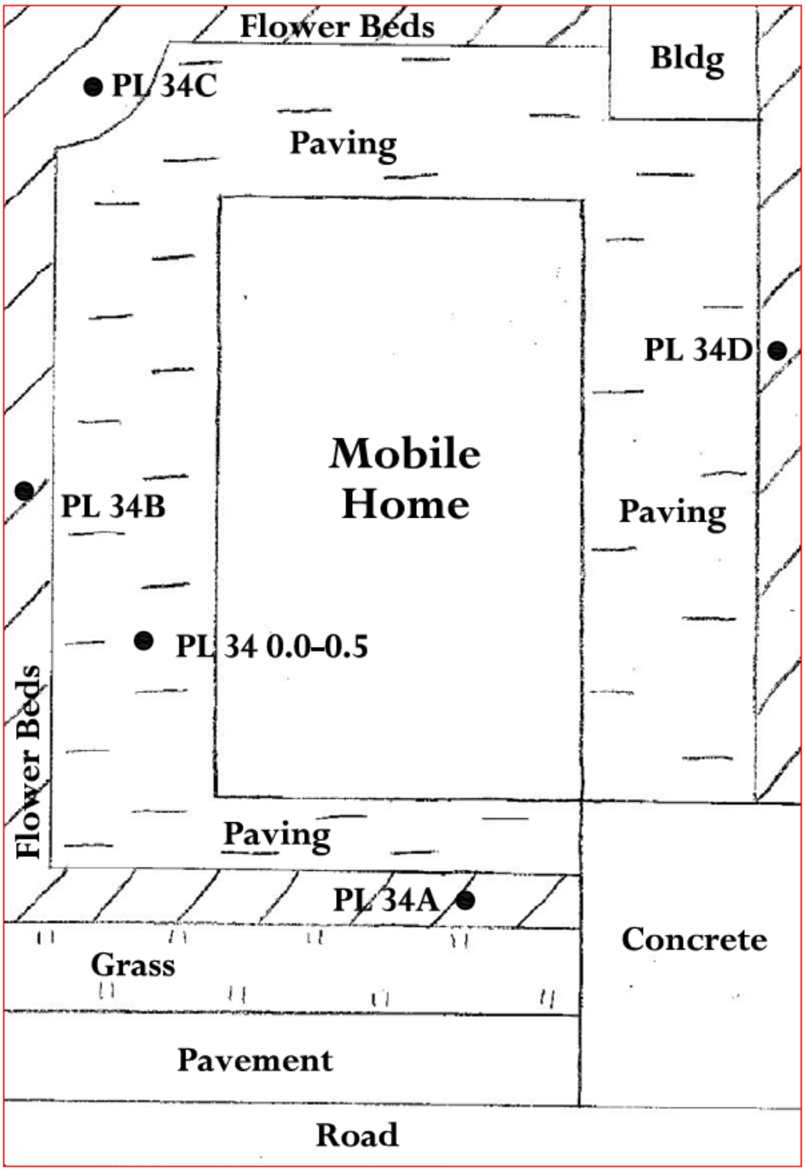
Eynesbury Mobile Home Park

PLOT 34



● PL 34A - 34D = Sample Locations

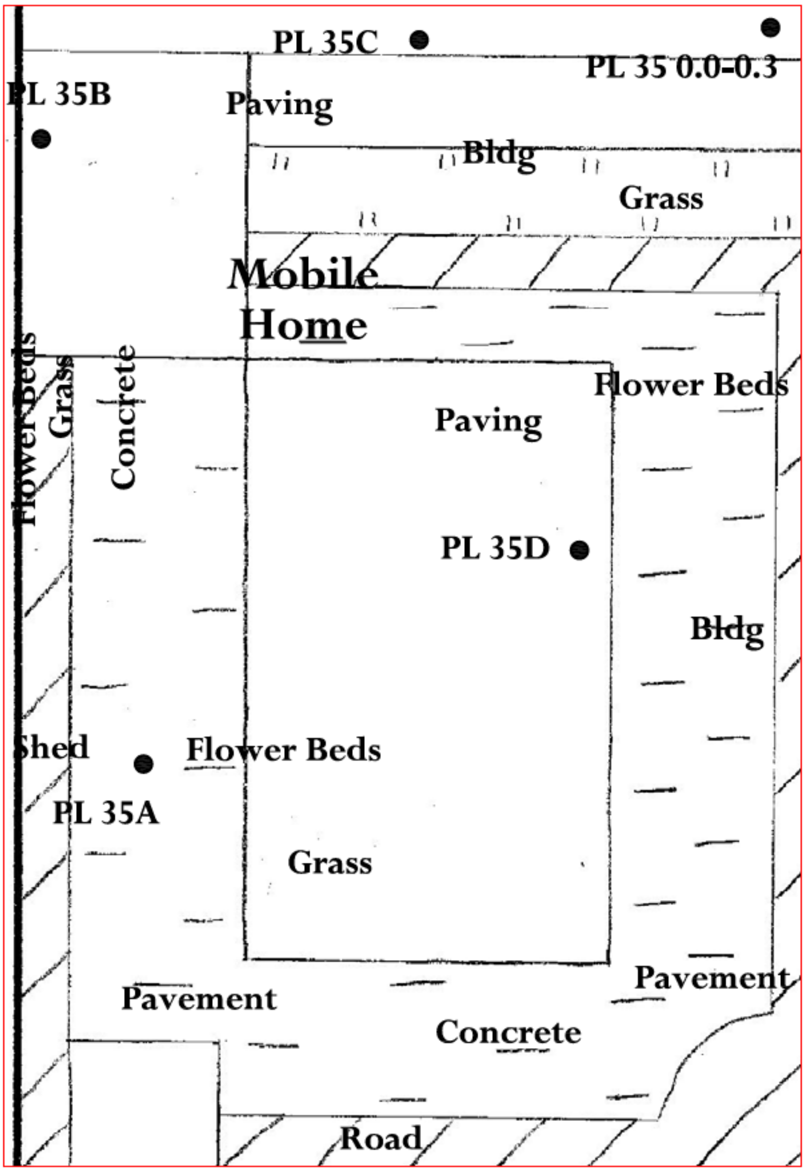
Plot 34	
Sample Ref	BAP
PL 34A	2.0
PL 34B	*0.1*
PL 34C	*0.1*
PL 34D	*0.1*
PL34 0.0-0.5	1.60
Means Value Test Result* =	**1.62**

* = 95th Percentile Means Value Test in accordance with CLR 7

Environmental Protection Strategies Ltd

Eynesbury Mobile Home Park

PLOT 35



● PL 35A - 35D = Sample Locations

Plot 35	
Sample Ref	BAP
PL 35A	*0.1*
PL 35B	*0.1*
PL 35C	1.2
PL 35D	18 2
PL35 0.0-0.3	1.40
Means Value Test Result* =	11.24

* = 95th Percentile Means Value Test in accordance with CLR 7

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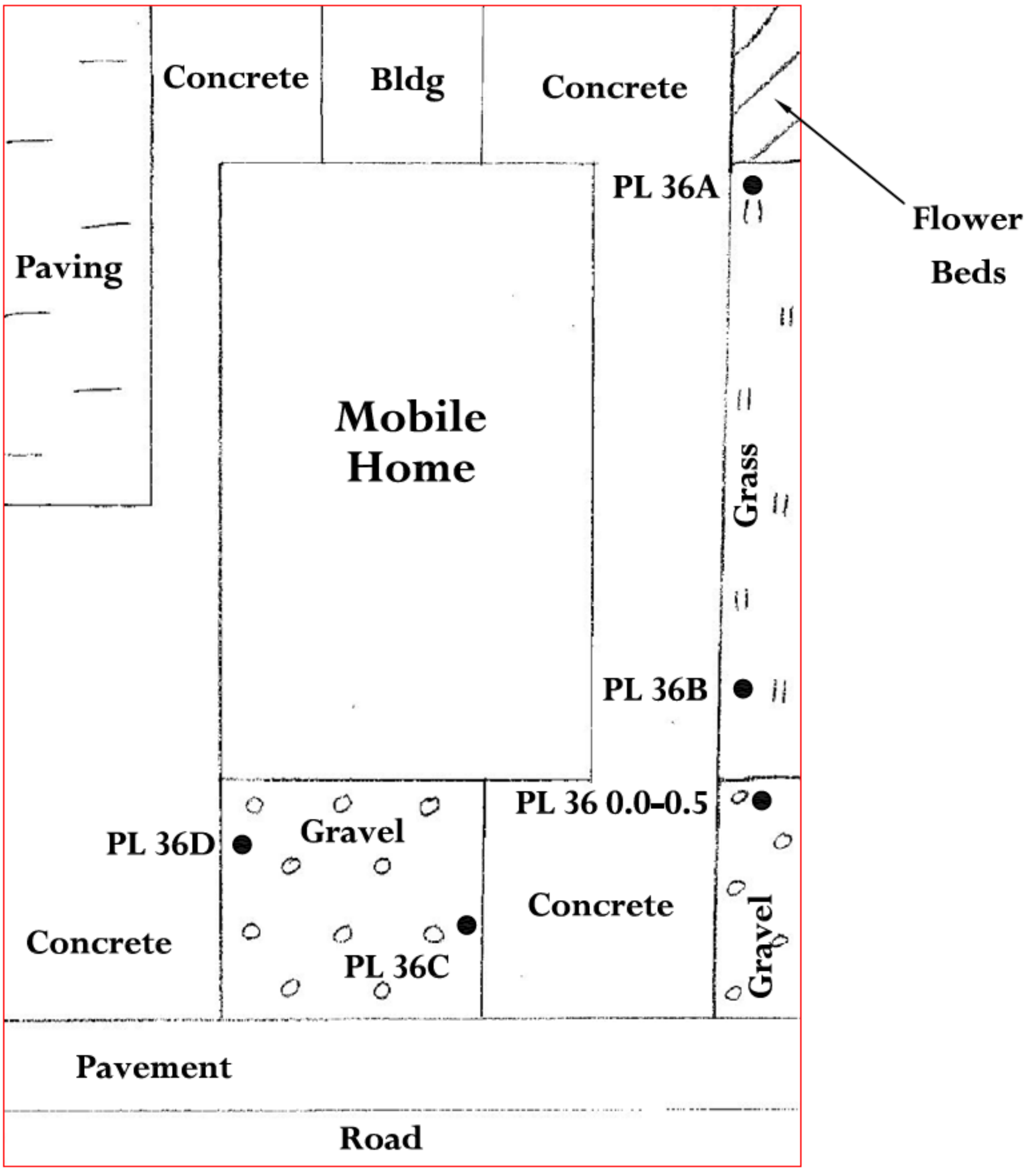
Eynesbury Mobile Home Park

PLOT 36



● PL 36A - 36D = Sample Locations

Plot 36	
Sample Ref	BAP
PL 36A	0.4
PL 36B	1.2
PL 36C	2.2
PL 36D	2.2
PL36 0.0-0.5	22.00
Means Value Test Result* =	13.89

* = 95th Percentile Means Value Test in accordance with CLR 7

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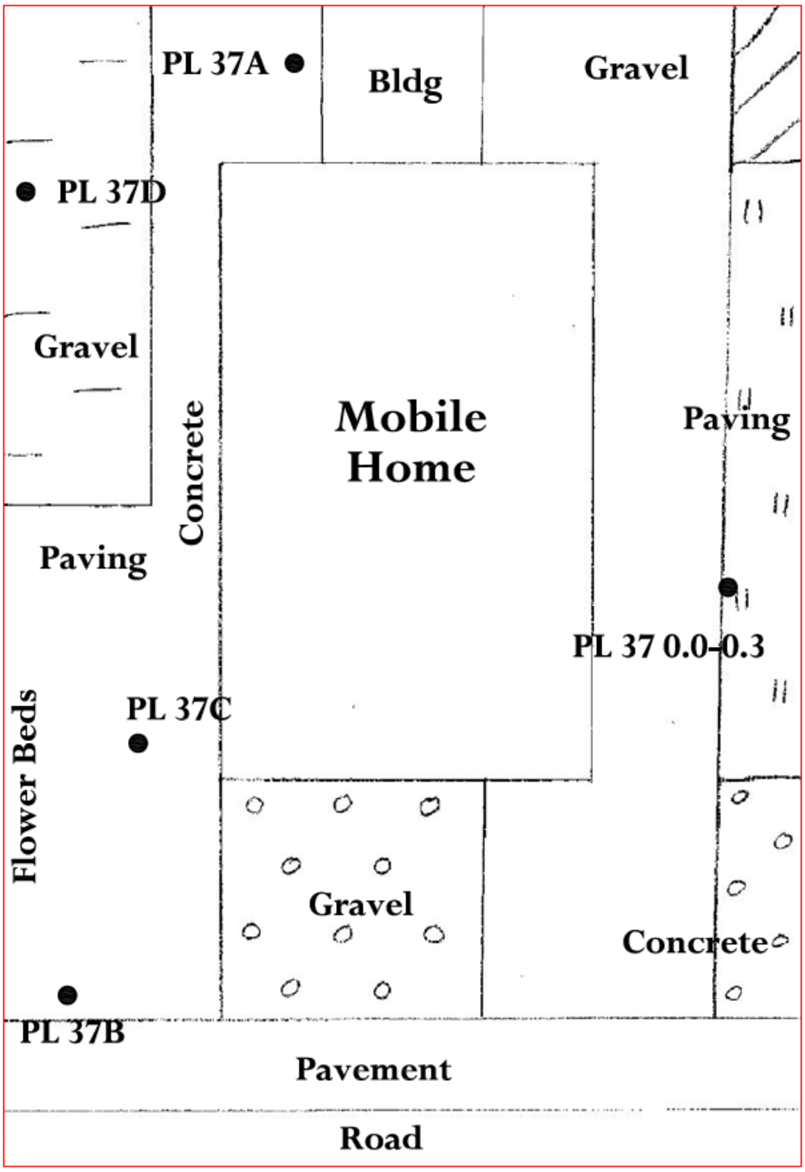
Eynesbury Mobile Home Park

PLOT 37



● PL 37A - 37D = Sample Locations

Plot 37	
Sample Ref	BAP
PL 37A	6.2
PL 37B	13.0
PL 37C	5.2
PL 37D	2.6
PL37 0.0-0.3	0.99
Means Value Test Result* =	9.79

* = 95th Percentile Means Value Test in accordance with CLR 7

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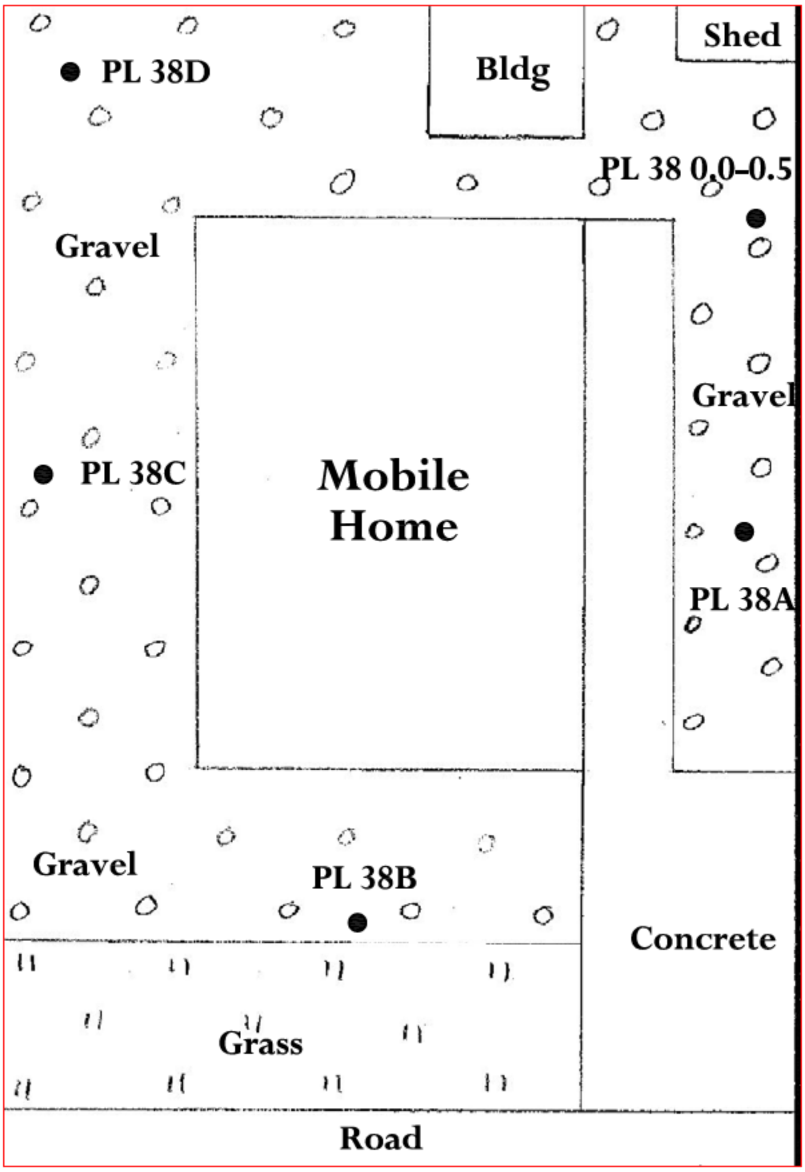
Eynesbury Mobile Home Park

