th November 1983 Crest had the

following scientific reports which showed the presence of bromide:

(1) Soil analysis carried out by Imperial College dated 18th February 1982 (2-1),

(2) STATS report dated August 1983 (ref: 83/3105) (2-2) showing bromide in the soil at depths of 0.5 – 1.4 m at concentrations up to 500mg/kg in boreholes 1, 2 and 5 but at 1000-2200mg/kg in boreholes 3 and 4,

(3) Maybe the STATS report dated September 1983 (ref: 83/3105A) (2-3) (this report is dated September 1983 and Crest bought part of SLC from Redland on 22nd September 1983) and

(4) Before purchasing the SA land, maybe the STATS reports of November 1983 (ref: 83/3105C and 83/3217) (2-4 and 5 respectively) (both of these reports are dated November 1983 and Crest bought part of SLC from the SA on 18th November 1983).

Tests showed contamination and, therefore, the Agency consider Crest did have the broad measure of bromide contamination at SLC.

227. Crest disagree. At paragraph 5.1 of its first response Crest states that,

"At the time of its acquisition, Crest did not know of the "broad measure" of the presence on the land of the bromide within D. 58 of the Guidance."

In paragraph 13.1 of its second response Crest offer two tests that it argues must be applied to decide if it had the "broad measure" of the presence of bromide on the land:

(i) To compare what Crest knew pre-purchase and in fact found in situ post purchase and

(ii) Assessment of whether the Agency is right about the significance of the contamination on site

228. In reply, the Agency note Crest knew the land was contaminated with bromide. STATS report of August 1983 (2-2) refers to boreholes being located in specific areas most likely to be contaminated – paragraphs 2.4 – 2.7 of the report. Therefore, before the sale became binding Crest had enough knowledge of SLC to know where to look for contamination. Even had Redland supplied Crest with more information the boreholes would still have been located in the locations specified since they would have been placed in areas where the greatest contamination would have been expected [i.e. from the positions in STATS report of August 1983 (2-2)].

229. Therefore, Crest did have the broad measure of the presence of bromide on the land. The Guidance does not require the precise degree of knowledge that Crest argues for. The Guidance only requires knowledge of the presence of bromide and the broad measure of that presence.

230. Paragraph D.58(c) of the Guidance requires consideration of whether the seller did anything material to misrepresent the implication of that presence. Redland did not do anything material to misrepresent the implications of that presence – see paragraph D. 58(c) of the Guidance. Crest argue at paragraph 5.4 of its first response that had Redland provided the additional information (i.e. leakage from the sumps as referred to in paragraph 5.3 of Crest's first response) about the extent of the contamination the nature of the remedial obligations would have significantly affected the value of the land. This is only supposition since there can be no guarantee that Crest would have carried out more intrusive investigations or even acted upon those representations.

(d) Retention by seller of interest in SLC

231. Redland did not retain any interest in SLC after the sale to Crest.

232. **Therefore, on this application of Test 3, Redland is excluded from liability for the bromide SPL.**

233. In accordance with paragraph D.41(c) of the Guidance since the application of this test leaves only Crest as the sole member of the liability group for the bromide SPL. None of the remaining tests need be considered although, in fact, none of them would apply in any event.

5.4.2.4 Test 4: changes to substances

234.Does not apply.

5.4.2.5 Test 5: escaped substances

235.Does not apply.

5.4.2.6 Test 6: introduction of pathways or receptors

236.Does not apply.

54.3 Conclusion to Stage 4

237.**After the application of all the exclusion tests, the liability group for each SPL is (see paragraphs D.99 and D.100 of the Guidance):**

The bromide SPL: Crest.

The bromate SPL: Redland.

5.5 The fifth stage: apportioning liability between members of a liability group

238. On the basis of the conclusion to stage 4 the costs for remediation of the bromate SPL are borne by Redland and the costs for the remediation of the bromide SPL are borne by Crest.

