Olympics Enabling Works

Construction Zone 3a
Change Notice Report Discovery of Radioactive Substances

May 2010

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Plan Design Enable

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1. INTRODUCTION

General

1.1 This Remediation Change Note Report presents a summary of the issues and consequences of the finding of Very Low-Level and some Low Level Radioactive waste at Construction Zone 3a; and how it is intended that the remediation process will be amended to take into account the unexpected contamination. The contamination is in the form of contaminated wastes (see Section 1.3), discovered in discreet patches across Construction Zone 3a, including broken pipes within Area A, (see Appendix A for a location plan). No isolated hot-spots were discovered within Construction Zone 3a, but some radioactive artefacts were found and are recorded in the CZ6a Change Notice (Ref 7).

1.2 The finding of this contamination represented unexpected contamination pursuant to planning condition SP 0.36 of the Olympic, Paralympic and Legacy Transformation Site Preparation Planning Permission (0790011FUMODA) (the "SP Permission") and as such triggered the need for a reappraisal of the remediation methods and the submission of a Remediation Change Note (pursuant to section 1.13 of the Remediation Discharge Protocol at Annex 5 of the SP Permission). The purpose of this report is to provide a record of the actions taken and the assessment of the potential impact that the event has on the Site Specific Remediation Strategy (SSRS) for Construction Zone 3a within the Olympic site.

Classification

1.3 Radioactive waste is classified as High Level Waste (HLW), Intermediate Level Waste (ILW), and Low Level Waste (LLW). All radioactive wastes discovered on the Olympic site have been in the LLW category. There is a sub-set of LLW, known as Very Low Level Waste (VLLW). The vast majority of the radioactive wastes found on the Olympic site have been in this category, the definition being wastes with no more than 4Bq/g of any radionuclide at unit density ("Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom" :March 2007 – section 5).

1.4 There is a further and non-related classification of radioactive waste, which is radioelement dependent, and also depends to some extent on the history of the radioactive material. Below certain thresholds, which are approximately 5Bq/g for the kind of radioactive wastes found on the Olympic site, the low level/very low level wastes are deemed to be 'exempt' under the provisions of the Radioactive Substances Act 1993 ("RSA 93"). The relevant Exemption Order is the Phosphatic Substances and Rare Earths Exemption Order 1962, (the "1962 Exemption Order") made under the RSA 93 and which is still in force[1]. Wastes exempt from the RSA (either due to the fact that they fall below the thresholds set out in Schedule 1 to the RSA 93 or due to the application of the 1962 Exemption Order) are below regulatory concern, because the risks posed

[1] It should be noted that the majority of provisions on radioactive substances contained in the RSA 93 have been superseded by Schedule 23 the Environmental Permitting Regulations 2010 ("EPR 2010"). The EPR 2010 came into force in England and Wales on 6 April 2010. Overall, there will be no substantial changes in the Government's regulatory policy for radioactive substances or in the Environment Agency's regulatory practice. Although the Department of Energy and Climate Change is currently carrying out a review of the exemption orders, the exemption orders (including the 1962 Exemption Order) made under the RSA 93 currently remain in force under EPR 2010. Existing registrations and authorisations granted under the RSA 93 will have automatically become environmental permits under Regulation 69 in Part 7 of the EPR 2010. All references to the RSA 93 in this Remediation Change Note should therefore be read as references to the relevant provisions of the EPR 2010.

are deemed to be trivial. The vast majority of the low level/very low level radioactive wastes found at the Olympic site fall within this exempt category.

Description of Events

1.5 Very Low-Level (VLLW) and some Low-Level (LLW) Radioactive waste was detected in spoil excavated from Construction Zone 3a, following reassurance monitoring provided by NUKEM Ltd., the Radiation Protection Advisor (RPA) in February 2008. The majority of this waste was found, on detailed assay, to be below the thresholds for authorisation set out in Schedule 1 of the RSA93 (now Schedule 23 of the EPR 2010) or under the 1962 Exemption Order made pursuant to the RSA93; that is, the waste was 'exempt' from the RSA and no authorisation for its accumulation or disposal was required from the Environment Agency (the "EA"). However, a small quantity – some few % of the total finds - was not in this exempt category and was therefore regulated pursuant to the RSA93. Further surveys of the main stadium handover area, by NUKEM Health Physics surveyors, confirmed the presence of radioactive waste in a number of areas as shown on the attached plan in Appendix A.

1.6 The main area of contamination was identified as Area A. This comprised mixed nuclides of natural uranium, protactinium [^{231}Pa] (part of the 235 U decay chain), thorium [^{232}Th] and radium [^{226}Ra], which are naturally occurring radioactive materials (NORM). These radioactive wastes were used in chemical and industrial processes, but without, so far as is known, any processing intended to alter their radioactivity.

1.7 The main excavation area for the stadium bowl was surveyed and discrete areas marked as areas D, F, G, H and I on the plan in Appendix A, were identified. All areas contained 231Pa, 226Ra and 232Th. A stockpile (Area B) was known from delivery tickets to have been the destination of waste from these discrete areas and this was found to have some elevated radioactivity readings above background levels.

1.8 Discrete radioactive materials were also found in Area C in 22 Marshgate Lane (CZ3a). This area is outside the stadium handover area and has also been fenced and quarantined. This is also a NORM source area [232Th], where the radioactive contamination is around buried concrete foundations.

1.9 All the radioactive waste in the above mentioned discrete areas were found to be above the sub-formation level (within the area of excavation).

1.10 Analytical results and supporting Radiological Protection Advisor (RPA) advice are to the effect that the principal radionuclides present are 232Th, 238U, 226Ra and 231Pa (the latter from the 235U decay chain). The maximum concentrations measured in samples at the time of assessment by the RPA were:

- 40Bq/g for $_{226}$Ra;
- 15 Bq/g for $_{232}$Th;
- 16 Bq/g for ^{231} Pa;
- 72 Bq/g for $_{238}$U.

1.11 The findings of the RPA are presented in Appendix B as the Radiation Protection Advice Note and the Radiological Risk Assessment Report. It should be noted that these documents are produced by NUKEM, subsequently the company was renamed and became NUVIA.

1.12 The unexpected radioactive waste found was predominantly contaminated soils containing distributed radioactivity, rather than artefacts. Some broken clay pipes were found in Area A. This would be consistent with the source being a deposit of wastes from the use or refining of materials with radioactive waste as an unwanted by-product.

2. PROPOSED CHANGES TO REMEDIATION METHODOLOGY

2.1 Following the finds of unexpected radiological contamination arising from material excavated in this CZ3a the Contractor prepared an Addenda to the Remediation Method Statement to cover radiological occurrences (Ref.: MST-ENL-CE-03a-OLP-SP1-E-0106) in the Main Stadium Area, which was approved by the PDT on 26 June 2008 (PDT ref. 08/90127/AODODA) (the "Addendum"). The purpose of the Addendum is to describe the process by which remediation of ground contamination resulting from the unforeseen radioactive materials and its verification at Construction Zone 3a will be undertaken, including the route the material will take from CZ3a to CZ6a to CZ4, taking into account existing information of ground conditions gained from site investigations, risk assessment and monitoring, and to be consistent with the relevant planning approvals and related discussions.

2.2 In the instances in CZ3a where radioactively contaminated materials were not directly transported to CZ6, the radioactive materials were temporarily stockpiled (Stockpile reference CZ5a/S03) in CZ5a prior to onward transportation to CZ6 for assaying by Nuvia. These radioactively contaminated materials were subsequently determined for either relocation in CZ4 or for off-site disposal. Following the removal of the stockpiled arisings from CZ5a, NUVIA conducted a clearance survey of the temporary stockpile area which recorded concentrations below the action limit[2]. Further details are provided in Appendix A Drawing Reference 2DD-ENL-CK-ZZZ-OLP-SP1-E-0280.

2.3 This report also confirms that the final location for the deposits as being beneath the approach embankment to the L03B bridge abutment in CZ4 on the Olympic site.

3. REGULATORY OVERVIEW

3.1 With regard to the control of radioactive substances, the Environment Agency is the regulatory body responsible. The PDT is responsible for planning decisions relating to the Olympic Park and whether the planning conditions within the SP permission can be discharged based on the compliance with such conditions. Discussions were held with the Environment Agency following the identification of excavated waste suspected of containing elevated concentrations of radioactivity regarding the process for dealing with radiological waste on the Olympic site, which comprised:

1. Obtaining an Authorisation as required under the RSA93[3] for Accumulation of non-exempt waste, by Morrison Construction who are formally responsible for the accumulation, storage and movement of radiological waste arising on the Olympic Park. This authorisation (varied and re-issued in January 2010) is presented in Appendix C; and
2. The methodology for segregation / sorting and co-processing of all radiological waste identified (with the exception of discrete artefacts) has been agreed with the Environment Agency.

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[2] The 'Action Limit' was an internal limit, established by Nuvia, for screening. The limit was based on conservative assumptions such that all 'cleared' material could definitely be confirmed as being below the relevant thresholds set out in the RSA 93/1962 Exemption Order without the need for further detailed assay.
[3] Note: the authorisation will have automatically become an Environmental Permit under the Environmental Permitting Regulations 2010.

3.2 In addition to discussions and agreements with the Environment Agency, agreements were provided by the pertinent stakeholders namely ODA Planning Decision Team, London Borough of Tower Hamlets and the London Development Agency regarding the retention of waste on the Olympic site and its placement in the discrete deposition area beneath the approach embankment to Bridge L03B in CZ4.

4. RISK REVIEW

4.1 Relevant worker safety risk assessments and method statements were prepared in advance of the proposed works and submitted to the relevant parties and the Health & Safety Executive in order to demonstrate that any workers exposed to ionising radiation during excavation works were protected, and that the consequences of the works did not lead to any adverse radiological consequencs for members of the public or visitors to the site. The implementation of these documents and the monitoring information available to date lead to the conclusion that neither site workers nor the general public have been unnecessarily exposed to ionising radiation as a consequence of the activities on the Olympic site.

4.2 A further risk assessment (radiological risk assessments, sometimes known as a radiological impact assessment) was carried out to determine the longer-term impacts of the proposed reburial. This assessment has shown that the calculated doses received as a result of the deposition are several orders of magnitude below any appropriate limits, these being 300 microsieverts per year for a member of the public and 1millisivert per year for a worker and the ALARP principle (As Low As Reasonably Practicable) has been implemented.

4.3 Further details of these assessments are provided in the NUKEM risk assessments document ref. 87230/PRA/001 'Groundwork operations in CZ3 at the Olympic Park Site, Radiological Risk Assessment' which covers the transport and deposition of this waste as attached at Appendix B and document ref. 87216/PRA/007 Issue 2 'Transfer and Deposition of Exempt and LLW into Approach Ramp to Bridge L03' in the Morrison Construction Report as attached at Appendix D.

5. MONITORING

5.1 The excavated and stockpiled waste was monitored during the works by the Health Physics Surveyor using a Groundhog™ (hand-held sodium iodide detector). The Health Physics Surveyors also supervised the transfer and disposal of waste, and the sampling of waste. The samples were taken for high resolution gamma spectrometry to classify spoil and to verify the clearance of the site.

5.2 Air monitors were established at selected locations around the works, both high volume for radiation and low volume pumped tubes for chemical contamination. No airborne contamination has been detected by the Health Physics Surveyors.

6. WASTE AND OPERATIONAL ISSUES

WASTE

6.1 The waste implications of the radiochemically contaminated waste found at Construction Zone 3a are as follows:-

- The majority of the contaminated wastes, although they may be defined as radioactive under the RSA93 (Ref 3) (now Schedule 23 of the EPR 2010), are exempt from the authorisation requirements according to the 1962 Exemption Order. As such, they will be deposited on the Olympic site beneath the L03B bridge embankment in Construction Zone 4, with the appropriate measures to ensure it does not pose a risk to the public. Calculations and modelling have been carried out to demonstrate that the long-term radioactive dose to members of the public will be within statutory limits. Removal and reburial of the radioactive waste constitutes a 'practice' as defined in legislation (*Radioactive Substances Basic Safety Standards (England & Wales) Direction 2000*[4]*, based on the requirements of the Euratom Basic Safety Standards Directive 1996)* for which the appropriate dose limit for members of the public now and in the future is no more than 300 microsieverts per year[5]. The Nuvia assessments have demonstrated that, using pessimistic assumptions of future uses of the site and human habits, the dose will be 2 orders of magnitude below this – a matter of a maximum of a few microsieverts (Appendix B).

- Co-processing of all spoil wastes(with the exception of discreet items and artefacts (which were classified as Low Level Waste and subject to the RSA93 Authorisation for the Olympic Site and will be removed from the Olympic Park site to the repository near Drigg within the timeframe noted in the RSA93). This implemented "co-processing" approach has had the effect that all of the bulk radiochemical waste is now in the 'exempt' from RSA93 regulation category as the bulk concentration values are below the thresholds for exemption as reported in Appendix B.
- With the agreement of the Environment Agency, the total volume of material placed in the deposition area CZ4 after co-processing was a total of 4146m3 of 'exempt' material such that, overall all the spoil was below the exemption thresholds as set out in the 1962 Exemption Order. All of the exempt material originated within the Olympic park, and from generally the same locations. Thus all the contaminated waste buried beneath the L03B bridge abutment in CZ4 on the Olympic site is "exempt waste", not requiring an authorisation under RSA93. The waste is both excluded from the Act by virtue of the concentration limits in Schedule 1 to the Act, and unconditionally exempted by reference to the concentration limits set out in the 1962 Exemption Order, which are higher. It has not been necessary to send any radiochemical contaminated soils off-site for disposal from this zone, but there will be a requirement to dispose of the artefacts towards the end of 2010 due to the expiry of the RSA93 Authorisation and completion of the Enabling Works earthworks. The EA acceptance to the co-processing methodology was taken due to the pressure on the Low Level Radioactive Waste Depository at Drigg in West Cumbria. The capacity of this national resource is limited, and the EA have a remit to ensure that only waste which really needs to go there actually does so.
- Removal and reburial of the radioactive waste constitutes a 'practice' as defined in legislation (Statutory Guidance to the Environment Agency, implementing aspects of the Euratom Basic Safety Standards Directive 1996), for which the appropriate dose limit for members of the public now and in the future is no more than 300 microsieverts per year, (see first bullet point above). The Nuvia assessments have demonstrated that, using pessimistic assumptions of future uses of the site and human habits, the dose will be 2 orders of magnitude below this – a matter of a maximum of a few microsieverts.
- As part of the validation process a review was made of the possible risks of radionuclides getting into the groundwater system, and in particular the River Terrace Deposits. This concluded that amongst other things that any radionuclide in the groundwater would be below the levels of detection, and would take at least 60 years to travel 10 metres. The full

[4] Due to the implementation of the EPR 2010, the 2000 Direction is no longer available. The relevant provisions of the Basic Safety Standards Directive (96/20/Euratom) are set out in Schedule 23 to the EPR 2010. The effect is the same as set out in the first bullet point of section 6.1 above.
[5] See also section 7 below.

assessment is presented in Appendix E and shows that there will be no impact to controlled waters.

- A small quantity of radiochemical contaminated waste is destined for off-site disposal at the Low Level Waste Repository (LLWR) near Drigg in West Cumbria. These artefacts were identified following the assaying completed by NUVIA.

6.2 There remains the potential for discrete areas of radioactive contamination at depth, outside the known areas for excavation proposed and completed during Enabling Works (for foundation piling or service trenches etc). Following an assessment of the impact (carried out by both monitoring and modelling), this discrete radioactive contamination has been left in-situ. The assessments show that possible future doses resulting from this waste are trivial. Background radiation in this area is of the order of 2000 microsieverts per year. The radiation dose from the material left in situ is no more than 1 microsievert per year and a small fraction of those arising from natural background radiation in CZ3a.

6.3 Average concentrations for bulk material reburied are:

- 3.84 Bq/g for ^{226}Ra;
- 4.64 Bq/g for ^{232}Th; and
- 3.87 Bq/g for ^{238}U.

6.4 Both Schedule 1 to the RSA93 and the 1962 Exemption Order are couched in terms of radioelements, not radioisotopes. Using conservative assumptions, the appropriate limits to apply are approximately 5 – 7.5Bq/g for the above radioisotopes.

Authorisation

6.5 The appropriate correspondence dealing with the authorisation of the activities under the RSA93, and in relation to the co-processing of the exempt waste and the Low Level waste is contained within Appendix C. As agreed with the Environment Agency, as part of the discussions in relation to co-processing, the material(taking all the radiological results and treating all the material as a single whole entity), is within the exemption thresholds from regulation under RSA93 after co-processing a small quantity of waste which was initially above the thresholds set out in the 1962Exemption Order. The details of the testing are contained in the relevant validation reports (see section 6.7 below)..

Operational Issues

6.6 Radioactive waste has been removed from areas within Construction Zone 3a where:-

1. Excavations took place, and the waste was due to be moved.
2. Radioactive Contamination was found at or close to the surface.

Validation

6.7 Details of the validation process for the CZ3A zone will be contained in the Human Health and Unsaturated Zone Validation Reports for CZ3a. While details of validation of the waste deposited beneath the L03B bridge abutment is contained in the CZ4 Human Health Validation Report (REP-ENL-CK-04Z-OLP-SP1-E-0278 Rev03).

7. OLYMPIC AND LEGACY USES

7.1 As detailed in the Site Specific Remediation Strategy for CZ3a (Ref. 6), the remediation work has been substantially implemented to prepare the site for Olympic and Legacy end use. In radiological protection terms, the changes the site is going through (from the current site use to the Olympic and, later, the Legacy use) are defined as a 'practice' as defined by the International Commission on Radiation Protection (ICRP); this definition has subsequently been adopted into European and UK legislation.

7.2 For any 'practice', the three principles of radiological protection must be applied. These are:

- **Justification:** There must be an overall benefit in carrying out the practice.
- **Limitation:** Radiation dose to any individual must be within acceptable limits. For the case in question, the appropriate legal limit is 300μSv, as defined in legislation (*Radioactive Substances Basic Safety Standards (England & Wales) Direction 2000, based on the requirements of the Euratom Basic Safety Standards Directive 1996)* to the most exposed individual. Doses should be estimated based on scenarios relating to the future use of the land.
- **Optimisation:** Notwithstanding the fact that dose limits will not be breached, doses post-change must be As Low As Reasonably Practicable (ALARP), economic and social factors being taken into account.

7.3 Restoration of contaminated ground is a justified practice – the Justification principle need not be covered here.

7.4 For the contamination in question it is likely that, based on current site knowledge gained from desk studies, site investigation and further works resulting in the majority of the excavated NORM waste having been removed from the Olympic site for disposal elsewhere, the remaining radiochemically contaminated materials can remain in-situ, with the site still complying with the Limitation and Optimisation principles. This will also apply to in-situ, undisturbed radiochemically contaminated materials present below the subgrade. Limitation and Optimisation principles will be complied with, as evidenced by this report and detailed in Appendix B.

7.5 **External dose.** The dose rate will be measured at the locations where members of the public or site workers are likely to have access for any length of time. An occupancy factor can be used to calculate dose. However, due to the nature of the radiochemical contamination identified to date, it is highly unlikely that any dose above area background will be detected, even with minimal ground cover above the buried contamination. Results of the gamma survey will be recorded as part of the demonstration that external dose limits have not been breached. There is no question of exceeding any external dose limits – this is barely conceivable. At about 300mm of soil cover, no external radiation above background will be detected at the surface as a consequence of the sub-surface material. This surface gamma survey was intended simply as re-assurance and for the record. This information will be provided in the validation report for CZ4, but note that placement of thickness of clean soil over the radioactive material found on the Olympics site, will attenuate the emissions back to background level, and the deposition area in CZ4 is due to have more than 2 metres of capping.

7.6 **Internal dose.** The possible pathways are:

- Inhalation of airborne dusts.
- Ingestion of contaminated spoils.
- Leaching to groundwater, followed by a drinking water pathway.
- Uptake in root vegetables, followed by ingestion of foodstuffs.

7.7 The first pathway (inhalation of airborne dusts) is to be mitigated by a ‘clean’ capping layer. The second pathway (ingestion) is also mitigated by the cap. The third pathway (leaching to groundwater) is mitigated by the nature of the radiochemical contamination identified to date (low mobility substances, low concentrations) and the results provided by past and ongoing groundwater monitoring (no significant radiochemical contamination above local background levels detected). The fourth pathway will be mitigated by restrictions on the Legacy land use, although bearing in mind the depth of ground cover currently proposed, this will probably not be necessary.[6] In any case where a Planning Application is made dealing with a change of use, or change in the condition of the site, an appropriate assessment should be made of the potential impact and mitigation works in relation to the possible presence of radiological material.

7.8 The Site Specific Remediation Strategy (SSRS) provides general recommendations to assist management of the earthworks program. One of them is carrying out post-formation validation testing, following the redeposit of soil waste. According to this recommendation, the programme for this has to be agreed with the relevant authorities, but will be linked to the sensitivity of the end use, controlled waters and level of existing contaminant data. This is covered in the Remediation Method Statement (ref. MST-ENL-CE-03a-OLP-SP1-E-0106) which was approved by the PDT, see section 2.1.

7.9 As mentioned above, for the particular case of radiochemical contamination of soils, a demonstration that the principles of radiological protection have been met will be achieved by simple modelling. For the modelling aspect, a simple dose model is appropriate, supported by some realistic assumptions. The Radioactive Contaminated Land Exposure Assessment (RCLEA) model is the tool to be employed. In order to assemble the argument and carry out the modelling, information has been assembled during the course of the restoration work at the Olympic site. This model was developd by the Healthy Protection Agency on behalf of the Government, and is the industry standard for such assessments.

8. Arrangements for Deposit of the Radioactive Waste on Site

8.1 All the radioactive material excavated in Construction Zone 3a and retained on the Olympic Park has been deposited at Construction Zone 4. This is a purpose made defined area for deposit (in short called the deposit area), within an approach embankment to bridge L03. A drawing (Reference ENW-ATK-4-SP1-DR-C-3-H11-0011, “Enabling Works, Zone 4, Possible Location of Deposit Area for Very Low Radioactive Waste") shows the details and is enclosed in Appendix F. It should be noted that exempt radioactive wastes arising from CZ6A/D within the Olympic Park have been placed within the same repository on the basis that such wastes complied with the same depositional requirements, including the NUKEM risk assessments document ref. 87230/PRA/001 ’Groundwork operations in CSZ3 at the Olympic Park Site, Radiological Risk Assessment’ which covers the transport and deposition of this waste is contained in Appendix B and document ref. 87216/PRA/007 Issue 2 ‘Transfer and Deposition of Exempt and LLW into Approach Ramp to Bridge L03’ in the Morrison Construction Report in Appendix D.