PLOT 38



● PL 38A - 38D = Sample Locations

Plot 38	
Sample Ref	BAP
PL 38A	3 3
PL 38B	27.6
PL 38C	0.7
PL 38D	4.8
PL38 0.0-0.5	2.00
Means Value Test Result* =	<u>17.80</u>

* = 95th Percentile Means Value Test in accordance with CLR 7

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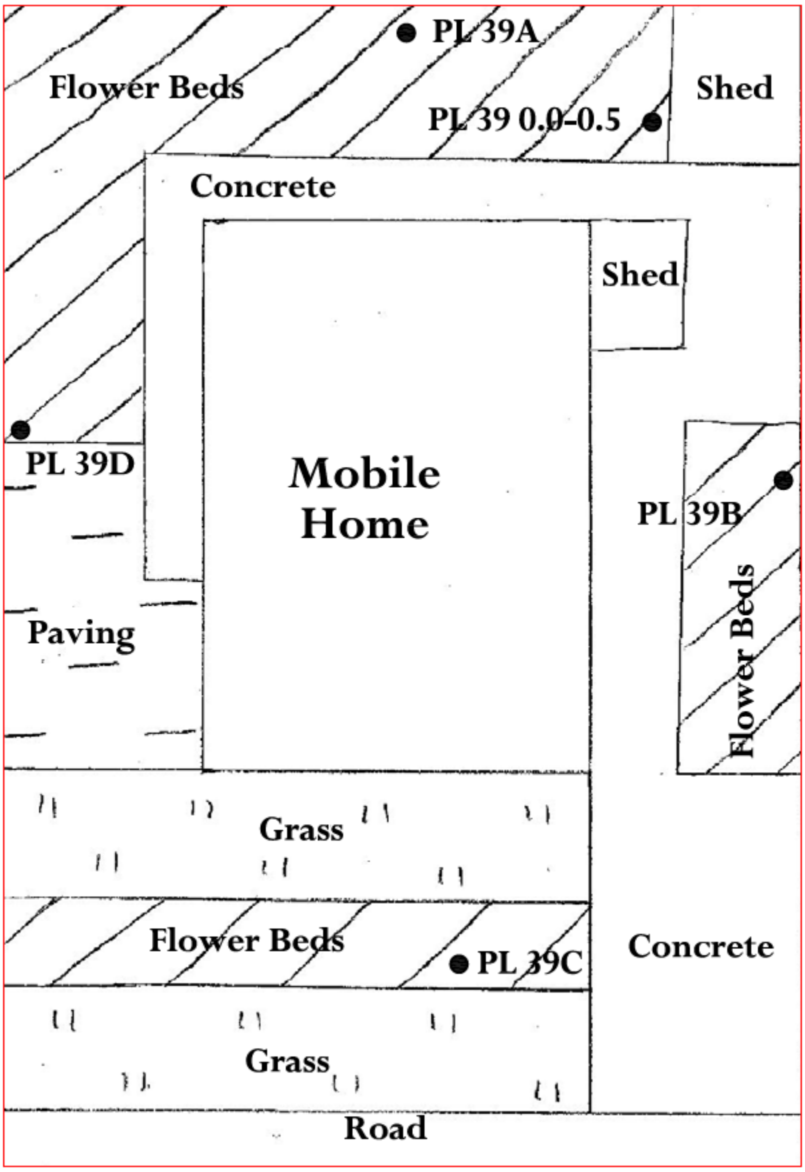
Eynesbury Mobile Home Park

PLOT 39



● PL 39A - 39D = Sample Locations

Plot 39	
Sample Ref	BAP
PL 39A	1.1
PL 39B	1.5
PL 39C	*0.1*
PL 39D	2.6
PL39 0.0-0.5	1.20
Means Value Test Result* =	<u>2.11</u>

* = 95th Percentile Means Value Test in accordance with CLR 7

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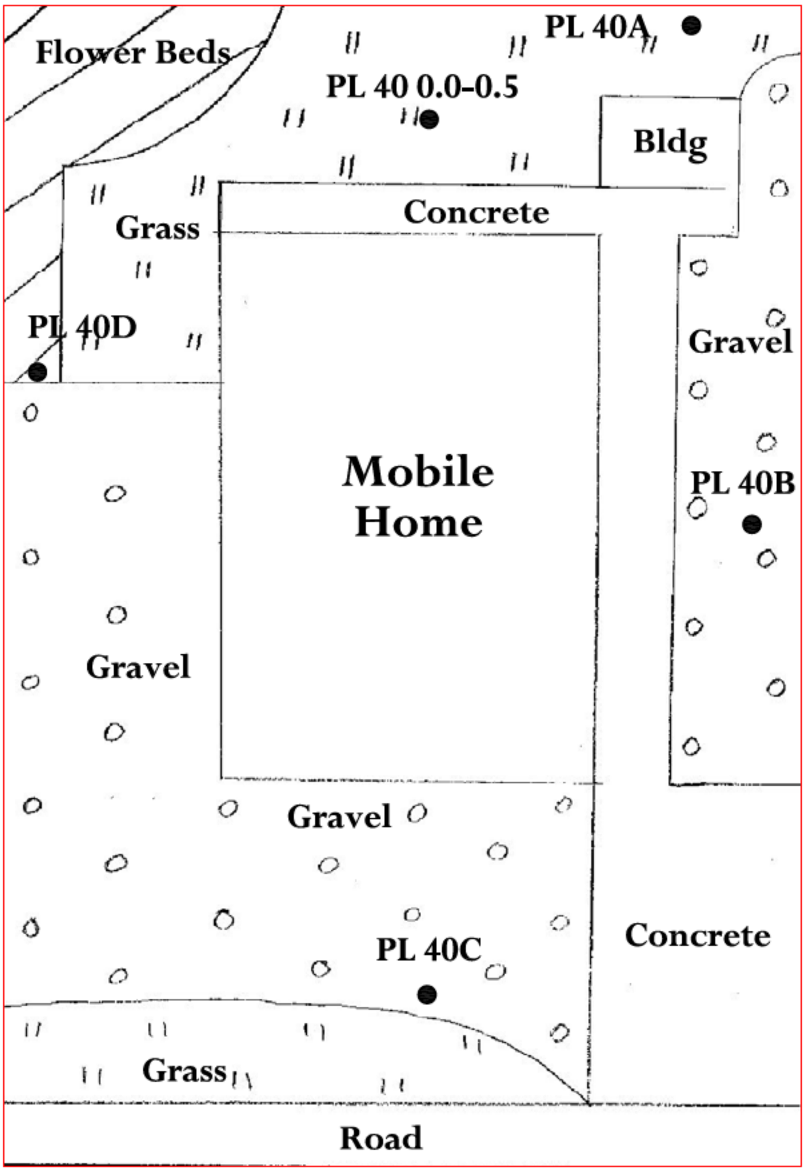
Eynesbury Mobile Home Park

PLOT 40



● PL 40A - 40D = Sample Locations

Plot 40	
Sample Ref	BAP
PL 40A	9.0
PL 40B	*0.1*
PL 40C	1.4
PL 40 D	4.1
PL40 0.0-0.5	9.50
Means Value Test Result* =	8.70

* = 95th Percentile Means Value Test in accordance with CLR 7

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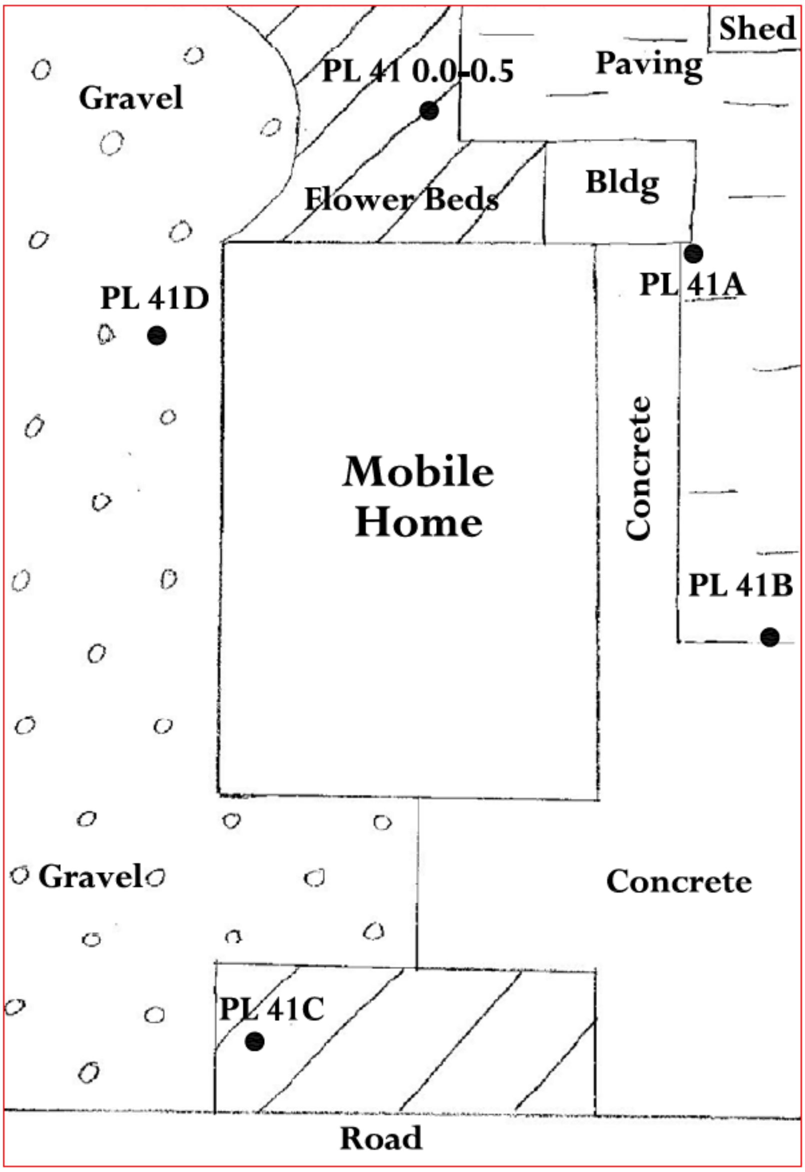
Eynesbury Mobile Home Park

PLOT 41



● PL 41A - 41D = Sample Locations

Plot 41	
Sample Ref	BAP
PL 41A	11.6
PL 41B	2.5
PL 41C	2.0
PL 41D	3.8
PL41 0.0-0.5	3.20
Means Value Test Result* =	8.19

* = 95th Percentile Means Value Test in accordance with CLR 7

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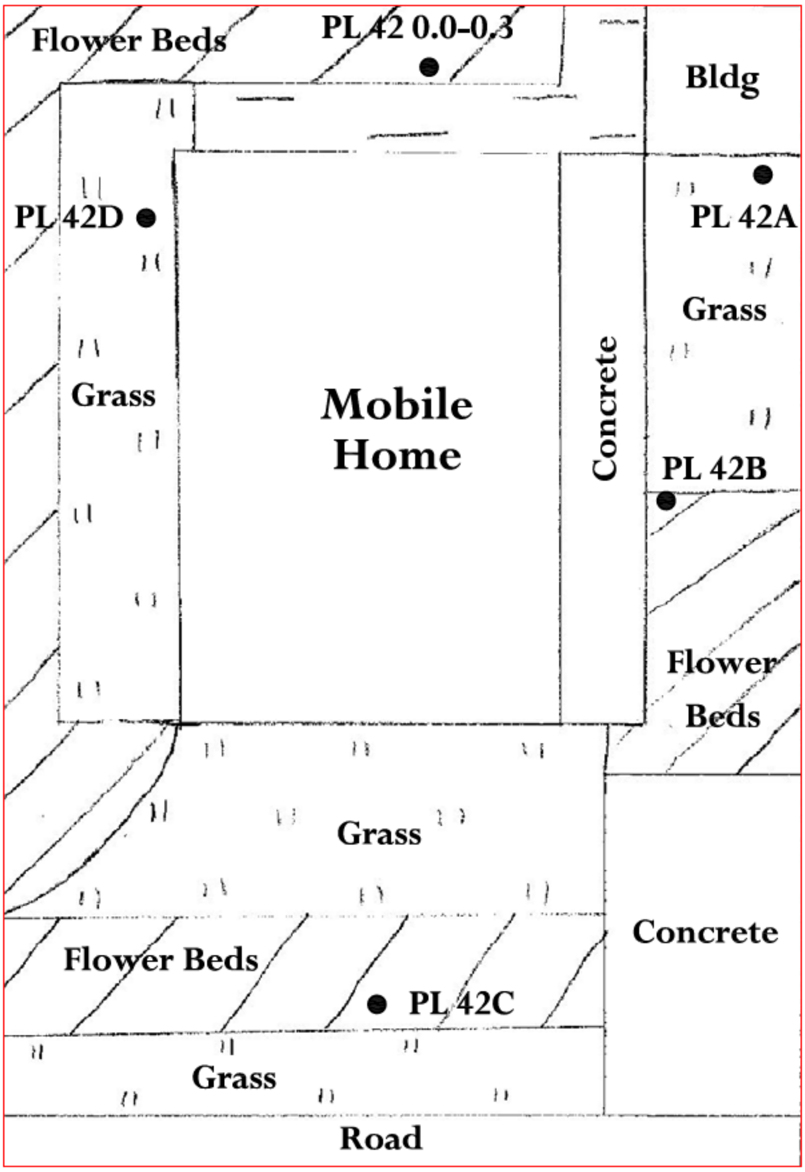
Eynesbury Mobile Home Park

PLOT 42



● PL 42A - 42D = Sample Locations

Plot 42	
Sample Ref	BAP
PL 42A	4.0
PL 42B	19.5
PL 42C	5.8
PL 42D	4.7
PL42 0.0-0.3	16.00
Means Value Test Result* =	16.50

* = 95th Percentile Means Value Test in accordance with CLR 7

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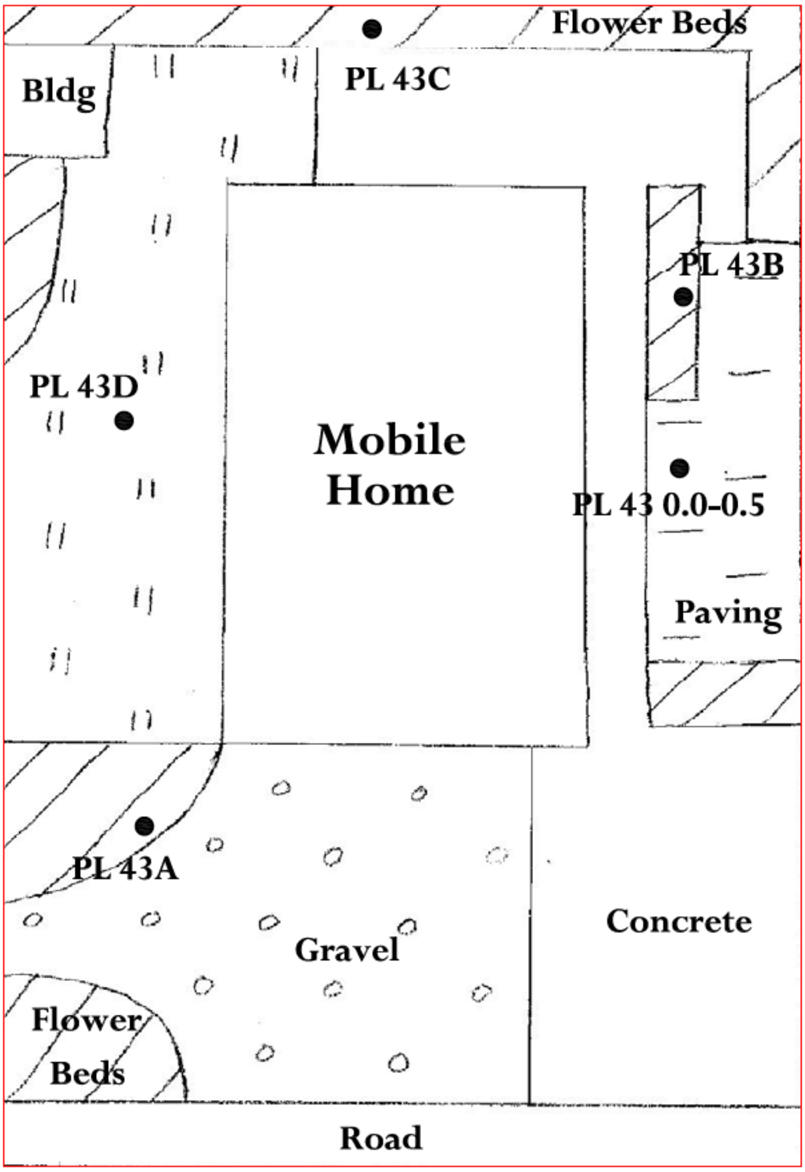
Eynesbury Mobile Home Park