239. **Since there is only one member for each liability group, the proportion in which costs should be borne for each SPL are simply as follows:**

Redland: 100%

Crest: 100%

6 Miscellaneous issues raised in the first responses

6.1 Jersey Farm

240. Crest at paragraphs 3.2 and 7.16 of its first response seeks to suggest that the former JF landfill site was a pre-existing source of bromide and that service of the notice is premature without a proper investigation of pre-existing sources of bromide. The Agency does not accept this suggestion.

241. The PAPs were provided as part of the consultation process with a copy of the ground contamination desk study prepared by Atkins of May 2003 to assess JF in

accordance with the Part IIA regime. They were also provided with the records of HCC and an investigation by Wembley Laboratories in 1976 (see 2-40 and 42).

242. In relation to JF it is necessary to distinguish between the lagoon and the landfill. Attached is a plan numbered 2 showing the location of both the lagoon and the landfill at JF.

243. JF in its present form comprises a restored landfill with a lagoon some 50m in diameter on its northern edge. The lagoon acts as a soakaway for surface water transmitted to it by two culverts. One ('the House Lane culvert') drains the northern end of House Lane and the part of Sandridge High Street around its junction with House Lane. This culvert is known to have been in existence at the time the Steetley factory was in operation and received surface drainage from the factory. The second culvert carries water from part of the Jersey Farm housing estate to the west and southwest of the landfill and lagoon and was presumably constructed at the same time as the housing development, believed to have been in the 1980's. During heavy rain the water level in the lagoon rises rapidly and then falls over the next few days as the water drains through its base into the chalk aquifer.

244. The present day landfill and lagoon occupy the site of a former quarry, believed to have been excavated in the 1950s. The file record indicates that the quarry had some standing water in the base suggesting it intercepted the water table at times. The greater part of the quarry was filled with household waste under a consent from HCC

between 1959 and 1969, leaving a small area at the northern end to continue functioning as a soakaway. It is believed that the soakaway area was substantially reshaped (e.g. to remove steep banks) into the present form of the lagoon when the landfill and lagoon areas were brought into use as a public open space by SADC in the 1980s.

245. To understand the potential impact on the plume it is necessary to consider the landfill and lagoon separately. It should be noted that the lagoon comprises controlled waters as defined by the WRA and that only the landfill could conceivably fall within the Part IIA regime. The purpose of the Atkins desk study of May 2003 was to examine the case for investigation of the landfill as a potential special site. Hence, it gives little consideration to the lagoon.

246. The sole reason for suspecting that the landfill might contain bromide is the fact that it was filled during the time when the Steetley factory was in operation. The Agency now considers it highly unlikely the landfill contained bromide for the reasons listed below.

(a) Condition 12 of the permit (2-42) which allowed the quarry to be filled with household waste specifically excluded the deposit of *"material of an injurious or poisonous nature or likely in any way to cause pollution or discoloration to surface or underground water supplies…"*. This was a standard condition of

permits issued by HCC at that time, which would have been interpreted to exclude any waste of a 'chemical' nature.

(b) Reports of HCC inspectors (2-42) and the recollections of their manager, Jack Stringer (2-41), give no indication that any deposit of waste from Steetleys ever occurred. Mr Stringer was formerly HCC County Environmental Health Officer and, in this role, had responsibility for oversight of the landfill during its operation. In a letter dated 27th January (2-41), as provided to the PAPs, he states,

"*I remember the site of the old bromine works well enough …… In spite of the works being temptingly close to the House Lane tip I have no memory of their waste being dumped there*"

The letter goes on to refer to the likelihood that any waste from the Steetley site would have been deposited at another site near Welwyn Garden City.

(d) In the report dated January 1975 of the JF investigation by Wembley Laboratories Ltd (2-41) and supplied to the PAPs nine boreholes drilled into the landfill in December 1974 revealed only typical domestic refuse and produced no evidence of any chemical waste or any unusual appearance or odour of the waste.