[6] Root vegetables will not have roots extending below the ground-cover depth. Use of the legacy site for a change in use, including allotments will be subject to a further application. At which point the site will be assessed again and additional cover may be required.

8.2 From the geometry of the deposit area in CZ4, minimum depth of cover is approximately 2.3 metres, rising in some areas to approximately 6.5 metres.

8.3 The waste material has now been deposited and the deposit area was completed in November 2008. Discussions were held with all parties, including the EA, local borough environmental health officers and the ODA Planning Decision Team on these operations. These parties were aware that the exempt radiological material was to be deposited beneath the approach embankment to the L03B bridge abutment in CZ4 on the Olympic site and were kept informed of the works at the monthly remediation forum held at the PDTs offices. As part of the validation process a review was made of the possible risks of radionuclide's getting into the groundwater system, and in particular the River Terrace Deposits. This concluded that amongst other things that any radionuclide in the groundwater would be below the levels of detection, and would take at least 60 years to travel 10 metres. The full assessment is presented in Appendix E.

9. CONCLUSIONS AND RECOMMENDATIONS

During construction

9.1 All working procedures and practices at the site have been designed so as to demonstrate the application of the As Low as Reasonably Practicable (ALARP) principle.

9.2 The Health Physics Surveyor has monitored excavated materials for radioactivity and put in place procedures to deal with any detected activity.

Waste

9.3 All the radioactive material excavated in Construction Zone 3a has been deposited beneath the LO3B bridge abutment at Construction Zone 4. A drawing (Reference ENW-ATK-4-SP1-DR-C-3-H11-0011, "Enabling Works, Zone 4, Possible Location of Deposit Area for Very Low Radioactive Waste") shows the details and is enclosed in Appendix F. It should be noted that radioactive wastes arising from CZ6a/6d within the Olympic Park have also be placed within the same deposit area on the basis that the wastes complied with the same depositional requirements, including the risk assessment (Appendix B).

9.4 Radiochemically contaminated materials can remain on site, as long as there is sufficient cover and the ground conditions are such as to guarantee that:-

- the dose for the general public will be below 300 µSv per year and, furthermore, the ALARP principle is applied,
- the release of α–emitting radionuclides to the atmosphere (as dust particles) is restricted to acceptable levels, and
- The transfer of α–emitting radionuclides to groundwaters is also restricted to acceptable levels.

9.5 The Waste Regulator (the Environment Agency) was kept informed of the associated activities related to this find. In addition the appropriate Certificate of Authorisation under the RSA93 was obtained and extended as appropriate. The Certificate and relevant correspondence are presented in Appendix C.

Olympic and Legacy Uses

9.6 In order to address the issues related to the as-built condition of the Construction Zone 3a site and its immediate (Olympic) and long-term (Legacy) use, a demonstration (via post-formation testing of the areas identified) of its 'radiologically safe' condition should be carried out when the construction work is finished as part of its validation. This demonstration should be by way of measurement (for the external component of the dose) and simple modelling (for the internal component of the dose)[7].

9.7 The external dose can be measured by gamma dose-rate equipment already available on site. The key information requirements for the internal dose modelling are:-

- As-built site plans showing depth of cover, areas of public and worker access, concreted areas etc; and
- Areas of contamination, radiochemical concentrations and radionuclide types. This information has been collected as site remediation and restoration proceeded.

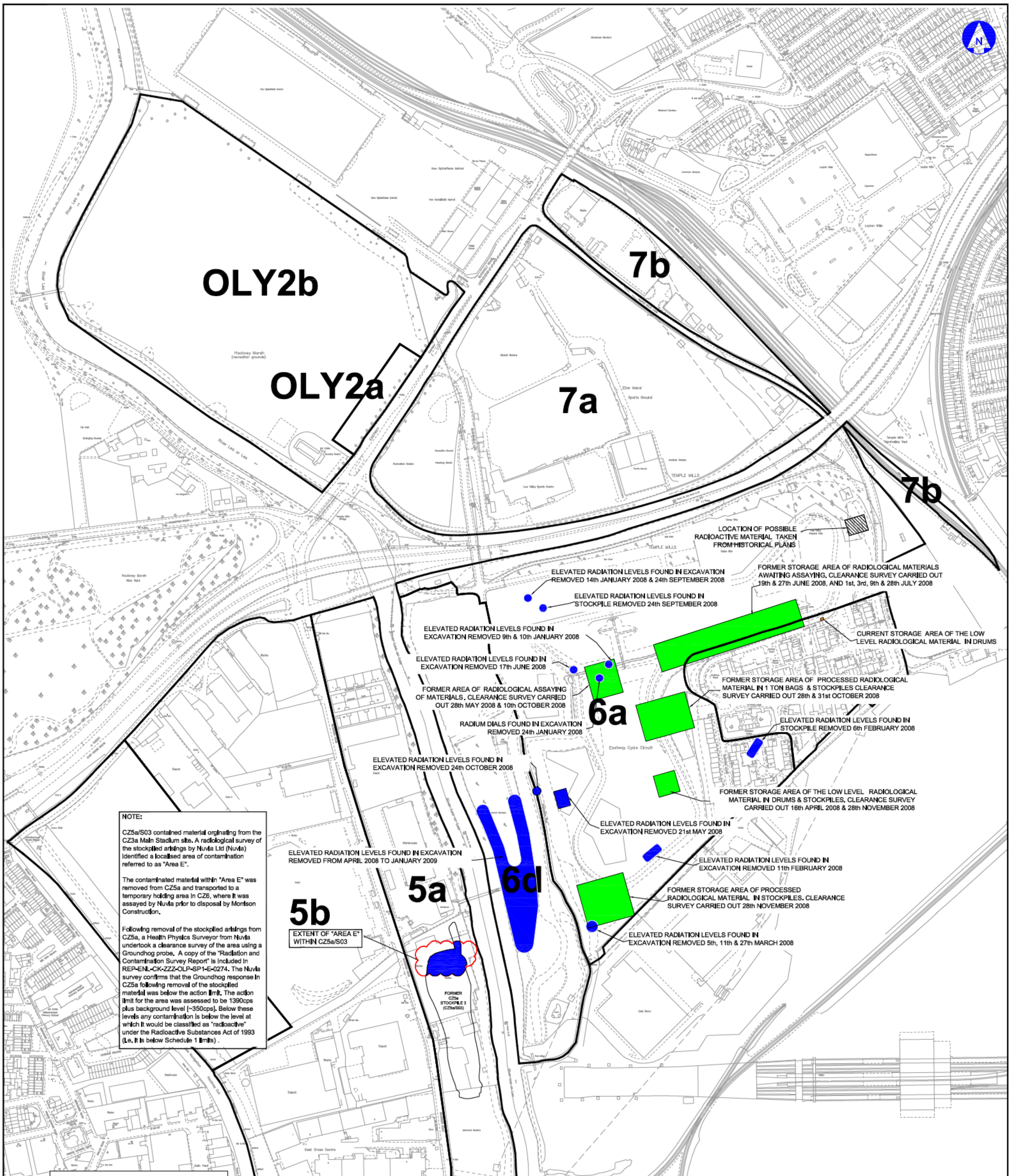
9.8 The results of the post-formation validation testing are included in the various validation reports. Drawing number 2DD-ENL-CK-ZZZ-OLP-SP1-E-O280, Rev01, "Olympic Park-Location of Radioactive Material Encountered (Sheet 2: South Park)" also identified the locations of "finds". This is included in Appendix A. The proposed 'clean' cover, show that the measures are likely to be appropriate to meet the requirements for External and Internal dose. This means that the current basis of the SSRS remains unchanged.

10. REFERENCES

1. Department for Environment, Food and Rural Affairs. 'Industry Profile. Industrial Activities Which Have Used Materials Containing Radioactivity'. March 2006.
2. The Ionising Radiations Regulations 1999. Statutory Instrument 1999 No. 3232.
3. Radioactive Substances Act 1993. HMSO 1993
4. Town and Council Planning Acts (various).
5. The Radioactive Substances (Phosphatic Substances and Rare Earths, etc) Exemption Order 1962. Statutory Instrument 1962 No. 2648.
6. Atkins. 'Site Specific Remediation Strategy – Construction Zone 3a – Main Site'. Final Rev01. October 2007. ODA Ref. REP-ATK-CH-03a-OLP-XXX-E-0002.
7. Atkins. 'Change Notice Report Discovery of Radioactive Substances – Construction Zone 6a. December 2009. ODA Ref. REP-ATK-CM-06a-OLP-SP 1-E-0003

[7] This work need not necessarily need to wait until the works are complete. Sufficient information may become available well before this time, at which the issue could be screened out of further consideration.

Appendix A Drawing 2DD-ENL-CK-ZZZ-OLP-SP1-E-0280 Rev01, Olympic Park Location of Radioactive Material Encountered (Sheet 1 and 2: North and South Park)



NOTE:

CZ5a/S03 contained material orginating from the CZ3a Main Stadium site. A radiological survey of the stockpiled arisings by Nuvia Ltd (Nuvia) identified a localised area of contamination referred to as "Area E".

The contaminated material within "Area E" was removed from CZ5a and transported to a temporary holding area in CZ6, where it was assayed by Nuvia prior to disposal by Morrison Construction.

Following removal of the stockpiled arisings from CZ5a, a Health Physics Surveyor from Nuvia undertook a clearance survey of the area using a Groundhog probe. A copy of the "Radiation and Contamination Survey Report" is included in REP-ENL-CK-ZZZ-OLP-SP1-E-0274. The Nuvia survey confirms that the Groundhog response in CZ5a following removal of the stockpiled material was below the action limit. The action limit for the area was assessed to be 1390cps plus background level [~350cps]. Below these levels any contamination is below the level at which it would be classified as "radioactive" under the Radioactive Substances Act of 1993 (i.e. it is below Schedule 1 limits) .

NOTE:
All information on this drawing has been reproduced from the original drawings 2DD-ENL-CK-ZZZ-OLP-SP1-E-0261 & 2DD-MOR-CK-06Z-ZZZ-XXX-E-0051. Reference should be made to the latest revision of these drawings.

DO NOT SCALE THIS DRAWING.

NOTES

- Construction Zone Boundary
- Current Storage & Processing Area
- Former Temporary Storage & Processing Area
- Area Where Elevated Levels of Radioactivity Encountered and Removed
- Possible Location of Radioactive Material from Historic Plans.

Rev	Description	Dm	Chk	Date
01	Amended Scale	DC	PG	18/01/10
00	First Issue	DC	AE	13/11/09

Client: OLYMPIC DELIVERY AUTHORITY
23rd Floor, 1 Churchill Place, Canary Wharf, E14 5LN

Organisation: Morrison Construction; bam nuttall

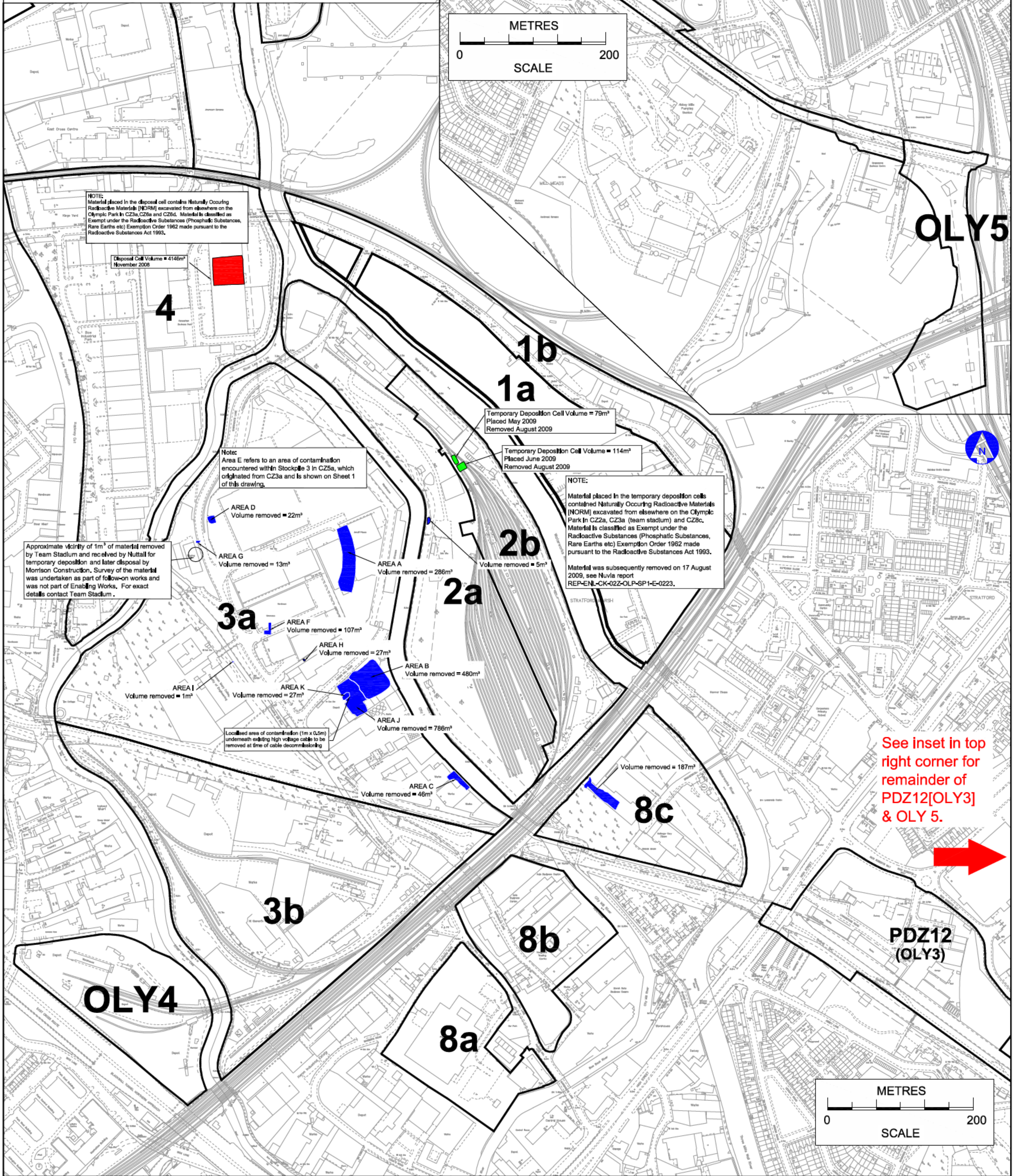
Project Title: OLYMPIC PARK REMEDIATION

Drawing Title: OLYMPIC PARK - LOCATION OF RADIOACTIVE MATERIAL ENCOUNTERED (Sheet 1: North Park)

Drawn: David Crowley	Scale(A3): 1:5000
Checked: Arron Evans	Date: 13/11/09
Approved: Arron Evans	Status: As Built
Work Instruction No: WI/ZZZ/033	
Drg. No.: 2DD-ENL-CK-ZZZ-OLP-SP1-E-0280	Rev.: 01

CAD FILE REF:- M:\1a Engineering Department\David Crowley\Paul Greenhalf\Sitewide drawings\Paul Rad Areas\New Rad Drawings\2DD-ENL-CK-ZZZ-OLP-SP1-2DD-ENL-CK-ZZZ-OLP-SP1-E-0280.dwg

NOTE:
All information on this drawing has been reproduced from the original drawing 2DD-ENL-CK-ZZZ-OLP-SP1-E-0260 . Reference should be made to the latest revision of this drawing.



CAD FILE REF:- M:\1a Engineering Department\David Crowley\Paul Greenhalf\Sitewide drawings\Paul Rad Areas\New Rad Drawings\2DD-ENL-CK-ZZZ-OLP-SP1-2DD-ENL-CK-ZZZ-OLP-SP1-E-0280.dwg

Rev	Description	Dm	Chk	Date
01	Amended Scale	DC	PG	18/01/10
00	First Issue	DC	PG	13/11/09

DO NOT SCALE THIS DRAWING.

NOTES

- Construction Zone Boundary
- Disposal Cell
- Temporary Deposition - Subsequently Disposed Off-site
- Area Where Elevated Levels of Radioactivity Encountered and Removed

Client: OLYMPIC DELIVERY AUTHORITY, 23rd Floor, 1 Churchill Place, Canary Wharf, E14 5LN

Organisation: Morrison Construction, bam nuttall

Project Title: OLYMPIC PARK REMEDIATION

Drawing Title: OLYMPIC PARK - LOCATION OF RADIOACTIVE MATERIAL ENCOUNTERED (Sheet 2: South Park)

Drawn	David Crowley	Scale(A3)	1:5000
Checked	Paul Greenhalf	Date	13/11/09
Approved	Paul Greenhalf	Status	As Built
Work Instruction No:	WI/ZZZ/033		
Drg. No.	2DD-ENL-CK-ZZZ-OLP-SP1-E-0280	Rev.	01

Appendix B NUKEM; Radiological Risk Assessment Report and Radiation Protection Advice Note

RADIATION PROTECTION ADVICE NOTE

Customer:	Nuttall Limited	Issue:	2
Topic:	**Radiological Survey of Site Construction Zone 3A**		
Date:	29th February 2008	Our reference:	87226AN001
Author:	[redacted]	Signature:	[redacted]
Reviewer:	[redacted]	Signature:	[redacted]
Received:	[redacted]	Signature:	

1 INTRODUCTION

On Wednesday 6th February radiological re-assurance monitoring was carried out by a Health Physics Surveyor, contracted by Morrison Construction Ltd, on construction site zone 6B (CSZ6B).

Site CSZ6B is operated by Morrison Construction Ltd and was receiving fill from zones operated by Edmund Nuttall Limited.

The re-assurance monitoring detected contaminated material that was above the hold point defined in the method statement developed for Morrisons. This prompted further monitoring investigation by the Health Physics Surveyor to determine the source of the material. Communication with the site engineer revealed that the contaminated material was being used as backfill in CSZ6B and originated from another construction zone within the Olympic Park, known as CSZ3A.

Radiological monitoring carried out in CSZ3A confirmed contaminated material was present.

The low resolution portable gamma spectrometer (GR135) identified the contamination as Radium (^{226}Ra).

A crude estimate based on the initial monitoring data indicates that specific activity concentration may be as high as 7Bq g^{-1}.

Further radiological surveys and assessment, including collection of samples from the site, was carried out in agreement with Edmund Nuttall Limited under a separate RPA Consultancy contract. The main objective of the survey was to determine the extent of the radiological contamination, to provide the appropriate advice to protect persons operating on the Olympic Park site and, if necessary, implement control measures for safe removal and transfer of radioactive materials in compliance with relevant legislation.

This advice note details the radiological survey carried out by the Health Physics Surveyors on behalf of Nuttall Limited between 11th and 15th February 2008 and contains advice to ensure compliance with the Ionising Radiations Regulations 1999.

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2 ABBREVIATIONS

IRR1999	Ionising Radiations Regulations 1999
RSA93	Radioactive Substances Act 1993
GR135	Low resolution gamma spectrometry hand held instrument
Cps	Counts per second
Bq g^{-1}	Becquerel per gram
^{226}Ra	Radium 226
^{238}U	Uranium 238
^{232}Th	Thorium 232
Bq	Becquerel
kBq	kilo Becquerel (10^3)
MBq	Mega Becquerel (10^6)

3 BACKGROUND

Historical information indicated that industries that operated within CSZ3A showed that a number of companies worked with ionising radiation that included ^{226}Ra and ^{232}Th.

^{226}Ra is an alkaline earth metal that is found in trace amounts in uranium ores; therefore it is part of the ^{238}U decay chain. ^{226}Ra has a half life of 1602 years, this is the time taken for the amount of radioactivity to reduce by 50%. ^{226}Ra is considered to be toxic (due to alpha radiation emission) if sufficient concentration of material is taken into the body and can also give rise to a whole body dose (externally) from its beta and gamma emitting daughters.

^{226}Ra was used extensively as a luminising agent in watches, timepieces, aircraft switches, instruments dials, etc from the 1900's up until the early 1960's. Luminising work was undertaken in small industrial premises and in the homes of piece workers.

^{232}Th was used in the manufacturing of gas mantles and has a much longer half life than ^{226}Ra ($1.4x10^{10}$ years) and is also considered toxic (due to alpha radiation emission), if ingested into the body. Gas mantle production was prevalent in east London during the latter half of the nineteenth century and the early twentieth century.

Little was known about the detrimental effects of radiation to human health at the time of gas mantle manufacture and radium-luminising, and industries that used radioactive materials typically took few precautions to minimise the exposure of employees or to restrict the spread of contamination. Legislation to control exposure to radioactive substances was first introduced in 1948 with the publication of the Radioactive Substances Act; it follows that storage, use and disposal of radioactive material was unregulated for the majority of the time that these works were undertaken, with the result that radioactive waste was co-disposed of with ordinary industrial and household waste.

Both elements in daughter chain of ^{226}Ra and ^{232}Th have gamma radiation properties and can be detected using suitable gamma radiation monitors, preferably sodium iodide based due to its increased sensitivity of detection.

4 SURVEY

Two Health Physics Surveyors carried out a series of walkover surveys using a 3" x 3" sodium iodide detector (Groundhog™). The Groundhog™ has a capability to detect ^{226}Ra down to approximately 30cm below the surface. As a guide, 1,500 cps on the Groundhog™ equate to approximately 0.4Bq g^{-1} over $2m^2$. However, interpretation of monitoring results needs careful consideration because discrete sources or artefacts that have a high radioactivity content may be present in bulk soil, in which case the assumption that the soil is homogenously contaminated with low concentrations of radioactivity would be false.

In order to provide a better judgement, the walkover survey was backed up with a small gamma probe (44B) to identify localised spots of contamination (no more than a few cm^2) or where discrete contaminated artefacts, rubble, etc, may be buried. A series of samples are collected from areas where significant level of radiation above background were observed.

Samples were sent to a UKAS accredited laboratory at Harwell for gamma spectrometry analysis. The results of the analysis identified the radioisotope and the concentration of activity in Bq g^{-1}.

The following locations within CSZ3A were surveyed:

- Site 'A' mound, eastside of the stadium bowl (fenced off area);
- Site 'A' basin, east side of the stadium bowl area (fenced off area);
- Stockpile 60 and stockpile 'DROF';
- The site 'Bowl' (centre of CSZ3A)
- Southwest and Southeast corner of CSZ3A

The results of the radiological survey are provided below:

5 SURVEY RESULT INTERPRETATION

5.1 Site 'A' eastside of stadium bowl

The approximate size of the plateau mound (situated on the east side of CSZ3A) is in the order of 15m x 30m x 1.5m thus giving a total volume $675m^3$ of soil and rubble.

