Eagle Eye
environmental solutions ltd.

VERIFICATION REPORT

RADIOLOGICAL SURVEY & REMEDIATION, DAEDALUS PARK B (SOUTH)

Tidebank Ltd

21 December 2018
NN986R01

The Old Brewhouse
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Wroxall, Ventnor
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1. INTRODUCTION

Eagle Eye Environmental Solutions Ltd (EEES) are pleased to present our survey and remediation report for radiological works undertaken by EEES at the Daedalus Park B site (South). EEES were engaged by Tidebank Ltd (The Client).

These works were required due to above background readings being detected during past surveys of the site, these works were undertaken prior to the clients purchase of the site. These previous survey works are detailed elsewhere and issued to EEES for review as part of tender under document package 'T7638 Tidebank – Daedalus Radiology Documents (7)'. Further survey and removal/ remediation were required as part of the redevelopment works.

2. PROPOSED DEVELOPMENT

It is understood that the site forms part of the wider Daedalus regeneration project, this site will for a commercial development consistent with portal frame warehouse structures. Site works will consist of site clearance earth works and building construction.

3. SCOPE OF WORK

The scope of works as quoted included the following;

- Project preliminaries (including permit application and method statements for works;
- Mobilisation of equipment to site and survey of impacted area;
- Removal of the radioactive liability; and,
- Full traceability and documentation to demonstrate that the material has be disposed of and the radioactive liability removed in accordance with all applicable regulations and permits.

All works were undertaken in accordance with technical requirements as detailed in the Environment Agency permit obtained by EEES for the works (Ref: EPR/PB3991DP) attached as Appendix A of this document. All site works were undertaken in accordance with the Radiological Risk Assessment and Method Statement for the Remediation of the Radium Contaminated area developed for the site by Dr Chris Murdock, the EEES Radiation protection advisor (RPA) as attached as Appendix B of this document. The site as defined as the work area is outlined as Figure 1 of this report.

Disposal of recovered material was undertaken by Eckert and Ziegler Ltd (EZ).

4. SITE WORKS

Site works were undertaken on 8 December 2018 and consisted of full survey of the defined area (as detailed in Figure 1). Ground clearance was achieved utilising a 3t tracked excavator to remove the made ground in 300mm layers. Survey of exposed layers of material by EEES personnel was achieved utilising a Ludlum 3000 with gamma 44-2 scintillator monitoring gamma radiation in counts per second at 300mm spacing horizontally. On detection of >60cps, a Tracerco T402 was utilised and soil removed at 50mm layers until source was identified. The survey rational is summarised in Table 1 below;

Table 1 – Survey Rationale

Survey Criteria	RSR Category	Action
<22cps	Material not above background	If natural material, leave in-situ or if excavated can use as backfill subject to other contaminant considerations *(outside the scope of this remediation)*
>22 cps up to 60 cps on Ludlum 44	Very low level waste	Contain in skip for very low level waste disposal to hazardous waste landfill
Individual discrete items >60 cps on Ludlum 44-2, survey at 5cm using Tracerco T402 and user conversion of 0.1 µSv/h per kBq to log all items	Low level waste disposal	Retain in bags (in locked signed store) for transfer into drums and permitted transfer by EZ

Background gamma readings (cps) within the local area were adjusted during site works to reflect natural ground background figures. Levels were determined by the RPS on site at 19-26cps. Logs from the radiological monitoring are included as Appendix C of this report. General site photographs of survey are included as Figure 2 of this report.

5. DETECTED SOURES OF RADIATION

A total of 6 individual packages of material were recovered during survey and excavation. These items were recorded as emitting >60 cps. Table 2 below summarises the individual packages collected from site.

Table 2 – Recovered packages Summary

Package I.D.	Weight (g)	Surface Dose Rate (µSv/h)	226Ra detected activity (kBq)	226Ra Activity concentration (Bq/g)	Description	Waste Category*
001	51.515	1.0	4.00	77.6	Soil/ Waste Ash	VLLW
002	16.895	2.5	10.00	591.9	Soil/ Waste Ash	VLLW
003	285.000	74.0	294.12	1032.0	Intact radium dial	LLW
004	155.675	22.0	89.24	573.2	Soil/ Waste Ash	LLW
005	21.930	11.0	45.20	2061.1	Soil/ Waste Ash	LLW
006	383.465	0.14	0.56	1.5	Soil/ Waste Ash	VLLW

**VLLW = Very Low Level Waste, LLW = Low Level Waste*

The activity calculations where based on comparison of dose rate and Ludlum 44-2 measurements with our known radium-226 source with the additional use of the Microshield 9.07 software to model the effect of geometry. Photographs of each individual sample are included within Figure 2 of this report.

6. STORAGE AND DISPOSAL

Storage was achieved utilised a shipping container with appropriate signage. Material was collected by EZ and transferred into transportation drums for removal and disposal. Disposal was also undertaken by EZ, the disposal certificate is included as Appendix D of this report.

7. VERIFICATION

Following site works the site survey area was passed with no readings above background detected. The remaining material was therefore considered to pose no further risk in relation to radiation contamination.



Drawn	CB
Approved	JO
Date	17/12/2018
Scale	NTS
Original	A3

Eagle Eye environmental solutions ltd.

Client:	TIDEBANK LTD			
Project:	CONTAMINANT REMOVAL - TIDEBANK SITE HMS DEADALUS (SITE B)			
Title:	SITE PLAN			
Project no:	NN986	Figure no:	Figure 1	Rev: 1

Base Map Copyright Google Earth
The Old Brew House, Appuldurcombe House, Wroxall, Ventnor, Isle of Wight, Po38 3EW, t:01983 852484, www.eees.co.uk



General Site photograph



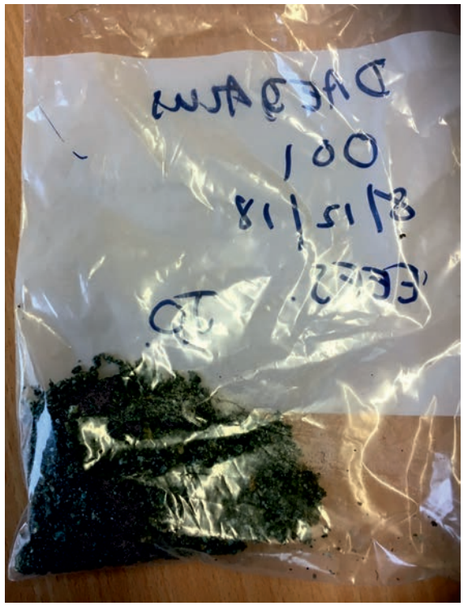
General Site photograph



General Site photograph



General Site photograph



Sample #001



Sample #002



Sample #003



Sample #004



Sample #005



Sample #006

Drawn	CB
Approved	JO
Date	17/12/2018
Scale	NTS
Original	A3

Eagle Eye environmental solutions ltd.

Client:	TIDEBANK LTD			
Project:	CONTAMINANT REMOVAL - TIDEBANK SITE HMS DEADALUS (SITE B)			
Title:	SITE PHOTOGPRAPHS			
Project no:	NN986	Figure no:	Figure 2	Rev: 1

The Old Brew House, Appuldurcombe House, Wroxall, Ventnor, Isle of Wight, Po38 3EW, t:01983 852484, www.eees.co.uk

APPENDIX A
Environment Agency Permit

Permit with introductory note

The Environmental Permitting (England & Wales) Regulations 2016

Eagle Eye Environmental Solutions Limited

Daedalus Park B Site (South)
Daedalus Drive
Lee on Solent
Hampshire
PO13 9YA

Permit number

EPR/PB3991DP

Permit number EPR/PB3991DP

Introductory note

This introductory note does not form a part of this permit

The permit allows the operator to accumulate and dispose of radioactive waste, in carrying on specified radioactive substances activities on the specified premises.

The permit is issued under the provisions of regulation 13 of the Environmental Permitting (England and Wales) Regulations 2016.

The operator must also comply with other legislation to which the accumulation and disposal of radioactive waste is subject. This includes legislation enforced by the Health and Safety Executive and by the Office for Nuclear Regulation.

The status log of the permit sets out the permitting history, including any changes to the permit reference number.

Status Log of the permit		
Detail	**Date**	**Response Date**
application EPR/PB3991DP/A001	duly made 19/09/2018	-
Additional information received, revised accumulation and disposal limits.	07/11/2018	09/11/2018
permit determined EPR/PB3991DP	DD/MM/YY	-

End of Introductory Note

Permit

The Environmental Permitting (England and Wales) Regulations 2016

Permit

Permit number
EPR/PB3991DP

The Environment Agency hereby authorises under regulation 13 of the Environmental Permitting (England and Wales) Regulations 2016

Eagle Eye Environmental Solutions Limited *("the operator")*

whose registered office is

12 Romney Place
Maidstone
Kent
ME15 6LE

company registration number **10350112**

to carry on radioactive substances activities at

Daedalus Park Site B (South)
Daedalus Drive
Lee on Solent
Hampshire
PO13 9YA
("the premises")

to the extent authorised by and subject to the conditions of this permit.

Name	Date
[name of authorised person]	DD/MM/YY

Authorised on behalf of the Environment Agency

Conditions

1 – Management

1.1 General management

1.1.1 The operator shall manage and operate the activities:

(a) in accordance with a written management system that is sufficient to ensure compliance with the conditions of this permit; and

(b) using sufficient competent persons and resources.