247. The lagoon, however, is acknowledged to have been a likely source of some contamination of the aquifer as a result of polluted run-off from the Steetley site which reached it via the House Lane culvert. One measurement of bromide, 51mg/l

in 1978 following an incident at SLC, exists [note from JT dated 25th August 2000 (2-21)]. In addition a local resident, a professional research chemist who studied the microorganisms in the lagoon from the early 1970s, has provided information in a letter and phone conversation [referred to in Atkins report on Jersey Farm, paragraph 4.53 (2-38)] that the water frequently had the characteristic odour of brominated organic chemicals. He reports that the odour persisted for a few years after the closure of the factory but that,

"since the pit was partly filled in and the banks levelled I haven't detected any halogen-like odour at all and the level of biodiversity within the pit is good"

248. On the basis of the above evidence it is clear that bromide (and other bromine compounds) is likely to have entered the groundwater via the lagoon until perhaps 1986. The following points are made in relation to this source of groundwater contamination:

(a) The discharge comprised rainwater and associated chemicals washed off the Steetley site by rainwater and would therefore have been intermittent and at a low concentration relative to the concentrations entering the ground and present in the groundwater at SLC.

(b) There has been no discharge of pollutants to the lagoon since about at least 1986 and possibly earlier. Concentrations of bromide in the lagoon measured by the

Agency as part of their monitoring in the period July 2000 – October 2002 [see Agency database of monitoring data, sample point 047 (2-26)] have generally been below 150µg/l except under circumstances (notably the period of excessively high groundwater levels in spring 2001) in which it was clear that contaminated groundwater from the underlying plume was rising into the lagoon.

(c) Because the lagoon is regularly flushed with large quantities of runoff any bromide which resided in the chalk matrix or putty chalk in the vicinity of the lagoon is no longer likely to be present. Should there be any continuing release of residual bromide from the chalk matrix or putty chalk it is likely to be highly diluted by the large volumes of water passing into the aquifer from the lagoon.

249. The significant conclusions from these points are:

(a) Any bromide which may have been discharged to the aquifer via the lagoon is likely to have been insignificant compared to that from SLC, and has diminished progressively since 1986 or earlier.

(b) There is no current discharge of bromide from the lagoon.

(c) On basic hydrogeological grounds the lagoon cannot be affecting any location which is upgradient of it. This includes any boreholes at or close to SLC.

250. In the light of these factors, it is considered that any bromide which has reached the groundwater downgradient of JF via the lagoon is insignificant and not a material factor such as to delay consideration of the issue of a remediation notice.

6.2 Other possible sources of contamination

251. At paragraph 18 of its first submission Redland refers to two other sources of contamination, *"local to the Tyttenhanger and Roestock pumping stations"* and the River Colne above Ellenbrook. Redland refers to the report of Mott MacDonald (MM) dated 21st December 2000 and the report of Vivendi of March 2002 as the reference points for those two sources (2-29 and 35 respectively). Plan 3 shows the Tyttenhanger and Roestock pumping stations, the River Colne and the Ellenbrook.

252. The reference by MM to other sources of contamination appears to be recommendation 4 on page 20 of its report that,

> "*Discharges to the upper reaches of the Colne should be identified, in order to establish the source of bromide and bromate upstream of the discharge from Bishops Rise.*"

253. The reference to the Colne by MM should be to the 'Colne surface water system' which would include the Ellenbrook. The Vivendi report recommends, at page 22, that,

"Existing information should be reviewed to identify more clearly the source, and the frequency of inputs, of bromate at the head of the Ellenbrook."

MM and Vivendi are therefore referring to the same source. This has been shown to be the discharge of contaminated groundwater from dewatering operations at Hatfield Quarry. It is, thus, a redistribution of bromate and bromide from the existing SLC contaminant plume, where it lies beneath Hatfield Quarry, into the Colne surface water system via the Ellenbrook. It is not a separate source of groundwater contamination additional to SLC.

254. For these reasons although these other potential sources have been considered they do not alter the Agency's conclusions as to the need to serve a Notice in respect of SLC.