The walkover survey on top of the plateau indicated elevated levels above background to be generally in the order of 1,000 to 3,000 cps with a localised a 'hotspot', covering $1m^2$, indicating around 10,000 counts per second.

For comparison purposes the background count on the Groundhog™ (away from the contaminated area) was averaging in the order of 300 cps. Therefore observed counts are generally 3 to 10 times above background.

There is evidence of contaminated items such as broken clay pipes buried amongst the mound; therefore the hotspot of 10,000 cps suggests that it is likely to a discrete item buried in the upper layer of the soil rather the soil being homogenously contaminated.

On the 'faced areas' of the mound (north face and west face) there is also evidence of broken clay pipes which are heavily contaminated. The 'inside surface' of one pipe showed contact beta-gamma radiation dose rate in excess of 10 milli Sieverts per hour and around 350 micro Sieverts per hour gamma radiation. A 1 metre gamma dose rate was taken so that it can be treated as a point source for activity assessment purposes. This was measured as 6.5 micro Sieverts per hour. Empirical data from the Handbook Radiological Protection gives a specific gamma ray dose rate constant at 1 metre for 1GBq of ^{226}Ra of 227 micro Sieverts per hour. Therefore the calculated activity on the pipe is 28 MBq.

A smear sample collected from the inner surface of the contaminated pipe indicated significant levels of loose alpha contamination (DP6) to be in the order 100kBq removable radioactivity (assuming 10% pick up factor). This level of loose alpha contamination will potentially present a significant internal radiation hazard to workers in direct contact with contaminated pipe work if no radiological controls are implemented.

5.2 Basin within the fenced off area

A walkover survey with the Groundhog™ detector in the ~900m^2 basin area indicated parts of the area have elevated levels from 800 up to 3000 cps (3 to 10 times above background). It is understood that there is no more excavation intended to be carried out in the basin area as the engineers have achieved the depth they require for foundation works.

5.3 Stockpile Monitoring

It must be noted that the survey on the stock pile is very limited due to the nature of accessibility and results will be only indicative of material that was present within the first 30cm depth of the stockpiles.

Stockpiles of excavated soil from CSZ3A have been distributed to identified stockpiles elsewhere in Olympic Park site. These stockpiles have been surveyed (identified by the site engineer).

5.3.1 Stockpile 60

The initial walkover on Stockpile 60 (situated within CZSA3) showed no significant levels above background on its surface. However, it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected. It is recommended that a watching brief is implemented.

5.3.2 DROF Stockpile

DROF Stockpile indicated elevated levels of radiation which averaged between 1,000 to 3,000 cps with a hotspot of 5,000 cps detected. Samples were collected from this area to determine whether it is homogenous contamination in the soil or indicates the presence of discrete contaminated items below the stockpile surface. This will need segregation and disposal.

5.3.3 Stockpile CSZ4

The initial walkover showed no significant levels above background on its surface. However, it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected. It is recommended that a watching brief is implemented.

5.3.4 Stockpile CSZ5

The initial walkover showed no significant levels above background on its surface. However, it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected. It is recommended that a watching brief is implemented.

5.3.5 Stockpile CSZ8

The initial walkover showed no significant levels above background on its surface. However, it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected. It is recommended that a watching brief is implemented.

5.4 Capital Print stockpile

A walkover survey with the Groundhog™ detector at Capital Print (attached map reference 082) indicated up to 15m^2 have elevated levels up to 15,000 cps (50 times above background). Since this was a main route for the site vehicles to travel over an agreement between the site engineer and the RPA was to remove the top layer off the route and stockpile the contaminated spoil nearby for further investigation. A walkover survey of the area after the top layer was removed confirmed levels are within acceptable background limits.

The stockpile registered levels in the region of 15,000 cps. This will require segregation and disposal.

5.5 Areas located south of CSZ3A

An area in the adjacent to the canal (attached map reference 327 & 328) and indicated three areas of elevated counts above background, which were 2,100 cps, 2,200cps and 9,000 cps. Upon inspection by the Health Physics Surveyors the contamination appears to be distributed throughout the soil medium as there was no obvious debris on the surface or immediately beneath the surface. This will require removal, segregation and disposal.

5.6 Site 'Bowl' (centre of CSZ3A)

The walkover survey (where accessible) across what is locally known as the 'Bowl', which covers the centre area of CSZ3A did not reveal any significant levels above background. Whilst it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected, it should be noted that only 1m to 1.5m of made ground remains above the natural alluvial materials in this area of the site. Sources identified have all been removed and the detector, whilst limited in its penetration, will still react to large sources at greater depths. However, as this area has been excavated to level it is not envisaged that there will be any risk to future users from buried material unless it is disturbed. If future works are undertaken that disturb the ground, then proportionate measures should be taken to protect staff, such as in-situ reassurance radiological monitoring carried out by a Health Physics Surveyor.

5.7 Remaining areas of CSZ3A

The initial walkover showed no significant levels above background on its surface. However, it cannot be concluded conclusively that it is free from radioactive material due to access limitations and the fact that material at depths greater than 0.3m will not be detected. However, as this area has been excavated to level it is not envisaged that there will be any risk to future users from buried material unless it is disturbed.

5.8 CZ5a/S03 LHS side of access slope and pile edge

This area I understand is in the vicinity of what was known as the bus depot (refer to map to identify area). The walkover survey carried out on the 21st February indicated the spoil contained significant counts above background (18,000 cps) and appeared to be clay soil. No sample was taken from this since this information came in late while mobilisation work was being put together. The spoil should be restricted from further used and samples collected for gamma spectrometry analysis.

5.9 Chemical Analysis Laboratory

Concerns were raised by personnel working within the chemical analysis laboratory since a number of samples have been collected in and around CSZ3A. Re-assurance monitoring of the laboratory was provided and results indicated no elevated radiation levels above background with the exception of a radioactive source store in one of the laboratories. However, ESGL as a company should seek advice from their Radiation Protection Adviser (if they have one) to develop receipt monitoring protocols and ensure that they have selected suitable radiation protection instrument(s) for detecting nuclides identified at the Olympic Park site.

5.9.1 Chemical sample storage (building ?)

Large number of samples are stored awaiting analysis within building ??. Monitoring in the storage area was carried out, but limited due to accessibility, and results indicated no elevated levels of radiation above background.

5.10 Soil Sample Radiochemical Analysis Results

Gamma spectrometry on the samples collected from construction site 6A has shown a mixture of Natural Uranium, Radium-226, Protactinium-231 and Thorium-232

Average activity concentrations were in the order of:

- 50Bq g^{-1}, Nat U;
- 15Bq g^{-1}, ^{232}Th;
- 40Bq g^{-1}, ^{226}Ra; and
- 10Bq g^{-1}, ^{231}Pa

Schedule 1 under the Radioactive Substances Act lists activity concentration for specified elements that can be disregarded as being 'radioactive', which includes radium (0.37Bq g^{-1}) thorium (2.59Bq g^{-1}) protactinium (0.37Bq g^{-1}) and uranium (11.1Bq g^{-1}). Elements below their respective activity concentration, the Radioactive Substances Act does not apply. Above the activity concentration limit the elements are regarded radioactive and the Act will apply.

There are Exemption Orders available for the users to utilise for removal/disposal of radioactive contaminated materials. The one of use is 'The Radioactive Substances (Phosphatic Substances and Rare Earths etc.) Exemption Order 1962, S.I. No. 2648.'

The purpose of Exemption Orders is to remove the administrative arrangements of certificates for use and storage of radioactive materials and authorisation for the accumulation and disposal of radioactive materials providing the user is able to comply with the conditions outlined within the utilised Exemption Order. None of the nuclides identified above will fall under the aforementioned exemption order as concentration activities are too high.

From a radiation protection perspective Schedule 8 of the Ionising Radiation Regulations requires the employer to put in place appropriate radiation protection measures if the activity concentration exceed;

- 1Bq g-1, Nat U
- 1Bq g^{-1}, ^{232}Th
- 10Bq g^{-1}, ^{226}Ra
- 10Bq g^{-1}, ^{231}Pa

Based on the results of the samples the IRR99 will measures to protect personnel working with the contaminated materials.

6 ADVICE

Based on the survey data it is recommended that areas where significant levels of radiation are present require radiological controls to be implemented in order to protect the workers on the Olympic Park site while the contaminated material is removed. Precautions should also be taken to prevent distribution of contaminated material within the Park, and unauthorised off-site disposal.

It is proposed to implement radiological controls in the following areas:

- areas with elevated levels of contamination
    - These will require to remain restricted to prevent unauthorised access since significant levels of radioactivity is present.
- The stockpiles containing material from CZS3A but with little or no detected activity
    - Due to limitation of the survey it is recommended to carry out radiological monitoring at regular intervals to ensure the material is free from radioactive contamination.

Nuttall Ltd is required to consult the Radiation Protection Adviser to devise a monitoring strategy for safe excavation of contaminated material to protect persons from exposure to ionising radiation.

This will require:

- development of system of work (risk assessments and method statement) including monitoring hold point criteria;
- identification of suitable instrumentation;
- monitoring regime;
- manpower resources;
- training;
- review of options to deal with contaminated soil, rubble, e.g. re-use of material, identify a suitable holding area, processing and ultimate disposal, etc...

- consideration to be given to the radiological safety of construction workers engaged in subsequent stages of development work at the site (i.e. subsequent to groundworks). The present arrangements are designed to ensure the safety of workers engaged in the current phase of works. These requirements must be passed on to future workers.
- a radiological risk assessment to be undertaken to identify a level at which material containing low concentrations of radium protoactinium, uranium and thorium contamination may be re-used on site without exposing development workers and future site occupants to unsatisfactory levels of risk.

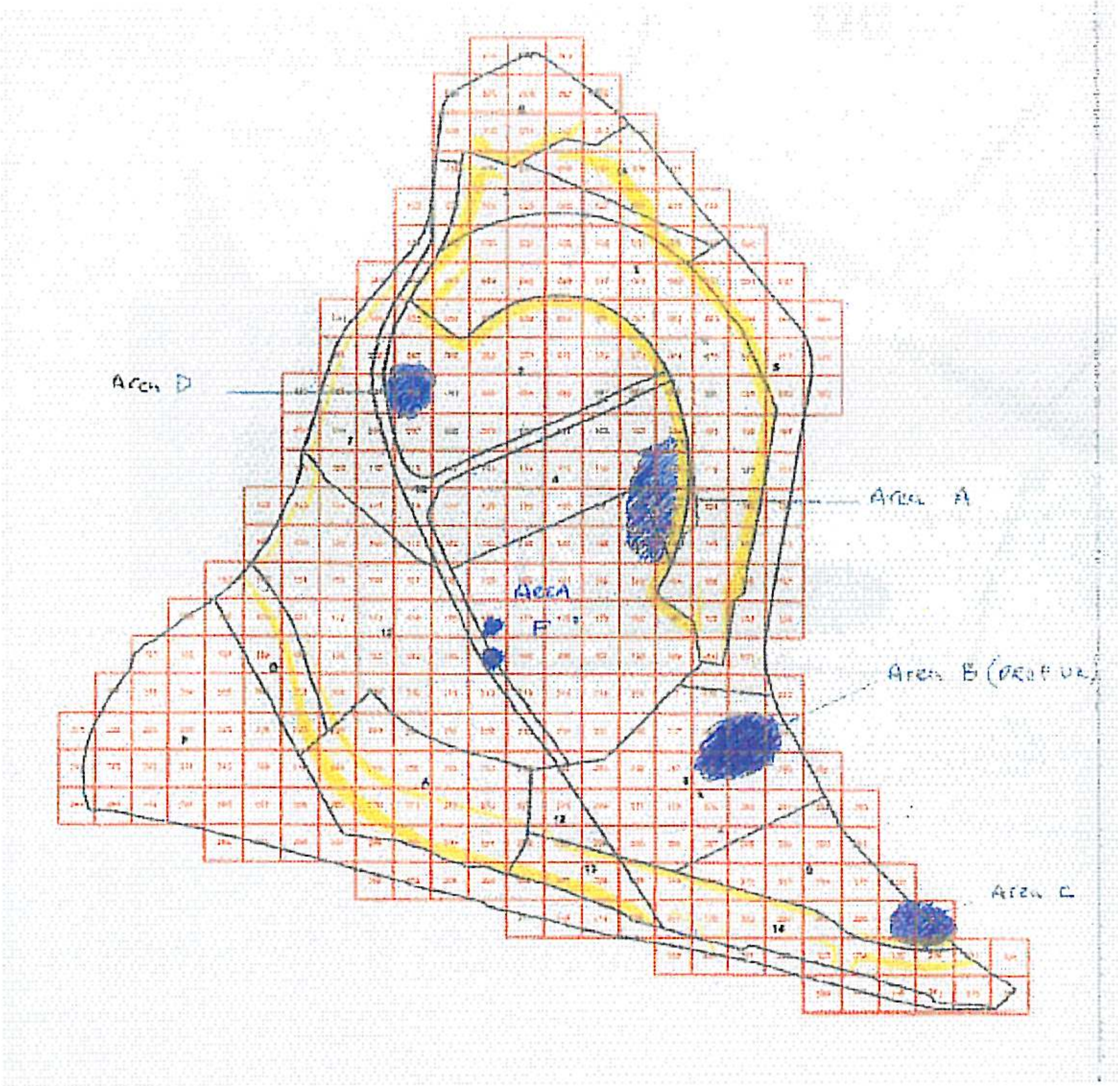
All of the above is part of the requirement to comply with the Ionising Radiations Regulations 1999 regulated by the Health & Safety Executive (HSE).

Further measures will be required to achieve compliance with the Radioactive Substances Act 1993 and the Environment Protection Act 1990, which are regulated by the Environment Agency (EA). These include:

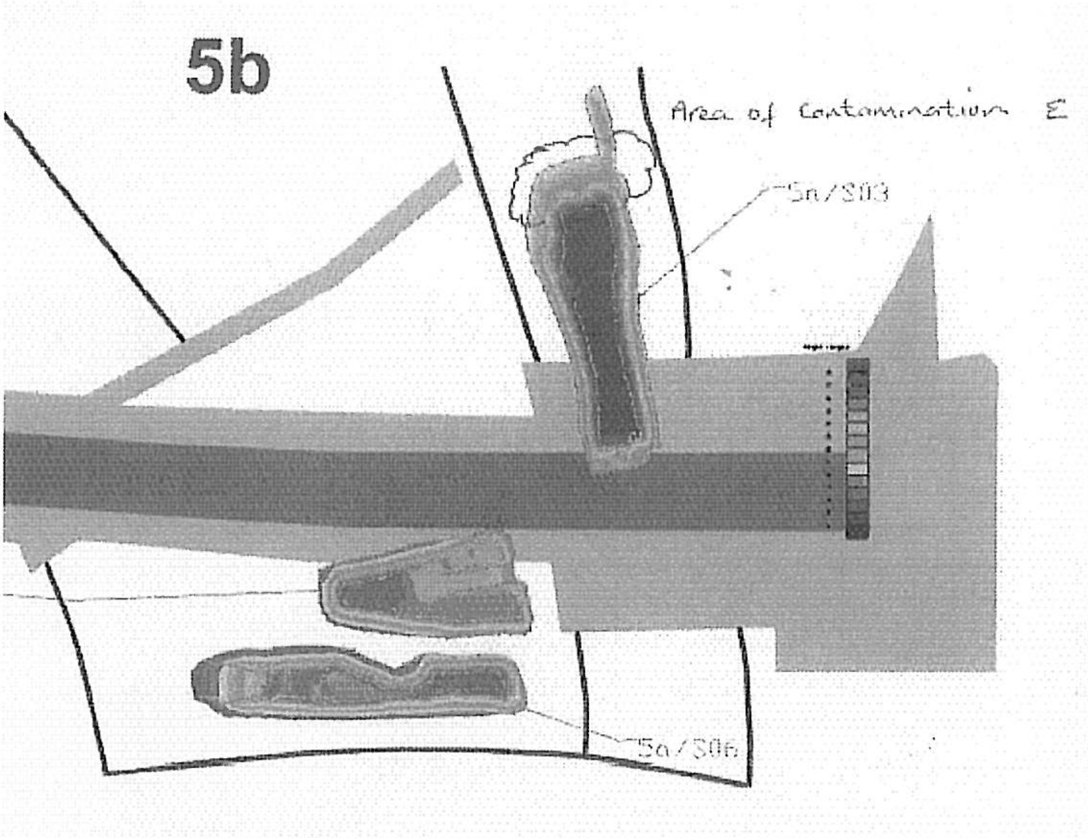
- acquisition of an authorisation to accumulate and dispose of radioactive waste (or consent from the EA to accumulate under the Morrisons authorisation, which may require amendments to accommodate this arrangement;
- identification of disposal routes for certain radioactive wastes (e.g. low level waste) and obtaining acceptance in principle from these sites to receive waste;
- operation of a system to assay and segregate waste into excluded, exempt and low level waste categories;
- operation of a radioactive material accountancy system to record the mass and radioactivity content of contaminated material;

In addition to the above, low level waste needs to be accumulated, processed and disposed of within a QA system that must be approved by Low Level Repository Limited, and the arrangements defined by this system should be implemented throughout the waste production process i.e. from excavation to consignment from site.

Appendix 1 – Plan of Construction site zone 3A



Appendix 2 – Plan of construction site zone 5a/S03



NUKEM

NUKEM Limited - a member of the Freyssinet Group

Title: Groundwork Operations in CSZ3 at the Olympic Park Site **Radiological Risk Assessment**	Reference: 87230/PRA/001 **Issue 1**

Prepared by:	[redacted] **(NUKEM Ltd RPA)** [redacted]	**Date:** 24/4/08.
Checked by:	[redacted] **(HealthPhysics)** [redacted]	**Date:**
Approved by:	[redacted] **(McAlpines Representative)**	**Date:**

1. INTRODUCTION

Under The Ionising Radiations Regulations 1999 (IRR99), a risk assessment has to be carried out to cover any new activity involving ionising radiation. Paragraph 44 of IRR99's Approved Code of Practice (ACoP) specifies those matters that must be considered within the assessment where they are relevant. . Paragraph 45 of the ACoP is a list of objectives that the assessment should enable an employer to achieve

Sir Robert McAlpines are contracted by the Olympic Delivery Authority to undertake the Olympic stadium build in construction site zone 3a. In preparation for the stadium build, a series of drilling and piling needs to be carried out down to depths of ~20 metres.

Information contained in the Technical Report carried out by Halcrow (no reference) supplementing the desktop reports (ref. REP-ENL-03a-OLP-SP1-E-0096-03 & REP-ENL-VL-ZZZ-OLP-SP1-E-0062-02) outlined industry history on the site (formally known as Lloyd Shoot) that may have used/stored radioactive substances.

Recent remediation work was carried out by Edmund Nuttall Ltd with support of NUKEM Limited in preparation to hand the stadium site over to Sir Robert McAlpines. The majority of the stadium arena has been surveyed by NUKEM limited along with samples analysis confirmed that the design level (~2 to 3 metres below the existing surface) does not contain any residual of significant levels of radioactivity. However, some groundwork operations are likely to go below the design level surface that has been surveyed, it cannot be ruled out that arising generated from these operations may contain radioactivity. In addition there are areas that have not been directly surveyed by NUKEM Limited Health Physics where excavation may take place, i.e. trenches for services, archaeological digs, etc.

The radiological risks involved with this work need to be properly assessed (in accordance with the Ionising Radiations Regulations 1999) in the form of a Prior Radiological Risk Assessment.

This PRA is for operations they may generate arising within CSZ3 which has the potential to contain radioactivity and to ensure the radiological controls are adequate addressed to protect personnel associated with the groundwork operations.

2. RISK ASSESSMENT

2.1 *What is the nature of the sources of ionising radiation to be used, or likely to be present, including the accumulation of radon in the working environment?*

The nature of ionising radiate is likely to be found within the soil. No artefacts such as dials have been found during the remediation work.

Samples collected from the site have been analysed and have identified a mixture of:

- Radium-226 (^{226}Ra)
- Protractinium-231 (^{231}Pa)
- Uranium Ore (Nat-U) and
- Thorium (^{232}Th)

Groundwork operations are to be undertaken in the open air, and therefore, even considering the fact that radium or thorium contaminated material may be removed, build up of radon or thoron in the environment will not be an issue.

2.2 *What are the estimated radiation dose rates to which anyone can be exposed?*

Discrete items have been found during the site remediation work and dose rates measurement peaking to 300microSv/h γ and in excess of 10milliSv/h $\beta\gamma$ (contact measurements) has been encountered. At one metre dose rate significantly drops down to 2-3 microSv/h γ and ~60 microSv/hr $\beta\gamma$. However, this was an isolated incident and dose rate from building rubble is expected to be significantly less, i.e. a few microSv/h (contact).

2.3 *What is the likelihood of contamination arising and being spread?*

There is the potential for contamination spread to occur during earth groundwork operations if safeguard measures are not implemented.

2.4 *What are the results of any previous personal dosimetry or area monitoring relevant to the proposed work?*

NUKEM Limited has been involved radiologically contaminated land projects, and personnel doses recorded on these projects tend to be significantly less than 1 milliSv per year.

There has been no notable dose recorded in any of the work at the Olympic Park Site to date. This information is based on the Morrison Construction and Edmund Nuttall Ltd who are also working at the Olympic Park where they have encountered radioactivity and carried out remediation activities.

General dose rates in the arena (CSZ3) is generally less than 1 microSv/h at waist height and is comparable to background levels.

2.5 *What is the advice from the manufacturer or supplier of equipment about its safe use and maintenance?*

This point is primarily aimed at radiation generating equipment and as none is being used it does not apply. However, as a general point, all instrumentation and equipment will be used by suitably qualified and experienced personnel following procedures / instructions that take account of manufacturer's advice.

2.6 *What engineering control measures and design features already in place or planned?*

From 2.3, above, it is apparent that the prime radiological hazard associated with this work is the spread of contamination, with the potential consequences of workers receiving a dose via ingestion or inhalation of radioactive materials or injection of radioactive material through a contaminated wound.

Control measures for the groundwork operations will be described in the Method Statement to minimise the risk of contamination spread and dose uptake to operators.

It is unlikely that airborne contamination will be generated during these operations; however a personal air sampler (PAS) will be issued routinely to the Health Physics Surveyor. Air sample results during remediation work showed no elevated levels of radioactivity.

If the spoil from the groundwork operations start generating dust then damping down measures should be implemented if radioactivity is present.

In order to prevent the spread of contamination, the area will be clearly demarcated with the appropriate signage in place until a post op survey of the spoil and equipment has been completed and contamination (if any detected) is segregated and stored away. A validation survey of the surrounding area will be carried out to confirm it is free from any significant residual contamination.