1.1.2 The operator shall maintain records demonstrating compliance with condition 1.1.1.

1.1.3 Any person having duties that are or may be affected by the matters set out in this permit shall have convenient access to a copy of it kept at or near the place where those duties are carried out.

1.1.4 The operator shall manage and operate the activities in consultation with such suitable radioactive waste advisers as are necessary for the purpose of advising the operator as to compliance with this permit.

2 – Operations

2.1 Permitted activities

2.1.1 The operator is only authorised to carry on the activities specified in Schedule 1, Table S1.1 (the "activities").

2.2 The site

2.2.1 The activities shall not extend beyond the site, being the land shown edged in green on the site plan at Schedule 5 to this permit.

2.3 Operating techniques

2.3.1 The operator shall use the best available techniques:

(a) to minimise the period over which radioactive waste is accumulated;

(b) to minimise the activity of radioactive waste produced on the premises that will require to be disposed of on or from the premises;

(c) to ensure that all relevant parts of the premises are constructed, maintained and used in such a manner that:

(i) they do not readily become contaminated; and

(ii) any contamination which does occur can be easily removed;

(d) to prevent:

(i) the loss of any radioactive waste; and

(ii) access to any radioactive waste by any person not authorised by the operator.

2.3.2 The operator shall use the best available techniques in respect of the disposal of radioactive waste pursuant to this permit to:

(a) minimise the activity of gaseous and aqueous radioactive waste disposed of by discharge to the environment;

(b) minimise the volume of radioactive waste disposed of by transfer to other premises; and

(c) dispose of radioactive waste at times, in a form, and in a manner so as to minimise the radiological effects on the environment and members of the public.

2.3.3 The operator shall use the best available techniques to:

(a) exclude all entrained solids, gases and non-aqueous liquids from radioactive aqueous waste prior to discharge to the environment;

(b) ensure that any discharge of radioactive gas to the atmosphere is made in a manner which prevents its entry into any building.

2.3.4 The operator shall maintain in good repair the systems and equipment provided:

(a) to meet the requirements of conditions 2.3.1, 2.3.2 and 2.3.3; and

(b) to carry out any monitoring and measurements necessary to determine compliance with the conditions of this permit.

2.3.5 The operator shall check, at an appropriate frequency, the effectiveness of systems, equipment and procedures provided to meet the requirements of conditions 2.3.1, 2.3.2 and 2.3.3.

2.3.6 Any container in which radioactive waste are stored shall be clearly and legibly marked with the word 'Radioactive', with the ionising radiation symbol conforming with BS 3510: 1968 or ISO 361 and any other information necessary for the identification of the or radioactive waste present.

2.3.7 The operator shall have and comply with appropriate criteria for the acceptance into service of systems, equipment and procedures for carrying out any monitoring and measurements necessary to determine compliance with the conditions of this permit.

2.3.8 The operator shall post copies of this permit on the premises, in such characters and in such positions to be conveniently read by persons who have duties on the premises which are or could be affected by the matters set out in this permit.

2.4 Pre-operational conditions

2.4.1 The activities shall not be brought into operation until the measures specified in Schedule 1, Table S1.2A have been completed.

2.4.2 The operations specified in Schedule 1 table S1.2B shall not commence until the measures specified in that table have been completed.

2.4.3 Written notification of the date of completion of each measure shall be sent to the Environment Agency within 14 days of the completion of each such requirement.

2.5 Improvement programme

2.5.1 The operator shall complete the improvements specified in Schedule 1, Table S1.3 by the date specified in that table unless otherwise agreed in writing by the Environment Agency.

2.5.2 Except in the case of an improvement which consists only of a submission to the Environment Agency, the operator shall notify the Environment Agency within 14 days of completion of each improvement.

2.6 Receipt of radioactive waste

2.6.1 No radioactive waste shall be received onto the premises.

2.7 Accumulation of radioactive waste

2.7.1 There shall be no accumulation of radioactive waste except of the types of radioactive waste specified in Schedule 2, Table S2.1.

2.7.2 The limits on accumulation given in Schedule 2 shall not be exceeded.

2.7.3 The operator shall maintain records of radioactive waste showing:

(a) the radionuclide present, the date on which accumulation began and the activity on that date;

(b) so far as is reasonably practicable its location on the premises;

(c) if it has been removed from the premises, the date of removal, the activity on that date and the name and address of the person to whom it was transferred; and

(d) the total activity and volume of radioactive waste present on the premises.

3 – Disposals of radioactive waste and monitoring

3.1 Disposals of radioactive waste

3.1.1 There shall be no disposals of radioactive waste except of the types of radioactive waste and by the disposal routes specified in Schedule 3.

3.1.2 The limits on disposals given in Schedule 3 shall not be exceeded.

3.1.3 The operator shall ensure that the transfer of radioactive waste:

(a) is in accordance with the directions of the person to whom the radioactive waste is transferred that are necessary to enable that person to comply with all relevant regulatory requirements;

(b) is done using a suitable container constructed and maintained so as to prevent the loss of waste; and

(c) so far as is reasonably practicable, is not subject to delays in transit and is accepted at the premises of the person to whom the operator transfers waste.

3.1.4 The operator shall:

(a) ensure that the person to whom radioactive waste is transferred receives at the time of transfer of each consignment a clear and legible note signed on the operator's behalf:

(i) stating the total activity in the consignment of each relevant radionuclide or group of radionuclides listed in the relevant table in Schedule 3; or

(ii) stating, when no relevant radionuclide or group of radionuclides is specified in Schedule 3, the total activity in the consignment of each radionuclide or group of radionuclides as listed in the written specification of the person to whom the radioactive waste is transferred.

(b) obtain a note signed on behalf of the person to whom radioactive waste is transferred, at the time of transfer, stating that the transfer has taken place; and

(c) keep a copy of any note issued under condition 3.1.4(a) and any note received under condition 3.1.4(b).

3.1.5 If required by the Environment Agency, the operator shall ensure that any consignment or part of any consignment of radioactive waste found, following transfer, not to be in accordance with the conditions of this permit:

(a) is packaged in accordance with the relevant legislation; and

(b) is returned as soon as is reasonably practicable to the operator’s site.

3.1.6 The operator shall, not later than 14 days after the end of each month or within such longer period as the Environment Agency may approve in writing, record all disposals of radioactive waste made during that month.

3.2 Monitoring

3.2.1 If required by the Environment Agency, the operator shall

(a) take such samples and conduct such measurements, tests, surveys, analyses and calculations, including environmental measurements and assessments, at such times and using such methods and equipment as the Environment Agency specifies; and

(b) keep samples, provide samples, or dispatch samples for tests at a laboratory, as the Environment Agency specifies, and ensure that the samples or residues thereof are collected from the laboratory within three months of receiving written notification that testing and repackaging in accordance with the relevant legislation are complete.

3.2.2 The operator shall maintain records of all monitoring required by this permit including records of the taking and analysis of samples, instrument measurements (periodic and continual), calibrations, examinations, tests and surveys and any assessment or evaluation made on the basis of such data.

3.2.3 The operator shall carry out:

(a) regular calibration, at an appropriate frequency, of systems and equipment provided for carrying out any monitoring and measurements necessary to determine compliance with the conditions of this permit; and

(b) regular checking, at an appropriate frequency, that such systems and equipment are serviceable and correctly used.

4 – Information

4.1 Records

4.1.1 All records required to be made by this permit shall:

(a) be legible;

(b) be made as soon as reasonably practicable;

(c) if amended, be amended in such a way that the original and any subsequent amendments remain legible, or are capable of retrieval; and

(d) be retained until notified in writing by the Environment Agency that records no longer need to be retained.

4.1.2 The operator shall:

(a) retain records made in accordance with any previous relevant permit issued to the operator and related to the premises covered by this permit; and

(b) retain records transferred to the operator, which were made in accordance with any previous relevant permit related to the premises covered by this permit.

4.1.3 The operator shall keep on site all records, plans and the management system required by this permit, unless otherwise agreed in writing by the Environment Agency.

4.2 Reporting

4.2.1 The operator shall send all reports and notifications required by this permit to the Environment Agency using the contact details supplied in writing by the Environment Agency.

4.2.2 The operator shall supply such information in relation to:

(a) the disposals of radioactive waste; and

(b) the samples, tests, surveys, analysis and calculations, environmental monitoring and assessments undertaken under condition 3.2.1;

in such format and within such timescales as the Environment Agency may specify in writing.

4.3 Notifications

4.3.1 The Environment Agency shall be notified without delay following the detection of:

(a) any malfunction, breakdown or failure of equipment or techniques or accident, which has caused, is causing or may cause significant pollution or may generate significant amounts of radioactive waste;

(b) the breach of a limit specified in this permit; or

(c) any significant adverse environmental effects; or

(d) any escape of accumulated radioactive waste.

4.3.2 Any information provided under condition 4.3.1 shall be confirmed by sending the information listed in Schedule 4 within the time period specified in that Schedule.

4.3.3 The Environment Agency shall be notified in writing, at least 21 days in advance or, where this is not possible, without delay, of the operator's intention to cease to accumulate or dispose of radioactive waste.

4.3.4 The Environment Agency shall be notified within 14 days of the occurrence of the following matters, except where such disclosure is prohibited by Stock Exchange rules:

(a) Where the operator is a registered company:

i. any change in the operator's trading name, registered name or registered office address; and

ii. any steps taken with a view to the operator going into administration, entering into a company voluntary arrangement or being wound up.