7 The Notice

255. Served with this document is the Notice.

7.1 Explanation of rationale for remediation actions D and E

7.1.1 Choice of sampling locations for action D

256. The locations are those which are necessary to characterise the following aspects of the bromate plume (as far as is possible given the boreholes which are available) but excluding any locations which also serve to characterise the bromide plume:

(a) boundaries of the bromate plume pollution (based on 10ug/l)

(b) polluted abstraction boreholes (and those at risk of pollution)

(c) contaminant concentrations along the centre line of the plume

(d) variation of contaminant concentrations across the width of the plume at one point along its length (Hatfield Quarry)

(e) depth of the plume

7.1.2 Choice of sampling locations for assessment action E

257. The locations are those which are necessary to characterise the bromide plume in respect of aspects (a)-(c) above within that part of the plume where bromide concentrations approach or exceed the concentration of 3000ug/l which has provisionally been taken to constitute ‘pollution’. However, they also supplement the locations above in characterising part of the bromate plume.

7.1.3 Objectives of characterisation

258. The dual objectives of thus characterising both the bromate and bromide plumes are to:

(a) Detect any changes that might threaten currently uncontaminated parts of the aquifer.

(b) Throw light on the factors affecting the shape, concentration and movement of the plume. A major such factor, causing decreasing contaminant concentration with increasing distance from SLC, is dilution by mixing with non-contaminated groundwater.

7.1.4 Need for concurrent analysis for bromate and bromide

259. Concurrent analysis contributes principally to objective (b) above in respect of both bromide and bromate plumes, as explained below.

260. The most reliable measure of dilution at any point downgradient is the concentration of total bromine. This is the sum of the bromine present in both bromide and bromate, which can be calculated only if both are measured.

261. A second reason for measuring both contaminants is that their ratio at any location can provide information on their behaviour. In a simple plume, in which bromate and bromide are moving similarly and being affected only by dilution this ratio

would remain constant (subject to a correction for the natural background concentration of bromide in groundwater). Measuring the ratio may provide information to allow the effect of other factors to be assessed.

262. Accordingly, given the presence of both bromate and bromide, analysis for both would be part of the assessment action for either of the two SPLs in the absence of the other. For this reason, following paragraph D.21 of the Guidance, action E is a shared action.

263.Turning now to issues raised by the first responses in respect of the notice:

7.2 General issues

7.2.1 Bromate the driver

264. The relative significance of the bromate and bromide SPLs is determined, in the first instance, by the concentrations in the aquifer at which each constitutes pollution. For waters which may be used for human consumption (which includes the aquifer affected by bromate and bromide, since all of it lies within the catchment of a public water supply) pollution is defined by Regulation 3(a) the Water Regulations as a state in which the water requires treatment, or a change in treatment, to make it fit for potable supply.

265. On this basis, the criterion for pollution by bromate appears to be that it exceeds 10ug/l, the standard set in the Water Regulations in the aquifer (although there may be grounds for arguing a more stringent criterion). The criterion for pollution by bromide is less clear because there is no relevant drinking water standard. On the basis of expert toxicological opinion [see letter from Dr J Fawell of Warren Associates dated 23rd March 2001 (1-124), included as Appendix B in the advice from the Agency to SADC, 24th May 2002] the Agency has taken the criterion to be 3000ug/l. Crest's second response at paragraph 17.2 appears to accept this as a working definition. However, there may be a more stringent criterion based on the concentration, believed likely to be lower than 3000ug/l, at which the treatment of water for public supply has to be significantly modified in order to prevent the formation of other bromine-containing compounds (bromate or bromoforms) for which drinking water standards do exist. Determination of such a criterion, if any, and of whether a more stringent criterion that 10ug/l for bromate should be applied, requires advice from the water industry which has yet to be obtained but has been requested.

266. The present assessment actions are, therefore, based on the criteria, 10ug/l for bromate and 3000ug/l for bromide. On this basis the monitoring carried out by the Agency shows that pollution by bromate extends over a much greater area (up to 20km downgradient of SLC) than pollution by bromide, whose concentration in groundwater diminishes to less than 3000ug/l approximately 2km downgradient of SLC.

267. The role of the Agency is to protect and, if possible, enhance the quality of groundwater in the aquifer generally (rather than protecting individual abstractions). Accordingly, the relative significance attached by the Agency to the bromide and bromate SPLs reflects the area of aquifer affected by each. In particular, the monitoring in action E, for which Crest and Redland are jointly responsible, covers only the area of aquifer in which the concentration of bromide has a significant possibility of exceeding 3000ug/l. If, on further inquiry from the water industry, the criterion for pollution by bromide is reduced to a lower value the area over which Crest are required to monitor may be increased correspondingly.