Access to the demarcated area will be only be made primarily by the Health Physics Surveyor to carry out the post op survey. Entry to the demarcated area will be controlled by the Health Physics Surveyor in attendance. All equipment will be checked for contamination and, where necessary, decontaminate before the area is released.

There may be instances that additional resources will be required to work in the demarcated area, i.e. excavator driver, dumper truck driver, etc. This will be identified in the method statement.

2.7 Area there any planned system of work? If so what?

Method statement will be prepared to incorporate the radiation protection measures identified by this risk assessment.

The radiological requirements of the Method Statement will be implemented by Health Physics, and responsibility for ensuring its implementation lies with McAlpine's Site Manager.

An RPA Advice Note (reference number 87230AN001) has been prepared to consider the controls required for compliance with the Ionising Radiations Regulations.

2.8 What are the estimated levels of airborne and surface contamination likely to be encountered?

Based on the radioactive material that has been found to date and experience on similar land remediation work the likelihood of generating significant airborne contamination is considered to be negligible.

Air sampling has invariably shown negligible airborne activity levels associated with this work (despite significant radiological contamination being present in the soil material).

Surface contamination levels will vary. Activity concentrations have been generally no more than 20Bq per gram and have mainly been in soil.

2.9 What is the effectiveness and suitability of personal protective equipment to be provided?

Personal Protective Equipment required for personnel involved in any removal of radiologically contaminated material consists of waterproof paper coveralls and gloves. This PPE should be sufficient to prevent any personal contamination. In addition, puncture resistant gloves should be worn to prevent contaminated wounds whilst working inside the demarcated area (Health Physics only) and ori-nasal mask is a requirement during excavation, tipping, transferring operations.

It is a site safety requirement to wear safety goggles.

2.10 What is the extent of unrestricted access to working areas where dose rates or contamination levels are likely to be significant?

The Olympic Park site is a large secure site, which is accessed by authorised persons only. Areas where groundwork operations are being carried out (that have been identified with presence of radioactivity) will be clearly demarcated with the appropriate warning signage displayed.

As mentioned in 2.6, above, access control will be managed by Health Physics. Only Health Physics will primarily be allowed access into the demarcated area to carry out radiological monitoring unless advised or specified by the method statement.

2.11 What are the possible accident situations, likelihood and potential severity?

Accident Situation:
The accident scenarios of a contaminated wound or the generation of airborne contamination have been considered in the dose assessment supplemented to this assessment.

Frequency:
The potential frequency of sustaining a contaminated wound during the removal of discrete items within contaminated spoil or decontaminating equipment that has sharp edges may increase while HP carrying out surveys. The risk of wound is mitigated by wearing puncture resistant gloves. Contaminated debris, if practicable, will primarily be removed remotely by means of a trowel or shovel.

Personnel should avoid direct handling of any contaminated debris.

Additional reasonably foreseeable radiological accident scenarios are:

- The spread of contaminated materials. The likelihood of this accident is considered to be moderate but the severity low. Health Physics is required to be in attendance to ensure personnel do not approach contaminated spoil, items or areas until a post op survey has been completed and declared safe by the Health Physics Surveyor.

- Inadvertent exposure of personnel to elevated dose rates. The likelihood of this accident scenario is considered to be low and the severity low. Electronic personal dosemeter will primarily be worn routinely by the Health Physics Surveyor that will be representative to those involved in the groundwork operations. In addition, the Groundhog probe is a gamma sensitive instrument and will provide early warning at distance if significant radiation dose rate is present.

2.12 What are the consequences of possible failures of control measures – such as electrical interlocks, ventilation systems, and warning devices – or systems of work?

Failure of the system of work to implement radiological controls on groundwork operations may result in the inadvertent spread of radiologically contaminated material and the exposure of personnel involved in the work to both internal and external radiation hazards.

2.13 What are the steps to prevent identified accident situations, or limit their consequences?

Method statements will be developed to control the work process and clearly identify the steps to be taken to prevent accident scenarios coupled with radiation awareness toolbox talk and site pre-works brief by Health Physics.

3. ACTIONS REQUIRED

3.1 What action is needed to ensure radiation exposure is ALARP?

The radiological exposure from groundwork operations is expected to be extremely low.

The actions and safeguards identified in this risk assessment should ensure that the risk of exposure to personnel from internal and external contamination are minimised to levels that are considered to be ALARP (**As Low As Reasonably Practicable**).

3.2 ***What steps are necessary to achieve this control of exposure by use of engineering controls, design features, safety devices, and warning devices and, in addition, by the development of systems of work?***

A safe system of work detailing the radiological controls necessary to control exposure has been developed. This can be summarised as:

- Temporary demarcation of the radiologically contaminated area
- Signage to warn personnel of not to enter the demarcated area
- Regular radiological surveys carried out by Health Physics
- Access to the demarcated area is primarily accessible by Health Physics only unless extra resources are required specified by the method statement.
- Contaminated material will be bagged, labelled and stored safely at a designated location/store
- Contaminated equipment will be decontaminated by Health Physics.

3.3 ***Is it appropriate to provide PPE and if so what type would be adequate and suitable?***

It is advised that personnel involved with ionising radiation work wear coveralls, gloves, ori-nasal dust masks and eye protection.

3.4 ***Is it appropriate to establish dose constraints for planning or design purposes and if so what values should be used?***

There should be minimal radiological exposure above general background levels to personnel involved in the removal of this contaminated material.

An individual Dose Constraint of 1 milliSv/y has been set (equivalent to the annual dose limit to members of the public). This is a common dose constraint set for projects involving the remediation of radiologically contaminated land.

Dose uptake received by personnel involved in this work will be reviewed regularly by the RPA by reviewing the Health Physics records and to ensure that they remain ALARP.

Personnel issued with EPD will be limited to 10μSv per day. EPD results on the Olympic Park have be typically background levels (1-3μSv per day).

3.5 ***Is there the need to alter the working conditions of any female employee who declares she is pregnant or is breast feeding? If so what alterations are necessary?***

There are no females declared as pregnant or are breastfeeding involved with the excavation work. Therefore working conditions will not require any alterations. However, if females realise they are pregnant they must inform the employer. The same will apply also if they are breast feeding. The employer will be required to carry out a further risk assessment to determine whether the female's working conditions should be altered. This is a requirement under the Management of Health and Safety at Work Regulations 1999 (MHSW1999).

3.6 ***What is an appropriate investigation level to check exposures are being restricted as far as reasonably practicable?***

Doses will be reviewed on a daily and a weekly basis to ensure that they remain ALARP. A formal investigation level of 1 milliSv/yr has been set and remains appropriate for these operations.

3.7 ***What maintenance and testing schedules are required for the control measures selected?***
The only maintenance and testing schedules required for the control measures selected are the annual calibration of all Health Physics instruments used to undertake monitoring.

3.8 ***What contingency plans are necessary to address reasonably foreseeable accidents?***
The only reasonably foreseeable accident scenario is the spread of uncontrolled contamination due to loss work controls, i.e. working outside the parameters of the developed method statement.

In this event, the Health Physic will cease work and the event forthwith reported to the McAlpine Site Manager and Radiation Protection Adviser. Health Physics will quickly establish the extent of contamination spread and, where necessary, extend the demarcated area.

Work must not resume until it is clear why work practices were not compliant with the relevant Method Statement.

3.9 ***What are the training needs of classified and non classified employees?***
All personnel undertaking this work must received basic general awareness training on radiological hazards (based on the findings of this risk assessment) and include the control measures in place via the method statement.

3.10 ***Is there a need to designate specific areas as controlled or supervised areas and to specify local rules? If so what areas?***
The demarcated area will be temporarily designated as a Supervised area in order to keep the are under review for contamination and radiation risks.

Local rules will not be required for these operations as method statement will cover the radiological controls. In the highly unlikely event that the area requires to be designated as controlled, Local Rules will be enforced and the system of work documents will require review by the RPA and McAlpine's site Manager to ensure controls are still appropriate.

3.11 ***What are the actions needed to ensure restriction of access and other specific measures in controlled or supervised areas?***
There is no access to the temporary demarcated supervised area except for Health Physics.

Access control will be managed by Health Physics.

3.12 ***Is there the need to designate certain employees as classified persons? If so who?***
Based on the land remediation work carried out by NUKEM Limited dose uptake were well below 1mSv/y; therefore persons will not be required to be designated as classified.

3.13 ***What is the content of a suitable programme of dose assessments for employees designated as classified persons and for others who enter controlled areas?***
Health Physics will routinely be wearing an electronic personal dosimeter and personal air sampler to represent staff involved in the groundwork operations to provide reassurance that they are not receiving exposure from external and internal radiation. If radiological conditions changes that will involve personnel to work with contaminated materials, the method statement will identify those requiring PAS and/or EPD.

The EPD and PAS will be recorded by Health Physics and reported on a weekly basis to the RPA.

3.13 ***What are the responsibilities of managers for ensuring compliance with these regulations?***
McAlpines is responsible for ensuring that groundwork operations are undertaken in compliance with the requirements of the Ionising Radiations Regulations 1999, by seeking advice from the appointed Radiation Protection Adviser, and other relevant non-radiological legislation.

3.14 ***What is an appropriate programme of monitoring or auditing of arrangements to check the requirements of IRR99 are being met?***
It is advised that McAlpines regularly consult with their Radiation Protection Adviser for the duration of the work at the Olympic Park to provide radiation protection advice on any potential radiological issues to ensure that the requirements of IRR99 are being met.

Appendix C Certificate of Authorisation, Radioactive Substances Act 1993, and associated correspondence

ENVIRONMENT AGENCY

RADIOACTIVE SUBSTANCES ACT 1993

Authorisation to Accumulate and Dispose of Radioactive Waste

Galliford Try Infrastructure Limited
(T/A Morrison Construction Limited)

CB9916/CE0419

This certifies that the Environment Agency ("the Agency") in exercise of its powers under sections 16(2) and 16(8) of the Radioactive Substances Act 1993 ("the Act") has authorised

Galliford Try Infrastructure Limited
(T/A Morrison Construction Limited)

Company Registered No ENGLAND 836539

("the user")

whose Registered Office is

Galliford Try plc
Cowley Business Park
Cowley, Uxbridge
Middlesex UB8 2AL

under sections 13(1), 13(3) and 14 of the Act, to accumulate the radioactive waste specified in paragraph 1 of Schedule 2 to this certificate on the premises (with a view to its subsequent disposal) and to dispose of the radioactive waste specified in paragraph 2 of Schedule 2 to this certificate, from the premises used by him at

Olympic Development Zone
Stratford
London E10 5PD

subject to the limitations and conditions in the Schedules to this Certificate of Authorisation.

This Authorisation shall come i[redacted]

Signe[redacted]

Authorised to sign on behalf of the Environment Agency

Dated the 21 December 2009

Schedule 1

STANDARD CONDITIONS AND LIMITATIONS

MANAGEMENT

1. The user shall have a management system, organisational structure and resources which are sufficient to achieve compliance with the limitations and conditions of this Authorisation and which include:

   a) provision for consultation with such suitable RPAs, or other such qualified experts as the Agency may approve in writing, as are necessary for the purpose of advising the user as to compliance with the limitations and conditions of this Authorisation and, in particular, on the matters addressed in paragraphs 2 and 4 in this Schedule;

   b) written operating procedures;

   c) adequate supervision of the disposal of radioactive waste by suitably qualified and experienced persons, whose names shall be clearly displayed with each copy of the Certificate of Authorisation that is posted on the premises as required by section 19 of the Act.

DISPOSAL OF RADIOACTIVE WASTE

2. The user shall use the best practicable means to:

   (a) minimise the activity in all disposals of radioactive waste;

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

   (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.

3. The user shall maintain in good repair the systems and equipment provided:

   (a) to meet the requirements of paragraph 2 in this Schedule;

   (b) for the disposal of radioactive waste.

4. The user shall check, at an appropriate frequency, the effectiveness of systems, equipment and procedures provided:

   (a) to meet the requirements of paragraph 2 in this Schedule;

   (b) for the disposal of radioactive waste.

ACCUMULATION OF RADIOACTIVE WASTE

5. The user shall so far as is reasonably practicable prevent -

(a) the loss or escape of any accumulated radioactive waste; and

(b) the access to any accumulated radioactive waste by any person not authorised by the user.

6. The user shall so far as is reasonably practicable ensure that accumulated radioactive waste is kept either:

(a) in a suitable container under continuous surveillance; or

(b) in a suitable container in a suitable store both of which -

(i) are so constructed, maintained and used so as to prevent the loss or unauthorised removal of the waste; and

(ii) are constructed of non-combustible materials; and

(iii) do not contain nor are located close to any corrosive, explosive or flammable material; and

(iv) are clearly and legibly marked with the word 'Radioactive' and with the ionising radiation symbol complying with BS 3510: 1968 or ISO 361 and any other information necessary for the identification of the waste present.

7. The user shall so far as is reasonably practicable ensure that all relevant parts of the premises are constructed, maintained and used in such a manner that -

(a) they do not readily become contaminated; and

(b) any contamination which does occur can be easily removed.

LOSS OF ACCUMULATED RADIOACTIVE WASTE

8. If the user believes or has reasonable grounds for believing that any accumulated radioactive waste has been lost or stolen he shall -

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

(b) so far as is reasonably practicable recover the waste; and

(c) as soon as is practicable notify the Agency in writing of the circumstances of the occurrence and the means taken to recover the waste.

ESCAPE OF ACCUMULATED RADIOACTIVE WASTE

9. If the user believes or has reasonable grounds for believing that any radioactive waste is escaping or has escaped from any container or location in which it is accumulated he shall -

   (a) without delay inform the Agency;

   (b) so far as is reasonably practicable:-

      (i) prevent any further escape; and

      (ii) minimise the spread of any contamination;

   (c) ensure that any discharge of radioactive gas to the atmosphere is made in a manner which prevents so far as is reasonably practicable its entry into any building; and

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

ACCUMULATION OR DISPOSAL NOT IN COMPLIANCE WITH AUTHORISATION

10. If the user believes or has reasonable grounds for believing that the accumulation or disposal of radioactive waste is occurring, has occurred or might occur which does not comply with the limitations and conditions of this authorisation he shall -

    (a) without delay inform the Agency;

    (b) so far as is reasonably practicable prevent the further accumulation or disposal of radioactive waste; and

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

CHANGE OF NAME OR CESSATION OF ACCUMULATION AND DISPOSAL

11. The user shall inform the Agency in writing, at least 28 days in advance or, where this is not possible, without delay, of his intention to -

    (a) change the name of the user; or

    (b) cease to occupy the premises; or

    (c) cease to accumulate and dispose of radioactive waste.

RECORDS

12. The user shall make, on the day of accumulation or disposal as appropriate, clear and legible records of accumulation and of disposal of radioactive waste.

13. The user shall, subject to paragraph 16 in this Schedule:

(a) make and retain records sufficient to demonstrate whether the limitations and conditions of this Authorisation are complied with;

(b) retain records made in accordance with any previous Authorisation issued to the user and related to the premises covered by this Authorisation;

(c) retain records transferred to the user by any predecessor user which were made in accordance with any previous Authorisation related to the premises covered by this Authorisation.

14. If the user amends any record made in accordance with this Authorisation it shall ensure that the original entry remains clear and legible.

15. If required by the Agency, the user shall keep the records referred to in paragraph 12 and 13 in this Schedule in a manner and place approved by the Agency.

16. The user shall retain the records referred to in paragraphs 12 and 13 in this Schedule until notified in writing by the Agency that the records no longer need to be retained.

PROVISION OF INFORMATION

17. The user shall supply such information in such format and within such time as the Agency may specify.

SAMPLING AND ANALYSIS OF WASTE AND OTHER SUBSTANCES

18. The user shall:

(a) take and analyse such samples of waste and conduct such other tests and surveys as the Agency may require;

(b) make and keep a record of each such analysis, test or survey; and

(c) retain such samples as may be directed by the Agency.

19. If required by the Agency, the user shall, as the Agency specifies -

(a) provide samples;

(b) dispatch samples for tests at a laboratory and ensure that the samples and residues thereof are collected from the laboratory within three months of receiving written notification that testing and repackaging in accordance with the appropriate transport regulations are complete.

INTERPRETATION

20. (1) In this Certificate of Authorisation -

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

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

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

"consignment" means an individual shipment of radioactive waste not greater in volume than 40 cubic metres or such lesser volume as specified in writing by the Agency;

"day" means a period of twenty-four consecutive hours commencing at midnight;

"decay products" means in relation to any radionuclide, the radionuclides succeeding it in the radioactive series in which it and they occur;

"drainage system" means any drainage system normally used for the disposal of foul water or trade effluent arising on the premises;

"half life" means the time taken for the activity of a radionuclide to lose half its value by decay;

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

"licensed landfill site" means a place where the deposit of waste is authorised by a waste management licence issued under Part II of the Environmental Protection Act 1990 or by a permit issued under The Pollution Prevention and Control (England and Wales) Regulations 2000;

"LLWR" means Low Level Waste Repository

"LLWR Operator" means the current holder of a site licence issued under the Nuclear Installations Act 1965 for the Low Level Waste Repository at Drigg;

"modifications" includes additions, alterations and omissions;

"month" means calendar month (ie 1-31 January, 1-28/29 February, 1-31 March, etc);

"operating procedures" means procedures for carrying out any operation that may have an effect on compliance with this Authorisation;

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

"period of accumulation" means the length of time that waste remains accumulated on the premises with a view to its subsequent disposal;

"radionuclide" means a species of atom characterised by its mass number and atomic number and subject to radioactive decay;

"record of accumulation" means a record made in such a manner as the Agency may require showing the origin, nature, volume and location of the accumulated waste together with such other information as may be specified by the Agency;

"record of disposal" means a record made in such a manner as the Agency may require showing the date, location, radioactive content of each disposal and in the case of waste transferred for the purpose of final disposal at the Low Level Waste Repository at Drigg, the nature of the waste, its weight and volume, together with such other information as may be specified by the Agency;

"relevant parts of the premises" includes for the purposes of paragraph 7 of this Schedule, the floor, ceiling, walls, fittings and furniture in any area where radioactive waste is accumulated or disposed of, and any associated drainage and ventilation systems;

"residual ash" includes cinders and other debris;

"RPA" means a Radiation Protection Adviser appointed under Regulation 13 of the Ionising Radiations Regulations 1999;

"Schedule" means a Schedule which forms part of this certificate;

"Sellafield Site Operator" means the current holder of a site licence issued under the Nuclear Installations Act 1965 for the Sellafield Site ;

"solid waste" means radioactive waste in the form of a solid and includes very low level waste;

"the Act" means the Radioactive Substances Act 1993;

"the Agency" means the Environment Agency;

"very low level waste" means waste in the form of solid, which can be disposed of with municipal, commercial or industrial waste:
- each $0.1m^3$ of waste containing less than 400 kBq of total activity; and
- single items containing less than 40 kBq of total activity.
For wastes containing carbon-14 or tritium:
- each $0.1m^3$, the activity limit is 4,000 kBq for carbon-14 and tritium taken together; and
- for any single item, the activity limit is 400 kBq for carbon-14 and tritium taken together.

"waste collection authority" has the same meaning as in Part II of the Environmental Protection Act 1990;

"year" means calendar year.

(2) (a) In determining whether particular means are the "best practicable" for the purposes of this authorisation, the user shall not be required to incur expenditure whether in money, time or trouble which is, or is likely to be, grossly disproportionate to the benefits to be derived from, or likely to be derived from, or the efficacy of, or likely efficacy of, employing them, the benefits or results produced being, or likely to be, insignificant in relation to the expenditure;

(b) Where reference is made to the use of "best practicable means" in this Certificate of Authorisation, the means to be employed shall include:

(i) the provision, maintenance and manner of operation of any relevant plant, machinery or equipment;

(ii) the supervision of any relevant operation.

Schedule 3

SOLID WASTE

ACCUMULATION OF SOLID WASTE

1. The user may only accumulate solid waste if -

   a. it is disposed of as soon as reasonably practicable;

   b. the activity of any radionuclide or group of radionuclides in the waste listed in Column 1 of Table 1 of this paragraph does not exceed the relevant limit specified in Column 2 of that Table;

   c. it contains only the radionuclides listed in Column 1 of Table 1 of this paragraph other than decay products in amounts which could be present through radioactive decay of a listed radionuclide in the waste;

   d. its volume does not exceed that specified in Table 2 of this paragraph; and

   e. the period of accumulation does not exceed that specified in Table 3 of this paragraph.

Table 1

Activity of Accumulated Solid Waste	
Column 1 Radionuclides	Column 2 Activity Limits
natural uranium natural thorium protactinium 231 actinium 227 radium 226 lead 210 polonium 210	2 gigabecquerels in total

Table 2

Maximum Volume of Accumulated Solid Waste
$5m^3$

Table 3

Maximum Period of Accumulation of Solid Waste
until 31 December 2010

DISPOSAL OF SOLID WASTES (Transfer to other persons)

2. The user may only, unless otherwise authorised, dispose of solid waste if -

(a) it is transferred to a person specified in Column 1 of the table in this paragraph in accordance with that person's directions;

(b) in any year the total activity of any radionuclide or group of radionuclides in the waste listed in Column 2 of the table in this paragraph does not exceed the relevant disposal limit specified in Column 3 of that table, in respect of the relevant person specified in Column 1 of that Table;

(c) it contains only the radionuclides listed in Column 2 of the table in this paragraph in respect of the relevant person specified in Column 1 of that table other than decay products in amounts which could be present through radioactive decay of a listed radionuclide in the waste;

(d) it is in a suitable container constructed and maintained so as to prevent the loss of waste;

(e) he ensures so far as is reasonably practicable that the waste is not delayed in transit and is accepted at the premises of the person to whom he transfers waste; and

(f) the person to whom he transfers waste receives, at the time of each transfer, a consignment note signed on the user's behalf, stating the total activity in the consignment of each radionuclide or group of radionuclides, listed in Column 2 of the table in this paragraph and containing such other information as may be specified by the Agency.

Table

Disposal Limits for Transfer of Solid Waste		
Column 1 Persons to whom solid waste may be transferred	Column 2 Radionuclides	Column 3 Annual Disposal Limits
Transfer, for the purpose of treatment prior to disposal, to the person operating Complexes B4, and facilities A50 and A51 on the Winfrith Nuclear Site.	actinium 227 lead 210 polonium 210 protactinium 231 radium 226 natural thorium natural uranium	2 gigabecquerels in total

3. If required by the Agency, the user shall ensure that any consignment or part of any consignment of waste found, following transfer, not to be in accordance with the limitations and conditions of this Authorisation-

   (a) is packaged in accordance with the appropriate transport regulations; and

   (b) is returned as soon as is reasonably practicable to the user's premises.