(b) Where the operator is a corporate body other than a registered company:

i. any change in the operator's name or address; and

ii. any steps taken with a view to the dissolution of the operator.

(c) In any other case:

i. the death of any of the named operators (where the operator consists of more than one named individual); and

ii. any steps taken with a view to the operator, or any one of them, going into bankruptcy, entering into a composition or arrangement with creditors, or, in the case them being in a partnership, dissolving the partnership.

4.3.5 If the operator believes or has reasonable grounds for believing that radioactive waste have been lost or stolen he shall:

(a) without delay inform the Police and the Environment Agency;

(b) make all reasonable efforts to recover that radioactive waste; and

(c) as soon as is practicable report the circumstances in writing to the Environment Agency.

4.4 Interpretation

4.4.1 In this permit the expressions listed below shall have the meaning given.

4.4.2 In this permit references to reports and notifications mean written reports and notifications, except where reference is made to notification being made "without delay", in which case it may be provided by telephone.

"activity", expressed in becquerels, means the number of spontaneous nuclear transformations occurring in a period of one second.

"annual limit" means the limit over a calendar year.

"aqueous waste" means radioactive waste in the form of a continuous aqueous phase together with any entrained solids, gases and non-aqueous liquids.

"best available techniques" means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:

(a) comparable processes, facilities or methods of operation which have recently been successfully tried out;

(b) technological advances and changes in scientific knowledge and understanding;

(c) the economic feasibility of such techniques;

(d) time limits for installation in both new and existing plants; and

(e) the nature and volume of the discharges and emissions concerned.

"Bq, kBq, MBq, GBq, TBq and PBq" are used as abbreviations meaning becquerels, kilobecquerels, megabecquerels, gigabecquerels, terabecquerels and petabecquerels respectively.

"calendar year" means a period of 12 consecutive months beginning on 1 January.

"environment" means all, or any, of the media of air, water (to include sewers and drains) and land.

"environmental permit" means a permit under the Environmental Permitting Regulations for the accumulation or disposal of radioactive waste.

"Environmental Permitting Regulations" means The Environmental Permitting (England and Wales) Regulations 2010.

"gaseous waste" means radioactive waste in the form of gases and associated mists and particulate matter.

"LLW" means solid radioactive waste, including any immediate packaging, with a maximum concentration of 4 gigabecquerels per tonne of alpha emitting radionuclides and 12 gigabecquerels per tonne of all other radionuclides.

"LLWR" means Low Level Waste Repository near Drigg, Cumbria.

"LLWR Site Operator" means the holder of the licence issued under the Nuclear Installations Act 1965 for the LLWR.

"Month" means calendar month.

"nuclear site" means a site licensed under the Nuclear Installations Act 1965.

"quarter" means any period of three consecutive months.

"organic liquid waste" means radioactive waste in the form of liquid, not being aqueous waste, containing one or more organic chemical compounds.

"packaging" includes any sack, drum, container or wrapping.

"radioactive waste adviser" means, subject to the transitional arrangements in the Agencies' Scheme for Radioactive Waste Advisers ("the Scheme"), either an individual certified under the Scheme and appointed in writing by the operator, or those individuals advising the operator under the operators arrangements for "corporate radioactive waste adviser" as approved under the Scheme. The Scheme is published at:

http://www.sepa.org.uk/radioactive_substances/radioactive_waste_advisers.aspx

"samples" includes samples that have been prepared or treated to enable measurements of activity to be made.

"techniques" include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.

"Total", where used in Schedule 1, Table S1.2, excludes any radionuclide which would fall within the description of radionuclides given for the total in question, but which is specifically identified and limited elsewhere in that table.

"VLLW" means very low level solid radioactive waste, which is disposed of with non-radioactive refuse, and in which:

(a) except in the case of carbon-14 and tritium, each $0.1m^3$ of waste contains less than 400 kBq of total activity;

(b) except in the case of carbon-14 and tritium, any single item contains less than 40 kBq of total activity;

(c) each $0.1m^3$ of waste contains less than 4000 kBq of carbon-14 and tritium, taken together; and

(d) any single item contains less than 400 kBq of carbon-14 and tritium, taken together.

Schedule 1 – Operations

Table S1.1: Activities			
Activity reference	**Activity listed in Schedule 23 of the Environmental Permitting Regulations**	**Description of specified activity**	**Limit of specified activity**
A1	Sch 23 Part 2 para 112)(c)	Accumulation of radioactive waste on the premises	Land remediation Disposing of waste
A2	Sch 23 Part 2 para 11(2)(b)	Disposal of radioactive waste on or from the premises	

Table S1.2A: Pre-operational measures	
Reference	**Pre-operational measures**
-	None specified

Table S1.2B Pre-operational measures for future development		
Reference	**Operation**	**Pre-operational measures**
-	None specified	-

Table S1.3: Improvement programme requirements		
Reference	**Requirement**	**Date**
-	None specified	-

Schedule 2 – Accumulation of radioactive waste

Table S2.1: Accumulation of radioactive waste				
Specified waste type	**Radionuclide or group of radionuclides permitted to be present in the waste[1] [2]**	**Activity limit**	**Volume limit**	**Period limit**
Solid Waste	Radium 226 and decay products	25 MBq	5m3	3 months
VLLW	Any radionuclide	VLLW	5 m^3	3 months

[1] together with any associated decay products present in amounts not exceeding those which could be present through radioactive decay of the specified radionuclides

[2] numerical limits apply only to the head of chain radionuclides

Schedule 3 – Disposals of radioactive waste

Table S3.1: Specified disposals to air				
Specified waste type	**Disposal outlet ref**	**Radionuclide or group of radionuclides permitted to be present in the waste[1 2]**	**Annual limits**	**Daily limits**
No disposals to air authorised	-	-	-	-

Table S3.2: Specified disposals to sewer or water				
Specified waste type	**Disposal outlet ref**	**Radionuclide or group of radionuclides permitted to be present in the waste[1 2]**	**Annual limits**	**Monthly limits**
No disposals to sewer or water authorised	-	-	-	-

Table S3.3: Specified transfers to other premises					
Specified waste type	**Person to whom waste may be transferred**	**Purpose of transfer**	**Radionuclide or group of radionuclides permitted to be present in the waste[1 2]**	**Annual limits**	**Annual volume limitsm[3]**
Solid Waste	The holder of a permit under the Environmental Permitting Regulations to receive and dispose of radioactive waste.	For further transfer and disposal	Radium 226 and decay products	25 MBq	-
Solid Waste	The holder of a permit under the Environmental Permitting Regulations to receive and dispose of radioactive waste.	For incineration	Radium 226 and decay products	25 MBq	-
VLLW	Any person who holds an environmental permit for the recovery or disposal of non-radioactive waste of the same type (excluding its radioactive properties) as the VLLW	For treatment or disposal	VLLW	No limit	No limit

Table S3.4: Specified disposal by on–site incineration				
Specified waste type	**Incinerator unit**	**Radionuclide or group of radionuclides permitted to be present in the waste[1 2]**	**Monthly limits**	**Daily limits**
No on-site incineration authorised	-	-	-	-

[1] together with any associated decay products present in amounts not exceeding those which could be present through radioactive decay of the specified radionuclides

[2] numerical limits apply only to the head of chain radionuclides

Schedule 4 - Notification

These pages outline the information that the operator must provide.

Units of measurement used in information supplied under Part A and B requirements shall be appropriate to the circumstances of the disposal. Where appropriate, a comparison should be made of actual disposals and permitted disposal limits.

Part A

Permit Number	**EPR/PB3991DP**
Name of operator	
Location of Facility	
Time and date of the detection	

(a) Notification requirements for any malfunction, breakdown or failure of equipment or techniques, accident, or disposal which has caused, is causing or may cause significant pollution or may generate significant amounts of radioactive waste	
To be notified within 24 hours of detection	
Date and time of the event	
Reference or description of the location of the event	
Description of where any disposal into the environment took place	
Radionuclides potentially released	
Best estimate of the quantity or rate of release of radionuclides or amount of radioactive waste generated	
Measures taken, or intended to be taken, to stop any disposal	
Description of the failure or accident	

(b) Notification requirements for the breach of a limit		
To be notified within 24 hours of detection unless otherwise specified below		
Disposal outlet reference/source		
Radionuclides		
Limit		
Measured value and uncertainty		
Date and time of monitoring		
Measures taken, or intended to be taken, to stop the disposal		
Time periods for notification following detection of a breach of a limit		
Parameter		Notification period

(c) Notification requirements for the detection of any significant adverse environmental effect	
To be notified within 24 hours of detection	
Description of where the effect on the environment was detected	
Radionuclides detected	
Activity of radionuclides detected	
Date of monitoring/sampling	

Part B - to be submitted as soon as practicable

Any more accurate information on the matters for notification under Part A	
Measures taken, or intended to be taken, to prevent a recurrence of the incident	
Measures taken, or intended to be taken, to rectify, limit or prevent any contamination of the environment which has been or may be caused by the disposal	
The dates of any unauthorised disposals from the facility in the preceding 24 months	

Name*	
Post	
Signature	
Date	

* authorised to sign on behalf of ***Eagle Eye Environmental Solutions Limited***

Schedule 5 - Site plan



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END of PERMIT

APPENDIX B

Risk Assessment & Method Statement

Radiological Risk Assessment and Method Statement for the Remediation of the Radium Contaminated Area at HMS Daedalus (Site B)

V2.2

Date: 17th August 2018 (updated 19/11/18)

Our Ref: NN986

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Document Detail

Prepared by:	Chris Murdock (RPA & RWA To Eagle Eye ES)
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Amendment Record

Revision No.	Date	Reason for Change	Authors Initials
2.0	17/8/18	Update to survey threshold limits (section 7.1.2) by RPA / RWA – required prior to permit application submission	CM
2.1	11/11/18	Changes to remove NORM and revise waste characterisation method and thresholds	CM
2.2	19/11/18	Addition of section 10 - End user (public) dose assessment	CM

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1 Introduction

1.1 Purpose and Scope of Radiological Risk Assessment

1.1.1 The purpose of this Radiological Risk Assessment & provisional working Method Statement (RAMS) is describe the risk and methods associated with the radiological remediation of Daedalus Park Site B “hot-spot”. It will assess the risk of this activity might have during planned remediation works and identify the safe working practices and controls that will be required during the proposed work to ensure;

- Appropriate protection of remediation operatives;
- Appropriate protection of other site users and the general public during remediation;
- The control of radioactively contaminated materials; and
- Methods for remediation are suitable to ensure that the radiological risk to future residential user of the site are kept as low as is reasonably achievable..