7.2.2 Prescriptive nature of assessment actions

268. An argument was raised that the assessment actions should not be prescriptive (paragraph 16 of Redland's first response). The Agency does not understand this point. The nature of assessment actions is set out in paragraphs C.65 to C.66 of the Guidance. As stated in the preamble to each assessment action, they are required to characterise the SPLs to enable the Agency to determine what would need to be achieved by any remedial treatment action (paragraph C.65(a) of the Guidance). An assessment action by its very nature has to impose a method and this is what they do. A remediation notice is mandatory and there are criminal sanctions for non-compliance. Therefore, it is considered appropriate that it provides defined

requirements in order that a recipient can be clear as to what is required in order to comply with it.

269. In turn the Agency rejects the assessment actions proposed by Redland in paragraph 17 of its first response.

7.2.3 Objectives of assessment actions

270. The Agency does not agree that the objectives are not set out with sufficient clarity in the opening paragraph to Schedule 2 (Crest's first response paragraph 3.1). The objectives accord with paragraph C. 65 of the Guidance.

7.2.4 Issues raised in respect of the specific assessment actions

271. In its first response Crest make the following points:

"7.1

(c) Bromide assessment premature

Because of the significance of bromate as the driver any further assessment of the bromide problem is premature until assessment and remediation of the bromate problem has been completed.

[Crest re-iterate this point at paragraph 15.3 of their second response.]

… …

8.2 Turning now to the specific Assessment Actions, monitoring for all the parameters for which it is sought to test under Action 2 does not relate to bromide contamination for which Crest could conceivably (on the Agency's case) be responsible. This monitoring would have been required by the bromate and/or the pre-existing concentrations of bromide in the groundwater in any event.

8.3 Further monitoring under Action 2 in respect of bromide is unnecessary in respect of the considerable amount of data already obtained. There is no explanation of the objective or of what might be achieved as a result of such monitoring."

272. High concentrations of bromide in the aquifer may be unacceptable for two possible reasons:

(a) They exceed 3000ug/l, the guideline value for potential effects on the health of consumers of untreated water which has previously been used as the criterion for pollution.

(b) They could result in the creation of either bromate or bromoform compounds in the course of treatment to disinfect water for potable supply. The concentration at which this risk arises is thought likely to be lower than 3000ug/l but has not yet been determined.

273. In relation to paragraph 8.4 of Crest's first response monitoring for bromide is now required at 11 locations where the

concentration is likely to exceed 3000ug/l. Moreover, the monitoring is now a shared action to both bromide and the bromate

SPLs resulting in the costs falling equally on Redland and Crest.

274. In relation to paragraph 8.3 of Crest's first response it cannot be assumed that the plume is wholly stable so existing data will need to be continually updated. The monitoring is required to detect any change in the high occurrence of bromide concentrations.

275. At paragraph 8.4 of its first response Crest makes the following point:

"In any event, a time-unlimited obligation as set out in Action 2 is insufficiently precise, given the criminal sanctions for non-compliance with such a provision. The recipient of a remediation notice must know precisely what is expected of him, and the draft notice does not fulfil that requirement."

In response, the monitoring has now been limited for a period of 5 years.

At paragraph 18 of its second response Crest argues that the remediation notice should specify the receptor. There is no such requirement in Regulation 4 of the Regulations.

8 The decision making process

276. The Agency does not agree with Crest's argument in paragraph 9 of its first response that there has been a breach of Article 6(1) of the European Convention of Human Rights.

277. The Agency operates what is called a Non-financial Scheme of Delegation. This sets out which documents are appropriate to be signed at what level of seniority. A remediation notice under Part IIA EPA has to be signed by an Area Manager. John Collins is the Area Manager of the North East Area of the Thames Region of the Agency in which SLC is located.

278. Mr Collins has signed the remediation notice on behalf of the Agency. He has had some contact with interested parties including TVW but this has not been at the detailed level of consideration that has gone into to the preparation of this decision.