ENVIRONMENT AGENCY

Reference
Number CB9916

Radioactive Substances Act 1993

NOTICE OF REVOCATION OF AN AUTHORISATION

1. This gives notice in accordance with Section 17(3) of the Act that the Environment Agency has revoked the authorisation under Sections 13 and 14 of the Radioactive Substances Act 1993 issued to MORRISON CONSTRUCTION LIMITED in respect of premises at OLYMPIC DEVELOPMENT ZONE, STRATFORD, LONDON E10 5PD details of which were contained in the certificate dated 25 JANUARY 2008 and referenced CB9916 with effect from 18 JANUARY 2010.

Signed [redacted]

Authorised to sign on behalf of the Environment Agency

Date: 21 December 2009

ENVIRONMENT AGENCY

RADIOACTIVE SUBSTANCES ACT 1993

CERTIFICATE OF AUTHORISATION
AND
INTRODUCTORY NOTE

ACCUMULATION AND DISPOSAL
OF RADIOACTIVE WASTE

GALLIFORD TRY INFRASTRUCTURE LIMITED

T/A MORRISON CONSTRUCTION
OLYMPIC DEVELOPMENT ZONE
STRATFORD
LONDON
E10 5PD

AUTHORISATION NUMBER
CB9916/CE0419

INTRODUCTORY NOTE

IN 1. This Note does not form part of the Certificate of Authorisation.

IN 2. The following certificate contains details of an authorisation issued by the Environment Agency under the provisions of Sections 13 and 14 of the Radioactive Substances Act 1993 ("the Act"). The authorisation permits the accumulation and disposal of the specified radioactive wastes from the specified premises.

The Certificate of Authorisation includes a signed Certificate together with schedules. The Certificate includes the date from which the Authorisation shall take effect. Schedule 1 contains general conditions relating to all waste streams. Schedule 2 specifies the categories of radioactive waste that are authorised for accumulation and disposal. Schedule 3 contains limitations and conditions on the physical nature and radionuclide content of individual waste streams. Schedule 4 contains any further conditions and modifications or deletions of the conditions in earlier schedules.

IN 3. The Radioactive Substances Act 1993 is concerned with the control of radioactive material and any subsequent accumulation and disposal of radioactive waste. The conditions attached to the authorisation are concerned with the control and security of the accumulated radioactive waste and its subsequent disposal.

IN 4. The holding and use of radioactive materials from which the radioactive waste covered by this authorisation is generated, is remediation of contaminated land.

IN 5. The authorisation does not permit contravention of any other enactment or any order made, granted or issued under any enactment; nor does it permit any contravention of any rule of law or breach of any agreement.
In particular any requirements governing the use of radioactive material under the Health & Safety at Work etc Act 1974 will additionally need to be observed.

IN 6. The undertaking to which this certificate relates may accumulate and dispose of the radionuclides **Ac-227, Pb-210, Po-210, Pa-231, Ra-226, natural thorium, natural uranium**. The radioactive waste included in the provisions of this certificate results excavations on a major construction site.

creating a better place

Environment Agency

[redacted]

Our ref: CB9916/CE0419
Your ref:

Nuvia Limited
The Library, 8th Street
Harwell Science and Innovation Centre
Didcot
Oxfordshire OX11 0RL

Date: 22 December 2009

Dear Sir

Issue of certificate of authorisation
Radioactive Substances Act 1993

Following your application under this Act, I enclose the certificate and cancellation notice for earlier certificate, together with our Specification made under condition 17 of Schedule 1 of the enclosed certificate of authorisation. By law, your organisation must meet the requirements of the certificate and Specification. The certificate contains several parts, all of which must be read, kept and displayed as one document.

Guidance is available on our website (http://www.environment-agency.gov.uk/business/sectors/39773.aspx) which we intend will help you to comply with the limitations and conditions of the certificate(s).

Under section 16(9)(b)(i) of the Act, we are obliged to send copies of certificates of authorisation issued under sections 13(1) and 14 to local authorities in whose area radioactive waste is to be disposed of or accumulated.

I am sending copies of your certificate to:
- London Borough of Newham
- Dorset County Council
- Purbeck District Council

Section 19 of the Act requires copies of certificates issued under sections 7, 13(1) and 14 to be displayed on the premises. I am sending copies to the premises to facilitate this. For security reasons, please do not display certificates in areas open to the public.

Apollo Court, 2 Bishop Square, St Albans Road West, Hatfield, Hertfordshire AL10 9EX
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

The certificates issued under this Act do not allow anyone to contravene the requirements of:

- the Ionising Radiations Regulations 1999
- the Radioactive Material (Road Transport) Regulations 2002 as amended in 2003

or any other legislation.

If you are dissatisfied with any of the limitations or conditions in the certificate, you may query these with us. You may also appeal to the Secretary of State against certain of the limitations or conditions of the certificate. Your appeal should be in writing and sent, **within two months** of the date of this letter, to:

Secretary of State for Environment, Food
and Rural Affairs
(FAO Head of RAS Division)
Defra
Nobel House
17 Smith Square
LONDON SW1P 3JR

Please note that no appeal will lie in respect of any limitations or conditions that we include in pursuance of a direction of the Secretary of State (see section 26 of the Act).

If there is an incident involving radioactive material, you should ring our emergency hotline number: 0800 807060.

Yours sincerely

[redacted]

RSR Technical Support Officer

Direct dial [redacted]
Direct fax
Direct e-mail

Cont/d..

Appendix D Method Statement for the Deposition of Assayed Soils at Bridge L03 Zone 4

Method Statement No: - CE/06A/0018
Deposition of exempt/LL radioactive soils at Bridge L03 Zone 4.

Morrison Construction

THIS COVER SHEET IS MANDATORY FOR ALL METHOD STATEMENTS

Contract Name:	Olympic Park – Earthworks Zone 6A		
Contract Number:	2140		
Method Statement No.:	CE/06A/0018	Rev. 03	Number of pages including cover sheet: 71

Method Statement for (operation):	Deposition of assayed soils at Bridge L03 Zone 4
ODA Ref:-	MST-MOR-CK-06a-OLP-SP1-E-0071
Works Instruction No :-	

Is this a Safety Critical Operation?	YES		NO	X
Does this operation involve Temporary Works?	YES		NO	X
Does this operation involve Specialist Technical Knowledge	YES	X	NO	

- **If this is a Safety Critical operation, the Project or Contract manager must review the working method before the works commence.**
- **If this operation involves Temporary Works then refer also to PR-DMM-040**
- **If this operation involves Specialist Technical Knowledge, a competent person who is not the author must review the working method before the works commence.**

Prepared by (Author):	[redacted]	16/10/08
Technical review by:		Date
MCSL review by:		17/10/08
S.C.O approved by:	Contract/Project Manager Signature	Date

If this method statement requires revision and is for a Safety Critical Operation:

- **The works must be stopped.**
- **The operatives must be withdrawn.**
- **A new method of works must be established and agreed.**
- **A new cover sheet must be completed.**
- **Operatives must be briefed on the new method of works.**

Distribution and responsibilities

Client / Engineer / Other	Name / Signature	Date
Sen.Works Manager/Site Safety Supervisor	[redacted]	Date
Environmental Manager		Date
Agent (s)		Date
Works Manager / Foreman		Date
Health & Safety Manager		Date
Working Supervisor	Name / Signature	Date
Engineer (s)	Signature	Date
Site File		

The contents of the attached method statement must be adequately explained to all those involved and a 'Briefing Record' (FM-H&S-002) completed.

1. Description of the Work

This method statement describes the procedures for transporting and placing exempt and Low level radioactive material at the designated area of permanent deposition at Zone 4 and the safety measures that will be implemented in connection with this operation. This method statement is part of the overall radiation protection strategy and must be read in conjunction with the Nuvia project specific procedures and methodologies.

2. Reference Documents

- MCL Safety Policy.
- ENW-ATK-4-SP1-DR-3-H11-0011 Rev.C1
- MCL Health and Safety Management System.
- Test and Inspection Plan

3. Responsibilities

- MCL Supervisor will undertake and record the Site Induction / Safety Awareness talk to all site employees, including sub – contractors' employees, prior to commencement of their works. A record of this induction will be kept on site and all operatives will sign to show that they have been inducted.
- The MCL Supervisor is to have a copy of this Method Statement and its corresponding Risk Assessment on site. All members of the site team involved in carrying out this work are to sign to show that they have understood this method statement and a record of this is to be kept on site.
- Work on site will adhere to the "Site Specific Code of Construction Practice". Document no:
  - PRO-MOR-CE-05c-OLP-SP1-E-0002.

4. Sequencing of the Work

MCL will issue a copy of this method statement to the ODA for approval.

Prior to commencement of works:

- MCL staff shall provide a site induction identifying the full scope of work to be carried out and highlighting all associated risks.
- Morrison Construction shall set up a Safe System of Work. All work personnel involved in the site wide operations shall read and understand this method statement and sign to record that it has been understood.
- Morrison Construction shall ensure all personnel involved have the correct personal protective equipment (PPE) to carry out the work in accordance with this method statement and risk assessment.
- Welfare facilities will be provided at both 6A and Zone 4site offices.

- Loading of the contaminated soils at the Morrison's site will be under the supervision of Nuvia and in accordance with the RPA's recommendations and guidelines. Particular attention must be paid to the procedure for loading and unloading wagons as the risk of cross contamination is high. To this end the presence of Health Physics Surveyors at both ends of the operation is critical in order to carry out inspections and maintain concise and unambiguous internal waste transfer tickets, description of contents and signatures for despatch and receipt. Great emphasis will be placed on the prevention of accidental spillage of material en route. This can be achieved by ensuring that the trucks are not overloaded, the material is adequately covered and random checks are undertaken along the route. Under loading the trucks is therefore a safe method of verification that no cross contamination or spillage takes place .Furthermore it is proposed that all road wagons leaving 6a are weighed on route to zone 4.

- No lorries arriving from the Morrison site will be allowed to tip unless directly instructed by the Nuvia Health Physics Surveyor whose key role is to ensure that the deposition of soils is undertaken as per RPA's recommendations.

- Prior to commencement of material deliveries the proposed area will be clearly identified, surveyed and fenced off. The Herras fencing will be positioned at such a distance from 3rd parties fencing so that a 5m exclusion zone is maintained. Radiological reassurance monitoring of the proposed deposition area will be undertaken by the Nuvia Health Physics Surveyor. All existing services in the area of works will be identified with the help of a cat scan .Service dwgs information from the various utility companies will be available on site at all times.

- All plant movements will be controlled by Banksmen.Two banks men, one at the point of loading and one at the point of off loading will be present. All operators of plant must hold a current certificate of training achievement a copy of which is to be retained in the site office along with the relevant test certificates for the plant in use. Records of weekly plant inspections must also be regularly entered in the LOLER register retained in the site office. Goal posts will be erected next to any overhead cables with the height restraints in place for all machines working in the vicinity.

- The material will be delivered in sheeted 8 wheeler trucks and will be spread in layers not exceeding 200mm in depth by a D6 dozer and will be compacted using a single drum roller as per Table 6/4 method 2 of the Specifications for Highway Works .Geotechnical testing will be as per table 6/1 Baseline Earthworks Specifications .It is proposed that the testing is carried out on the basis that 3no PSDs, 5no MCs, 2no MCVs and 3no PLs are carried out per 1000m3 of fill placed. In addition to the above periodical nuclear gauge testing will be undertaken in order to demonstrate that the fill has been adequately compacted.

- Once the material has been deposited it will be further tested in terms of chemical acceptability by sampling at a rate of approximately 1 test per 500 m3 of fill placed.

- Although screening of the existing stockpiles for radiological contamination has been undertaken by Nuvia the likelihood of other contaminants in the soil such as asbestos or heavy metals must be considered. It is therefore proposed that regular monitoring is undertaken during placing of the fill and it is essential that all operatives are familiar with the health and safety guidelines and procedures for work undertaken in a contaminated environment; particular emphasis will be placed on the PPE issues, air monitoring and dust suppression during backfilling. A crop spraying equipment ,or similar system,will be employed in order to ensure that the workforce or other contractors are not exposed to dust generated by the site operations. A decontamination unit will be installed within the site compound and all personnel will be inducted in the procedures to be adopted and the dirty/ clean protocol currently in implementation at the 6a Earthworks contract. A series of tool box talks will be carried out by the site supervisor in order to highlight the hazards associated with contaminated soils.

- As previously stated the risk of cross contamination must be addressed at both ends of the operation and to this end a jet wash will be employed at the deposition area for the duration of the works.

5. Emergency Rescue Procedures

First Aid boxes will be stored in the Site Office and the Security Cabin. The hospital route is shown on a plan and can be found within the site file for the project. If any person suffers an injury then the emergency services should be called if necessary and first aid administered.

If an ambulance is required the site address is:

TBC

All accidents / incidents must be reported to a member of the Morrison CL management team and reported in the site accident book.

6. Unexploded Ordnance

N/A

7. Contaminated Ground

Contaminated ground awareness and protocol will be covered in the Site Induction.

Dirty / Clean working will be adhered to.

Washing and shower facilities will be available at the site compound.

8. Resources (Labour, Plant, Materials, Sub-Contractor)

Labour	4 no operatives Sub-Agent Engineer Supervisor Health Physics Surveyors (2 no)
Plant	35t Excavators, 8 wheeler trucks,D6 dozer, single drum roller, Decontamination unit, weigh bridge, jet washer, Nuvia equipment as per their method statement.

9. Access and Working Area

Access to the proposed are4a of works site will be over the River Lea crossing between CZ 5 and CZ 6 via a security gate. The working area will be fenced off with Heras panels where there is not already a boundary fence or wall.

10. COSHH and PPE

Full PPE will be worn at all times .

11. Protection for the Public and Other Contractors

Due to the area being closed to the public third party injuries are not expected.

12. Site Specific Rules

As site induction.

13. Security Systems

No plant shall be left on site unattended during the shift in a potentially unsafe manner. All plant shall parked in the specified location as shown on the site plan.

14. Permits (safe systems of work)

This method statement should be read in conjunction with the Risk Assessment. Together with the permits to excavate and excavation check sheets.

15. Programme

The works will be carried out during normal working hours through the week.

16. Sub-contractors

Works will be carried out by plant hire operatives with hired plant. All operations will be supervised and controlled by Morrison Construction.

Appendix A

1) Nuvia Method Statement

Emergency Instructions
for Drivers Transporting
Radioactive Material on site

Please read these instructions before commencing your journey and keep them on your person at all times for reference.

1. Do not carry passengers without the prior permission of the person consigning the radioactive material and the Health Physics Surveyor.

2. Do not leave the vehicle unattended when loaded. In the event of an emergency, stay with the vehicle and get a message to the supervisor who will arrange recovery. All breaks to be taken after discharge of load.

3. Breakdowns and minor accidents, which do not affect the integrity of the load, may be dealt with at the discretion of the driver, provided that none of the above are infringed. Inform the Site Supervisor and the Health Physics Surveyor of any such occurrences immediately.

4. You must as soon as reasonably practicable, arrange for the Site Supervisor / Recipient to be informed if you suspect that in the course of the journey:

a) any radioactive material has spilt from the vehicle;

b) the vehicle or its load is in danger, e.g. from fire.

IN THE EVENT OF SUCH AN ACCIDENT OR INCIDENT CARRY OUT THE INSTRUCTIONS ON THE REVERSE OF THIS SHEET IMMEDIATELY.

EMERGENCY INSTRUCTIONS

The following instructions apply for any accident or incident in which damage to, or loss of any part of the radioactive load cannot be ruled out.

1. Ring the Site Supervisor and provide details of incident, including location and return telephone number

2. The Site Supervisor to inform the Health Physics Surveyor and Site Manager for recovery assistance who can seek recovery advice from the Radiation Protection Adviser.

3. If you are in an accident whilst carrying radioactive material there is no cause for alarm. If, however, there is any reason to suspect the load has been spilt you should take the following action whilst awaiting a response from steps 1 and 2 (above):

   a) Keep people away from the vehicle subject to the overriding need of saving life

   b) Keep at hand any documentation relevant to the consignment, especially this document

   c) Do not attempt to remove the load from the vehicle.

   d) If there appears to be any escape of radioactive material, and especially if it is spilt on the road, erect, if possible, a temporary barrier around the affected area. As far as possible any approach should be made from upwind.

   e) If any person at the scene has handled, or otherwise come into contact with the contaminated soil that person should remain at the scene and be instructed not to eat, drink, smoke or otherwise put their hands to their mouth.

   f) Any such person who may be contaminated should be kept in a safe position and arrangements should be made through the Health Physics Surveyor via the Site Supervisor for expert attention as soon as possible

   g) If any radioactive material is thought to have settled on anyone's clothing, e.g. shoes, the affected items should be removed at the earliest practicable opportunity, taking care not to touch the contaminated parts, and should be placed where they cannot contaminate other people or property, pending examination by Health Physics Surveyor.

Distribution: Carrier,

Work Description: Radiation protection controls for removal and transfer of radiologically contaminated soil, and placement in final deposition area in the approach ramp to bridge L03.	**NUVIA Reference: 87216/MS/005** **Rev. Details: Issue 4**

PRIOR TO **COMMENCEMENT**

Author: [redacted] **Date:** 09/10/2008

Checked by: [redacted] Advisor) **Date:** 09/10/2008

Approved by Morrison Construction: [redacted] 22/10/08

Approved by Nuttalls: [redacted] **Date:** 22/10/08

All persons who will work to this method statement to sign below to acknowledge that they have read and understood this statement and will work in accordance with the methods described within.

	NAME	SIGNATURE	DATE
1	[redacted]		19/10/08
2			19-10-08
3			9/11/08
4			
5			
6			
7			
8			

Background and scope

During the excavation of Olympic sites, as part of the enabling works, radioactively contaminated spoil was discovered in areas in CSZ3A, CSZ6A and CSZ6D. This spoil has since been removed and transferred to a bunded area at CSZ6 (**Morrison Construction**) and assayed prior to disposal under controlled conditions (ref. MS/87216/003). The disposal location for this material is in the foundations to the approach ramp of bridge "L03", the construction of which is the responsibility of **Nuttalls**.

As required by the Ionising Radiations Regulations IRR1999 (Regulation 13), both **Morrison Construction** and **Nuttalls** have appointed a Radiation Protection Adviser (RPA) from Nuvia to provide radiation protection advice to comply with the Ionising Radiations Regulations 1999. Due to the nature of this work (the transport and deposition of active material from the **Morrison** site to the **Nuttalls** site), this Method Statement has been prepared to detail the radiological protection requirements for both contractors.

The specific steps within this Method Statement have been colour coded such that steps that are the responsibility of **Morrison** are coloured **red**, and those that are the responsibility of **Nuttalls** are coloured **green**. Any steps that are relevant to both Morrisons and Nuttalls are coloured **blue**.

A Prior Radiological Risk Assessment (PRA) has been completed for the deposition of the active spoil at bridge L03 (ref. 87216/PRA/007). This forms the basis of controls as described in this method statement to ensure that personnel and equipment exposures to ionising radiations are adequately minimised and dose uptakes are ALARP (As Low As Reasonably Practicable).

These items are identified with this method statement:

Standard PPE Requirements	HP Monitoring Equipment	Associated Documentation
▪ Hard hats ▪ Light Eye Protection (LEP) ▪ Gloves ▪ Hi Vis Jacket ▪ FFP3 Ori-nasal mask ▪ Disposable coveralls ▪ Mid-sole safety boots	▪ GroundHog probe ▪ 44B gamma probe ▪ Alpha + Beta contamination probe ▪ 110v Static Air sampler ▪ Personal Indicating Dosimeter (PID) ▪ Static Air Sampler (SAS)	▪ Prior Radiological Risk Assessment (87216/PRA/006)

Additional equipment may be required as the work evolves.

The role of the Nuvia Health Physics team (contracted to **Morrison** or **Nuttalls**) is to carry out radiological re-assurance monitoring of the recovered spoil stockpile areas, new deposition area, surrounding areas and personnel, plant, machinery and equipment used in the works. Radiological hold points are defined within the Method Statement to determine whether any additional controls are required. Material with radioactive contamination will be moved under the supervision of Health Physics from CSZ6 and placed for safe final deposition in one of the bridge L03 approach ramps.

The recovery and transport of the stockpiled material from CSZ6 to bridge L03 will involve the use of an excavator, fork lift and dumper trucks.

Some damping down methods may be employed, by means of misting (water), if contaminated material being excavated appears to be dry and dusty in order to minimise airborne contamination arisings.

Site Welfare & Emergency Procedure

Welfare facilities have been provided by **Morrison** and **Nuttalls** as requested by Nuvia. Decontamination facilities, toilets, showers, canteen etc are as per site induction, as are the emergency procedures. All site personnel are asked to check notice boards daily. These will advise upon any changes; including assembly points; which are identified on site notice boards and advised at induction.

In the event of a site emergency, which requires the support from the emergency services, dial **0300 20 12 222**.

Additional information

The additional PPE required by Nuvia whilst working on the transfer operation will be FFP3 face mask and a personal dose meter. The PPE requirement will be adequate to protect personnel from the radiological hazards and must be worn in addition to the PPE outlined in the table on page 2.