2 Description of the Radiological Hazard

2.1 Nature and Location of Radioactive Contamination

2.1.1 Non-intrusive (walk over surveying) of of the Daedalus Park Site B south in 2007 identified a hot spot of radiation at grid reference point SU 56161 01454 (Ref 1) and this was again confirmed by a follow up survey conducted by Aurora in 2017 (Ref 2).

2.1.2 Invasive sampling by Entec in 2007 identified contaminated metal object in soil at a depth of 0.2 m with radium-226 activity concentration >4 Bq/g.

2.1.3 In June 2018 Eagle Eye ES and Eckert & Ziegler (E&Z) carried out sampling of this area removing 2 bags (approximate masses of 0.15 kg each) for analysis by E&Z at their laboratories.

2.1.4 Analysis of this material confirmed the presence of radioum-226 and it was estimated that the activity concentration of this radionuclide (and decay products) were as follows ((pers. comm E&Z):

Bag 1: 132.85 Bq/g

Bag 2: 32.87 Bq/g respectively. (Bq/g = Becquerels per gram)

2.1.5 It was noted that discrete metallic / ash items were present in this material with activity concentration to be significantly higher than the average value given above.

2.1.6 The results from this analyses are compared against the following The Environmental Permitting (England and Wales) Regulations 2016 (as amended)

Table 1 Relevant classification of radioactive wastes (radium-226 contamination soils)

Radionuclide	Origin of waste	EPR Out of Scope Activity (Bq/g)	Radioactive Waste Classification For This Material
Radium-226	Historic radium contamination / waste arising from remediation of land contaminated by radium[1]	1.0	**Permitted Very Low Level Waste (VLLW) or Low level waste (LLW)**

2.1.7 Peak RPA Ltd were contracted to be the RPA & RWA for this remediation project after removal of this material to the E&Z laboratory. As soon as the results from the survey of bag 1 and bag 2 were available, and the non-exempt waste classification was determined, Peak RPA advised on the following:

[1] Evidence form historical use of the site and Ref 1

- An EPR2016 radioactive waste permit is required in order for this work to proceed – no work in this immediate location can take place until this permit has been issued
- The waste bags (1 & 2) must be held by E&Z prior to disposal under the Daedalus site B permit
- Hold any work in this area and ensure the area is made safe as follows:
    - Cover the area by a tarpaulin
    - The area out to approximately 40 m2 (centred on the surveyed area) should be fenced off to form a physical barrier restricting access. You are to arrange for dust suppression Harris fencing to be installed.
    - A sign should be placed on each side of the fence area warning of the radiation / contamination / asbestos risks and prohibiting access. From a radiation perspective the area inside the fence should be designated as a supervised area,

2.1.8 An EPR application to the Environment Agency is being drawn up.

2.1.9 From preliminary consideration of remediation methods, the heterogeneity of this material and the remediation method described later it is tentatively considered that the following volumes of waste material will be obtained from this site:

Table 2: Estimated maximum volumes of soil to be removed from site and consideration of radioactive waste classification

Approximate (maximum) Volumes (m3)	Waste Classification	Action
<10	Background (non-detectable radiation / contamination above natural site levels	Use as back fill material subject to consideration of asbestos content
<15	Greater than site background (>+10%) conservatively assumed to be > 1 Bq/g out of scope limit and therefore VLLW	Hazardous waste landfill as VLLW, packaged to ensure the activity contamination does not exceed 0.4 MBq per 0.1 m3 and no single item is > 40 kBq
<0.2	LLW	Transfer to permitted facility for direct incineration (e.g. Grundon) or to a facility permitted o accept radioactive LLW for onward transfer / disposal; e.g. Eckert & Ziegler, Didcot

NB the hazardous waste landfill requirement will principally be driven by potential asbestos content

3 Radiation Protection Considerations

3.1 Persons Likely to be affected by Radioactive Material

3.1.1 Eagle Eye ES is responsible for the remediation works and has been made aware of the presence of the radioactive contamination and the requirements to restrict access by the project Radiation Protection Adviser (RPA). The areas of contamination will be enclosed with Harris fencing with a single barrier access and egress point.

3.1.2 The only persons likely to be affected by the contamination in its current condition are those that enter the work area and come into direct contact with the contaminated soil. This should be restricted to the personnel who are appropriately trained and who understand the radiological risk associated with such contamination and the measures required to control and minimise exposure. Personnel working in the area are to be in the presence of a Radiation Protection Supervisor.

3.2 Public and other resident close by.

3.2.1 Access to the Daedalus site and this contamination area will be restricted both at the overall site boundary and the remediation boundary and fencing and signage and supervision will prevent unauthorised access to the work area.

3.2.2 Workers elsewhere on the site will be briefed on the access restrictions to the remediation site

3.2.3 Where required contamination control measure listed in section 7 e.g. damping down, will restrict any spread of contamination of dusts and contamination (exit) monitoring of operatives at the work boundary will ensure no contamination is removed from the site on PPE / clothing & equipment

3.2.4 It is not proposed that any trainees under the age of 18 years old will be undertaking the remediation works. Should this change for any reason this RRA will be reviewed and updated to account for the additional consideration of radiological exposure.

3.2.5 The work has been designed to ensure protection of workers and the general public in accordance with the requirements of the Ionising Radiation Regulations 2017 (IRR17).

3.2.6 Eagle Eye ES are registered with the HSE under Reg. 6 to:

- work with over 1000 kg of radioactive material containing artificial radionuclides or radioactive material containing naturally occurring radionuclides which are processed for their radioactive, fissile or fertile properties

4 Likelihood of Surface and Airborne Contamination Being Generated

4.1.1 Loose contamination may be generated during the work which can affect both surfaces and the air. This will be in the form of dust, soil particles and rubble.

4.1.2 Potential doses from inhalation and ingestion of radium-226 (Ra) contaminated dusts are modelled in the dose assessment (Section 5) with recommended control measures which are included below.

5 Assessment of Surface and Airborne Contamination Risks

5.1 Exposure pathways

5.1.1 Radiological analysis undertaken on samples collected during previous investigations undertaken (Refs. 1 & 2 and pers. comm Eckert & Ziegler) identified the elevated levels of radioactivity are due to elevated levels of radium decay series nuclides through the burial of ash produced from, burning of radium luminised aircraft dials.

The following prior radiological risk assessment has been completed by the Radiation Protection Adviser involved in this project. Radiological exposure from the following pathways are foreseeable and each is assessed here with recommendations on how to restrict exposure:

- Skin doses from direct contamination;
- Gamma doses from in-situ material and during excavation;
- Doses from inhalation of re-suspended material; and
- Doses from inadvertent ingestion of contaminated material.

5.2 Skin contamination by homogenously contaminated soil (not discrete higher activity objects)

5.2.1 Assumptions based on exposure (before controls measures are in place)

i) Person is not wearing PPE;

ii) Transfer of contamination of active material is 0.2763 mg / cm^2 directly onto the skin (Ref 3) and 10 times this onto clothing;

iii) The skin dose "coefficients" for the radium-226 decay chain nuclides (Ref 4) include contributions from both beta and gamma emission (beta emission dominate);

- The total skin dose coefficient for the ^{226}Ra assuming no radon loss is 6.56 mSv/h per kBq/cm^2;

iv) Any deposition of solid material onto the skin and clothing occurs at masses given in ii), this contamination remains in place for 8 h/d and the project length is at this stage assumed to be 5 working days. The activity concentration of 226Ra (in equilibrium to 210Po) is in the worst case assumed to be 10 Bq/g (10 times the out of scope limit). Attenuation of the beta emissions by clothing is ignored.

v) The assumptions in v) should be considered to be worst case for cob.

5.2.2 Using the assumptions made in 4.1.2 the skin dose rates are calculated to be :

^{226}Ra and decay products : 8.0 µSv/h

5.2.3 This skin dose should be compared against the IRR17 dose limit of 500,000 µSv/y which, if averaged over a 240 day working year, equates to a daily limit of 2083 µSv or a 5 day project limit of 10415 µSv.