PLOT 43



● PL 43A - 43D = Sample Locations

Plot 43	
Sample Ref	BAP
PL 43A	3.3
PL 43B	4.0
PL 43C	1.1
PL 43D	4.8
PL43 0.0-0.5	5.90
Means Value Test Result* =	5.46

* = 95th Percentile Means Value Test in accordance with CLR 7

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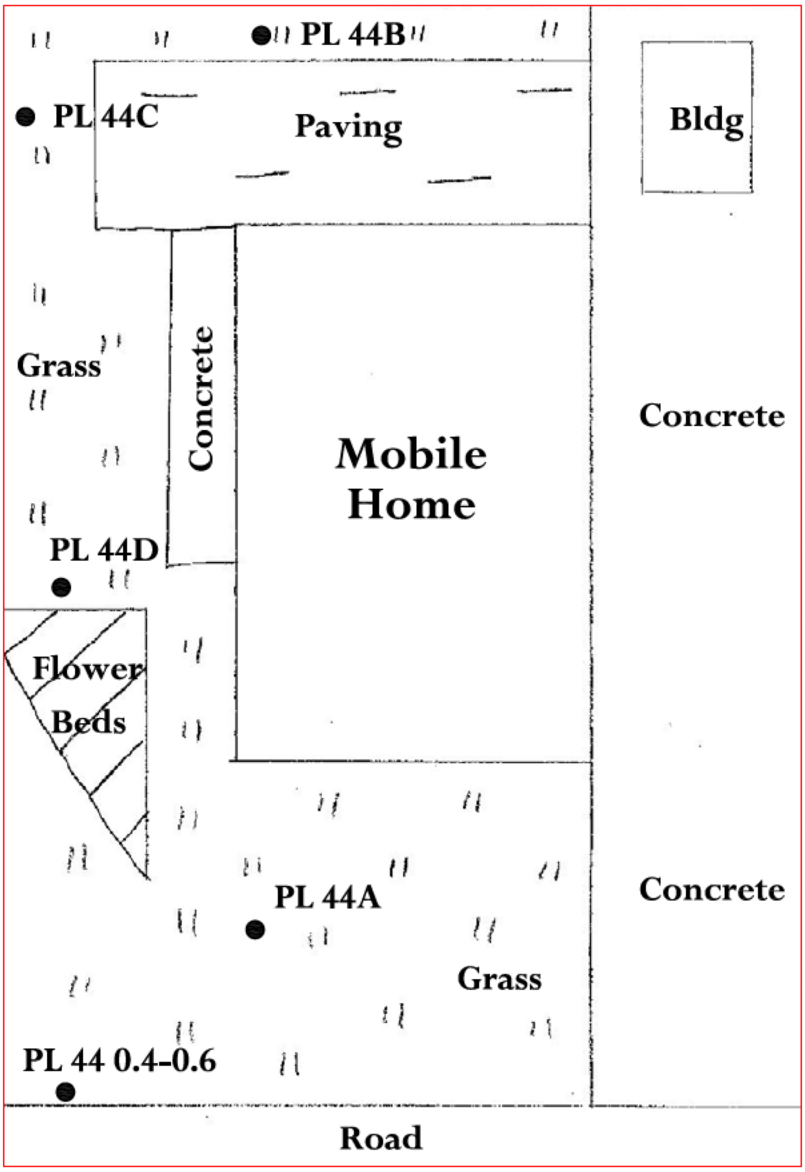
Eynesbury Mobile Home Park

PLOT 44



● PL 44A - 44D = Sample Locations

Plot 44	
Sample Ref	BAP
PL 44A	1.0
PL 44B	*0.1*
PL 44C	1.2
PL 44D	4.2
PL44 0.4-0.6	0.31
Means Value Test Result* =	2.83

* = 95th Percentile Means Value Test in accordance with CLR 7

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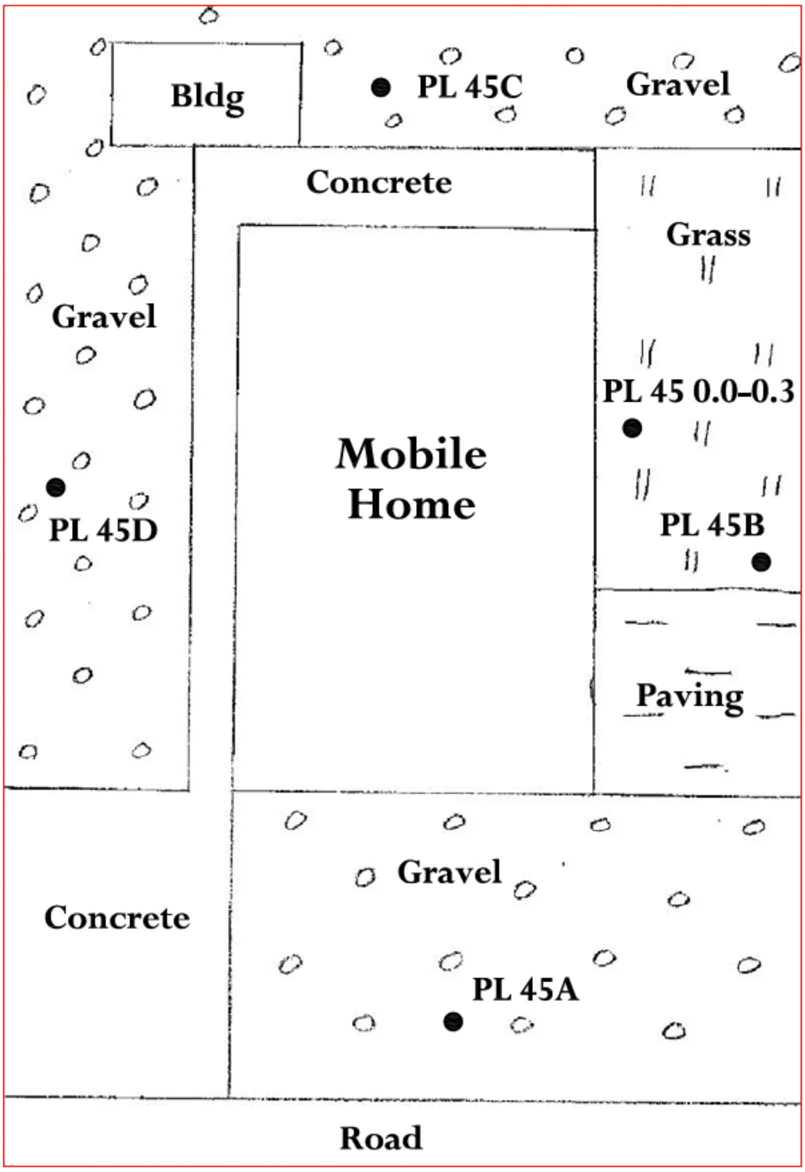
Eynesbury Mobile Home Park

PLOT 45



● PL 45A - 45D = Sample Locations

Plot 45	
Sample Ref	BAP
PL 45A	3.3
PL 45B	2.7
PL 45C	3.3
PL 45D	1.6
PL45 0.0-0.3	3.70
Means Value Test Result* =	3.67

* = 95th Percentile Means Value Test in accordance with CLR 7

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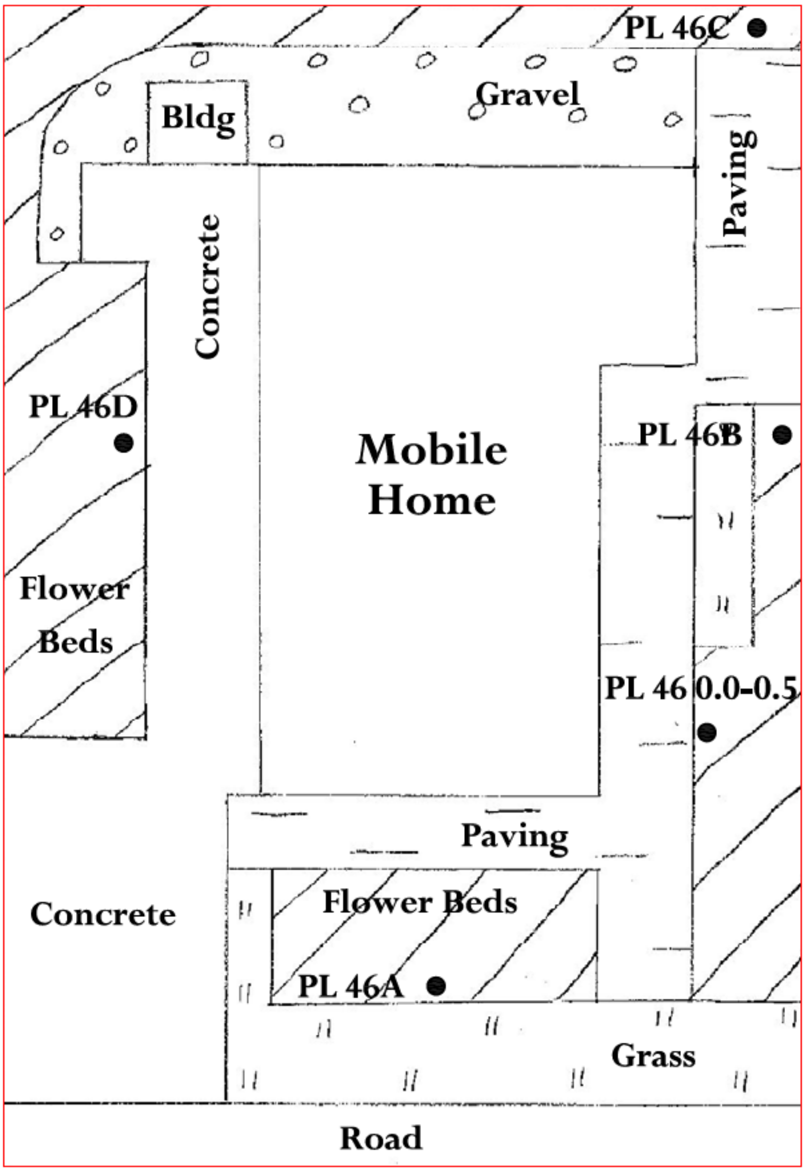
Eynesbury Mobile Home Park

PLOT 46



● PL 46A - 46D = Sample Locations

Plot 46	
Sample Ref	BAP
PL 46A	1.5
PL 46B	3.3
PL 46C	2.1
PL 46D	3.9
PL46 0.0-0.5	5.10
Means Value Test Result* =	4.49

* = 95th Percentile Means Value Test in accordance with CLR 7

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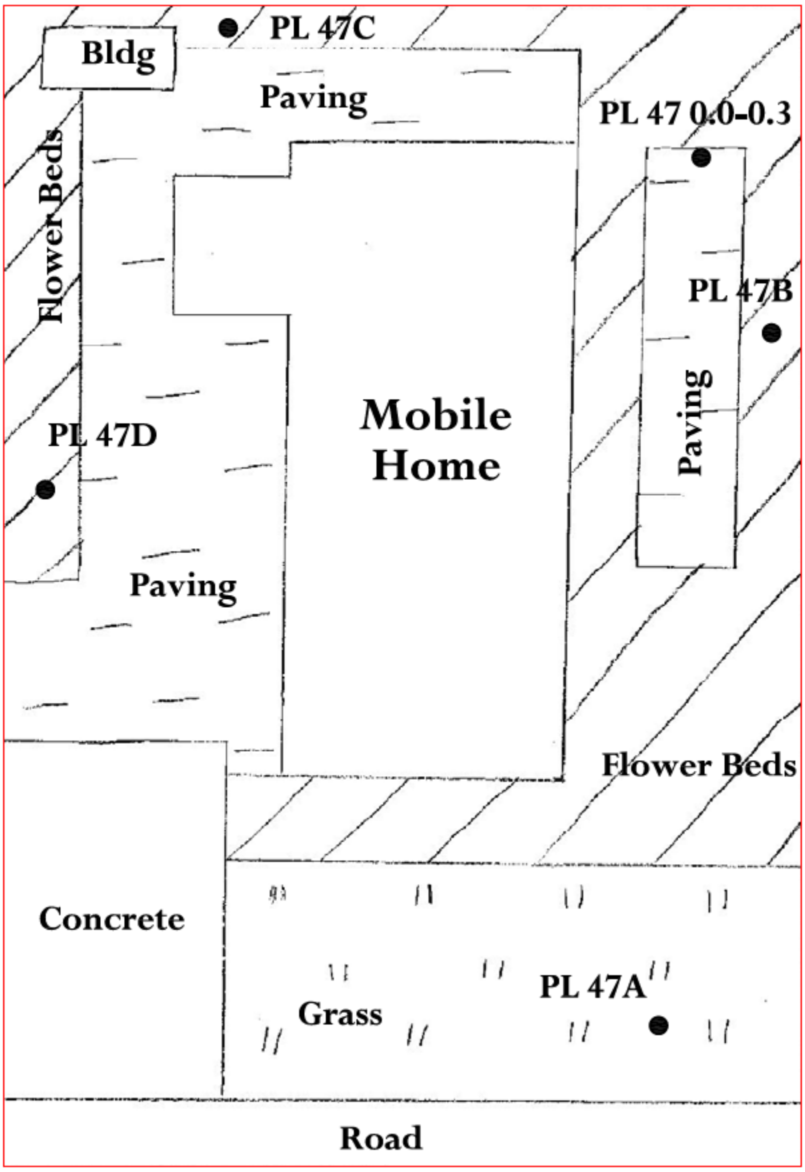
Eynesbury Mobile Home Park

PLOT 47



● PL 47A – 47D = Sample Locations

Plot 47	
Sample Ref	BAP
PL47A	2.2
PL 47B	1.5
PL 47C	1.3
PL47D	4.6
PL47 0.0-0.3	3.90
Means Value Test Result* =	4.02

* = 95th Percentile Means Value Test in accordance with CLR 7

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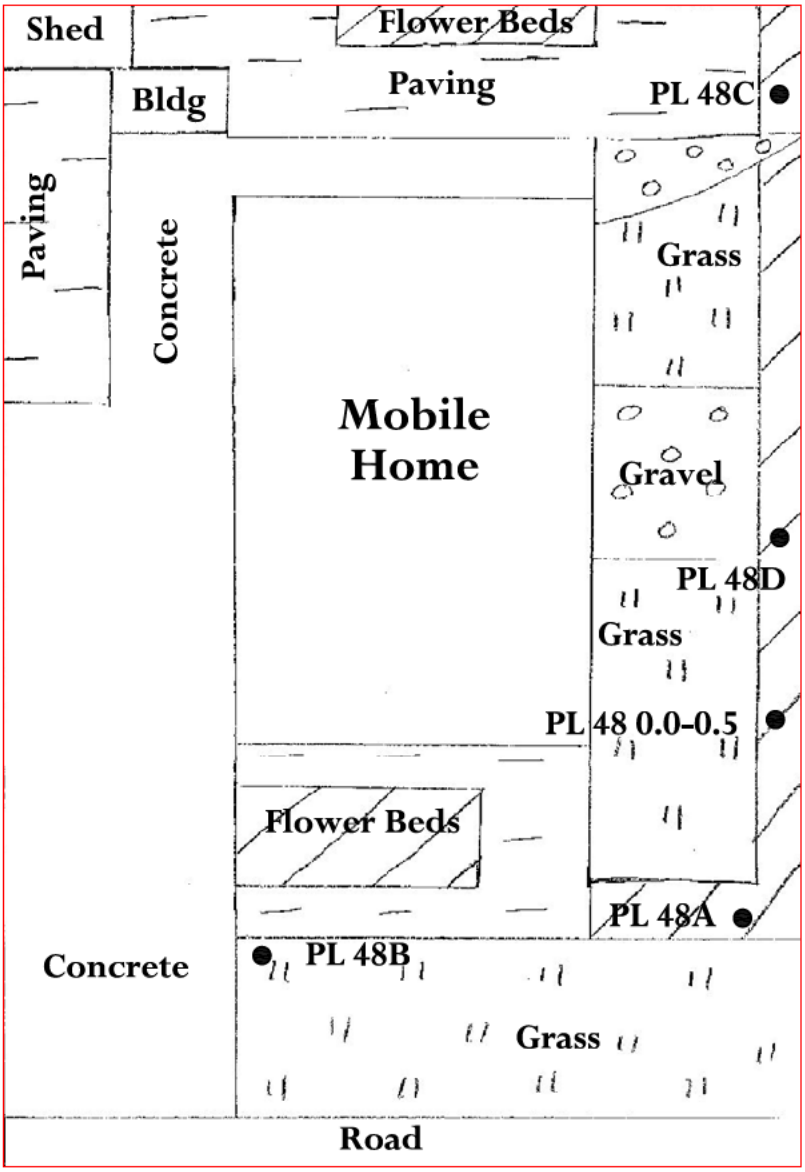
Eynesbury Mobile Home Park