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
1	**Preliminaries**					
1.1	Undertake a sensitive walkover gamma radiation survey (using a Groundhog™ probe) of the area in the bridge L03 approach, where the spoil deposition is to take place. This is to ensure the area is at general background levels. Survey the immediate surroundings to ensure no pre-existing contamination and uniform background. **Groundhog Walkover Hold Point**: <900cps no action required >900cps = mark out area for further investigation	Radioactivity	Dose uptake	SQEP HP Surveyor	GroundHog probe Spray paint to mark out any potentially contaminated areas.	HP Surveyor
2	**Counts <900cps**					

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
2.1	Prepare a survey report confirming that the surface layer of the LO3 approach is clear from contamination.	-	-	-	Survey Report	HP Surveyor
3	**Counts >900cps**					
3.1	Notify Nuttalls site manager and demarcate contaminated site with barrier and signage stating 'Contaminated Area'.	Radioactivity	Dose uptake	SQEP HP Surveyor Legal dosimetry	GroundHog probe Radiation dose rate meter Barrier assembly Signage PID (HP Surveyor) Mark on drawing	HP surveyor Site operative(s)
3.2	Carry out dose rate measurements. Contact RPA for advice on area designation. **ACTION: If dose rate exceeds 7.5µSv/h, contact RPA for further advice.**					
3.3	Determine if contamination is widespread or detection is caused by discrete items in ground by deploying 44B probe to contaminated area.	Radioactivity	Dose uptake	SQEP HP Surveyor	44B gamma probe	HP surveyor
3.4	Mark contaminated site on map/drawing.				Site map with references of plots	

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
4	**Evidence of discrete items (including those found arising in spoils)**					
4.1	Extract discrete item(s) from the ground using handtools and place into a seal grip pvc bag (supplied by Nuvia).	Radioactivity	Dose uptake	SQEP HP Surveyor PPE (puncture resistant gloves / coveralls)	44B gamma probe PID (HP Surveyor) Sample pots or sealable bags Marker pen 200 ltr black drum Black drum inventory log Artefact inventory log	HP Surveyor Hand tools Artefact store in CSZ6.
4.2	Mark up bag with contamination and radiation details, noting the plot location where the item came from.					
4.3	Add all discrete items found to the artefact inventory and store in the artefact store in CSZ6.					
4.4	Re-survey the ground until the Groundhog level is <900cps. If survey result is <900cps, revoke the demarcation and signage.	Traces of residual radioactivity	Dose uptake	HP SQEP Surveyor	GroundHog probe	HP Surveyor
4.5	An inventory of items must be maintained. All discrete items to be placed into 200ltr black drum for transfer to artefact store in CSZ6.				Survey report forms Site map with plot references Black drum inventory log	Artefact store in CSZ6

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
5	**Widespread contamination (no discrete items)**					
5.1	Record details of contamination.	Radioactivity	Dose uptake	SQEP HP Surveyor Site safety awareness Pre-works brief on hazards HP to define safe monitoring area	GroundHog probe 110v Air sampler Ori-nasal mask (FFP3) PIDs Static Air Sampler HP Survey report form	HP Surveyor Generator
5.2	Where possible, photograph exposed surfaces, particularly evidence of contamination and/or man-made material. Arrange for images to be sent to the RPA.	-	-	-	-	Digital camera
6	**Monitoring of the Stockpile of "clean" cover material for bridge L03**					
6.1	Carry out a survey of the clean stockpiled material that is to be used as clean backfill, as outlined in section 1 of this method statement.	As Section 1.				
6.2	Stockpile area must be clearly demarcated by means of temporary fencing (i.e. Heras fencing) to prevent addition of unmonitored materials following survey.					

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
6.3	Record details of monitoring survey in monitoring certificate, and report any radiation levels above 900 cps to the RPA.					
7	**Transfer of Exempt and LLW material from stockpiles in CSZ6 to Bridge L03 area (Morrison)**					
7.1	Report estimated volume of material to be transferred to site CSZ6 to L03.	-	-	-	-	-
7.2	Ensure that the transfer of exempt and LLW material does not take place without the express permission of the Morrison Site Manager and Nuttall site manager.	Unauthorised disposal or radioactive waste.	Breach of regulations. Additional work in retrieving the waste.	Morrison Site Manager Nuttall Site Manager Safe System of Work.		
7.3	Ensure a facility for washing wheels is in place at the exit point of the stockpile quarantine area (within the designated area).	Contaminated wheels	Contamination spread across site	Wheel washing facilities		Hose or pressure washer + Operative
7.4	Set up air samplers at the stockpile area downwind to the active spoil. All air samples to be counted initially, followed by 72 hours decay count. 72 hour air sample hold point: <0.05 Bq/m^3 = no action >0.05 Bq/m^3 = contact RPA	Airborne contamination	Internal radiation hazard	Static Air sampling FFP3 dustmasks	Static Air Samplers	HP Surveyor Site operative

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
7.5	Set up four air samplers at the deposition site at points of the compass at the boundary to the deposition site. All samples counted initially followed by 72 hour decay count. **72 hour air sample hold point:** <0.05 Bq/m^3 = no action >0.05 Bq/m^3 = contact RPA	Airborne contamination	Internal radiation hazard	Static Air sampling FFP3 dustmasks	Static Air Samplers	HP Surveyor Site operative
7.6	Materials to be wetted (if any airborne dust is likely to be generated) in the heap using pressure washer or hose to minimise dust when loading and tipping	Dispersible material Radiation dose rate	Airborne contamination Mis-directed load and accidental tipping Dose uptake	Pre-works brief PID results logged by HP Surveyor (for drivers carrying LLW). FFP3 dustmask.	Establish route and present to drivers PID to driver carrying LLW. Emergency instructions	Excavator + driver Forklift + driver Lorry drivers Lorries with automatic sheeting
7.7	Establish route to / from CSZ6 and L03 (ensuring that the risk of material spillages are minimised).					
7.8	**ACTION: Seek advice from the RPA if vehicles are likely to be transporting material on public highway**					
7.9	Drivers transferring the LLW bags must be issued with Personal Indicating Dosimeters for re-assurance purposes and receive a pre-works brief before any transfer commences. **PID limit = 10μSv per day**					

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
7.10	Drivers issued with emergency instructions (a laminated A4 sheet prepared by Nuvia) and map of approved route.					
7.11	The LLW bags are to be transferred first. They are to be transported without mixing with other wastes. A forklift is to be used to load LLW bags into truck. Load bags as a **single** layer in truck base. The load is to be sheeted over to prevent dust arisings during transport.					
7.12	Only after all LLW waste bags have been moved will the loose stockpiled Exempt spoil be moved. An excavator is to transfer the Exempt contaminated material from the stockpile into the lorry leaving 300mm between the load and the top of the skip. *Note that the lorry should be located outside the supervised area to prevent it becoming contaminated during loading.* Excavator driver to load truck from as low height as possible (to minimise dust arisings). Damp down as necessary. **DO NOT MIX EXEMPT MATERIAL AND LLW MATERIAL IN SAME LORRY.**	Dispersible material	Airborne contamination	Controlled tipping SQEP HP surveyor to advise HP monitoring of any personnel or plant leaving the supervised areas. FFP3 dustmasks Static Air Sampler	110v Air sampler (located at stockpile workfront)	Generator

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
7.13	Using the back of the bucket, the excavator will be utilised to pat down the Exempt spoil load to seal it from wind. Additionally, the lorry driver will use the automatic sheeting to cover each load before the lorry moves off from CZS6 to L03.					
7.14	HP will advise the lorry driver of the correct deposition location of the spoil upon arrival at L03.					
7.15	Prior to any lorry leaving site, the HPS will survey the wheels for radioactive material. HPS to do a walk around of the load with the RO2 (or equivalent) dose rate meter, to check for radiation dose rate emitted 1m from the vehicle's edge and driver's cab.	Radiation	Dose uptake	SQEP HP Surveyor	Radiation dose rate meter	HP Surveyor
7.16	**Vehicle Dose Rate Hold Point:** Any vehicle found to have a dose rate greater than 2.5μSv/h at 1 metre from the edge of the vehicle or in the driver's cab will be prevented from leaving CSZ6 until the rate is reduced.	-	-	-	-	-
7.17	Wheels will be washed down by a nominated operative with a pressure washer and monitored by Health Physics.	Contaminated wheels	Contamination spread	Washing facility SQEP HP	Hose or pressure washer Contamination instruments	Health Physics surveyor
7.18	Lorries will be issued with an internal waste transfer ticket by the Banksman.	Lost control of waste traceability	Inadvertent tipping of contaminated	Waste ticket system	Waste tickets	Site waste ticket issue system

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
7.19	Lorries will proceed directly to deposition site at Bridge L03 using the approved route.		material	Establish approved route	Site map indicating route to Bridge L03	
7.20	Lorries will not break their journey when loaded – all breaks will be taken after discharge of spoil at Bridge L03.	Increased risk of spills of active material.	Spread of contamination.			
7.21	On arrival at the bridge L03 deposition site, driver will await contact by Morrison's banksman or HP. Once he has been contacted and directed to the appropriate deposition area, he will discharge load as directed by Morrison staff. **ON NO ACCOUNT** is any load to be unloaded or tipped without explicit direction from Morrison staff [inc. their HP Surveyor]. Receiving staff are to sign transfer ticket and return copy to driver, retaining one copy.	Material tipped at incorrect site.	Unauthorised tipping Site unprepared to receive material	Establish contact point at Morrison		
8	**Deposition of the Wastes in L03 Disposal Cell**					
8.1	Prior to any waste deposition the bag splitter to be relocated from CSZ6 to Bridge L03. The bag splitter is to be lowered into the deposition area using an excavator or forklift.	Potential contamination on bag splitter.	Spread of contamination.	HP clearance survey prior to movement of bag splitter.	HP instruments.	HP Surveyor
8.2	Confirm the presence of the bag splitter in the deposition area.	-	-	-	-	-

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
8.3	Dumper driver to drive into prepared location within the supervised area, along with FLT / telehandler driver.	Exposure to exempt material	Spread of contamination, chronic exposure to contaminated material	Drivers to remain within cab of vehicle. FFP3 dustmask to be worn during bag splitting.	-	Dumper driver FLT driver
8.4	Ensure that the bag is free from damage and visually assess condition before lifting (using FLT / telehandler).	Potential for contaminated spoil spilling from builders bags as a result of splitting or tearing during lifting operations	Potential dose to operators in clearing up spillage.	Visual inspection of bag prior to lifting		
8.5	Lift the 1 tonne bag using the FLT / telehandler and suspend over the centre of the deposition area as directed by a banksmen.	Potential spill of LLW in wrong location	Potential dose to operators in moving the spillage.	FLT driver to remain within cab. Visual inspection of bag prior to lifting.		Banksmen FLT driver
8.6	HP Surveyor to note the bag reference from the side of the bag (this should be ticked off a list of all LLW bags).	Industrial hazard from suspended load.	Injury to surveyor.	HP surveyor to maintain distance from the bag and plant.	List of LLW bags with references to be marked as bags are split.	Health Physics Surveyor

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
8.7	Using the bag splitter, mounted on a FLT, lower the LLW bag on top of the splitter to split the base of the LLW bag over the deposition area.	Potential generation of airborne activity.	Potential internal dose to operators.	FFP3 dustmasks to be worn by all operators involved in the work. Damp down material if visible airborne material is seen. Operation to be carried out remotely (operators in cabs). Standard site PPE.	Bag splitter Damping down equipment.	2 FLT drivers
8.8	Remove the split bag from the forks of the FLT/telehandler and place in a secure location until the disposal route for the empty bags is established.	Industrial hazards from working with plant. Low level contamination remaining on bags.	Industrial injury. Potential internal dose.	FFP3 dustmasks. Puncture resistant gloves to be worn.	HP instruments.	HP Surveyor / Banksman
8.9	Periodically move the bag splitter location to ensure an even distribution of LLW spoil within the deposition area. Repeat steps 8.4 to 8.8 until all of the LLW bags have been emptied into the base of the deposition area.	As above	-	-	-	-

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
8.10	If any manufactured artefacts (e.g. Radium dials) are observed in the spoil during the operation, the HP surveyor should be informed in order to remove and place in artefacts store. **Consult RPA for advice if required.**	Radiation and contamination hazard.	Radiation dose. Potential for contaminated clothing and inhalation of airborne contamination.	FFP3 dustmasks. Damping down if necessary. Puncture resistant gloves	Hand tools. HP instruments. PIDs	HP surveyor
8.11	Monitor the wheels of the FLT and truck out of the supervised area. Ensure that wheels are washed and re-monitored prior to leaving the supervised area if contamination is detected.	Potential spread of contamination.	Potential internal dose to staff at the site.	Health Physics monitoring of plant prior to leaving the supervised area.	Health Physics monitoring equipment. Wheel washing equipment.	Health Physics Surveyor
8.12	On completion of unloading or tipping, receiving HP will check trucks for contamination. HP will ensure any trucks failing are cleaned within receiving supervised area prior to authorising return to CSZ6.	Residual contamination	Contamination spread Dose uptake	SQEP HP Surveyor Washing facility set up Automatic sheeting deployed	Alpha + beta contamination probes	
8.13	Lorries must re-cover the empty skip with the automatic sheeting to prevent any residual dust from being blown out during transport.					
8.14	All drivers will return to CSZ6 stockpile area to return signed ticket to despatching HP. HP will be responsible for ensuring complete records are created and maintained for all materials transferred.	-	-	-	-	-

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
8.15	At the end of the day the lorry skip must be washed out. PID returned to HP Surveyor.	Residual contamination	Contamination spread Dose uptake	SQEP HP Surveyor Washing facility deployed	Alpha + Beta contamination probes	
9	**Deposition of exempt soil and clean cover**					
9.1	Deposit the exempt material into the L03 location using standard excavation and deposition techniques.	Exposure to low levels of contamination	Potential internal dose. Contamination of plant / equipment.	Monitoring of equipment as it leaves the area. Damping down. Air sampling. PPE. FFP3 dustmasks.	Dump truck. Health physics monitoring equipment. Static Air Sampler.	HP Surveyor Dumper driver.
9.2	Upon completion of the placement of the LLW spoil and the Exempt spoil, the deposition area is to be covered with a cap of clean spoil from the "clean" spoil stockpile (following the survey undertaken in step 9.1).				Design drawings.	
9.3	After completion of the cover and its compaction Health Physics will walk over the completed deposition and immediate surrounding areas with a gamma sensitive detector. Groundhog walkover hold point identified in 1.1	Residual radioactivity	Contamination spread Dose uptake	SQEP HP Surveyor	Groundhog^{TM} probe Survey report form	

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
9.4	Health Physics to complete a survey report of the final walkover survey.				HP report form	HP Surveyor
10	**Monitoring of equipment plant, workplace and personnel**					
10.1	Monitor for contamination all plant, equipment and personnel before leaving the supervised areas.	Radioactive contamination	Dose uptake Contamination spread	SQEP HP Surveyor	44B gamma probe Alpha + beta contamination probes Wet wipes (swabs) Survey schedule Pressure Washer for washing down contaminated heavy plant equipment	
10.2	Carry out re-assurance checks of all plant and equipment.					
10.3	Decontaminate as necessary using hand tools (brushes, scrapers, etc).					
10.4	Any waste generated from decontamination activity must be disposed of with the deposited waste in L03 prior to the capping layer being placed.					
11	**Stockpile area final walkover survey clearance**					
11.1	Health Physics will walk over the Exempt and LLW bag stockpile areas once all of the contaminated material has been successfully transferred with a gamma sensitive detector. Groundhog™ walkover hold point identified in 1.1.	Residual radioactivity	Contamination spread Dose uptake	SQEP HP Surveyor	GroundHog probe Survey report from	HP Surveyor
11.2	Health Physics to complete a survey report of the final walkover survey.					

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
12	**Reporting**					
12.1	Survey results are to be verbally reported to the Radiation Protection Advisers, including any positive air sampler results, and documented on standard contamination and radiation survey report.	-			Survey report forms.	
13	**Contingency Plan**					
13.1	In the event that active material is spilled (outside the trucks or supervised area), operators should cease operations and inform the HP surveyor.	Exposure of personnel to low levels of radiation and contamination.	External and internal dose of radiation.			
13.2	Health Physics surveyor should, as soon as possible, recover the material and place into a builders bag, using hand tools (unless it is a major spill when mechanical means may be required). Ensure that the material is damped down if there is potential for dust arising. If there are any problems contact the project RPA, or if the project RPA is not available the Radiation Emergency Response Officer (tel. 07659 121614 and leave name and contact number)	External and internal radiation exposure.	External or internal dose of radiation.	FFP3 dustmask SQEP HP surveyor	Handtools Health Physics monitoring kit FFP3 dustmask	HP surveyor
13.3	Undertake a survey of the area to ensure that all radioactivity has been removed.	-	-	-	Health Physics monitoring equipment.	HP surveyor

No	Activity	Hazards	Risk	Safeguards	Equipment, drawing etc	Tools, services required
14	**Boundary Monitoring**					
14.1	Set up four air samplers at the four points of the compass at the boundary to the deposition site. All samples counted initially followed by 72 hour decay count. **72 hour air sample hold point:** <0.05 Bq/m^3 = no action >0.05 Bq/m^3 = contact RPA	Airborne contamination	Internal radiation hazard	Static Air sampling FFP3 dustmasks	Static Air Samplers	HP Surveyor Site operative
14.2	Undertake a daily radiation survey around the boundary of the deposition site. Report results of survey to RPA should dose rates exceed 1 microSv/h at the boundary of the deposition site.	Radiation exposure to on-site workers	External radiation hazard	Routine radiation surveys	Health Physics instruments Survey report form	HP Surveyor
14.3	Undertake daily contamination surveys at the access point to the demarcated area around the deposition area to ensure no spread of contamination. Report results of survey to RPA should any contamination be detected outside the designated area.	Spread of contamination onto the site	Internal radiation hazard	Routine contamination surveys	Health Physics instruments Survey report form	HP Surveyor

Title: Transfer and Deposition of Exempt and LLW into Approach Ramp to Bridge L03 **Radiological Risk Assessment**	**Reference:** **87216/PRA/007** **Issue 2**

Prepared by: [redacted] **Nuvia RPA)** [redacted]	**Date:** 04/10/08
Checked by: [redacted] **(Nuvia Ltd RPA)** [redacted]	**Date:** 9 Oct 08
Approved by: [redacted] **(Nuvia Project Manager)**	**Date:** 9th October 2008

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1.0	**INTRODUCTION** As part of the Olympic park enabling and remediation works, several areas across the site have been found to contain elevated levels of radioactivity. This material has been segregated and assayed (in accordance with PRA/87216/006) in order to confirm it's radiological status (i.e. whether it is radiologically exempt under the Phosphatic Substances and Rare Earths Exemption Order, or whether it is classified as Low Level Waste). Following consultation with the appropriate authorities, agreement has been reached that this material can be co-processed as a whole and disposed of as "exempt material" on the site. The material is currently being stored in stockpiles and 1 m^3 builders bags on the Morrison site (Zone CZ6A). The deposition location has been agreed at the foundations of the approach ramp to bridge L03, which is in Zone 4 on the site. Although this work is similar to other radioactive material assay and excavation work that has been undertaken across the site (with specific Prior Risk Assessments), this PRA has been prepared to ensure that all radiological risks specific to this task are considered. Paragraph 44 of IRR99's Approved Code of Practice (ACoP) specifies those matters that must be considered within the assessment where they are relevant. Paragraph 45 of the ACoP is a list of objectives that the assessment should enable an employer to achieve. **Scope of this Prior Radiological Risk Assessment** The scope of this PRA is to consider the radiological hazards associated with the movement of the exempt and LLW material from its current location on the Morrison site (CZ6A), and its deposition in the foundations of the approach ramp to bridge L03. This material is either currently stored in stockpiles of exempt waste, or builders bags (of exempt or LLW). Note that this PRA is purely concerned with any radiological hazard from the works, and does not consider any conventional industrial hazards associated with the work. In the event that additional radioactive materials are discovered during the project (which may or may not have a similar fingerprint to that already accumulated), this PRA should be reviewed and the hazards addressed accordingly.
2 2.1	**Risk Assessment** *What is the nature of the sources of ionising radiation to be used, or likely to be present, including the accumulation of radon in the working environment?* Samples taken from the contaminated spoil that has been accumulated (and has been assayed) have been sent for laboratory gamma spectrometry analysis. The results of the analysis identified a mixture of nuclides, namely: • Radium-226 (Ra-226)

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	• Protactinium-231 (Pa-231) • Uranium Ore (Nat-U) • Thorium-232 These isotopes are consistent with the results from High Resolution Gamma Spectrometry that has been undertaken on a high proportion of the waste. The contamination is in the form of soil (estimated to be 90%), with building rubble (estimated to be 5%) and domestic rubbish (estimated to be 5%). All the work to be undertaken is outside, therefore build up of radon is not an issue.
2.2	*What are the estimated radiation dose rates to which anyone can be exposed?* The highest dose rates that have been encountered to date are discrete items showing 300 μSv/h γ and in excess of 10 milliSv/h β/γ on contact. However, at one metre from these items the dose rates drop significantly to 2-3 microSv/h gamma and 60 microSv/h β/γ (items of this activity have been segregated and placed in a 200 litre drum). The most active spoil has been contained within 1 m^3 builders bags (double skinned). The maximum dose rates on contact with these bags vary between a couple of microSv/h to 50 microSv/h on contact, however this dose rate drops off significantly within 1 metre (to a couple of microSv/h). When the spoil is removed from these bags at the deposition site, the dose rates should generally decrease as the material will be less concentrated in the deposition area.
2.3	*What is the likelihood of contamination arising and being spread?* There is the potential for contamination to spread if safeguard measures are not implemented.
2.4	*What are the results of any previous personal dosimetry or area monitoring relevant to the proposed work?* During the excavation, accumulation, bagging (where required) and transport across site of this material staff were subject to personal air sampling, electronic personal dosimetry and static air sampling were all in place (depending on the particular operation and the level of radiological hazard). No doses have been recorded on the personal dosimetry, and all air sampling results (both personal and static) have shown no evidence of any airborne contamination.
2.5	*What is the advice from the manufacturer or supplier of equipment about its safe use and maintenance?* This point is primarily aimed at radiation generating equipment and as none is being used it does not apply. However, as a general point, all instrumentation and excavating equipment will be used by suitably qualified and experienced personnel following procedures / instructions that take account of manufacturers advice.
2.6	*What engineering control measures and design features already in place or planned?* The prime radiological hazard associated with the assay of this material is the potential spread of contamination, with the potential consequences of workers receiving a dose via ingestion or inhalation of radioactive materials or injection of radioactive material through a contaminated wound. It is highly unlikely that any airborne contamination will be generated whilst the material is contained within builders bags. The stockpiled material has been covered and compacted to minimise any dispersion. Prior to the excavation and moving of this material it will be damped down if this appears necessary to minimise any dust arisings (depending on the dampness of the material).