279. Mr Collins has been briefed as to the details of the factual material behind this decision. This has allowed Mr Collins to review the arguments considered in the decision and to consider the arguments of the Agency and those consulted before determining whether to issue the notice on behalf of the Agency or not.

280. The Agency has followed the procedure as set out in the Guidance and referred to at paragraph 7 of the decision. There is also a statutory right of appeal against the service and the terms of the notice open to any recipient of the notice. The Agency

considers that the process is fair and compatible with Article 6 of the European Convention of Human Rights and the requirements of the Human Rights Act 1988.

281. It is lawful and inevitable that, as a regulator, the Agency has been in contact with various parties with an interest in the issues raised by SLC. It is not accepted that such contact prevents the Agency from making an unbiased, procedurally correct and properly informed decision. The Agency confirms that it does not consider that it has been biased in any way in this matter. It believes it has acted according to its duty under s. 78E EPA.

9. Resumé of decisions leading to determining liabilities according to Part 3 of Chapter D of the Guidance

9.1 First stage: identification of appropriate persons and liability groups

282. The current owners/occupiers are not a Class A person by virtue of not causing or knowingly permitting the pollution for either SPL.

Beechgrove is not a Class A person by virtue of not causing or knowingly permitting the pollution for either SPL.

SA is not a Class A person because it did not cause or knowingly permit the pollution for either SPL.

Woolwich did not cause the pollution for either SPL. Woolwich did not cause or knowingly permit the pollution for the bromate SPL. However, it could have knowingly permitted the pollution for the bromide SPL. The Agency does not reach a decision on this element of the procedure.

Redland is a Class A person by virtue of causing the pollution for both SPLs and is a member of the liability group for both SPLs.

Crest did not cause or knowingly permit the pollution for the bromate SPL nor did it cause the pollution for the bromide SPL. Crest is a Class A person by virtue of knowingly permitting the pollution for the bromide SPL and is a member of the liability group for the bromide SPL.

9.2 Second stage: characterising the remediation actions

283. Remediation actions 1A to 1D for the bromate SPL are single linkage actions.

Remediation action 2E for the bromate and bromide SPLs is a shared common action

9.3. Third stage: attributing responsibility between liability groups

284. Bromate liability group (Redland)

- 100% of the cost of the assessment action for the bromate SPL.
- 50% of the cost of the assessment action for the bromide SPL.

Bromide liability group (Redland, Crest and Woolwich)

50% of the assessment action for the bromide SPL.

9.4 The fourth stage: excluding members of a liability group

285. Woolwich is excluded from the bromide SPL (if it were a member of that group) through the application of Test 1 and is no longer a member of the liability group.

Redland is excluded from the bromide SPL through the application of Test 3 and is no longer a member of the liability group.

After application of exclusion tests members of the liability group for each SPL are:

The bromide SPL: Crest.

The bromate SPL: Redland.

9.5 Fifth stage: apportioning liability between members of a liability group

286. Bromate SPL: Redland, 100%

Bromide SPL: Crest, 100%

287. For the reasons set out in this decision the Agency has determined to issue the notice in the form attached.

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John Collins

Area Manager of North East Area of the Thames Region of the Environment Agency

8th November 2005

APPENDIX 1

Estimate of the adjustment to be made to the Agency's estimate of the bromide left in-situ at SLC by Crest to take account of the localised areas of deeper excavation

1. JT39 records her recollection that the chalk was exposed in the areas of the two sumps whose approximate locations are shown in Figure 3 of the Atkins report (2-24).

2. The logs of the four deep boreholes drilled by Crest (2-9) and Chemfix (2-14) in 1984-85 and by Komex and Atkins in the recent investigations (2-22 and 2-24) show that the depth of the Chalk in these areas is not more than approximately 4.0m.

3. So assume Crest deepened their excavations to 4.0m.

4. The calculation by MR of the bromide remaining on the site was based on the assumption that the bromide concentrations given in the Chemfix report of March 1985 (2-14) continued to a depth below ground of 4.0m. His calculation included an adjustment for the bromide that was removed in the shallow excavations to 0.75 or 1.5m.