PLOT 48



● PL 48A - 48D = Sample Locations

Plot 48	
Sample Ref	BAP
PL 48A	3.5
PL 48B	3.7
PL48C	1.6
PL48D	3.1
PL48 0.0-0.5	2.60
Means Value Test Result* =	3.63

* = 95th Percentile Means Value Test in accordance with CLR 7

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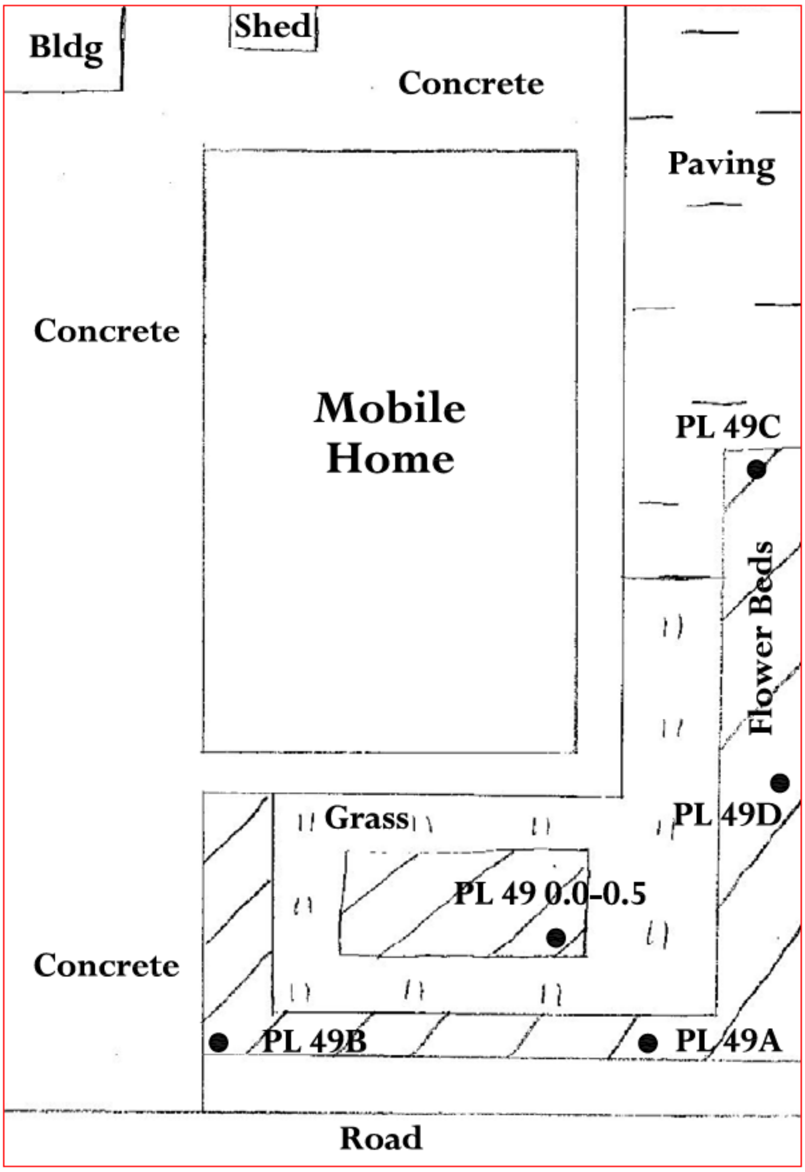
Eynesbury Mobile Home Park

PLOT 49



● PL 49A - 49D = Sample Locations

Plot 49	
Sample Ref	BAP
PL 49A	9.3
PL 49B	11
PL 49C	2.6
PL 49D	2.5
PL49 0.0-0.5	6.60
Means Value Test Result* =	9.76

* = 95th Percentile Means Value Test in accordance with CLR 7

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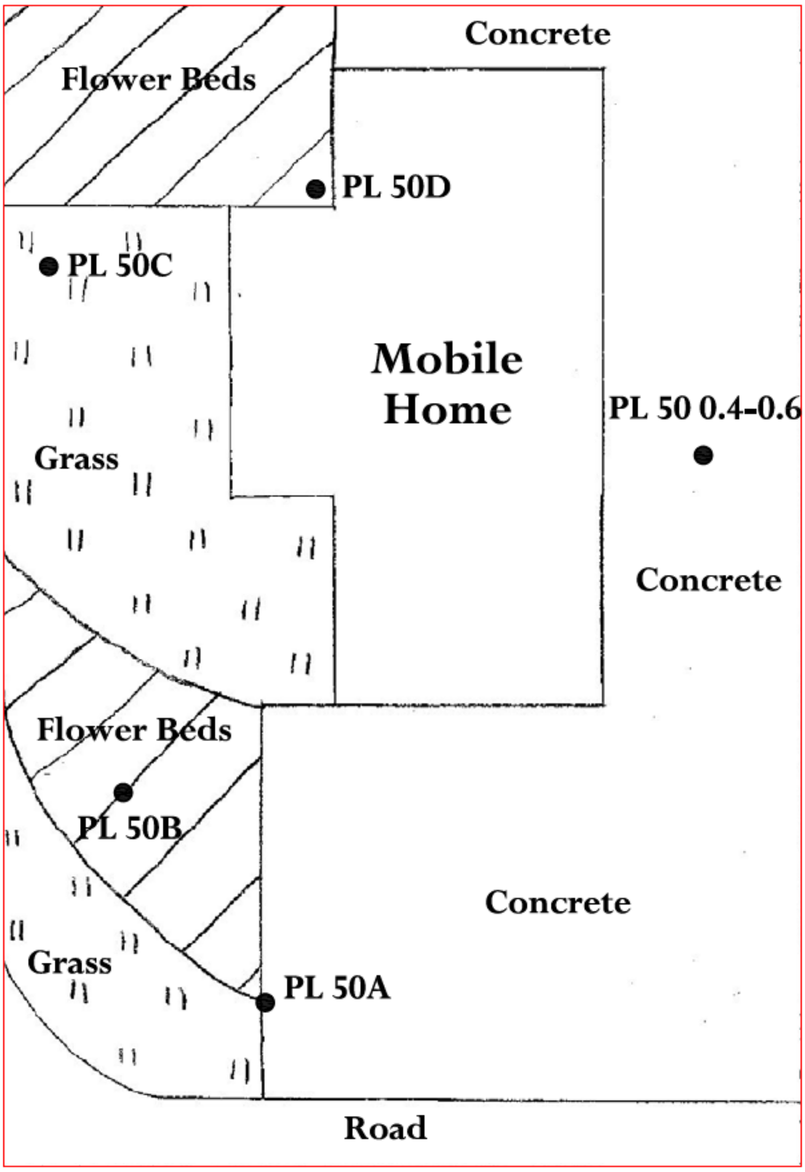
Eynesbury Mobile Home Park

PLOT 50



● PL 50A - 50D = Sample Locations

Plot 50	
Sample Ref	BAP
PL 50A	1.0
PL 50B	1.1
PL 50C	*0.1*
PL 50D	1.2
PL50 0.4-0.6	2.60
Means Value Test Result* =	2.00

* = 95th Percentile Means Value Test in accordance with CLR 7

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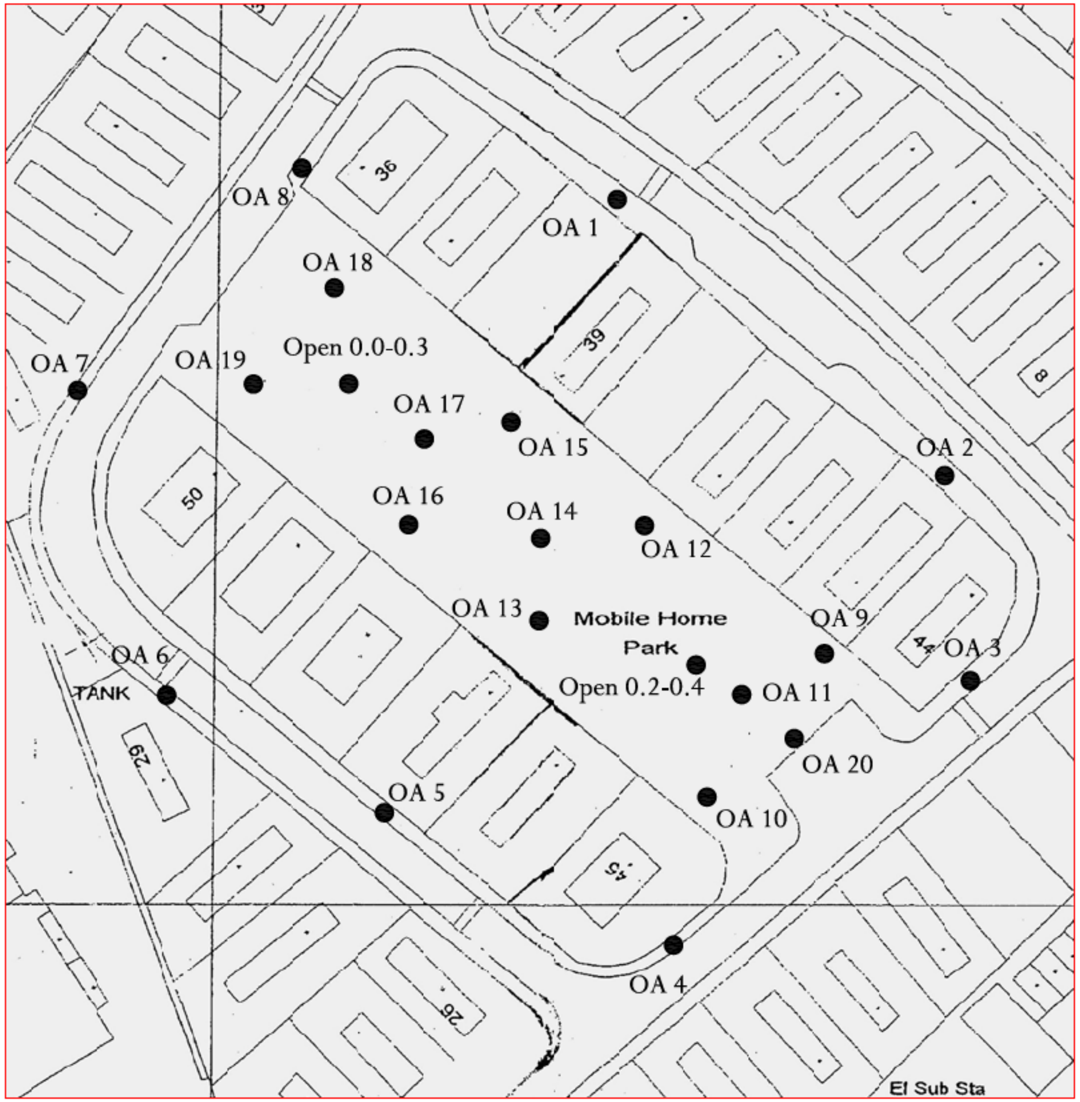
Eynesbury Mobile Home Park

Open Area and Verges



● OA 1 - OA 20 = **Sample Locations**

Open Area	
Sample Ref	BAP
OA 1	1.3
OA 2	1.3
OA 3	0.7
OA 4	3.2
OA 5	1.4
OA 6	2.2
OA 7	*0.1*
OA 8	*0.1*
OA 9	3.9
OA 10	2.3
OA 11	4.5
OA 12	6.3
OA 13	1.9
OA 14	2.5
OA 15	2.5
OA 16	2.9
OA 17	2.7
OA 18	1.3
OA 19	1.7
OA 20	1.5
Open 0.0-0.3	8.20
Open 0.2-0.4	6.30
Means Value Test Result* =	**3.44**

* = 95th Percentile Means Value Test in accordance with CLR 7

Environmental Protection Strategies Ltd

NOTICE TO INTERESTED PARTIES

The purpose of this report is to present the findings of a soil sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements.

No investigation method is capable of completely identifying all the contaminants that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and/or trial pits to recover soil and/or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface. However, ground conditions are naturally variable and it may be possible that localised ground controls could influence the spread of contaminants within the site subsurface. For this reason it is possible that samples collected during the investigation may not represent the conditions across the entire site.

The investigation was carried out to assess the significance of contamination resulting from the use of the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made.

If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS. However, EPS cannot guarantee the validity of these data.

The report has been prepared for the client(s) listed on the report title page and has been subject to standard internal EPS review procedures. EPS accepts no liability or responsibility for use of, or reliance upon, this report and or the information contained within it by third parties.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS.

Annex Three

Remedial Treatment Action

The Remedial Treatment Action is expected to be completed between the Summer of 2006 and the Spring of 2008

Remedial Options Appraisal
Remediation Strategy
& Implementation Plan

St Neots Mobile Home Park
Eynesbury
St Neots
PE19 2JR

Prepared for:

Huntingdonshire District Council
Pathfinder House
St Mary's Street
Huntingdon
PE29 3TN

Report Status: FINAL_B

Date Issued: 23th May 2006

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Appendix

1 INTRODUCTION

In January 2006, Huntingdonshire District Council (HDC) commissioned Environmental Protection Strategies Ltd (EPS) to prepare a Remedial Options Appraisal, agree a Remediation Strategy and develop an Implementation Plan for the St Neots Mobile Home Park, Eynesbury, St Neots ('the site'). This report comprises all three tasks and constitutes an "assessment action" under Section 78A(7)(a) of the Environmental Protection Act 1990 (EPA1990).

This report should be read *in conjunction* with previous environmental reports concerning the site as the information contained in those reports forms the basis of and describes the site conceptual model, and details the derivation of the site-specific assessment criteria.

1.1 Previous Work

Previous environmental work conducted on the site is summarised below:

Environmental Assessment Report. EPS, Dec 2005

This report comprised a desk study and intrusive investigation. 8 boreholes were drilled to a maximum depth of 7.0m bgl and gas monitoring wells were installed at each location. 52 shallow soil boreholes were drilled using a hand auger within domestic and communal garden areas to a maximum depth of 1.0mbgl.

Benzo(a)pyrene was found to be present in shallow soils at concentrations in excess of a provisional Site Specific Assessment Criterion (SSAC) calculated using the Contaminated Land Exposure Assessment (CLEA) methodology. Gas monitoring identified the presence of carbon dioxide at concentrations over 10% at several locations to a maximum concentration of 19.4%. Flow rates were found to be negligible. No pollutant linkages associated with controlled waters are considered to be active.

The report recommended that ventilation bricks be incorporated into brick built surrounds around the base of mobile homes and that further consultation and liaison with UK expert bodies involved with the CLEA guidance and methodology be conducted with regard to what level of risk is considered unacceptable and whether the levels of BaP identified at this site or individual plots represent a significant risk of significant harm to site users.

Derivation of a Site-specific Assessment Criterion for Benzo(a)pyrene for use at the St Neots Mobile Home Park, Eynesbury. Land Quality Management Ltd, Dec 2005

Land Quality Management Ltd (LQM) developed a conceptual human health exposure model to determine an Index Dose-based SSAC for BaP. LQM considered the zoning area to comprise surface soils (0 to 0.5m depth) as the main routes of human exposure involve these soils only. A residential SSAC for BaP of 1.2 mg/kg was derived.

The report also addressed the question of how far above the SSAC the relevant soil concentration would have to be to meet the "unacceptable intake" test in the statutory guidance pertaining to Part IIA. It stated that "At the present time published DEFRA/Environment Agency technical guidance on risk assessment does not address this issue … Given the uncertainty in the eventual findings of the SGV Task Force, a cautious multiplier of 5 has been adopted to assist the inspection of the site."

The report concluded that "The overall site US_{95} exceed the SSAC by a factor of 6, supporting the presence of significant possibility of significant harm based on the above."

Written Record of Determination of Contaminated Land, St Neots Mobile Home Park. HDC, Jan 2006

On the basis of these two reports, on 4 January 2006 HDC formally determined the site as Contaminated Land as defined in Section 78A(2) of the EPA 1990. Details of the Significant Pollutant Linkages affecting the land are presented in Table 1.

Additional Soil Sampling. EPS, April 2006

EPS conducted additional soil sampling on all residential plots, the central open area and verges. Four samples were collected from each residential plot, twelve from the central open area on an approximate 15m grid, and eight from the verges. All samples were collected on a depth-composite basis between the surface and 600mm depth and analysed for benzo(a)pyrene.