5.3 Skin contamination from exposure to beta / gamma emissions from single discrete objects

5.3.1 It is assumed during excavation up to five single discrete luminised article (a broken piece of aircraft dial) containing 40 kBq is uncovered. The dose rate to the skin will be 115,470 µSv/h (from beta & gamma emission) (Ref 3) assuming 226Ra in equilibrium to 210Po . It is unlikely that a discrete item will be present on the skin for more than 15 seconds before it is removed so it is assumed that over the course of the project 5 such items are present on the skin for 15 seconds. The total skin dose is 2405 µSv.

5.3.2 The total skin dose (from soil and discrete item contamination) is estimated to be ~2413 µSv, this dose should be compared against the IRR17 dose limit of 500,000 µSv /y which, if averaged over a 240 day working year, equates to a daily limit of 2083 µSv or a 5 day project limit of 10415 µSv.

5.3.3 Although the IRR17 skin dose limit is not expected to be challenged, even considering these very unlikely assumptions, to comply with Reg. 9 of IRR17 (restriction of exposure), it is necessary to implement the controls listed in section 7 to minimise exposures to as low as is reasonably practicable.

5.4 Gamma doses from in-situ material and excavation

5.4.1 The above assessment considers contamination to the skin. It is also necessary to consider the external gamma (and beta) doses that will result from operators being in close proximity to (but not in contact with) contaminated material and hotspots that are could be accounted during the excavation of the site.

Assuming the following:

a) that all areas of elevated Ra levels areas (i.e. all site material) are contaminated at the worst case activity concentrations which are assumed to be 10 times the out of scope limit (10 Bq/g ^{226}Ra). It is not absolutely clear what the geometry of this uniformly contaminated material is likely to, if it is present at all, but for the purposes of this assessment it is assumed that an infinite slab is uncovered and the contaminated slab has a depth of 25 cm.
b) the density of the slab is assumed to be 1.6 g/cm^2
c) in a single excavated trial pits one discrete radium luminised items with an activity of 40 kBq is found.

Assumed geometry	^{226}Ra* decay series dose rate µSv/h	
	At 10 cm above slab	At 100 cm above slab
25 cm infinite slab of contamination (10 Bq/g)[a]	5.1	4.7
From discrete unburied 40 kBq source[b]	85	0.8

[a]Modelled using MicroShield™, [b]Modelled using data form ref 4

Note the dose rates around the slab do not follow inverse square law as the contamination is not a point source.

As previous gamma radiation walkover surveys did not identify any areas of elevated radiation at current surface levels, it would be unrealistic to assume that, in the present work, the exposure of operators to the elevated levels modelled above will occur for 100% of the project time. Instead it is assumed that after removing the overlying background depths of soil to 30 cm a contaminated horizon occurs at each trial pit site.

- Over the 5 day project length it is assumed that operators are exposed to this "contaminated" horizon for 50% of the project length : 20 hours
- For 25% of these 20 hours the operator is positioned 10 cm form the contaminated ground and for the remainder they are 100 cm
    - Dose to operator spending 5 h at 10 cm is 26 µSv
    - Dose to operator spending 15 hours at 100 cm is 71 µSv
- Exposure to the discrete 40 kBq point is assumed to occur for 1 minutes at 10 cm distance before detection and implementation of the contingency plan.
    - Dose to the operator : 14 µSv
- Total whole body dose due to gamma radiation < 100 µSv

Note: these calculations will need to be revised if the project length differs from 5 days.

5.4.2 It is important to note here that these modelled results are based on the assumption that there is a significant buried layer of 10 Bq/g radium-226. A recent walk over survey of the site with a gamma dose rate meter found levels in near contact with the ground surface of 0.22 µSv/h. this is just over twice background but more than 20 times below the modelled levels here. Whilst the above assumption should be considered to be very pessimistic there is a risk that excavation of overlying material will reveal contaminated material that has previously been shielded by inert overlying soils. If this occurs dose rates will potentially increase significantly above current maximum levels of 0.22 µSv/h and it will be necessary to implement the controls listed in section 7 in order to minimise radiological exposure.

5.5 Doses from inadvertent ingestion of contaminated material

5.5.1 Whilst it is expected that the risk of inadvertent ingestion of this contaminated material is lower than inhalation risk it is still foreseeable and must be assessed here.

The following assumptions are made:

- Inadvertent ingestion of the contaminated material occurs at the same rate as the soil ingestion rate given in ref. 5 : 5 mg/h
- The active phase of this project takes 40 hours during which time ingestion occurs at this rate continually.
- The activity concentrations of ^{226}Ra in the material is 10 Bq/g respectively
    - o In addition to the ingestion of fine soil particles deposited on the skin it is assumed that in the worst case the ingestion of 1 (No.) discrete 10 kBq particle occurs
- Ingestion dose coefficients are taken from ref. 6.

5.5.2 Worst case doses during excavation of the active area before dose restriction control measures

Decay chain	Committed effective dose from ingestion / µSv
Radium-226	Soil particles : 18.2 Discrete particle†: 45,700

^{226}Ra in secular equilibrium with decay products

The doses from inadvertent ingestion of soil particles are low but clearly, although extremely unlikely to occur, inadvertent ingestion of a 10 kBq discrete particle could result in a significant radiation dose. Control measures listed in section 7 are necessary to minimise this exposure:

6 Conclusions, area designation and dosimetry recommendations

6.1 Designation of Areas

6.1.1 Due to the potential generation of contamination and dose rate the identified “hot spots” work around this area is to be designated as 'Contamination & Radiation Supervised Area' and in accordance with the provisions of IRR17, with signage posted on access points to identify them as such and the nature of the radiation hazard prior to work in that area beginning.

6.1.2 All other areas will be monitored during works. Should radioactivity be detected above background levels designation as a supervised area will be initially set up.

6.1.3 The radioactive waste storage area is to be designated a controlled area.

6.1.4 Following remediation of the controlled area, the designated area may be reduced, dependent on the results of monitoring surveys taken in the remediated area.

6.2 Classification of Persons and Dose Monitoring

6.2.1 Based on the dose rates recorded and anticipated for the work persons would not require to be 'classified worker' in accordance with the provisions of IRR17.

6.2.2 Assessment of potential inhalation doses demonstrates that classification of workers would not be required.

6.3 Potential Accidents/Incidents, their Likelihood and Radiological Severity

6.3.1 See *Appendix A* for this assessment of incidents.

6.4 Conclusion

6.4.1 The radiological risks associated with remediation works of the soils from Daedalus Park Site B radium contaminated area are not considered to be significant if undertaken in a controlled manner and the identified control measures implemented.

7 Methodological Controls and Radiation Protection Considerations

7.1 Preliminary Methods to Control Radiation Exposure and Minimise the Generation of Contamination

This section details the preliminary method to minimise the exposure to radiation and contamination levels to site operatives and the risk of contamination spreading outside of the designated work area. An expanded version of this will be produced once the radiation detection equipment and site permit is available.

7.1.1 As personnel undertaking remediation work will be subject to an elevated dose rate they must minimise the time they are working within the affected area. The work should be planned to ensure that all activities that can be undertaken in a low background area (e.g. planning and preparation) are done so.

7.1.2 To minimise and control the generation of contamination, the following requirements apply to the work:-

- Personal Protective Equipment (including Respiratory Protective Equipment (RPE) as required by the RPA is to be worn (see below);
- Routine visual inspection of clothing will take place to check for damage and accumulation of active material
- A contamination monitor (Mini 900 44B or equivalent) will be on hand continually through this work to verify skin and clothing is free from contamination (this monitor is capable of detecting Bq levels of 226Ra decay series radionuclides over both small (point) or large areas sources.
- All personnel will be monitored and decontaminated as necessary using damp disposable wipes / tissues prior to egress from the controlled area

- All tools / equipment used are to be monitored at the end of the working day and decontaminated as necessary using damp disposable wipes / tissues;
- Dust suppression techniques will be employed during excavation works where airborne dusts are likely;
- Vehicular movement within the designated area will be kept to a minimum (when moving wastes in the secure unit);
- The excavation will only occur once a survey of the upper surface of the material to be extracted has been carried out. The excavation will be halted if radiation levels exceed a given count rate / dose rate as defined in the method statement.
    - The dose rate hold point is initially to be set at 5 µSv/h,
    - RPA to advise on the contamination meter hold point once the instrument/s to be used area known
- To restrict finger and skin exposure to point source discrete items the method statement will prohibit surveyors from picking up discrete items that have been identified as having elevated radiation more than 3 times background. Instead, such items will be moved using 30 cm tongs.
- Excavated material will be placed on heavy duty polyethene within the designated area and will be spread out to a depth of no more than 2 cm, width 10 cm for survey and characterisation
    - Preliminary Survey limits for characterisation of waste
        - Out of scope:
            - count rate at 1 cm above the excavated material; or below local site background (+10 %)
            - Note : this in-situ survey threshold is conservatively set and will ensure that material quite considerably below the out of scope limit of 1 Bq/g (but above the site background expected to be ~<0.05 Bq/g) will be identified as VLLW and removed.
        - VLLW / LLW
            - If count rate at 1 cm exceeds background (+10%)
            - If uniform contamination up to twice background (30 cps net) on Ludlum 44-2 (with no single item above this this) then contain and dispose in skip as uniform VLLW where uniform concentration is significantly below the VLLW limit of 400 kBq per 0.1 m3
            - If contamination at any point exceeds twice background (or 30 cps net) this prompts VLLW / LLW assessment / characterisation of individual items extracted from the waste. These are monitored using the Tracerco T402 dose rate meter to assess discrete contaminated areas as follows:
                - Characterise waste according to the following:
                    - VLLW (<40 kBq radium-226 item) for small items < 5 cm2