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	Action 1. Ensure that prior to moving current stockpiled material, it is damped down if there is the potential for dust arisings or dust arisings are observed (note that the minimum amount of water should be used in order to prevent the build up of pools of water or generating running water). In addition, damping down may be required when the exempt and LLW is deposited into the deposition area in order to prevent any material becoming airborne. **Morrison Construction** Vehicles used for transporting the active material across site will be only partially filled, and covered to prevent spillages. **Action 2.** Ensure that vehicles used for transporting active spoil are only partially filled, and are covered to prevent spillages. **Morrison Construction** In order to prevent spread of contamination the areas involved in the waste assay (the deposition area and the stockpile areas), will be clearly demarcated with appropriate signage and access controls. Static air samplers will be operating down wind in the areas where contaminated material is being excavated and deposited (the stockpiles and the bridge L03 footings) to provide reassurance that airborne contamination remains not an issue. **Action 3.** Ensure that static air sampling is undertaken at the stockpile area during excavation of the stockpiles, and at bridge footings during the deposition of the waste. **Morrison Construction / Nuttalls**
2.7	*Are there any planned systems of work? If so what?* A Method Statement has been prepared to detail the radiological controls to be taken during the work (87216/MS/005). This Method Statement will be incorporated into the safe system of work adopted by the two contractors responsible for the two areas associated with the work (Morrison Construction and Nuttalls). All personnel involved in the work (typically two HP surveyors, a digger driver, a banksman, a Fork Lift Truck driver and dumper drivers) will be familiar with the contents of this Method Statement and associated safeguards.
2.8	*What are the estimated levels of airborne and surface contamination likely to be encountered?* Based on the work that has been undertaken to date in initially excavating this material, and experience from previous land remediation projects, the likelihood of generating significant airborne contamination is considered to be low. No air sample results have yet been recorded that show activity-in-air concentrations above 0.05 Bq/m^3 (this is the level to which all work front air sample papers are decay counted down to). However, small pieces of debris have indicated significant levels of loose alpha contamination and where these are identified they have been wrapped and segregated from the majority of the waste to help prevent any spread of contamination. See Appendix 1 for an assessment of potential airborne contamination levels (although in practise none have been measured or are expected). Low levels of surface contamination have been detected on plant and implements utilised in the excavation of these materials, however this has been easily removed by the HP surveyor at the time, and has in general been no more than a few becquerels per square centimetre over small areas.
2.9	*What is the effectiveness and suitability of personal protective equipment to be provided?* Personal Protective Equipment required for personnel involved in the excavation and

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	deposition of the radiologically contaminated material consists of waterproof coveralls and gloves (which are a site requirement). This PPE should be sufficient to prevent any personal contamination. In addition, puncture resistant gloves should be worn by any personnel who could potentially be handling contaminated materials or touching plant or equipment that could be contaminated (in order to prevent contaminated wounds). FFP3 dustmasks will be worn by personnel working within the supervised areas in order to minimise any hazard from internal radiation (see Appendix 1).
2.10	*What is the extent of unrestricted access to working areas where dose rates or contamination levels are likely to be significant?* The Olympic Park site is a large secure site, which is accessed by authorised persons only. The stockpile areas where the contaminated spoil is stored is clearly demarcated with appropriate warning signage displayed. The deposition area will be similarly demarcated and signed up until the point that the active material is covered in 2 metre depth of radiologically clean topsoil. Access will only be permitted when qualified and experienced Health Physics surveyors are present to provide health physics cover, contamination monitoring and provide dosimetry. **Action 4.** Ensure that access is only permitted to the stockpile and deposition area to personnel that are required for the completion of the works, and under the supervision of a Health Physics surveyor. **Morrison Construction/ Nuttalls**
2.11	*What are the possible accident situations, likelihood and potential severity?* The most likely potential accident situation associated with the transfer and deposition of the material is the spillage or splitting of a bag of the higher activity material resulting in a spread of radioactive materials during transport to the deposition area. The likelihood of such an accident scenario is considered to be moderate, however the consequences are considered to be low. In addition, there is the potential for the generation of airborne contamination if the material becomes dry or is not adequately damped down. The likelihood for such an accident situation is considered to be moderate and the consequences are low. There is the potential for inadvertent exposure of personnel to elevated dose rates. Since most of the material has already been monitored as it was excavated and/or placed in bags the dose rates are fairly well understood. Therefore, the likelihood of this accident scenario is considered to be low and the severity low. The potential for contaminated wounds (and consequences) have been addressed in previous Prior Radiological Risk Assessments for similar work on the Olympic site.
2.12	*What are the consequences of possible failures of control measures – such as electrical interlocks, ventilation systems, and warning devices – or systems of work?* The relevant control measures and consequences of potential failure are detailed below: Failure of the damping down system could result in increased levels of dust loading at the stockpile / deposition area, and therefore the increased potential for airborne contamination to be generated. Failure of the system of work for radiological controls (determined by the actions from this risk assessment) could result in the chronic exposure of personnel to radioactive contamination due to the potential spread of contamination from well defined areas and potential airborne contamination. This could result in both internal and external radiation hazards.

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2.13	*What are the steps to prevent identified accident situations, or limit their consequences?* A detailed method statement (ref. 87216/MS/005) has been prepared which incorporates the appropriates controls required to prevent accident situations and includes contingency arrangements for limiting their consequences.
3.0	**Actions Required as a Result of Risk Assessment**
3.1	*What action is needed to ensure radiation exposure is ALARP?* The radiological exposure from the transfer and deposition of accumulated contaminated material is expected to be very low (judging by exposure to date from similar work with the same material). The actions and safeguards identified in this risk assessment and implemented through the Method Statement should ensure that the risk of exposure to personnel from internal and external radiological hazards are minimised to levels that are considered ALARP.
3.2	*What steps are necessary to achieve this control of exposure by use of engineering controls, design features, safety devices, and warning devices and, in addition, by the development of systems of work?* A safe system of work incorporating the radiological controls necessary to control exposure has been developed (ref. 87216/MS/005), this takes into account the recommendations of this PRA. This system of work should be regularly reviewed during the work to ensure that the radiological controls in place are sufficient to control exposure. The radiation dose rate should not exceed 2.5 microSv/h at any point around the perimeter of the work areas, and the whole body dose rate should not exceed 7.5 microSv/h within the accessible areas of the work locations at any time during the work.
3.3	*Is it appropriate to provide PPE and if so what type would be adequate and suitable?* In general, the PPE required by all operators to wear on the site should be sufficient to prevent any personal contamination (i.e. waterproof coveralls and gloves). However, in addition, for any operations that may involve the handling of contaminated material, or the handling of equipment that may have become contaminated, puncture resistant gloves should be worn. **Action 5.** Ensure that puncture resistant gloves are worn by any personnel likely to handle contaminated material or equipment during the waste assay operations. **Morrison Construction / Nuttalls** A Health Physics surveyor must be available to monitor personnel out of the supervised areas when any work with contaminated material has been undertaken.
3.4	*Is it appropriate to establish dose constraints for planning or design purposes and if so what values should be used?* There should be negligible radiological exposure above general background levels to personnel involved in this project. In this event, an individual Dose Constraint of 1 milliSv/y has been set (equivalent to the annual dose limit to members of the public), as this is a common dose constraint set for projects involving the remediation of radiologically contaminated land. This Dose Constraint may be subject to review should more information on the nature and extent of any contamination be obtained. It is consistent with the dose constraint set for the other work on the Olympic site.
3.5	*Is there the need to alter the working conditions of any female employee who declares she is pregnant or is breastfeeding? If so what alterations are necessary?*

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	Due to the known active materials that are present, any female employee who declares she is pregnant or breast feeding will not be asked to work in the stockpile or deposition areas. If this causes operational problems, a specific risk assessment will be undertaken taking into account the latest radiological information, to determine detailed controls that will be required to ensure that the working conditions of any such individual are acceptable.
3.6	*What is an appropriate investigation level to check exposures are being restricted as far as reasonably practicable?* An appropriate annual investigation level is 1 milliSv/yr, which will be monitored by the use of Personal Indicating Dosimeters and routine dosimetry (worn by non-classified and classified personnel respectively) when undertaking work excavating and depositing the waste. In addition, any doses above background will be reported to the RPA to ensure that doses received remain ALARP.
3.7	*What maintenance and testing schedules are required for the control measures selected?* The only maintenance and testing schedules required for the control measures selected are the annual calibration of all Health Physics instruments used to undertake monitoring.
3.8	*What contingency plans are necessary to address reasonably foreseeable accidents?* The most likely reasonably foreseeable accident scenario is considered to be the spread of uncontrolled contamination due to loss of work controls. In this event the Health Physics surveyor will instruct that work is ceased and inform the Morrison site manager and / or Nuttalls site manager and Radiation Protection Adviser. Health Physics monitoring should establish the extent of the contamination spread, and if appropriate extend any demarcated area. Agreement will be sought on the most effective method of removing the contamination, and work must not resume until it is clear why work practises were ineffective. In the event of elevated dose rates being monitored, the work will be reviewed to ensure that doses received remain ALARP. Routine Health Physics monitoring should ensure that any elevated dose rates are quickly identified and immediate actions (such as increasing the distance of personnel from the dose rate and segregating any items) can be implemented.
3.9	*What are the training needs of classified and non classified employees?* Nuvia Health Physics personnel will be supervising this work, and will brief any personnel unfamiliar with radiological hazards on the specific hazards of this work. **Action 6.** Ensure that all personnel undergo a toolbox talk on the radiological hazards associated with the waste deposition work. **Morrison Construction / Nuttalls**
3.10	*Is there a need to designate specific areas as controlled or supervised areas and to specify local rules? If so what areas?* In order to ensure that the radiological conditions of the work areas under review, the following areas should be designated as supervised areas: 1. The stockpile areas on the Morrison site (CZ6A); 2. The LLW bag and exempt bag accumulation areas on the Morrison site (CZ6A); 3. The deposition area at the footings to bridge L03 where the waste is to be deposited. The designation of these areas will be kept under constant review to determine whether they are required to become controlled. Local Rules for these areas have been prepared. Note that once the waste has been placed in the deposition area and a clean capping layer placed on top, a radiological survey will be undertaken to confirm that there are no elevated radiation or contamination levels prior to the area being de-designated. In addition, once all the exempt and LLW bags and stockpiles have been removed from their locations on the Morrison site (CZ6A), these areas will be surveyed to ensure absence of contamination or radiation and de-designated as appropriate.

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3.11	*What are the actions needed to ensure restriction of access and other specific measures in controlled or supervised areas?* All supervised areas will be segregated (through "heras" fencing) with only one access and egress point. Only authorised personnel directly involved in the operation will be permitted access. Access control remains the responsibility of Morrison Construction and Nuttalls.
3.12	*Is there the need to designate certain employees as classified persons? If so who?* No.
3.13	*What is the content of a suitable programme of dose assessments for employees designated as classified persons and for others who enter controlled areas?* Non-classified staff who do not have routine issue dosimetry will be required to wear electronic Personal Indicating Dosimeters (PIDs) when involved with the LLW transfer and all deposition work . Due to the fact that there has been no evidence of any airborne contamination in the initial excavation of this material, and static air sampling will be undertaken at the work sites, there is considered to be no requirement for staff to wear personal air samplers. This requirement will be reviewed if there is evidence of airborne contamination through static air sample results, or the appearance of significant quantities of dust (despite dust suppression measures).
3.14	*What are the responsibilities of managers for ensuring compliance with these regulations?* Morrison Construction and Nuttalls are responsible for ensuring that the ground work is undertaken in compliance with the requirement of the Ionising Radiations Regulations 1999.
3.15	*What is an appropriate programme of monitoring or auditing of arrangements to check the requirements of IRR99 are being met?* It is advised that Morrison Construction and Nuttalls regularly consult with a Radiation Protection Adviser as the project develops and radiological conditions potentially change.

Summary of Actions:

Action 1. Ensure that prior to moving current stockpiled material, it is damped down if there is the potential for dust arisings or dust arisings are observed (note that the minimum amount of water should be used in order to prevent the build up of pools of water or generating running water). In addition, damping down may be required when the exempt and LLW is deposited into the deposition area in order to prevent any material becoming airborne. **Morrison Construction**

Action 2. Ensure that vehicles used for transporting active spoil are only partially filled, and are covered to prevent spillages. **Morrison Construction**

Action 3. Ensure that static air sampling is undertaken at the stockpile area during excavation of the stockpiles, and at bridge footings during the deposition of the waste. **Morrison Construction / Nuttalls**

Action 4. Ensure that access is only permitted to the stockpile and deposition area to personnel that are required for the completion of the works, and under the supervision of a Health Physics surveyor. **Morrison Construction/ Nuttalls**

Action 5. Ensure that puncture resistant gloves are worn by any personnel likely to handle contaminated material or equipment during the waste assay operations. **Morrison Construction / Nuttalls**

Action 6. Ensure that all personnel undergo a toolbox talk on the radiological hazards associated with the waste deposition work. **Morrison Construction / Nuttalls**

APPENDIX 1

Potential Airborne Activity Assessments

Activity Estimates for Waste accumulated in the Bunded Area
Site 'A' = 34 Bq/g U-238
Site 'B' = 40 Bq/g Ra-226 and 10 Bq/g Pa-231
Site 'C' = 15 Bq/g Th-232

Dust Loading Fraction: Although relatively high dust loading fractions have been measured on the site as a whole, these are generally due to dried out mud on roads etc. The average dust loading fraction measured in a land remediation project where similar methods have been used was 0.3 mg/m^3, which tallies with the fact that no airborne activity has been measured on any air sampling at the site to date.

Potential airborne activity release, pessimistically assuming that all activity is mobile:

Site 'A' = $34\ Bq/g \times 0.3 \times 10^{-3}\ g/m^3 = 0.0102\ Bq/m^3$
Site 'B' = $40\ Bq/g \times 0.3 \times 10^{-3}\ g/m^3 = 0.012\ Bq/m^3$
$10\ Bq/g \times 0.3 \times 10^{-3}\ g/m^3 = 0.003\ Bq/m^3$
Site 'C' = $15\ Bq/g \times 0.3 \times 10^{-3}\ g/m^3 = 0.0045\ Bq/m^3$

Dose Uptake via Inalation

Breathing rate for average man (ICRP model) = 1.2 m^3/h

Dose co-efficient (Sv/Bq) for workers, ICRP68:

U-238 = 5.7×10^{-6} Sv/Bq
Ra-226 = 2.2×10^{-6} Sv/Bq
Pa-231 = 8.9×10^{-5} Sv/Bq
Th-232 = 2.9×10^{-5} Sv/Bq

Potential internal dose from inhalation:

Site 'A' Material: $0.0102\ Bq/m^3 \times 1.2\ m^3/h \times 5.7 \times 10^{-6}\ Sv/Bq = 0.07\ \mu Sv/h$
Site 'B' Material: $0.012\ Bq/m^3 \times 1.2\ m^3/h \times 2.2 \times 10^{-6}\ Sv/Bq$
$+ 0.003\ Bq/m^3 \times 1.2\ m^3/h \times 8.9 \times 10^{-5}\ Sv/Bq = 0.35\ \mu Sv/h$

Site 'C' Material: $0.0045\ Bq/m^3 \times 1.2\ m^3/h \times 2.9 \times 10^{-5}\ Sv/Bq = 0.16\ \mu Sv/h$

Note that all personnel will be wearing an orinasal FFP3 face mask, which will offer a protection factor of 10, therefore these dose rates will reduce by a factor of 10. Any internal doses from inhalation are therefore assessed to be negligible, however the work will be reviewed if any positive static air sample results are reported, or if dust arisings are visibly noticed.

NUVIA	**Olympic Park** **Radiological Safety Assessment Report**	Document Ref. 87216/TR/053 Issue 2 Date 15/10/08 Page 1 of 25 Author [redacted]
Title: Radiological Safety Assessment for the Disposal Cell in Bridge L03A Approach containing the Site's Arising of Exempt Waste		

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Signatures	
Author [redacted]	**Date** 15th October 2008
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EXECUTIVE SUMMARY

During the excavation of sites as part of the enabling works for the main Olympic Stadium and other facilities at the Olympic Park, Stratford, London limited areas of radioactively contaminated spoil were discovered in areas in Construction Zones 3A, 6A and 6D (CSZ3A, CSZ6A and CSZ6D). All of the radioactive contamination discovered was naturally occurring radioactive material (NORM). The spoil was monitored, excavated and assayed. It was temporarily stored in stockpiles in CSZ6A. It is now proposed to dispose of that waste in a dedicated disposal cell to be constructed in the approach ramp to bridge L03A over the River Lee at Olympic Park. The total mass of radioactively contaminated spoil to be disposed of is 7370.5 tonnes.

This report describes a radiological risk assessment that was undertaken to determine the impacts of the disposal of waste with radioactive contamination in a dedicated waste disposal cell in the eastern approach ramp to bridge L03A at Olympic Park. The assessment addresses potential radiation exposures to humans living, working and/or playing on the site, now and in the future, after completion of the disposal cell. The assessment identified four groups of potential contamination receptors, who will occupy the site, both during the Olympic Park construction works and during use of the completed park. These were: potential future residents on the disposal site (adult, child and infants); roadway maintenance workers, general site workers and visitors to the Park.

The results show that wastes in the proposed disposal cell with the design of that cell present a negligible risk to roadway maintenance staff, general site workers or visitors to Olympic Park today or likely at any time over at least the next 1000 years. All potential exposures will be very much below both the Environment Agency's and the International Commission on Radiological Protection's risk target for the public from the disposal of low and intermediate level radioactive waste of 10^{-6} per annum, i.e. an effective dose of 2 x 10^{-2}mSv/a. In accordance with the European Commission's Basic Safety Standard doses below a few tens of μSv/a would be below regulatory concern. Should the disposal cell area at sometime in the future be used for housing, the same conclusion will generally apply. However, there would be a restriction. This is that the house would need to be designed to minimise radon intrusion. In addition, water should not be abstracted from below the disposal site to water vegetables, etc, in the garden, which are then to be consumed. Even without any of these restrictions the exposure to the resident would only be ~0.9 mSv/a over the first 100 years, rising to 2 mSv/a by year 1000. The public dose limit is 1 mSv/a. Radon control measures would be sufficient alone to avoid exceeding the public dose limit.

It may be concluded, therefore, that the that the disposal cell is fully fit for the purpose of disposing of the NORM waste arising from the redevelopment works at Olympic Park. No dose limits would be exceeded and the disposal has been optimised to reduce resulting doses to "as low as reasonably practicable".

DISCLAIMER

NUVIA Limited has prepared this report for the sole use of Morrison Construction Ltd in accordance with the Agreement under which our services were performed using all due care and diligence and in accordance with the standards of a qualified and competent consultant experienced in carrying out work of a similar scope and complexity to the services provided and current at the time when the services were performed. No other warranty, expressed or implied, is made as to the professional advice included in this report or any other services provided by us. No extract from this report shall be taken as representative of the report as a whole. This report may not be relied upon by any other party without the prior and express written agreement of NUVIA Limited.

Unless otherwise stated in this report, the assessments made assume that the sites and facilities will continue to be used for their current purpose without significant change. The conclusions and recommendations contained in this report are based upon information provided by others, and upon the assumption that all relevant information has been provided by those parties from whom it has been requested. Information obtained from third parties has not been independently verified by NUVIA Limited unless otherwise stated in the report.

Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the services. Morrison Construction Ltd and any other party to whom NUVIA Limited may extend reliance shall recognise that the services conducted will not necessarily reveal all adverse or other material conditions at the site that could be identified either through a different formulation of the services or through more detailed work being carried out by NUVIA Limited. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant delay in using this report.

CONTENTS

1 INTRODUCTION

During the excavation of sites as part of the enabling works for the main Olympic Stadium and other facilities at the Olympic Park, Stratford, London limited areas of radioactively contaminated spoil were discovered in areas in Construction Zones 3A, 6A and 6D (CSZ3A, CSZ6A and CSZ6D). All of the radioactive contamination discovered was naturally occurring radioactive material (NORM). The spoil was monitored, excavated and assayed. It was temporarily stored in stockpiles in CSZ6A. It is now proposed to dispose of that waste in a dedicated disposal cell to be constructed in the approach ramp to bridge L03A over the River Lee at Olympic Park. The total mass of radioactively contaminated spoil to be disposed of is ~7500 tonnes. This has been used as the base case for the assessment.

This report describes a radiological risk assessment that was undertaken to determine the impacts of the disposal of waste with radioactive contamination in a dedicated waste disposal cell in the eastern approach ramp to bridge L03A at Olympic Park. The assessment addresses potential radiation exposures to humans living, working and/or playing on the site, now and in the future, after completion of the disposal cell. The assessment identified four potentially exposed groups of people, who will occupy the site, both during the Olympic Park construction works and during use of the completed park. These were: potential future residents on the disposal site (adult, child and infants); roadway maintenance workers, general site workers and visitors to the Park.

1.1 Background

During the excavation of sites as part of the enabling works for the main Olympic Stadium and other facilities at the Olympic Park, Stratford, London limited areas of radioactively contaminated spoil were discovered in areas in Construction Zones 3A, 6A and 6D (CSZ3A, CSZ6A and CSZ6D). All of the radioactive contamination discovered derived from naturally occurring radioactive material (NORM). The radioactivity was technologically enhanced above natural levels, likely by past processing, etc, operations undertaken on or near the site. Phosphate-based fertiliser manufacture and metals processing were known to have occurred on the site. In addition, part of the site formed the West Ham Tip. This received a wide variety of wastes from the local area. Other industries, which generated and disposed of NORM wastes, including Thorium Ltd, are known to have operated within 5 km of the site. They may have sent wastes to the tip.

The areas of contamination were identified by gamma monitoring and sampling. The contaminated spoil was removed and transported to a central bunded storage location within CSZ6A, which was operated by Morrison Construction. In this area the spoil was assayed by gamma spectrometry, using a bag or calibrated bucket monitoring system. Some waste also underwent basic assaying prior to delivery to CSZ6A by monitoring the trucks, carrying the loads, with a calibrated monitoring system. In CSZ6A the assayed waste was stored in stockpiles to await disposal.

The contamination derived from a number of discrete processes. Some included the full natural uranium (U238) series, some derived from the truncated natural chain, based upon radium (Ra226), some derived from a truncated uranium U235 chain, based upon Pa231, and some included the full natural thorium (Th232) chain.

Samples of these wastes were also sent for laboratory analyses. The maximum concentrations measured in samples were:

- 40 Bq/g for ^{226}Ra;
- 15 Bq/g for ^{232}Th;
- 16 Bq/g for ^{231}Pa;
- 72 Bq/g for ^{238}U.

In the waste assaying operations a total of 786 bags of waste, weighing 658 tonnes, were assayed on a rotating turntable using a high resolution gamma spectrometer. The results were used to generate radionuclide fingerprints for the bucket and truck assaying systems. They were also used to generate the radionuclide fingerprints for the radiological risk assessment presented in this report. Of the 786 bags some 741 were assayed to contain waste, which was classified as Exempt under the Phosphatics Substances and Rare Earths Exemption Order(1) under the Radioactive Substances Act of 1993 (RSA 93). The remaining 45 bags contained waste, which was above the limit for that exemption order. This was in the low-level waste category (LLW), albeit at the very bottom level of that category. Taken as a whole lot, the bagged waste was Exempt. It has been treated as such for the purpose of disposal on-site.

Table 1 summarises the analyses of the bagged wastes in terms of their total and mean specific activities for the Schedule 1 (RSA 93) radioelements. It also lists the Schedule 1 limits defined in RSA 93. These Schedule 1 limits define the specific activity levels below which a material containing any of these radioelements is not deemed to be a radioactive material under UK law (RSA 93).