Mean value test results on samples from residential plots were between 1.6 mg/kg and 41 mg/kg. The mean value test result on the open area and verge samples was 3.4 mg/kg.

1.2 Approach to Risk Management

This report adopts the approach to structured decision-making described in The Model Procedures for the Management of Land Contamination (DEFRA/Environment Agency 2004) (hereafter referred to as 'the Model Procedures'). The Model Procedures identify three main stages in the options appraisal process, each of which comprises two sub-stages:

1. *Identify feasible remediation options for each relevant pollutant linkage*

    a. Identify site-specific remediation and other objectives that apply to the options appraisal
    b. Select which remediation options should be taken forward for more detailed evaluation

2. *Carry out a detailed evaluation of feasible remediation options to identify the most appropriate option for each particular pollutant linkage*

    a. Identify remediation option(s) most appropriate for each relevant pollutant linkage
    b. Identify which options, if any, need to be combined

3. *Produce a remediation strategy to address all relevant pollutant linkages, where appropriate by combining remediation options*

    a. Outline how, in broad terms, the remediation strategy is to be implemented
    b. Determine whether the remediation strategy will meet all site-specific objectives

1.3 Report Organisation

This report is divided into the following sections:

1. Introduction
2. Environmental Setting
3. Risk Management Objectives
4. Remedial Technology Assessment & Selection
5. Remediation Strategy & Implementation Plan

2 ENVIRONMENTAL SETTING

Much of the information provided in the following section has been taken from the following reports: *'Environmental Assessment Report, St Neots Mobile Home Park, Eynesbury, Cambridgeshire'* (EPS, Dec 2005) and '*Additional Soil Sampling, St Neots Mobile Home Park, Eynesbury, Cambridgeshire*' (EPS, April 2006)

Although an overview of the findings of the above referenced report is presented in this section, EPS recommends that for a thorough understanding of the site condition and history the reader review the reports in full.

2.1 Site Description

The site is located in Eynesbury, St Neots and is currently a mobile home park, which has been its use since at least 1980. The site is roughly square, relatively flat and covers an area of approximately 1.5 hectares. The site is bound by Howitts's Lane along the northern boundary, beyond which is a cemetery, to the north and east of which is a mixture of light industrial and residential housing. To the west is residential housing and an industrial estate is located to the south. A site location plan is presented as Figure 1.

There are 50 individual residential plots, each of approximately 120m2, arranged along a perimeter road with verges, surrounding a central open area. A site plan is presented as Figure 2. Each plot comprises a variety of different surface cover, which can be categorised into two main types:

Hardstanding: concrete cover, below mobile homes and sheds and on driveways
Soft cover: lawn, paved and gravel areas and vegetable plots

A plan of Plot 48, which contains all surface cover types, is presented as Figure 3 for illustrative purposes.

2.2 Regional Geology & Hydrogeology

British Geological Survey maps of the area report the site to be underlain by grey mudstones of the Oxford Clay, although HDC records suggest that Terrace River Gravels may extend across the northern area of the site, which are classed as a minor aquifer.

2.3 Site Geology & Hydrogeology

Generalised geology comprised brown clayey top soil to a maximum depth of 0.9m over made ground of soft to stiff brown grey mottled silty clay with some gravel to a maximum depth of 5.8mbgl. Natural ground comprising firm to stiff sandy clay was encountered at all locations. Fragments of brick, concrete, flint gravel, coal, ash, clinker and pulverised fuel ash (PFA) were found in topsoil and made ground.

Clay extraction pits associated with a brick and tile works, which were predominantly in the eastern and southern area of the site, are reported in HDC records to have been backfilled as a pre-licensing landfill.

Groundwater was encountered between 1.21mbgl and 3.26mbgl.

2.4 Soil Quality

Elevated concentrations of metals and poly-aromatic hydrocarbons (PAHs) were detected in soil samples from most residential plots and the central open area. A mean value test undertaken for the 'risk driver' of the PAH group, benzo(a)pyrene (BaP), for all samples collected from all garden areas in EPS's first phase of investigation (EPS, Dec 2005) gave a 95th percentile result of 11.24mg/kg.

2.5 Groundwater Quality

Concentrations of metals within groundwater were generally found to be below their respective Environmental Quality Standards (EQS) for freshwater. Total Petroleum Hydrocarbons (TPH) were reported at concentrations between 0.01mg/l and 0.049mg/l. No pollutant linkages associated with controlled waters are considered to be active at the site.

2.6 Site-Specific Assessment Criteria

Land Quality Management Ltd (LQM) developed a conceptual human health exposure model to determine an Index Dose-based site-specific assessment criterion (SSAC) for BaP. LQM considered the zoning area to comprise surface soils (0 to 0.5m depth) as the main routes of human exposure involve these soils only. A residential SSAC ($SSAC_{resi}$) for BaP in surface soils of 1.2 mg/kg was derived, taking into account all active pathways on domestic plots (Table 2a).

HDC has calculated a SSAC for the central open area, using the same information and assumptions employed by LQM to calculate the residential SSAC and making adjustments for the absence of the following pathways:

- Ingestion of home-grown vegetables and soil attached to vegetables
- Ingestion of soil (indoor)
- Inhalation of soil derived fugitive dust (indoor)
- Inhalation of soil derived vapours (indoor)

These adjustments give an open area SSAC ($SSAC_{open}$) of 1.7 mg/kg (Table 2b).

SSACs are calculated by site-specific quantitative risk assessment. It is important to recognise that, owing to the uncertainties inherent in characterising the environment, site-specific quantitative risk assessment is necessarily conservative. EPS recommends that the reader review LQM (2006) for a full discussion of the uncertainties.

Amongst the many uncertainties inherent in the derivation of SSACs for the site (see LQM 2006), perhaps the greatest involves the decision regarding how far above the Index Dose based SSAC the relevant soil concentration would have to be to meet the 'unacceptable intake' test in the statutory guidance pertaining to Part IIA. The following passage from LQM (2006) addresses this as follows:

> *The key question … is a matter of currently unavailable national policy and guidance. At the present time published DEFRA/Environment Agency technical guidance on risk assessment does not address this issue. The DEFRA SGV Task Force is considering several proposals for defining 'potentially unacceptable intakes' – doses higher than the Index Dose – that would meet the legal test for Part IIA. In the case of oral exposure to BaP it seems that some of the options essentially involve straight multipliers of the Index Dose by factors of approximately 10. Given the uncertainty in the eventual findings of the SGV Task Force, a cautious multiplier of 5 has been adopted to assist the inspection of the site.*
>
> (Paragraph 151, Section 8.3.4, LQM (2006))

Discussions between HDC, EPS and DEFRA have indicated that a multiplier of 2 would be appropriate in order to be protective of human health and consistent with the ALARP (as low as reasonably practicable) principle in CLR 10 (DEFRA/EA, 2005).

The multiplier of 2 gives the following Remedial Targets (RT) for BaP for the site:

$\mathbf{RT_{resi}}$	**2.4 mg/kg**
$\mathbf{RT_{open}}$	**3.4 mg/kg**

2.7 Comparison of Soil Quality with SSAC

The mean value concentration of BaP in surface soils exceeded the RT_{resi} in all except Plots 30, 34, 39 and 50 i.e. in 46 of the 50 residential plots (Figure 4).

The mean value concentration of BaP in surface soils in the central open area and verges did not exceed the RT_{open}.

3 RISK MANAGEMENT OBJECTIVES

This section documents Stage 1a: *identify site-specific remediation and other objectives* of the Options Appraisal process outlined in the Model Procedures. The remaining stages, 1b to 3b, are covered in the following sections of this report.

3.1 Overall Objectives

The overall objective of risk management at St Neots Mobile Home Park is to ensure that the significant pollutant linkages identified in Schedule 4 of the Written Record of Determination of Contaminated Land (HDC, Jan 2006) are no longer active (see Section 1.1 above and Table 1), through any one or a combination of:

i. removing or treating the pollutant
ii. breaking or removing the pathway
iii. protecting or removing the receptor (DETR Circular 2/2000 para C.18)

This overall objective will be attained by meeting sub-objectives, defined in the Model Procedures as (i) remediation objectives and (ii) management and (iii) "other" technical objectives.

3.2 Remediation, Management & "Other" Technical Objectives

The Model Procedures define remediation, management and "other" technical objectives as follows:

> A *remediation objective* is a site-specific objective that relates solely to the reduction or control of the risks associated with one or more pollutant linkage(s)
>
> *Management objectives* should aim to define reasonably precisely the specific desired outcomes of remediation, or ways in which it is to be carried out
>
> *"Other" technical objectives* are usually defined by wider technical goals … or the need to avoid practical problems, such as disruption to site activities.

EPS considers the following remediation, management and "other" technical objectives to be appropriate for the remedial work at St Neots Mobile Home Park:

- Ensure concentrations of BaP in soil measured to a depth of at least 0.5m below ground level do not exceed the RTs
- Prevent human exposure to soils containing BaP at concentrations exceeding the RTs
- Complete remediation with minimum disruption to all stakeholders during and after works
- Retain the existing variety of land use where possible
- Achieve the optimum balance between all foregoing objectives and cost of remediation

4 REMEDIAL TECHNOLOGY ASSESSMENT& SELECTION

This section documents the following stages of the Options Appraisal process outlined in the Model Procedures.

1. *Identify feasible remediation options for each relevant pollutant linkage*

    b. Select which remediation options should be taken forward for more detailed evaluation

2. *Carry out a detailed evaluation of feasible remediation options to identify the most appropriate option for each particular pollutant linkage*

    a. Identify remediation option(s) most appropriate for each relevant pollutant linkage
    b. Identify which options, if any, need to be combined

4.1 Selection of remediation options for detailed evaluation

The selection of remediation options for subsequent detailed evaluation comprises two key steps:

Step 1. Identification of those options which have the *potential* to achieve the *overall objective* (Section 3.1) of breaking the identified source-pathway-receptor linkage, irrespective of site-specific factors, through one or a combination of:

i. removing or treating the pollutant
ii. breaking or removing the pathway
iii. protecting or removing the receptor

These remedial options are presented in Table 3 together with a summary of their advantages and limitations.

Step 2. Incorporation of site-specific factors relating to the pollutant linkage, the remedial approach and the wider management context for the site to arrive at a manageable shortlist of feasible remediation options.

The site-specific factors are summarised in Table 4. Table 5 summarises the assessment of the suitability of each remedial option taking into account these factors to arrive at a manageable shortlist.

4.2 Detailed evaluation of feasible remediation options

The review of remedial options identified the following four approaches for detailed evaluation:

- Engineered cover system
- Simple cover system
- Voluntary agreements
- Planning controls

Table 6 considers the advantages and limitations of each remedial approach in the context of managing the risks identified at St Neots Mobile Home Park. The variety of land use, including existing concrete hardcover, which already prevents exposure to soils under mobile homes, sheds and driveways, together with the overarching legal framework regarding the rights and responsibilities of tenants and landlord, within which remediation must be conducted, indicates that a combination of all four remedial approaches is required.

5 REMEDIATION STRATEGY & IMPLEMENTATION PLAN

5.1 Remediation Strategy

The aim of this stage of Options Appraisal is to develop a remediation strategy capable of practical implementation on the site and to describe in broad terms the characteristics of that strategy. The Model Procedures outline practical issues to be considered at this stage, including:

- How the site should be packaged or zoned to accommodate different types of phases of remediation
- How the remediation strategy is to be verified
- Whether and how preparatory work should be factored into the early stages of remediation design

Section 4 identified the following remedial options as appropriate for addressing the significant pollutant linkages as follows:

Remedial option	Application
Engineered cover system	Retention of existing hard (concrete) cover e.g. under mobile homes and sheds and on driveways
Simple cover system	Lawn areas, vegetable plots, existing paved and gravel areas
Voluntary agreements	Ensure the retention and maintenance of existing hardstanding (concrete cover) and control future alterations to it and/or the completed remediation works
Planning controls	

The Remediation Strategy will comprise the implementation of a combination of all four remedial options at all 46 residential plots requiring remediation. Figure 5 illustrates how each of the remedial options would apply to a typical plot; Plot 48 has been selected for illustrative purposes as it contains all surface types.

5.1.1 Engineered Cover System

Existing concrete hard cover will be retained and inspected for integrity. Where necessary it will be repaired or replaced. EPS does not envisage that any additional engineered cover system will be used in areas where it is not currently present as the risks in these areas will be managed through implementation of a simple cover system (see Section 5.1.2), voluntary stakeholder agreements and planning controls (see Section 5.1.3).

5.1.2 Simple Cover System

Areas currently occupied by lawn, paving or gravel cover or vegetable plots will be remediated by means of a simple cover system. This involves the excavation of impacted soil, the lining of bottom and sides of excavations with a proprietary geotextile and subsequent backfilling with imported clean topsoil. The geotextile serves a number of purposes, principally the prevention of mixing/bioturbation and root penetration, whilst also acting as a visible and physical indicator to mark the limit of the remediated soil and prevent deeper digging.

EPS has taken advice on the design of a simple cover system from the NHBC. The NHBC advised that the guidance in the BRE publication *Cover Systems for Land Regeneration: Thickness Design of Cover Systems for Contaminated Land (BRE, Mar 2004)* would be appropriate to calculate the required thickness of topsoil. Examples of calculations of minimum topsoil cover thicknesses are presented in Appendix A, assuming a concentration of BaP in imported topsoil of 1.2 mg/kg ($SSAC_{resi}$).

EPS has considered the practicalities of a different cover thickness on each plot of land, and the potential restriction of land use that would be imposed by a shallow geotextile layer, and recommends that a uniform cover thickness of 600 mm be implemented on all plots i.e. excavation to 600 mm depth and replacement with clean imported topsoil.

Imported topsoil must conform to BS 3882:1994 and must be tested in accordance with that standard prior to receipt on site. Additional sampling will be required to ensure that concentrations of BaP do not exceed the $SSAC_{resi}$ of 1.2 mg/kg.

5.1.3 Voluntary Agreements & Planning Controls

Either one or a combination of voluntary agreements and planning controls would be employed to ensure the retention and maintenance of existing hardstanding (concrete cover) and control future alterations to it and/or the completed remediation works.

<u>Voluntary Agreements</u>

It is recommended that HDC explore its legal options with the intent to enter into voluntary agreements with residents and their successors not to break up existing concrete structures or break through membranes provided for soil segregation (see Section 5.1.2) without seeking the landowner's permission. The granting of permission would be conditional upon the proper health and safety process being carried out by the resident. The agreements would not prevent the laying of further hardcover if residents so desire, for example to relocate a mobile home, providing that the existing concrete cover is retained rather than re-landscaped.

The voluntary agreements could also be accompanied by individual scaled plans of the plots.

Planning controls

The Planning Department at Huntingdonshire District Council has advised that planning permission will be required for the proposed remediation works. If planning permission is granted the permission may have conditions attached to it which control future alterations to hardstandings and/or to the completed remediation works. Whilst they are not essential, and cannot be relied on to happen, any such conditions would be an effective management control and act as a support, complement or as an alternative to the voluntary agreements.

5.2 Implementation plan

The aim of this stage in the implementation of remediation is to prepare an implementation plan such that the remediation strategy can be put into place in an effective and orderly manner. The Model Procedures outline factors to be considered at this stage, including:

- Responsibility for each aspect of implementation of the remediation strategy and what competencies are required
- What regulatory permits or licences are likely to be required
- What form of contract and technical specifications will be used to deliver the remediation strategy
- Timescales for completion of different activities

The following sections present and outline of factors that will need to be taken into account when implementing remediation; these, together with other concerns, will be addressed fully and in detail in the remedial design and planning phase.

5.2.1 Internal Approval for Remediation Strategy

HDC Housing Services will liaise with HDC Environmental Protection, and any other relevant departments, such as Planning, to ensure that all internal requirements are met.

5.2.2 Development of Communication Plan

The determination of a piece of land as "contaminated land" can be an emotive issue for those resident on it or living nearby. The remedial approaches recommended in this report will require the agreement of residents to some disruption and inconvenience. It is therefore EPS's recommendation that early and sensitive contact with all stakeholders be started to ensure that all the remedial objectives (Section 3.2) are met successfully.

5.2.3 Consult With & Obtain Agreement from Stakeholders

Consultation with stakeholders will be an iterative process utilising the communication mechanisms developed in the Communication Plan (see Section 5.2.2).

5.2.4 Draft & Complete Voluntary Agreements

See Section 5.1.3

5.2.5 Regulatory Issues

Planning

See Section 5.1.3.

Mobile Plant Licence

The Environment Agency (Brampton office) has advised that a Mobile Plant Licence will not be required.

5.2.6 Development of Tender Documents

Tender documents will identify the type of remedial works to be undertaken on each individual plot of land and detail other specifications such as management requirements, verification and health, safety and environmental standards.

5.2.7 Contractor Tender & Selection

Contractor selection is a critical step in the implementation plan. The successful contractor will need to demonstrate competence in project and programme management and "soft" people management skills as well as technical competence in dealing with all aspects of physical remedial works.