        - Dose rate at 5 cm : < 4 µSv/h
    - LLW (>40 kBq) for small items <5 cm2
        - Use conversion dose rate at 5 cm of 0.1 µSv/h per 1 kBq
        - So 20 µSv/h item at 5 cm suggest waste item activity is 200 kBq
- Following waste classification VLLW and LLW will be secured in transport containers (expected to be 205 litre metal drums). If overnight storage is required then will need to be stored in a secure compound on site e.g. Locked Iso-Freight container.
- A clean change area will be set up where operators will remove their PPE and carry out contamination monitoring of clothing and skin. No PPE is to be worn outside the site's designated area boundary (is must be retained at the site boundary on exit)
- The time spent within the highest dose rate area should be minimised and, so far as is reasonably practicable, excavation of this material should so far as is reasonably predictable be completed by an operator within a mechanical digger as this will provide a good degree of shielding. Manual should only occur when mechanical access is not possible.
- Training in PPE removal prior to work starting to include a reminder on the importance of good occupational hygiene practices both within and outside of the designated area
- Prohibition of food / chewing gum etc. within the radiation work area.

7.2 Personal Protective Equipment

7.2.1 In order to undertake any excavation and removal work on the areas close to radioactive contamination the following PPE is mandatory:

- Approved Dosimetry (whole body TLD);
- Disposable coveralls with a hood;
- Steel Toe-Capped Boots
- Disposable overshoes;
- Protective eyewear when using tools;
- Suitable gloves for the nature of the work;
- Disposable nitrile gloves, worn over work gloves.
- High visibility jacket / vest; and
- Hard Hat.
- RPE (FFP3) – if resuspendable dusts are likely to be present

8 Asbestos fragment removal

8.1.1 Following previous works on site, a small quantity (>20kg) of asbestos cement (AC) was discovered. A test was carried out to determine the amount and type of asbestos contamination.

8.1.2 Test results

DETS Report No: 18-77425				
Eagle Eye Environmental Solutions Ltd		Date Sampled	20/06/18	
Site Reference: Daedalus		Time Sampled	None Supplied	
Project / Job Ref: NN910-2		TP / BH No	A1	
Order No: None Supplied		Additional Refs	None Supplied	
Reporting Date: 02/07/2018		Depth (m)	0.20 – 0.50m	
		QTSE Sample No	343090	
Determinand	**Unit**	**RL**	**Accreditation**	
Asbestos Screen (S)	N/a	N/a	ISO17025	DETECTED
Sample Matrix (S)	Material Type	N/a	None	Multiple cement fragments in soil
Asbestos Type (S)	PLM Result	N/a	ISO17025	Chrysotile

8.1.3 From the test result it was determined that the asbestos was confined to pieces of asbestos cement (AC)

8.1.4 Method for removal (based on HSE A11 – Removing asbestos cement (AC) debris)

- Dampen the AC debris with spray.
- Pick up pieces of debris and put them in the asbestos waste bag.
- Dispose of material via licenced ACM contractor

8.1.5 Picker should be asbestos qualified

8.1.6 PPE is outlined in section 7.2

9 Summary of Working Method Statement

The final method statement will include information on each of the following.

- Site preparation
    - Fencing and IRR17 supervised area signage 5-7 m from work area
    - Clean change and PPE (dirty) change area to be segregated : contamination monitoring using Ludlum 2000 44/2
        - Contamination (of PPE / surveyors) defined as twice background
    - Create and label the following waste holding areas (all to be positioned within the supervised area):
        - Out of scope material with radiation levels consistent with site background – to be used for backfilling : covered tarpaulin.
        - Bulk VLLW: waste uniformly contaminated with VLLW levels of radium -226 (<400 kBq per 0.1 m3) contain in skip or 205 litre drums for hazardous waste landfill disposal
        - VLLW : waste containing discrete radium ash / article fragments each with an activity no more than 40 kBq : contain in 205 litre drums or skips for hazardous waste landfill disposal
        - LLW : waste containing discrete radium luminised dial fragments each with an activity greater than 40 kBq : contain in 205 litre drums for permitted transfer
        - VLLW drum / or skip and LLW drums to be positioned within the designated area work area but at a suitable distance to ensure that radiation levels emitted do not influence survey of excavated material
- Ground preparation
    - Tarp / polythene lay down area
    - Use of dust suppression sprays if ground is dry and dusts are likely to be resuspended
    - Use of excavator to remove up to 100 kg each pass
    - Site H&S rules to be followed to ensure operators are visible and away from the excavator
    - Excavator operator to place the excavated material into a 30 cm line now more than 2 cm deep
    - Surveyors to characterise the material using appropriate instrumentation e.g. Ludlum 2000 44/2 and Tracerco T402 dose rate meter
- Initial survey (health and safety point of work risk assessment)
    - Use of Tracerco dose rate meter to survey over the excavated material noting any area of dose rate > 1 µSv/h
    - If any dose rate exceeds 4 µSv/h then the survey should be halted the team move back to a dose rate below 0.5 µSv/h and a method drawn up for removal of this discrete item to waste containment (205 l drum) using 30 cm tongs

- Sequentially remove discrete radiation items using the 30 cm tongs and characterise using the method below into VLLW & LLW streams.

Detailed survey method used for waste characterisation

1) Use of Ludlum 2000 / 44/2 radiation meter to monitor excavated material spread to a depth of 2 cm on tarpaulin / polythene sheeting
    a. Material is exempt (Out of Scope) if:
        - The count rate at 1 cm above the excavated material <=local site background (+10 %)
        - Retain for backfilling or if contains asbestos contain in skip for haz-waste landfill disposal

    b. Material is VLLW bulk waste if:
        - The count rate is no more 60 cps above background on Ludlum 2000 / 44-2 across large areas of excavated material
        - Contain in skip for VLLW haz-waste landfill
        - Estimate volume of bulk VLLW produced

    c. If the count rate over the bulk waste is more than 60 cps above background then individual areas or discrete items of waste must be quantified using a gamma dose rate meter (Tracerco T402) as outlined below:
        - Extract area of waste using trowel or long handled tongs onto polythene sheeting and characterise waste according to the following:
            - If the dose rate at 5 cm above these individual items is < 4 µSv/h then the waste item is a "VLLW item" up to 40 kBq 226Ra
            - Contain item in 205 litre drum for haz-waste landfill – label drum as VLLW
            - Ensure no more than 10 discrete items each 4 µSv/h are contained in each 0.1 m3, this is equivalent to no more than 20 discrete items each measuring 4 µSv/h at 5 cm per 205 l drum
        - If above the VLLW (>40 kBq) for small items <5 cm^2
            - Use conversion dose rate at 5 cm of 0.1 µSv/h per 1 kBq
            - So 20 µSv/h item at 5 cm suggest waste item activity is 200 kBq
            - Contain this item in 205 l drum for E&Z or Grundon permitted transfer
            - Record dose rate, calculated activity & approximate mass of each item going into the labelled LLW drum
        - Take care to segregate VLLW and LLW drums and ensure labelling is very visible
2) Once these hot spots are removed from the line of excavated material the Ludlum 2000 44-2 is to be used again to assess the bulk material i.e. repeat the above actions 1 a-c

Notes:

- All surveying must be carried out with a calibrated Tracerco T402 gamma dose rate meter and Ludlum 44/2., to identify "hot-spots" in excavated material
- Grove's Microshield™ modelling software has been used to determine the above thresholds – assuming the following:
    - Bulk VLLW waste modelling: 30 x 20 x 2 cm geometry, in-situ bulk density 1.3 g/cm3, loss of 30 % radon, effective gamma energy of 226Ra decay progeny assumed to be 400 keV (based on empirical data obtained by Peak RPA using a 226Ra source)
    - For VLLW individual item assessment these are assumed to be 1 cm in diameter and are measured at a distance of 5 cm using a gamma dose rate meter that has low threshold for beta detection (Tracerco T402).

Eckert & Ziegler

- E&Z will be carrying out the site surveying, they will provide :
    - additional methodology for waste characterisation based on the monitoring equipment they are to use
    - methods for
        - sample preparation and consignment
        - movement and storage of radioactive wastes (including waste accountancy)
        - packaging of radioactive waste for transportation

Post remediation

- post remediation reassurance monitoring will be provided according to the following method
- after excavation of the site back to the natural ground layer a full survey of the excavated site will be carried out using the Ludlum 2000 44-2 prior to backfilling with out of scope material
    - Hold point and re-excavation if any count rate exceeds site background + 10%
        - This +10% count rate is required because natural background typically shows small scale spatial variation of at least this level
- Once the above site survey of the excavated area is satisfactorily completed the site will be backfilled with out of scope material
    - Each excavator bucket of backfill will be surveyed back into the ground using the Ludlum 44-2
    - Hold point and re-excavation if any Ludlum 2000 44-2 count rate exceeds site background + 10%

10 End user (public) dose assessment

The above Risk Assessment and Method Statement outlines the survey methodology and end point thresholds that will be followed by Eagle Eye ES to remediate the Daedalus Site B hot spot.