5. Therefore, in the areas of the sumps it is likely that MR assumed excavation to 1.5m.

6. So the bromide removed by the deeper excavation, which MR failed to deduct from his total was that contained between the depth of 1.5m and 4.0m.

7. The highest bromide concentration in Fig 2 of the report by MR, derived from the March 1985 data and used in his estimate, is 1277mg/kg (in cell J-H 4-5). This is an appropriate concentration to assume for bromide in the soil in the deeper excavation for the purposes of adjusting MR's estimate.

8. Note that if the actual concentration removed exceeded this value, or if the depth of excavation exceeded 4.0m this is irrelevant for the purpose of adjusting MR's estimate, because any contamination deeper that 4.0m, or exceeding 1277mg/kg was not included in the estimate.

9. The area of each sump is estimated to have been 5m x 5m. Assume that the deeper excavation round each sump was over an area 10m x 10m. and that additional excavation in other areas of high contamination amounted to a third excavation of this size (although, as noted above, JT recalls seeing deeper excavation only in the vicinity of the two sumps). So the bromide to be deducted from MR's estimate is that over an area of $300m^2$ (3 excavations, each measuring 10m x 10m), 2.5m thick (deepening the shallow excavation from 1.5m below ground to 4.0m below ground) with a bromide concentration of, say, 1300mg/kg. A reasonable figure for density of the material and that used by Roberts is $2000kg/m^3$.

10. Hence, the weight of bromide in the soil removed by deepening the excavation can be estimated as follows:

Volume of soil removed = $300m^2$ x 2.5m = $750m^3$.

Weight of soil removed = volume x density = $750m^3$ x $2000kg/m^3$

= 1500000kg

Weight of bromide removed = wt of soil x bromide concentration

= 1500000kg x 1300mg/kg

=1.95×10^9mg = 1950kg

11. Subtracting this figure from MR's estimate of 5129-11729kg reduces it to 3179-9475kg.

12. Applying the same calculation to an area of excavation other than $300m^2$ would increase or decrease it pro-rata.

APPENDIX 2

Estimate of the bromide that would have been removed by excavation of 1-2m of chalk beneath SLC

1. The evidence from the 4 deep boreholes, STATS 1, 2 and 3 and Chemfix C1 (2-9 and 2-14 respectively), is that bromide concentrations in the putty chalk were similar to those found at the surface. Accordingly, to estimate the quantity of bromide that could have been removed by the excavation of 1-2m of chalk, the best assumption that can be made is that the concentration in the putty chalk was that shown in the report by MR (2-30) Fig 2 in the top left-hand corner of each cell. This figure, if in red print, is the bromide concentration (the average of approximately 4 samples) found in the upper 1m or so of the soil. If the figure is black it is a best estimate, in the absence of a measured figure, calculated from the data in surrounding cells.

2. The calculation of the weight of bromide in a 1-metre depth of chalk is then as follows, similar to that in Appendix 1:

Each cell in Fig 2 of the MR report represents an area 10m x 10m = 100 m^2.

Volume of chalk of depth 2m below each cell= depth of chalk x area of cell

= 2 x 100 = 200m^3.

Assume density of chalk is 2000kg/m^3 as assumed by Roberts

Weight of chalk of depth 2m below each cell= volume x density

$= 200m^3 \times 2000kg/m^3 = 400000kg$

Milligrams of bromide in chalk below cell = wt of soil x bromide conc in mg/kg

= 400000kg x bromide conc in mg/kg

Kilograms of bromide in chalk below cell $= \frac{400000 \times \text{bromide conc in mg/kg}}{1000000}$

$=0.4 \times$ bromide conc in mg/kg

Thus, as an example, for cell C-D 2-3 in MR Fig 2 where the bromide concentration is 593mg/kg

Wt of bromide in 2m depth of chalk below cell C-D 2-3 = 0.4 x 593 =237kg

3. Applying this calculation to every cell in MR Fig 2 and summing the results gives a total quantity of bromide in a 2m depth of chalk beneath the site of 7168kg.