It is EPS's opinion that the contractors should be involved at an early stage and be fully responsible for ensuring successful planning and implementation of works. A form of contract such as the *ICE Design and Construct Conditions of Contract: 2nd edition* would be appropriate as it makes the Contractor responsible for all aspects of design and construction. Although the Form of Tender provides for payment on a lump sum basis, other forms of payment may be used.

5.2.8 Implementation of Remedial Works: Programme and Duration of works

The exact programme and duration of works will be established in the tendering process and through agreement with residents, contractors and other stakeholders.

It is not possible at this stage to estimate the time required to negotiate the voluntary stakeholder agreements, but EPS estimates that the physical remediation on each plot is likely to take up to 5 working days. Consequently, if each plot is remediated separately, this would result in a programme duration of just under one year. EPS would assist HDC in researching ways to shorten this programme where possible.

5.2.9 Implementation of Remedial Works: Health, Safety, Environmental & Security Concerns

The nominated contractor will be responsible for all aspects of Health, Safety and Environmental concerns for the duration of planning and implementation and completion of the remediation works.

All physical remediation works should be conducted under Construction (Design and Management) Regulations (1994).

All plots will be surveyed for the presence of underground services prior to commencement of any intrusive works.

A semi-permanent site office, equipped with utilities such as electricity, water and welfare facilities, will be required owing to the duration and nature of the works.

Implementation of the simple cover system remedial works will involve mobile plant such as mini-diggers and require excavation of surface soil to a depth of 600 mm. In these circumstances residents will need to be relocated for the duration of remedial work on their plot, to ensure the safety of residents and safe working conditions for the contractor.

Excavation to a depth of 600 mm adjacent to existing mobile home support rafts and fence boundaries may introduce issues of stability and raft integrity, which will have to be taken into account by the remedial works contractor.

Excavated soil will be classified and disposed of in accordance with all applicable legislation including the Hazardous Waste (England & Wales) Regulations 2005.

Depending on the time of year and meteorological conditions, fugitive dust may be an issue during remediation works, for which the contractor must make provision. Disposal of excavated soil to landfill and importation of clean topsoil will involve significant additional traffic movements, for which the contractor must make appropriate allowance and provision.

Security of residents' property will be of paramount importance throughout remediation works. Suitable on-site storage, such as shipping containers equipped with alarms, will be required for the belongings of residents whilst they are temporarily relocated.

5.2.10 Reinstatement of Remediated Areas

Where possible and reasonable, all areas remediated by means of the simple cover system will be reinstated as per their pre-remediation state. The standard of reinstatement will be agreed with each resident during the consultation process (Section 5.2.3) for incorporation into the voluntary stakeholder agreements and prior to commencement of remediation works.

5.2.11 Production and Approval of Final Reports

The contractor will be responsible for all CDM documentation including final verification of remediation works. EPS will be available to assist HDC in reviewing all documentation.

NOTICE TO INTERESTED PARTIES

The purpose of this report is to present the findings of a remedial options evaluation at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements.

No investigation method is capable of completely identifying all the contaminants that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and/or trial pits to recover soil and/or groundwater samples. The locations of these excavations, sampling points and the nature of the tests performed are considered to be representative of / appropriate for the condition of the whole site subsurface. However, ground conditions are naturally variable and it may be possible that localised ground controls could influence both the flow of groundwater or air and the spread of contaminants within the site subsurface. For this reason it is possible that samples collected / test results obtained during the investigation may not represent the conditions across the entire site.

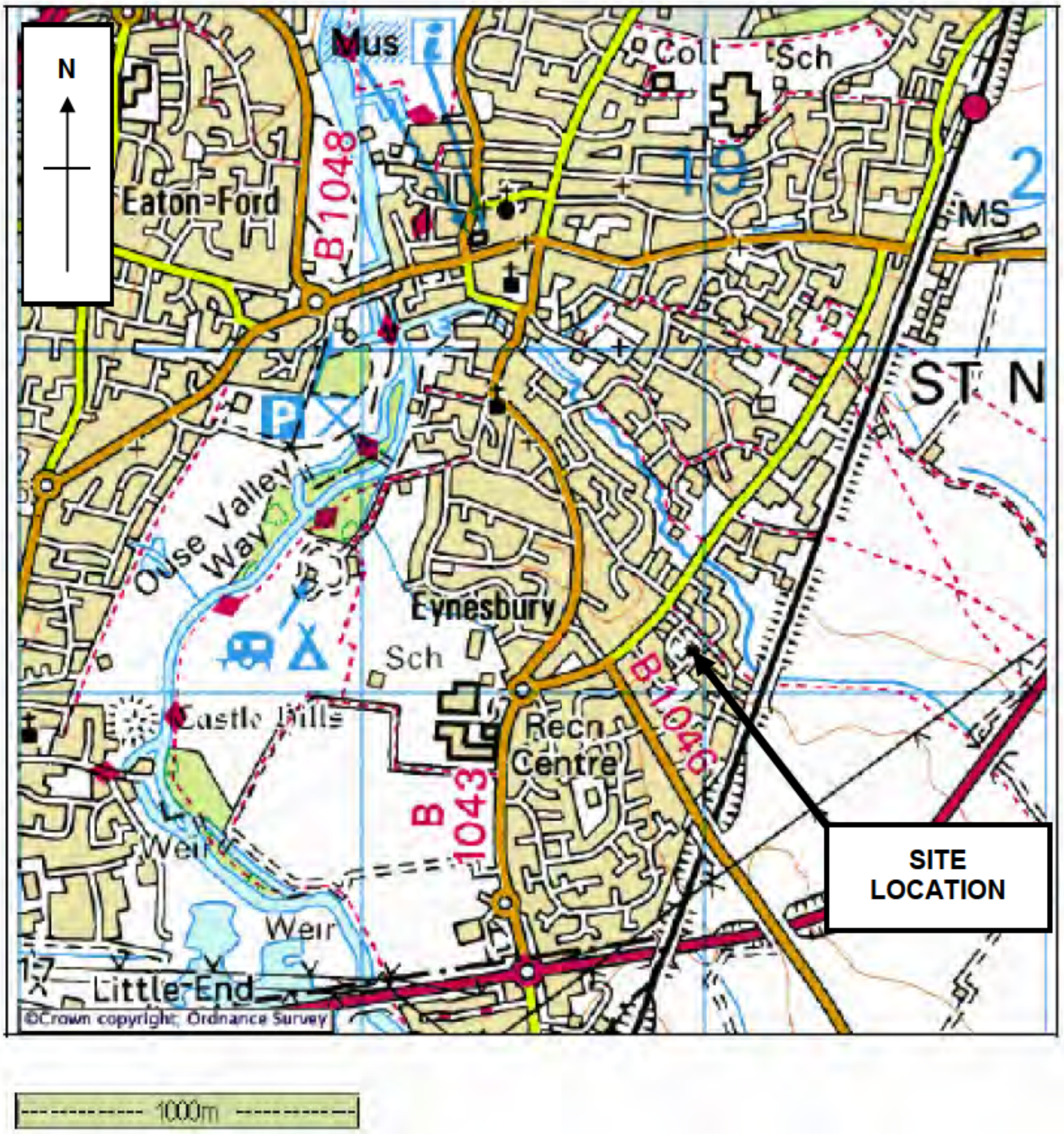
The investigation was carried out to assess the significance of contamination resulting from the historical use of the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made.

If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS. However, EPS cannot guarantee the validity of these data.

The report has been prepared for the client(s) listed on the report title page. EPS accepts no liability or responsibility for use of, or reliance upon, this report and or the information contained within it by third parties.

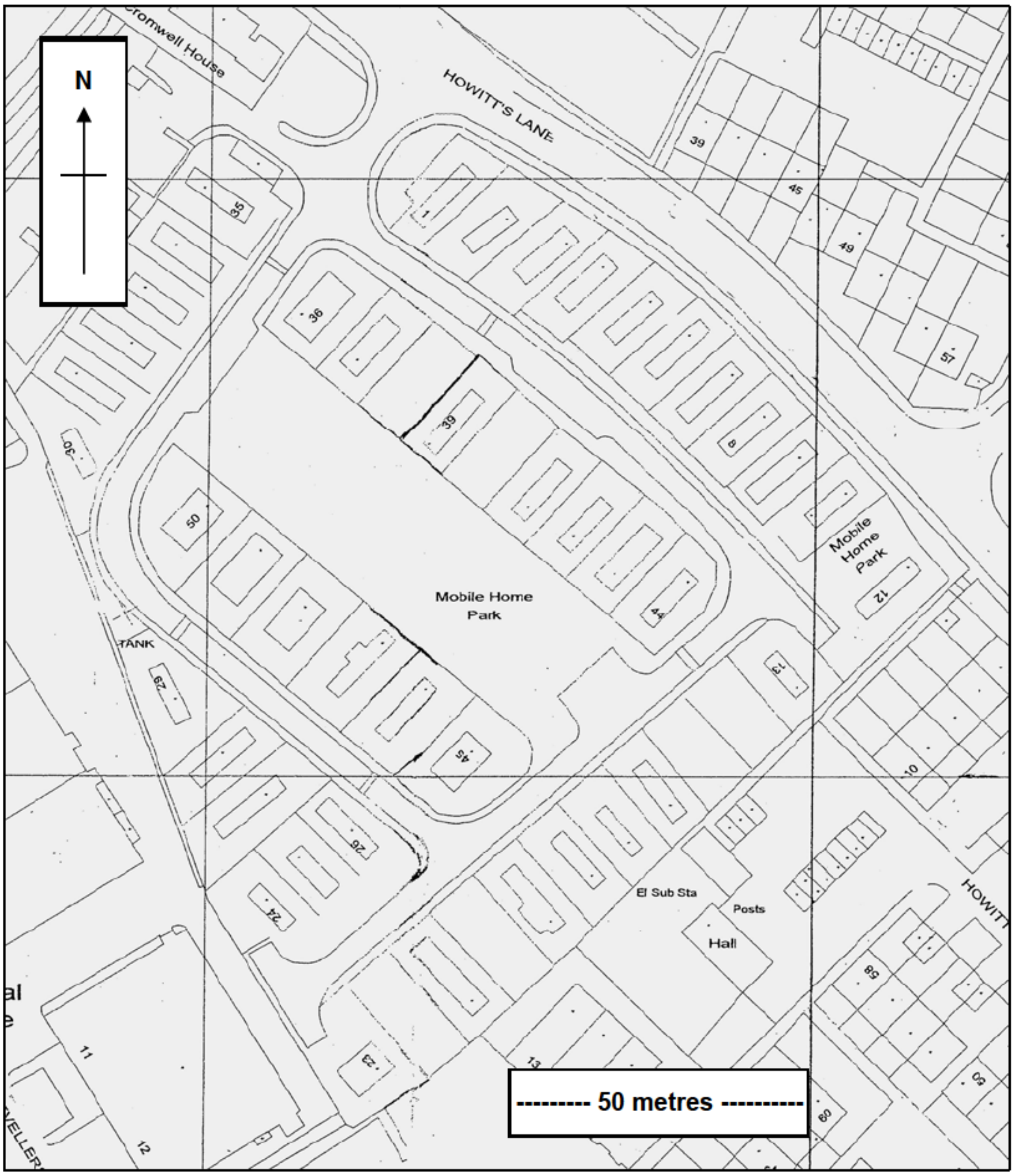
No part of this report, or references to it, may be included in published documents of any kind, except by the client(s) listed on the report title page, without approval from EPS.

FIGURES



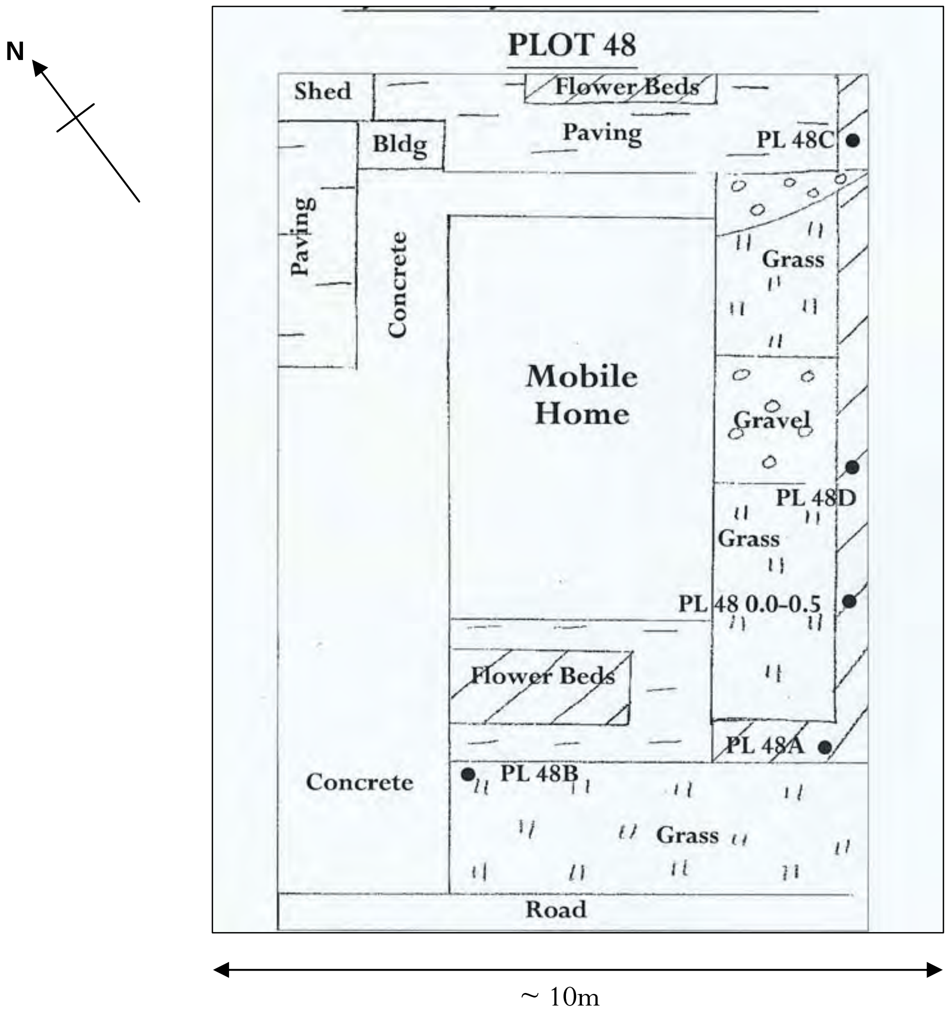
Environmental Protection Strategies Ltd

Client:	Huntingdonshire District Council
Title:	Site location plan
Figure No.:	Figure 1
Scale:	As shown
Date:	15 May 2006



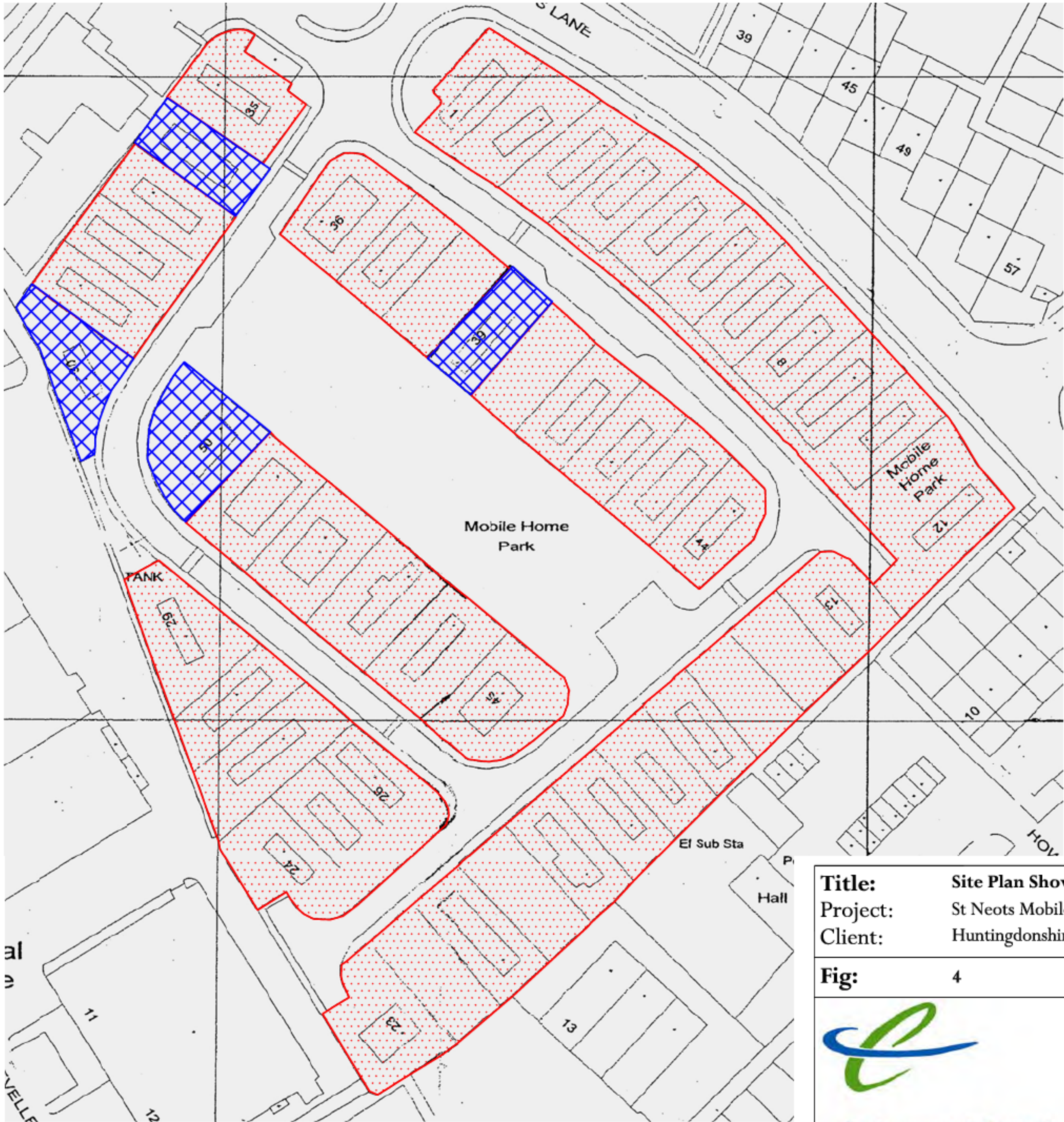
Environmental Protection Strategies Ltd

Client:	Huntingdonshire District Council
Title:	Site layout plan
Figure No.:	Figure 2
Scale:	As shown
Date:	15 May 2006