No material will be left on the site that exceeds 10% of the site background as measured using the Ludlum / 44-2 gamma / beta survey meter. Excavation of the site will be back to natural ground and therefore visual observation during excavation is an important part of the site radiological surveying & remediation. Any backfilled material will be surveyed to ensure it complies with the <=background +10%

Practical working limits assuming a site background of 20 counts per second (on Ludlum 44-2):

Survey criteria	RSR Category	Action
<22 cps	**Material not distinguishable above background**	**If natural material leave in-situ or if excavated can use as backfill subject to asbestos considerations**
>22 cps up to 60 cps on Ludlum 44-2	**Very low level waste**	**Contain in skip for very low level waste disposal to hazardous waste landfill**
Individual discrete items > 60 cps on Ludlum 44-2, survey at 5 cm using Tracerco T402 and user conversion of 0.1 µSv/h per kBq to log all items	**Low level waste disposal**	**Retain in bags (in locked store) for transfer into drum/s and permitted transfer to Eckert & Ziegler**

Previous surveying on this site have indicated that the typical local background of the Ludlum 44-2 is 20 counts per second. Consideration of this background count rate, the previous responses of this Ludlum 44-2 to Daedalus site B 226Ra contamination and modelling of expected monitor responses to different contamination scenarios, it is considered that the monitoring method outlined above is capable of detecting:

a) a single small (<1 cm2) 226Ra item of 20 Bq buried at 2 cm
b) a single small (<1 cm2) 226Ra item of 2 Bq on the surface
c) bulk 226Ra contamination of soil at ~10 Bq per kg above the natural site level.

If surveyed material passing the <=10% above background threshold is used to backfill then if we assume that every other kg of soil backfilled contains one item at 20 Bq and one at 2 Bq then the average activity

concentration of radium backfilled will be <10 Bq/kg above the site's natural 226Ra level. This is comparable with the detection threshold for 226Ra in bulk material [(c) above].

An activity concentration of 10 Bq/kg (0.01 Bq/g) is 100 times lower than the 1 Bq/g out of scope threshold laid down in the recent EPR amendment (Ref 7). This out of scope threshold is the activity concentration above which material produced during the remediation of land contaminated with radium becomes "radioactive material" under EP law.

When considering the radiological risk to end users living or working on land remediated from radium-226 contamination, if material of up to 1 Bq/g 226Ra is left on site Ref 8. concludes that the dose to the end user (i.e. a member of the public) will not exceed 300 micro-sieverts per year. It is important to note here that this dose criterion is typically based on members of the public (adults, children and infants) occupying domestic residences built on a remediated site. These dose pathway assumptions are likely to be pessimistic compared to the expected use of Daedalus site B following remediation.

Since the Daedalus site B survey and remediation method, described in the present RAMS document, is capable of detecting a 226Ra activity concentration in backfilled and surveyed material of >0.01 Bq/g then the radiological dose to the end user of this site, post remediation, is expected to be <=3 µSv/y (100 times under the 300 µSv/y dose criterion in Ref. 8).

The risk associated with the level of exposure discussed is considered extremely low compared to the average dose from all background sources. The average dose to a UK member of the public from all background sources of radiation, such as radon, terrestrial & comic sources, medical exposures etc. is ~2700 µSv/y (Ref. 9). .

References

1) Entec report Radiological Survey of Daedalus Site 2007.

2) Aurora : Radiological Survey of Daedalus Park Site 'B' For Tidebank, 2017

3) Holmes, KK; Shirai, JH; Richter, KY; Kissel, JC. (1999). Field measurement of dermal soil loadings in occupational and recreational activities. Environ Res 80: 148 - 157.

4) Radionuclide and Radiation Protection Data Handbook, Second Ed. 2002

5) Generalised Habit Data for Radiological Assessments NRPB W41, 2003

6) ICRP Compendium of Dose Coefficients based on ICRP Publication 60. 2002

7) The Environmental Permitting (England and Wales) (Amendment) (No. 2) Regulations 2018

8) Scope of and Exemptions from the Radioactive Substances Legislation in England, Wales and Northern Ireland, Guidance Document, BEIS 2018

9) Public Health England, PHE-CRCE-026:Ionising Radiation Exposure of the UK Population: 2010 review

Appendices

Appendix A

Possible Radiological Accidents / Incidents their Likelihood, Radiological Severity and Control Measures During Remediation of Daedalus Site B by Eagle Eye ES

Hazards Identified	Caused By	Who is at risk?	Likelihood	Radiological Severity	Risk Level	Risk Control Measure(s)	Likelihood	Severity	Revised Risk Level with Control Measure(s)
Inhalation / ingestion of contamination resulting in contamination of persons	Working with contaminated soils Excavation and removal causing dusty conditions Careless methods of handling / excavating / removing contaminated materials Not wearing PPE / RPE	Eagle Eye ES / Remediation personnel	MEDIUM	LOW	MEDIUM	Facial Half Mask to prevent inhalation of soil particles Damping down of arisings if dusty conditions arise Regular monitoring of arisings Absolutely no eating, drinking or smoking within controlled area Wearing of disposable gloves, disposable coveralls and disposable shoe covers	LOW	LOW	LOW
		Contractor Staff	MEDIUM	LOW	MEDIUM		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
		General Public	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
Ingestion of contamination through open cuts / wounds	Having an open cut / wound when working with contaminated materials Working on contaminated materials without PPE Receiving an injury while using tools e.g. chisel	Eagle Eye ES / Remediation personnel	LOW	LOW	LOW	Disposable coverall with hood, gloves and overshoes worn Covering up any cuts / wounds prior to undertaking the work Damping down of contaminated surface Regular monitoring Minimise use of tools and careful use of tools to avoid injury	LOW	NEGLIGIBLE	LOW
		Contractor Staff	MEDIUM	LOW	MEDIUM		LOW	NEGLIGIBLE	LOW

Hazards Identified	Caused By	Who is at risk?	Likelihood	Radiological Severity	Risk Level	Risk Control Measure(s)	Likelihood	Severity	Revised Risk Level with Control Measure(s)
External radiation exposure	Working in close proximity to Ra contaminated materials (beta and gamma emissions)	Eagle Eye ES /Remediation personnel	MEDIUM	LOW	LOW	Use of dose rate meter to confirm levels. Areas to be marked and operators to minimise time spent here. Hold point if dose rate exceeds 50 µSv/h (to be finalised) which may be revised downwards once initial measurements are made	LOW	LOW	LOW
		Contractor Staff	MEDIUM	LOW	LOW		LOW	LOW	LOW
Fire resulting in spread of contamination	Poor storage of combustible materials Ignition of combustible materials Other site works	All persons including fire brigade	LOW	NEGLIGIBLE	LOW	Combustible / flammable materials not to be stored with radioactive waste Radioactive waste stored in dedicated bags and a secure industrial unit	LOW	NEGLIGIBLE	LOW
Spillage of radioactive material during movement	Moving over rough ground Poor manual handling Not using	Eagle Eye ES / Remediation personnel	MEDIUM	LOW	MEDIUM	Movement of soils and within bags to be over the shortest distance possible No packages containing waste to be moved without being securely	LOW	NEGLIGIBLE	LOW

Hazards Identified	Caused By	Who is at risk?	Likelihood	Radiological Severity	Risk Level	Risk Control Measure(s)	Likelihood	Severity	Revised Risk Level with Control Measure(s)
	suitable container Not sealing the container properly Unbalanced load Not securing a container properly for movement	Eagle Eye ES / contractor staff	MEDIUM	LOW	MEDIUM	fastened Any container used for movement to be suitable for the work Wooden boarding to be used if required to provide a smooth surface All movements to be supported by RPA approved radiation monitoring	LOW	NEGLIGIBLE	LOW
Loss of radioactive materials	Poor storage arrangements Not accounting for waste Deliberate theft	All persons	LOW	HIGH	MEDIUM	Secure storage locations for waste Accountancy procedure for waste Site security Handover to authorised carrier	LOW	HIGH	MEDIUM

Radiological Risk Assessment Criteria

The following tables provide the assessment criteria upon which the Likelihood and Radiological Severity are based.