Client:	Huntingdonshire District Council
Title:	Plot 48 showing different surface cover (illustrative)
Figure No.:	Figure 3
Scale:	As shown
Date:	15 May 2006

Environmental Protection Strategies Ltd



N

Key

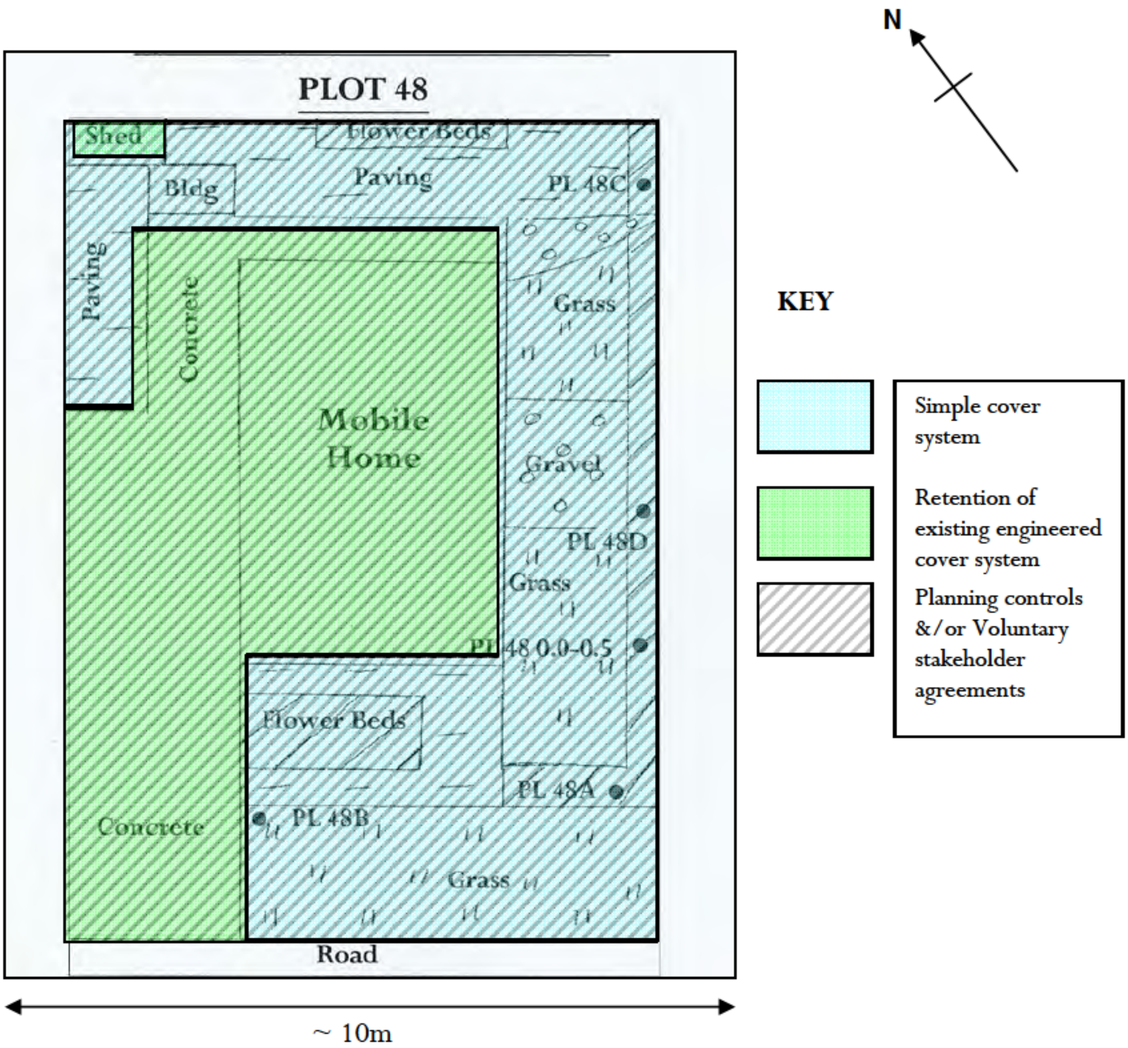
Plots where 95th Percentile Mean Value Test exceeds remedial target

Plots where 95th Percentile Mean Value Test does not exceed remedial target

Title:	**Site Plan Showing Plots Requiring Remediation**
Project:	St Neots Mobile Home Park
Client:	Huntingdonshire District Council
Fig:	4

Environmental Protection Strategies Ltd

Scale:	NTS - Indicative Only
Drawn By:	TRL
Job No:	UK05.0250
Dwg No:	HDC/MHP/0406/01
Date:	April 2006



Environmental Protection Strategies Ltd

Client:	Huntingdonshire District Council
Title:	Plot 48 showing application of remedial approaches (illustrative)
Figure No.:	Figure 5
Scale:	As shown
Date:	15 May 2006

TABLES

Table 1 Details of Significant Pollutant Linkages Affecting the Land

(after HDC, Jan 2006)

1. Source	2. Pathway	3. Receptor	4. Reason why possibility of harm is significant
Benzo(a)pyrene in on and under the land	Ingestion of soil (indoor & outdoor) Ingestion of home-grown vegetables and soil attached to vegetables Dermal contact (indoor & outdoor) Inhalation of soil derived fugitive dust (indoor & outdoor) Inhalation of soil derived vapours (indoor & outdoor)	Human beings (occupiers of the land)	The amount of pollutant in the poluutant linkage in question which a human receptor in that linkage might take in as a result of the pathway in that linkage would represent an unacceptable intake assessed on the basis of relevant information on the toxicological properties of the pollutant. Table B. Section 1 of DETR Circular 02/2000 and Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene. (TOX2)

Table 2a Preliminary Site-Specific Assessment Criteria for Human Health (residential)

(after LQM, Dec 2005)

Pathway	ASSESSMENT CRITERIA (MG/KG)
Ingestion of soil – $ASC_{ingestion}$ (indoor & outdoor)	1.7
Ingestion of home-grown vegetables and soil attached to vegetables – ASC_{veg} (indoor & outdoor)	4.6
Dermal contact ASC_{dermal} (indoor & outdoor)	1790*
Inhalation of soil derived fugitive dust - ASC_{dust} (indoor & outdoor)	55.1
Inhalation of soil derived vapours - ASC_{vapour} (indoor & outdoor)	65.4
$SSAC_{resi}$	**1.2****

Table 2b Preliminary Site-Specific Assessment Criteria for Human Health (open area)

Pathway	ASSESSMENT CRITERIA (MG/KG)
Ingestion of soil – $ASC_{ingestion}$ (outdoor only)	1.7
Dermal contact ASC_{dermal} (outdoor only)	6808.5
Inhalation of soil derived fugitive dust - ASC_{dust} (outdoor only)	278.5
Inhalation of soil derived vapours - ASC_{vapour} (outdoor only)	330.6
$SSAC_{open}$	**1.7****

* Derived assuming the relevant health criteria for dermal exposure is the same as for oral exposure

** Calculated using Equation 6.3 in LQM (2006)

Table 3 Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Management controls					
Change of land use	Receptor / pathway	Nature of land use changed to alter receptor exposure and/or eliminate active pathways	Conventional	Immediately effective Pollutant linkage severed for duration of change of land use	May not be possible (legal, planning etc reasons) May involve significant disruption / compensation costs if land occupied for current use Leaves contaminants in-situ hence possible restrictions on future land use
Restrictive covenants / Planning controls	Receptor / pathways	Imposition of limitations on use of land and/or development to alter receptor exposure and/or eliminate active pathways	Conventional	Immediately effective Pollutant linkage severed for duration of covenants / controls Easier to enforce than voluntary agreements	May not be possible / planning conditions determined by Planning Dept Compensation may be required May encounter resistance from those to whom restrictions apply Controls may not be observed by current or future occupiers of land Leaves contaminants in-situ hence possible restrictions on future land use
Voluntary agreements	Receptor	Voluntary agreements with site users regarding limitations on use of land and/or development to alter receptor exposure and/or eliminate active pathways	Conventional	Immediately effective Pollutant linkage severed for duration of agreements	May not be possible – site users may not agree Compensation may be required Agreements may not be observed by current or future occupiers of land Leaves contaminants in-situ hence possible restrictions on future land use

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Civil engineering methods					
Engineered cover system	Pathway	Physical barrier designed to provide the complete separation of the receptor from the hazard and to perform a number of functions including limiting upward migration of contaminants due to capillary rise and controlling the downward infiltration of water	Conventional	Quick and often cost-effective installation Provides permanent severance of pollutant linkage Can be used irrespective of degree of contamination Little and simple on-going monitoring or maintenance Extensive track record	Leaves contaminated soil in-situ Requires excavation of shallow soil if elevation of ground level to be avoided Can result in significant disruption to site occupiers and neighbours Off-site transport impacts Can limit future land use Drainage considerations need to be taken into account
Simple cover system	Pathway	Reduction of exposure to underlying contaminants through shallow excavation of contamination soil and replacement with uncontaminated soil as soft cover layer which still allows mixing and provides a suitable medium for plant growth	Conventional	Quick and often cost-effective installation Little and simple on-going monitoring or maintenance Extensive track record	Leaves contaminated soil in-situ Potential re-contamination of surface soil through mixing Requires excavation of shallow soil if elevation of ground level to be avoided Can result in significant disruption to site occupiers and neighbours Off-site transport impacts Can limit future land use

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Excavation	Source	Conventional excavating techniques methods are used to remove contaminated materials from the subsurface and removed to a suitable location for ex-situ treatment or disposal	Conventional	Quick and effective remedy for shallow soils and hotspots Ensures thorough remediation through inspection and testing No on-going costs Perception of completed remediation	Disposal costs can be prohibitive if soils are classified as hazardous waste Can cause problems of stability for neighbouring structures Only normally suitable for depths up to 4m Potential fugitive dust emissions Can be disruptive to site occupiers and neighbours Off-site transport impacts
Biological methods					
Biopiles / windrows	Source	Excavated soils are screened and placed in piles of specific size to allow adequate airflow Moisture content is optimised and nutrients and other amendments may be added to enhance biodegradation of contaminants Biopiles are vented by in-pile vents Windrows are periodically turned / tilled to aerate the soil Treated soils are re-instated after treatment Alternatively biopiles or windrows can be used to treat soil prior to disposal to landfill	Conventional	Can be rapid & complete within a few months Can be cost-effective compared with disposal to landfill Can be combined with excavation for pre-treatment of soil before disposal to landfill	Substantial space may be required on or off-site May need bulking agents for low-permeability soils Concentration reductions > 90% difficult to achieve Higher molecular weight compounds degrade more slowly than lower molecular weight May result in increase in material volume owing to addition of amendment material Excavation of contaminated soils required Can cause problems of stability for neighbouring structures Only normally suitable for depths up to 4m Potential fugitive dust emissions Can be disruptive to site occupiers and neighbours Off-site transport impacts

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Bioventing	Source	Natural biodegradative activity of indigenous soil microbial populations enhanced by inducing air flow through unsaturated zone Hydrocarbons and certain organics biodegraded in-situ	Conventional	Requires reasonably short timescales (6 mths – 2 yrs) Off-gas treatment not normally required	Higher molecular weight compounds degrade more slowly than lower molecular weight On-going monitoring and maintenance required Cannot always achieve very low remediation standards Heterogeneity of soils may prevent increased airflow where it is required and hence limit biodegradation
Landfarming	Source	Soils are periodically turned / tilled in-situ to aerate the soil Moisture content is optimised and nutrients and other amendments may be added to enhance biodegradation of contaminants	Innovative	Can be rapid & complete within a few months Can be cost-effective compared with disposal to landfill	Requires open access to land and land is unusable during treatment period May need bulking agents for low-permeability soils Concentration reductions > 90% difficult to achieve Higher molecular weight compounds degrade more slowly than lower molecular weight May result in increase in material volume owing to addition of amendment material Only normally suitable for shallow soils Potential fugitive dust emissions Can be disruptive to site occupiers and neighbours
Monitored natural attenuation	Source	Natural biological and chemical processes remove contaminants from soils Regular sampling takes place to check for efficacy and progress	Innovative	In-situ technique requires no excavation of soil Minimal disruption to site users and neighbours Minimal equipment Can be cost-effective	Can involve long timescales and may not manage risk within required time Intensive monitoring required

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
In-situ bioremediation of unsaturated soils	Source	Bioremediation involves enhancement of natural processes to degrade contaminants Bioremediation generally requires a mechanism for stimulating and maintaining the activity of suitable micro-organisms	Innovative	In-situ technique does not require excavation or disposal of soils or waste products Less disruption than ex-situ techniques	Works best in soils of permeability > 10^{-4} cm/s Injection wells & infiltration galleries may become clogged by microbial growth or mineral precipitates Can be difficult to ensure all areas requiring treatment are reached if underground structures/facilities present Site-specific bench and pilot scale tests required Can be difficult to reproduce laboratory results on site
Phytoremediation	Source	Vegetation planted to remove contamination from shallow soils through direct uptake into plant, immobilisation of contaminants or microbial transformation of contaminants in plant root zones Hybrid poplar trees are often used	Emerging	Effective in shallow soils incl clayey soils Minimal waste Relatively low cost Good public perception Medium monitoring and maintenance required	Can be long-term solution and land may need to be set aside High concentrations of contaminants may be toxic to plants May require disposal of vegetation Potential for contaminants to enter food chain Planting can only be done in Spring and Summer
Chemical methods					
Chemical oxidation	Source	Application of strong oxidising agent to soils in-situ or ex-situ Oxidants degrade contaminants to H2O, CO2 and mineral salts Can be conducted in-situ or ex-situ after excavation of soils	Conventional	Fast acting Can require only a single application If in-situ, does not require excavation or reinstatement of soil	Action is highly dependent on pH Reagents can be highly reactive (difficult to handle) If incomplete, degradation can leave by-products High density of injection wells required Reactions may product vapours and raise temperature of ground Site-specific bench and pilot scale tests are recommended

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Soil flushing	Source	Contaminated soils are flooded in-situ with flushing solutions to sweep contaminants to recovery wells or drains May be enhanced by addition of steam, alkalis, surfactants or co-solvent solutions	Innovative	Technology used extensively in tertiary oil recovery In-situ technique does not require excavation	Heterogenous soils may adversely affect sweep efficiency hence prolonging remediation Careful control of contaminants mobilised by flood is required to prevent detrimental off-site migration Site-specific bench and pilot scale tests are recommended Requires space for flooding or trench installation Operationally demanding technology
Physical methods					
Soil washing	Source	Excavated soil volumes are reduced and contaminants concentrated by particle size and gravity separation, attrition scrubbing and dissolving/suspending contaminants in wash solution (usually water or water with surfactant) Treated soils are reinstated Alternatively treated soil may be disposed of to landfill	Innovative	Can be cost-effective way of reducing volume of material to be disposed of or treated by more energy-intensive process No on-going monitoring and maintenance required	Difficult to remove organics from clay-sized particles Aqueous stream requires treatment Limited field use in UK Requires excavation of soils to be treated hence limitations of excavation techniques apply

Table 3 (cont) Selection of Remediation Options for Detailed Evaluation Step 1

Method	Category	Description	Conventional / innovative / emerging	Advantages	Limitations
Stabilisation & solidification methods					
Solidification / stabilisation with cement, organophilic clays or Quicklime	Source	In-situ mixing of contaminated soils with amendments which encapsulate (solidify) or immobilise contaminants by chemical reactions (stabilise)	Conventional / Innovative	In-situ technique minimises off-site disposal requirements Treated soils have improved geotechnical properties Should require only a single application	Treatability studies required Soil volume increase occurs Solidified soils may restrict future land use and plant re-growth Limited data availability on durability Limited equipment available in UK for in-situ treatment
Thermal methods					
Thermal desorption	Source	Excavated soils are passed through a thermal desorption unit where they are heated up to 600°C to destroy contaminants	Conventional	Rapid treatment times, typically 10-20 tonnes per hour Can treat very high concentrations Requires only a single treatment	High energy consumption Expensive Limited equipment availability in UK Requires excavation of soils to be treated hence limitations of excavation techniques apply

Table 4 Selection of Remediation Options for Detailed Evaluation: Site-Specific Factors

FACTOR	Detail	Description
Effectiveness & durability	Type and extent of contamination	Benzo(a)pyrene in shallow soils underlying a variety of land uses
	Geology / hydrogeology	Brown clayey top soil containing fragments of red brick, concrete, flint gravel and coal over made ground comprising a soft to stiff grey mottled silty clay with abundant fragments of red brick, coal and ash
	Technology development status	It is necessary to consider how well established the technology/approach is in the UK. Successful implementation abroad does not necessarily ensure success in UK hydrogeological conditions. Technology development status is normally divided into Conventional, Innovative and Emerging. Conventional (proven) technologies will rate more highly in terms of effectiveness and durability
	Potential of technology to manage pollutant linkage	Ability of technology/approach to manage the risks posed by the active pollutant linkage within an acceptable timescale. Some technologies may, for example, be able to reduce contaminant concentrations to the required level but not within a timescale that is acceptable
Practicability	Availability of equipment / facility	Implementation of different remedial approaches may involve no equipment, commonly available machinery or specialist facilities. This may have a significant bearing on the suitability of a remedial approach
	Operational impact & demands	Particular factors to consider at St Neots Mobile Home Park include: • Variety of land use: concrete hardstanding, pavement, gravel, lawn, vegetable plots means that active exposure pathways vary by plot and location within plot. For example, existing concrete hard cover may provide sufficient risk management • Permanent residences - need to minimise disruption e.g. avoid relocation and interruption of services if possible; otherwise keep to a minimum duration • Public perception: different remedial approaches have different public perceptions in terms of their efficacy. It is essential that no perception of residual risk of harm remains following remediation works • Neighbourhood impact: St Neots Mobile Home Park is in a residential area, where noise, dust and additional traffic movements should be kept to a minimum • Stability of structures: excavation techniques, depending on depth, and some in-situ remedial technologies have the potential to affect the stability of underground and above-ground structures. Retention of structural stability and integrity is essential

Table 4 (cont) Selection of Remediation Options for Detailed Evaluation: Site-Specific Factors

FACTOR	Detail	Description
Practicability	Long-term impact	Following remedial treatment, remediated areas will require verification and/or monitoring depending on the remedial approach taken. These activities should be minimised, where possible, whilst retaining validity. Some remedial technologies, such as engineered cover or solidification/stabilisation techniques, can alter the properties of soils and therefore may restrict future land use; this should be avoided/minimised if possible
	Timescale	Owing to the need to minimise disruption to residents and neighbours, timescale for remediation should be kept to a minimum
	Legal considerations	Intrusive remediation works will involve activities on residents' land, which may require legal consent. Non-intrusive approaches, such as planning controls and voluntary agreements, may be feasible, although restrictive covenants are not
Reasonable-ness	Best value	It is important to ensure the optimal combination of costs and benefits, taking into account the factors listed above in this table, as an application for funding under the CLCPP scheme will be submitted. Expenditure of public funds requires particular responsibility

Table 5 Selection of Remediation Options for Detailed Evaluation Step 2 Compilation of Manageable Shortlist

	Effectiveness & durability				Practicability					Reasonable-ness	TOTAL
Method	**Type and extent of contamination**	**Geology / hydrogeology**	**Technology development status**	**Potential of technology to manage pollutant linkage**	**Availability of equipment / facility**	**Operational impact & demands**	**Long-term impact**	**Timescale**	**Legal considerations**	**Best value**	
Management controls											
Change of land use	2	3	3	2	0	0	0	0	0	0	0
Restrictive covenants	2	2	3	2	0	0	0	0	0	0	0
Planning controls	2	2	3	2	2	2	3	2	2	3	23
Voluntary agreements	2	2	3	2	2	2	2	2	2	3	22

KEY

3 – suitable (>90%)
2 – probably work (70%)
1 – may work (50%)
0 – not suitable

NB A score of zero in any column means that the method is unsuitable irrespective of all other scores

Table 5 (cont) Selection of Remediation Options for Detailed Evaluation Step 2 Compilation of Manageable Shortlist

	Effectiveness & durability				Practicability					Reasonable-ness	TOTAL
Method	**Type and extent of contamination**	**Geology / hydrogeology**	**Technology development status**	**Potential of technology to manage pollutant linkage**	**Availability of equipment / facility**	**Operational impact & demands**	**Long-term impact**	**Timescale**	**Legal considerations**	**Best value**	
Civil engineering methods											
Engineered cover system	3	3	3	3	3	2	1	2	1	2	23
Simple cover system	3	3	3	3	3	2	3	3	3	3	29
Excavation (deep)	3	3	3	3	3	0	3	1	2	1	0

KEY

3 – suitable (>90%)
2 – probably work (70%)
1 – may work (50%)
0 – not suitable

NB A score of zero in any column means that the method is unsuitable irrespective of all other scores

Table 5 (cont) Selection of Remediation Options for Detailed Evaluation Step 2 Compilation of Manageable Shortlist

	Effectiveness & durability				Practicability					Reasonable-ness	TOTAL
Method	**Type and extent of contamination**	**Geology / hydrogeology**	**Technology development status**	**Potential of technology to manage pollutant linkage**	**Availability of equipment / facility**	**Operational impact & demands**	**Long-term impact**	**Timescale**	**Legal considerations**	**Best value**	
Biological methods											
Biopiles / windrows	2	1	2	2	1	0	3	0	0	2	0
Bioventing	1	0	3	1	3	2	3	1	2	2	0
Landfarming	2	2	2	2	3	0	3	0	0	2	0
Monitored natural attenuation	1	0	3	1	3	3	3	0	0	2	0
In-situ bioremediation of unsaturated soils	1	0	2	1	3	2	3	1	2	2	0
Phytoremediation	1	0	1	1	3	2	0	0	0	2	0

KEY

3 – suitable (>90%)
2 – probably work (70%)
1 – may work (50%)
0 – not suitable

NB A score of zero in any column means that the method is unsuitable irrespective of all other scores

Table 5 (cont) Selection of Remediation Options for Detailed Evaluation Step 2 Compilation of Manageable Shortlist

	Effectiveness & durability				Practicability					Reasonable-ness	TOTAL
Method	**Type and extent of contamination**	**Geology / hydrogeology**	**Technology development status**	**Potential of technology to manage pollutant linkage**	**Availability of equipment / facility**	**Operational impact & demands**	**Long-term impact**	**Timescale**	**Legal considerations**	**Best value**	
Chemical methods											
Chemical oxidation	2	0	3	3	3	1	3	3	2	1	0
Soil flushing	1	0	2	2	1	1	3	1	1	2	0
Physical methods											
Soil washing	2	1	2	3	2	0	3	0	0	2	0
Stabilisation & solidification methods											
Solidification / stabilisation with cement, organophilic clays or Quicklime	3	3	2	1	2	2	1	2	1	2	19

KEY

3 – suitable (>90%)
2 – probably work (70%)
1 – may work (50%)
0 – not suitable

NB A score of zero in any column means that the method is unsuitable irrespective of all other scores

Table 5 (cont) Selection of Remediation Options for Detailed Evaluation Step 2 Compilation of Manageable Shortlist

	Effectiveness & durability				Practicability					Reasonable-ness	TOTAL
Method	**Type and extent of contamination**	**Geology / hydrogeology**	**Technology development status**	**Potential of technology to manage pollutant linkage**	**Availability of equipment / facility**	**Operational impact & demands**	**Long-term impact**	**Timescale**	**Legal considerations**	**Best value**	
Thermal methods											
Thermal desorption	3	3	3	3	1	1	3	1	3	0	0

KEY

3 – suitable (>90%)
2 – probably work (70%)
1 – may work (50%)
0 – not suitable

NB A score of zero in any column means that the method is unsuitable irrespective of all other scores

Table 6 Detailed Evaluation of Feasible Remedial Options

Remedial option	Description	Examples	Advantages	Limitations	Applicability
Simple cover system	Reduction of exposure to underlying contaminants through shallow excavation of contamination soil and replacement with uncontaminated soil as soft cover layer which still allows mixing and provides a suitable medium for plant growth	Typically consist of topsoil, often to a depth of 600m (see BRE guidance) underlain by geotextile or compacted free-draining fill to reduce root penetration and mixing	One-off installation Provides risk management where flexibility in terms of future land use is required No on-going monitoring or maintenance Several plots can be remediated at the same time	Leaves contaminated soil in-situ Potential re-contamination of surface soil through mixing Requires excavation of shallow soil if elevation of ground level to be avoided Can result in significant short-term disruption to site occupiers and neighbours Off-site transport impacts	Simple cover systems are applicable to all areas of residential plots where there is no existing concrete hardstanding i.e. lawns, gravel and paved areas and vegetable plots

Table 6 (cont) Detailed Evaluation of Feasible Remedial Options

Remedial option	Description	Examples	Advantages	Limitations	Applicability
Engineered cover system	Physical barrier designed to provide the complete separation of the receptor from the hazard and to perform a number of functions including limiting upward migration of contaminants due to capillary rise and controlling the downward infiltration of water	Typically constructed of a low-permeability material such as clay or concrete. Examples include areas under mobile homes and driveways	One-off installation No on-going monitoring or maintenance Several plots can be remediated at the same time Provides permanent severance of pollutant linkage Can be used irrespective of degree of contamination	Leaves contaminated soil in-situ Requires excavation of shallow soil if elevation of ground level to be avoided Can result in significant short-term disruption to site occupiers and neighbours Off-site transport impacts Can limit future land use Drainage considerations need to be taken into account	Existing areas of plots covered with concrete hardstanding include mobile home rafts, driveways and shed bases, the last following a recent shed base replacement programme undertaken by HDC. These areas should be checked for integrity and repaired and/or left in-situ. No new areas of concrete need be lain

Table 6 (cont) Detailed Evaluation of Feasible Remedial Options

Remedial option	Description	Examples	Advantages	Limitations	Applicability
Voluntary agreements	Voluntary agreements with site users regarding limitations on use of land and/or development to alter receptor exposure and/or eliminate active pathways. Agreements would be applicable to all successors of current residents	1) Residents agree to retain existing hardstanding within plot boundaries, even if location of mobile home, for example, is altered 2) Residents agree not to grow vegetables at any location within their plot	No physical disruption to residents Remediation becomes effective as soon as agreements are signed Template agreement can be developed and customised for each individual plot	Consensus on content of agreement may be difficult to achieve Adherence to agreement may lapse over time / change of resident – easier to monitor with concrete than soft-surface areas such as lawn, gravel, paving or vegetable plots Compensation may be required for restriction on land use Leaves contaminants in-situ hence possible restrictions on future land use	Voluntary agreements can be used to ensure existing areas of concrete hardstanding are retained and maintained

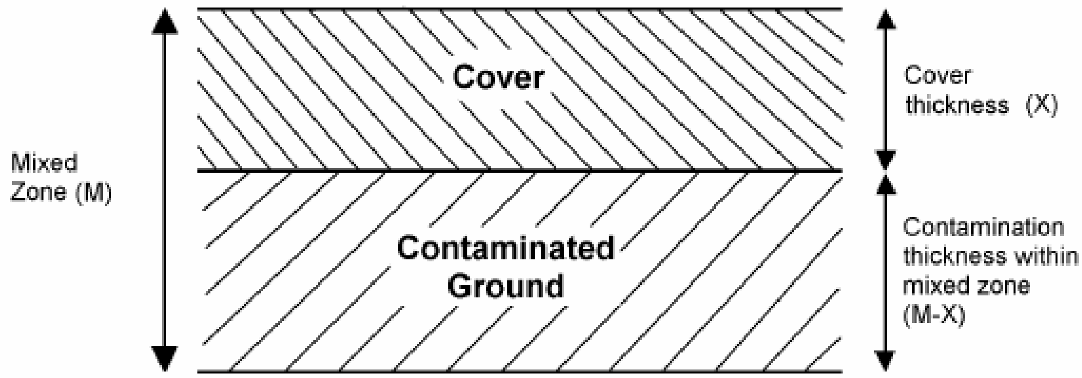
Table 6 (cont) Detailed Evaluation of Feasible Remedial Options

Remedial option	Description	Examples	Advantages	Limitations	Applicability
Planning controls	Planning permission, which is required for engineered and simple cover system remediation works, may have conditions attached to it to control future development of the site	Planning permission includes conditions to control future alterations to hardstandings and/or to the remediated soft cover areas	No physical disruption to residents Remediation becomes effective as soon as agreements are signed Conditions are legally enforceable	Planning conditions are determined by Planning Dept not HDC Housing Services Adherence needs to be monitored over time / change of resident – easier to ensure with concrete than soft-surface areas such as lawn, gravel, paving or vegetable plots Leaves contaminants in-situ hence possible restrictions on future land use	Planning conditions can be used to ensure existing areas of concrete hardstanding are retained and maintained and remediated soft cover areas are disturbed only if appropriate precautions are employed

APPENDIX A

Soil Cover Thickness Calculations

The mathematical model assumes that in the worst case, over time, there will be complete natural intermixing of cover materials with the underlying contaminated material over a thickness referred to as the **mixed zone.**



This model is also presented as Figure 2.

M	=	mixed zone
Tv	=	adopted target guideline value (e.g. CLEA or other modelled value etc)
Cc	=	contaminant concentration of cover (expressed as proportion of Tv, ie less than 1) Note: Cc concentrations must be below Tv, ie clean material.
Cg	=	contaminant concentration of existing ground (expressed as a multiple of Tv)
X	=	cover thickness
T	=	total overall allowable contamination as a result of complete mixing (expressed as a proportion of Tv i.e. 1)
T	=	$(X/M)(Cc) + ((M - X)/M)(Cg)$
X	=	$M(Cg - 1)/(Cg - Cc)$

(after BRE, 2004)

M = 0.6 m

Tv = 2.4 mg/kg ($SSAC_{resi}$)

Assume maximum allowable concentration of BaP in cover = 1.2 mg/kg

i.e. **Cc** = 1 / 2.4 = 0.42

Minimum cover thickness

Plot with lowest mean value BaP still requiring remediation is Plot 3

Mean value concentration = 2.47 mg/kg

Hence minimum cover thickness required = **33 mm**

Calculations based on mixed zone (M) 600 mm

Contaminant	Site Data				Expressed as a Factor of Target Guideline Value				Cover Thickness Required for Compliance to Specified Target Guideline Value	
	Contamination of Ground (Cg)	Contamination of Cover (Co)	Target Guideline Value 1	Target Guideline Value 2	Soil / Target Guideline Value 1	Cover / Target Guideline Value 1	Soil / Target Guideline Value 2	Cover / Target Guideline Value 2	Target Guideline Value 1	Target Guideline Value 2
	Units		Units		Fraction				(mm)	
Benzo(a)pyrene	2.47	1.2	2.4		1.0	0.5	No TV	No TV	33	No TV

Maximum cover thickness

Plot with highest mean value BaP requiring remediation is Plot 14

Mean value concentration = 41.04 mg/kg

Hence maximum cover thickness required = **582 mm**

Calculations based on mixed zone (M) 600 mm

Contaminant	Site Data				Expressed as a Factor of Target Guideline Value				Cover Thickness Required for Compliance to Specified Target Guideline Value	
	Contamination of Ground (Cg)	Contamination of Cover (Co)	Target Guideline Value 1	Target Guideline Value 2	Soil / Target Guideline Value 1	Cover / Target Guideline Value 1	Soil / Target Guideline Value 2	Cover / Target Guideline Value 2	Target Guideline Value 1	Target Guideline Value 2
	Units		Units		Fraction				(mm)	
Benzo(a)pyrene	41.04	1.2	2.4		17.1	0.5	No TV	No TV	582	No TV