Likelihood	Radiological Severity			
	HIGH	MEDIUM	LOW	NEGLIGIBLE
HIGH	H	H	M	L
MEDIUM	H	M	M	L
LOW	M	M	L	N
NEGLIGIBLE	L	L	N	N

LIKELIHOOD	FREQUENCY
HIGH	≤1 year
MEDIUM	1 - ≤ 5 years
LOW	5 - ≤ 30 years
NEGLIGIBLE	> 30 years

RADIOLOGICAL SEVERITY	MAX. INDIVIDUAL EFFECTIVE DOSE
HIGH	≥ 6 mSv
MEDIUM	1 - ≤ 6 mSv
LOW	0.02 - ≤ 1 mSv
NEGLIGIBLE	< 0.02 mSv

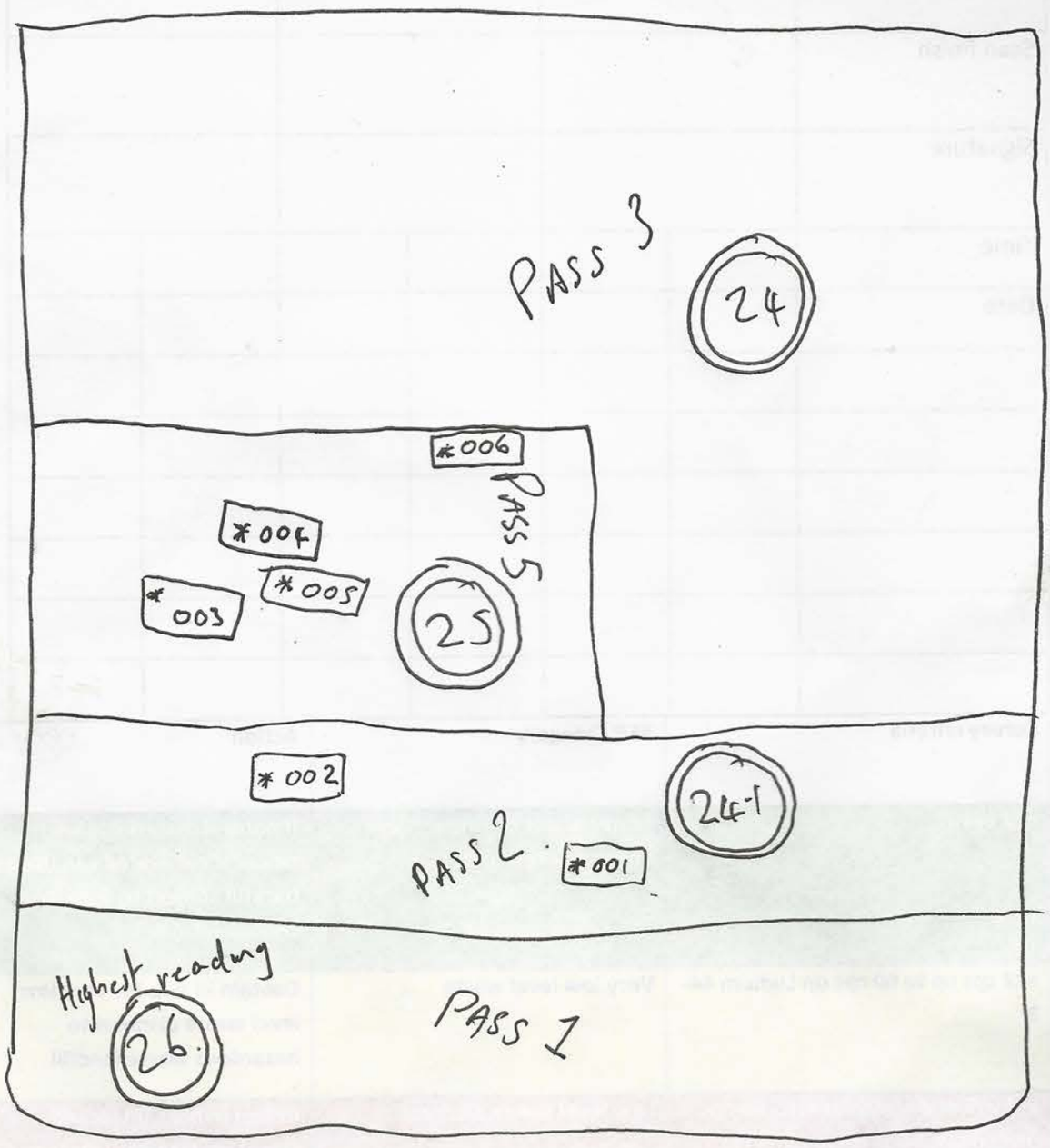
APPENDIX C
Site Logs

Eagle Eye	JL		JO		HO	
Scan Start	0·08		0·08		0·08	
Scan finish	0·10		0·08		008	
Signature	JWS		JWS		JWS	
Time Start	10	07	10	00	10	07
Date Start	08	12	08	12	08	12
T Finish	14	08	14	05	14	10
D Finish	08	12	08	12	08	12
			/	/	/	/

Survey criteria	RSR Category	Action
<22 cps	Material not distinguishable above background	If natural material leave in-situ or if excavated can use as backfill subject to asbestos considerations
>22 cps up to 60 cps on Ludlum 44-2	Very low level waste	Contain in skip for very low level waste disposal to hazardous waste landfill
Individual discrete items > 60 cps on Ludlum 44-2, survey at 5 cm using Tracerco T402 and user conversion of 0.1 µSv/h per kBq to log all items	Low level waste disposal	Retain in bags (in locked store) for transfer into drum/s and permitted transfer to Eckert & Ziegler

Number	Wt (kg)	Ludlum CPS	Tracerco	Picture	Sign RPS
001	51.515g	189	1.00	001	
002	16.895g	719	2.50	002	
003	285.0g	11.3K	73.53	003	
004	155.475g	2.4K	22.31	004	
005	21.930g	1.9K	11.5	005	
006	383.465g	89	0.14	006	

19 - 26


PASS 3
24
*006
PASS 5
*004
*005
*003
25
*002
24-1
PASS 2
*001
Highest reading
26
PASS 1

APPENDIX D
Disposal Documentation

Customer Copy

CONSIGNORS (SHIPPERS) CERTIFICATE

Eckert & Ziegler

Ref: No:	SP14909

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended)

Name and Address of Consignee	Mr Richard Dawson, Eckert & Ziegler Environmental Services Ltd, 3A Didcot Park, Didcot, Oxfordshire, OX11 7HB	

UN Number	Proper Shipping Name	Class No	Tunnel Code	Radionuclide(s)	Physical form	Chemical form	Max Activity	No and type of package(s) *	C/A mark(s)	Category *	TI	CSI
UN 2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE	7	E	Ra-226	Solid	Sulphate	443.1kBq	1 x Type A Package	N/A	I - White		N/A
										~~II - Yellow~~	N/A	N/A
										~~III - Yellow~~	N/A	N/A
UN								x		I - White		
										II - Yellow		
										III - Yellow		
UN								x		I - White		
										II - Yellow		
										III - Yellow		
UN								x		I - White		
										II - Yellow		
										III - Yellow		

for LSA-II, LSA-III, SCO-1 and SCO-II the total activity of the consignment as a multiple of A2		N/A	~~Exclusive Use Shipment*~~	* = Delete as apllicable

Supplimentry Requirements for loading, stowage etc:	None
Restrictions on the mode of carriage, vehicle or routing:	Road Only

Technical Review of Pre Collection Data	Name	Appointment	Signature	Date
Completed By	Bob Baker	Sales, Project & Compliance Manager		13/12/2018
Data reviewed by	Adrian Francis	Technician		13/12/2018

DECLARATION

I hereby declare that the contents of this consignment are fully and accurately described by the proper shipping name and are classified, packed, marked and labelled, and are in all respects in proper condition for transport by road according to the applicable international and national governmental regulations and codes.

Name and address of Consignor — Eckert & Ziegler is a member of RADSAFE. EMERGENCY CONTACT: call 0800 834 153 quoting code X1

Eckert & Ziegler Environmental Services Ltd
3A Didcot Park
Churchward
Didcot
Oxfordshire, OX11 7HB

Name: ADRIAN FRANCIS — Signature — Date: 14/12/2018

Tel No: 01235 514310 — Fax No: 01235 514358

Red (Original) Travels in Cab
Blue Copy - Customer
Yellow Copy - File

CUSTOMER COPY

Eckert & Ziegler Environmental Services Ltd Package Inventory

SP #	14909	1 of 1	**Package**	ABF-040	**Serial**	12	**DR Package Surface**	3	µSv/hr
Customer	Eagle Eye Environmental		**Package Type**	Type A	**Seal**	4561	**DR Inside Package**	10	µSv/hr
Delivery to	Eckert & Ziegler Unit 3A Didcot Park, Churchward Didcot, Oxfordshire, OX11 7HB		**Package Unloaded**	6.00 kg	**Seal 2**	N/A	**DR at 1m**	N/A	µSv/hr
			Total Contents	2.00 kg	**Seal 3**	N/A	**TI =**	N/A	
			Gross Weight	8.00 kg	**Seal 4**	N/A			

Identification Number			Nuclide	HASS (Y)	Description	State	Activity (Bq)		Vol (cm^3)	Item(s) Packed (LT Initial)	Notes	No of Same Items
SP	Item	Customer ID					Declared	Transport Purposes				
SP14909	1	001	Ra-226	N	Contaminated Soil / Debris	S	4.000E+03	4.000E+03		AC		1
SP14909	2	002	Ra-226	N	Contaminated Soil / Debris	S	1.000E+04	1.000E+04				1
SP14909	3	003	Ra-226	N	Radium Dial	S	2.941E+05	2.941E+05				1
SP14909	4	004	Ra-226	N	Contaminated Soil / Debris	S	8.924E+04	8.924E+04				1
SP14909	5	005	Ra-226	N	Contaminated Soil / Debris	S	4.520E+04	4.520E+04				1
SP14909	6	006	Ra-226	N	Contaminated Soil / Debris	S	5.600E+02	5.600E+02				1

Total Number of Items (this page):	6	Activity (for page)	4.431E+05	Bq
Total Number of Items (all pages):	6	Activity (all pages)	4.431E+05	Bq
All Gauge Shutters Locked Shut	N/A	Specific Pack. Handling Issues		

Package Loaded & Sealed By:	**EZE Name**	**Adrian Francis**	**Signed:**	**Date:**	**14 December 2018**
Contents Confirmed By:	**Source Holder Name**		**Signed:**	**Date:**	

CUSTOMER COPY