Table 1 Summary of the Radioelement Analyses of the bagged Wastes

	Schedule 1 Elements						
Element	Actinium	Lead	Polonium	Proactinium	Radium	Thorium	Uranium
Total Activity, Bq	3.95E8	4.43E9	6.52E9	1.53E9	2.53E9	3.06E9	2.55E9
Mean Specific Activity, Bq/g	6.00E-1	6.73	9.91	2.32	3.84	4.64	3.87
RSA 93 Schedule 1 Limit, Bq/g	3.7E-1	7.4E-1	3.7E-1	3.7E-1	3.7E-1	2.59	1.11E1

Table 2 summaries the total and mean specific activities of individual gamma-emitting radionuclides, as measured by high resolution gamma spectrometry during the bag assaying. These radionuclides were used to derive maximum estimates of the specific activities of other members in the uranium and thorium series in the risk assessment.

Table 2 Measured total and mean specific Activities of individual gamma-emitting Radionuclides from the Waste Bag Assays

	^{208}Tl	^{214}Bi	^{219}Rn	^{223}Ra	^{234m}Pa	^{234}Th
Total Activity, Bq	1.80±0.60E7	3.24±0.77E8	7.14±2.85E7	7.19±2.72E7	1.47±0.87E8	1.58±0.96E8
Mean Specific Activity, Bq/g	2.74±0.91E-2	4.92±1.17E-1	1.09±0.43E-1	1.09±0.41E-1	2.23±1.32E-1	2.41±1.45E-1

The bucket monitoring involved assaying 5964 buckets with 6712.5 tonnes of spoil, i.e. in approximately 1 tonne lots. Of these only 6 buckets were assessed to have LLW.

Thus the total mass of radioactively contaminated spoil to be disposed of is **~7500 tonnes**.

The proposal now is to dispose of all of this radioactive spoil in a dedicated disposal cell in the approach ramp to bridge L03A.

2 THE Proposed Disposal CELL

The location of the bridge L03A is shown in the above section of the site plan. It is located almost due north of the main stadium site in Construction Zone 3A and just south of Stratford International station. The disposal cell is located in the bank under the approach road to the bridge. It is on the eastern bank of the River Lee, which forms the boundary between the London Boroughs of Tower Hamlets to the west and Newham to the east. Further to the west is the Lee Navigation channel.

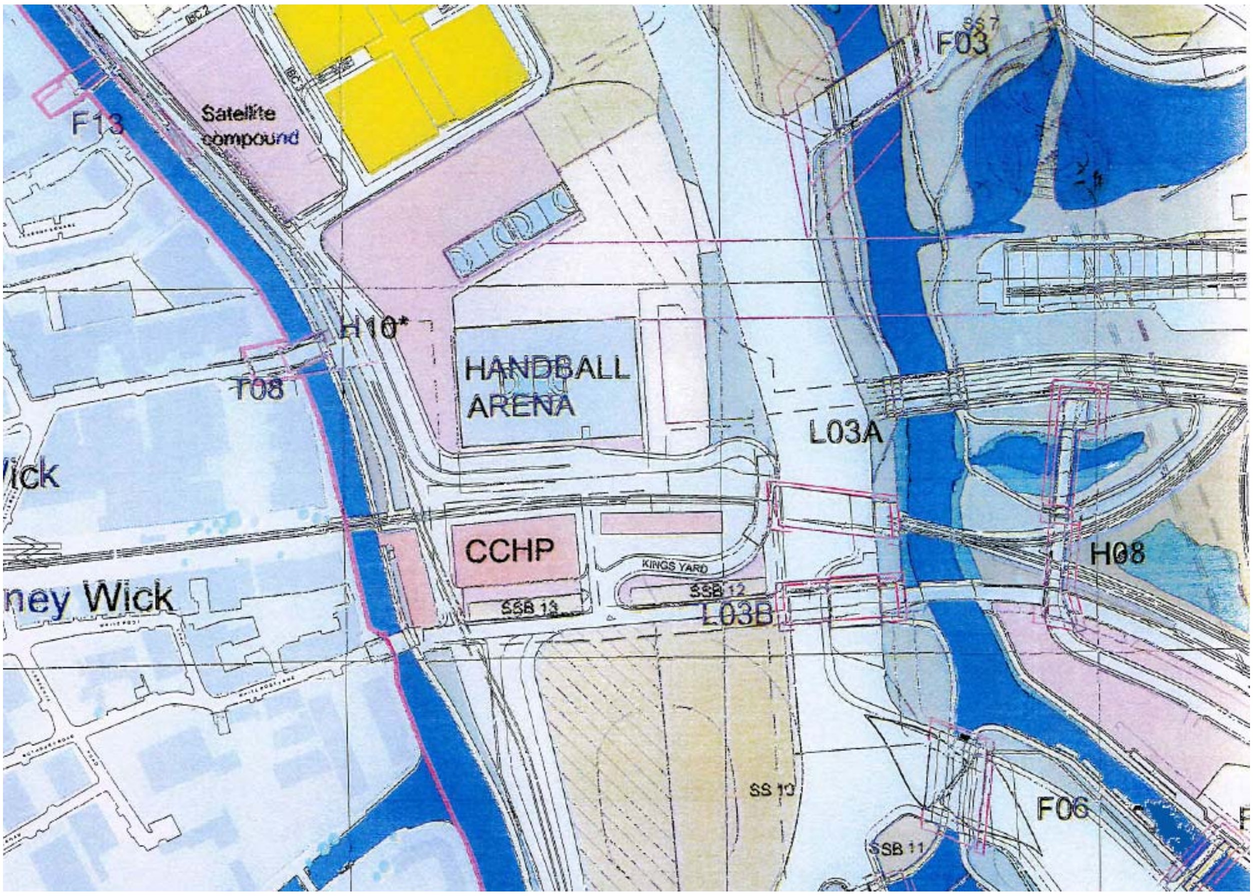

Figure 1 Section of the Olympic Park Site immediately north of the main Stadium Area

A section and plan of the disposal cell are shown in Figures 2 and 3 below.

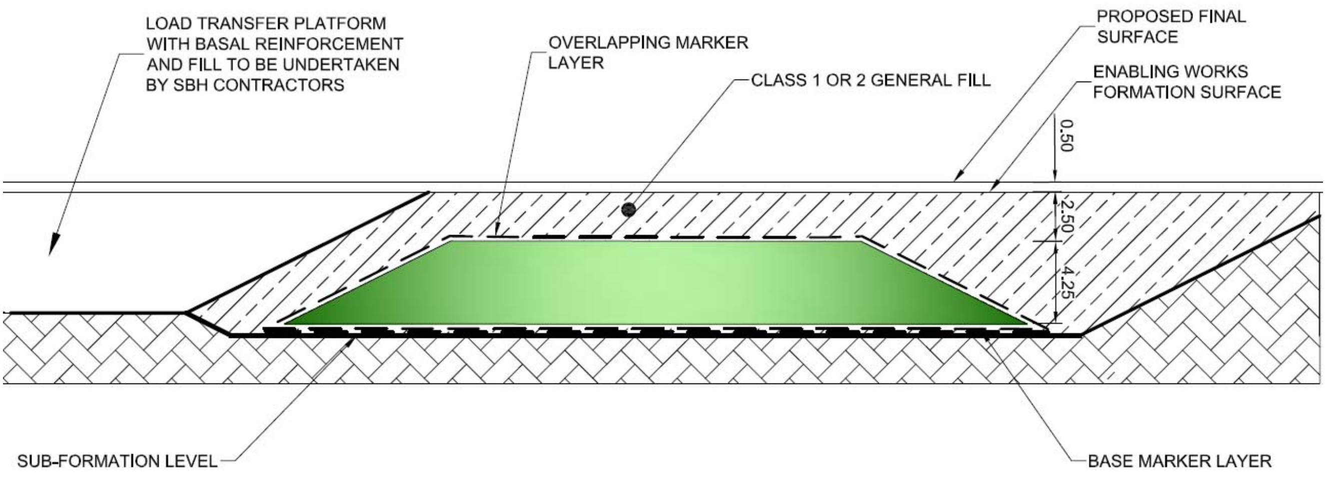

Figure 2 A Section through the proposed Waste Disposal Cell

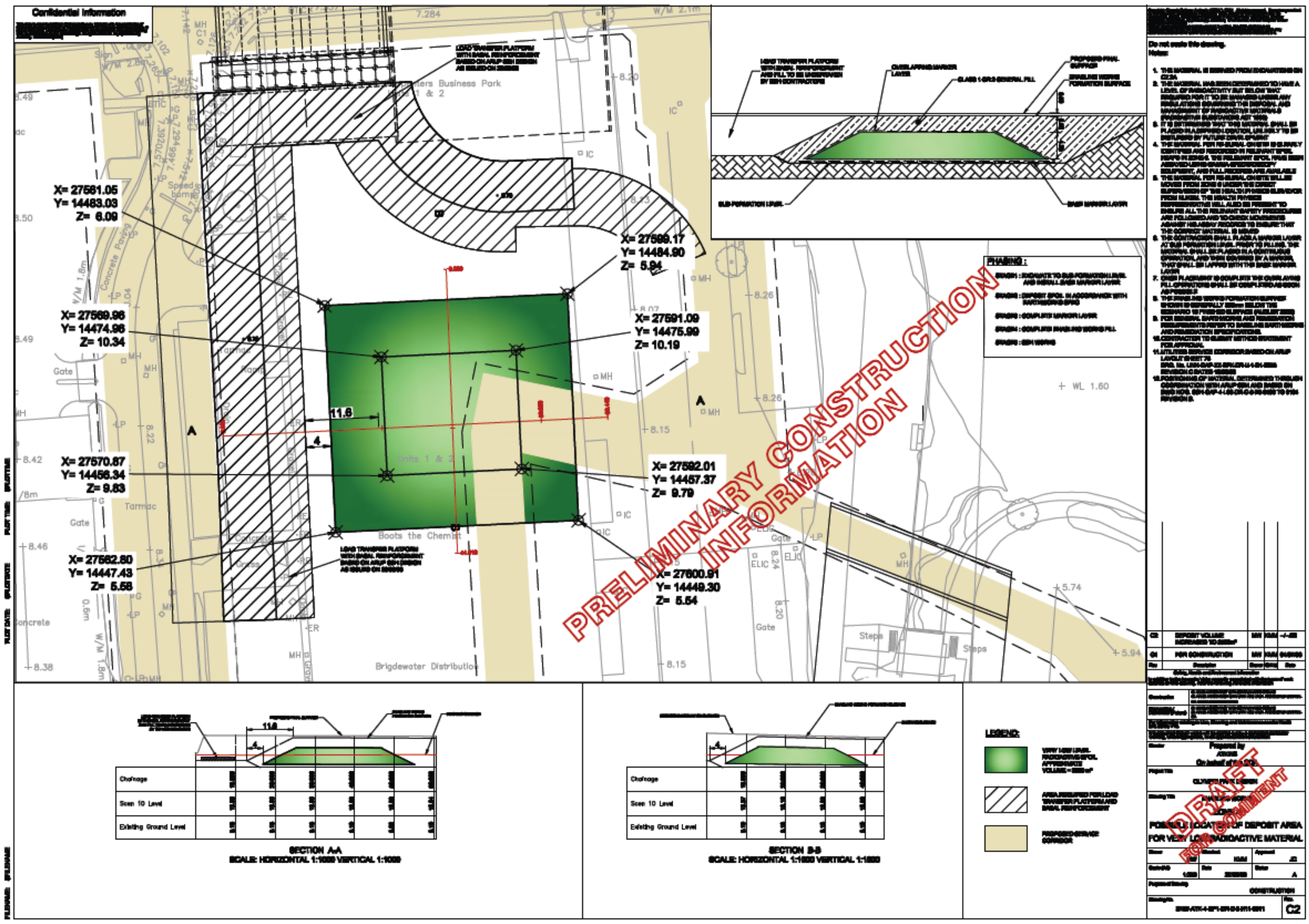

Figure 3 A dimensioned Plan View of the proposed Waste Disposal Cell

The disposal cell is in the form of a truncated pyramid. It is covered on its sides and capped with a layer of clean general fill. Over the top surface will be a road. This will form an additional shielding layer of 0.5 m thickness. Its bitumen top surface will also restrict water infiltration. The contaminated fill zone will be covered, top and bottom, by an overlapping marker. This will likely be a polymer sheet wrap. In the short term this will also act as a further barrier to water infiltration into the waste.

3 Background to the POST-CLOSURE RISK ASSESSMENT

An assessment has been made of the potential radiation exposures to humans living, working and/or playing on the site, now and in the future, after completion of the disposal cell.

The modelling work has four main components:

i) source analysis. This addresses the problem of deriving the source terms that determine the rates at which the contaminating radioactivity is released into the environment. This rate is a function of the geometry of the contaminated zone, the concentrations of the radionuclides present, the rates of in-growth and decay of the radionuclides present and their rates of removal by physical processes, such as surface erosion and leaching;

ii) environmental transport analysis. This addresses the problems of identifying environmental pathways by which the radionuclides can migrate from the source areas to others where they can directly or indirectly affect human populations. It also determines the rates of radionuclide migration along these pathways and hence determines the relative significance of each;

iii) dose/exposure analysis. This addresses the problem of deriving dose conversion factors for the radiation dose that will be incurred by exposures to ionising radiation; and

iv) scenario analysis. The parameters, which control the rates of radionuclide release into the environment and the duration and extent of human exposure at any given location, are determined by the patterns of human activity. These activities include workers operating on the site, construction workers undertaking later repairs to the roadway over the disposal cell, etc, nearby residents as well as potential future scenarios for the use of the site for potential housing uses.

The modelling treats the contaminated zone as effectively a vertical cylinder of land with the contaminated soil/material as one layer. The underlying unsaturated and saturated geology is then approximated by a series of discrete, homogeneous layers of defined thicknesses. Variations in the shape of the contaminated site are accommodated by the use of a shape factor or drawing out the shape. If the shape factor is used, it is unity, if the area is circular and less if it is irregularly shaped. If the radionuclide distributions are approximately uniform throughout the contaminated region, a single cylinder is used as the source geometry. This is the case with the disposal cell.

The model considers the evolution with time of doses from each individual pathway. The time dependence of dose is controlled by:

i) the rate at which radionuclides are leached from the contaminated zone;

ii) the rate of in-growth and decay of the individual radionuclides;

iii) the rate of erosion of any clean cover and the contaminated soil, as will occur due to the action of rain and wind. Such erosion is affected by a number of factors, including climate, vegetation, ground slope, agricultural and land usage practices;

iv) the rate of contaminant transport through the environmental pathways.

The first three of these processes occur within or primarily within the contaminated zone, whereas the last process occurs outside.

3.1 The potential Receptors

The assessment identified four groups of potential contamination receptors, who will occupy the site, both during the Olympic Park construction works and during use of the completed park. These are described in Table 3.

Table 3 The potentially exposed Human Receptor Groups

Receptor group	
Potential future residents on the disposal site (adult, child and infants)	Resident of a house constructed over the disposal cell and who consumes vegetables, etc, grown in the garden
Roadway maintenance workers	Workers involved in maintaining the bridge, the roadway, possibly installing services below the road surface, etc.
General site workers	Workers engaged in the construction of Olympic Park infrastructure, its later use and redevelopment
Visitors to the Park	Visitors using the amenity facilities, including the grounds, of the Olympic Park

3.2 The potential Exposure Pathways

Three major pathways by which humans may be exposed to the contaminants are considered in the model. A schematic diagram showing these pathways is given in Figure 4. Radionuclides can migrate by the pathways from the source to points, where humans can become exposed. Some of the components of these can occur as segments in more than one pathway. Thus contaminated ground or surface water can contribute to the human drinking water pathway. It can also contribute through the food chain, if contaminated water is used to irrigate crops or water livestock.

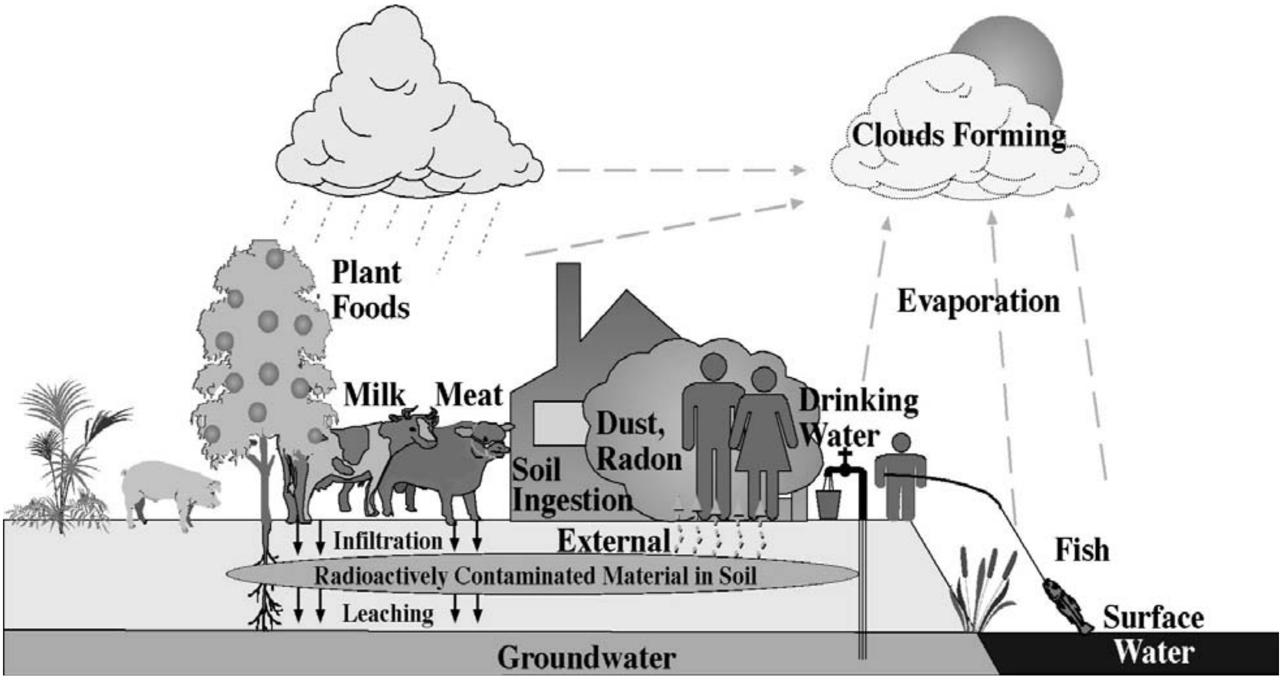

Figure 4 The potential Exposure Pathways to Human Receptors

The pathways considered are:

i) External radiation.
- Ground
  - Volume source
  - Surface source
- Air
  - Dust
  - Radon and its decay products
  - Other gaseous airborne radionuclides
- Water

ii) Inhalation.
- Dust
- Radon and decay products
- Other gaseous airborne radionuclides

iii) Ingestion

- Food
    - Plant foods, e.g. vegetables, grains and fruits;
    - Meat, e.g. chickens, sheep and cattle;
    - Aquatic foods, e.g. fish, crustaceans and molluscs;
- Water
    - Groundwater, e.g. through wells;
    - Surface water, as through rivers and canals;
- Soil

The disposal cell at Olympic Park is of limited size (~40 m x 40 m in area). The Olympic Park site is located in a major urban area. The adjacent River Lee is a small river in terms of lateral dimensions and flowrates. As a consequence of these geographical factors, the following assumptions have been made in the dose calculations in respect of ingestion routes:

- Chickens could be reared in gardens, but not larger livestock;
- The river can sustain recreational fishing, but its use as a major source of food has been discounted;
- All domestic water in the area derives from sources away and upstream of the site, e.g. River Thames and New River. Hence the use of a well to access the groundwater immediately below the site or of the adjacent river for use as the drinking water source is discounted.

The potential pathways by which the receptors identified in Table 1 may be exposed to contamination at Olympic Park are summarised in Table 4, below.

Table 4 Potential Exposure Pathways for the different Receptor Groups

Exposure Pathway	Residents	Maintenance workers	Visitors	Site workers
External radiation	√	√	√	√
Inhalation of contaminated dust	√	√	√	√
Ingestion of contaminated soil and dust	√	√	√	√
Ingestion of contaminated crops grown on-site	√			
Ingestion of meat from animals (fowl) reared on-site	√			
Dermal contact with soil and dust	√	√	√	√
Inhalation of radon gas	√	√	√	√

3.3 The Assessment Codes used

The prime code, which has been selected for this assessment is the RESRAD code. This is an internationally accepted computer model code, which is designed to estimate radiation doses and risks from RESidual RADioactive materials. It was developed by Argonne National Laboratory (ANL) with direct support from the US Offices of Health, Safety and Security and of Environmental Management and from the U.S. Nuclear Regulatory Commission. It has been extensively used to assess contaminated sites in the United States and overseas. It has also successfully been used in a number of international intercomparison exercises. RESRAD (V.6.4)[(2)] is the most recent update of the RESRAD family of codes which provides a model for assessing radiation dose and risk from soil containing residual radioactive material. It has been developed into an extensive family of codes. These codes share the same radionuclide database and include International Commission on Radiological Protection (ICRP) 72 age-dependent dose conversion factors. The codes have also been tested successfully on Windows Vista and XP operating systems.

RESRAD offers greater flexibility than codes, such as RCLEA[(3)] and ReCLAIM[(4)], which were primarily developed to determine the current risks posed by levels of contamination on sites. RCLEA and ReCLAIM have been used for this purpose at Olympic Park, in determining acceptable levels of residual contamination, which might be left on or near the surface after remediation works. RESRAD enables account to be taken of the evolution of sites with time. This enables predictions to be made on future doses resulting from the migration of radionuclides from the site. This is particularly important in disposal situations, as the half-lives of many of the radionuclides of concern are in the range of 10^2-10^7 years.

In the modelling radiation from the ground is the only external radiation source considered. External radiation from surface layers formed by any re-deposition of contaminated dust carried off-site by the wind or from airborne dust or surface waters are at least two orders of magnitude smaller and are judged as insignificant, when compared to the residual material in its original location.

Inhalation exposure results primarily from inhalation of contaminated dust and of radon decay products. The inhalation pathway is treated as comprised of two components; an airborne exposure part linking the contaminated zone to the exposure location and an inhalation component linking the airborne radionuclides to the exposed individuals. The former is the critical part. It is characterised by the air/soil concentration ratio, which is the ratio of the airborne concentration of a radionuclide at the point of human exposure to the concentration in the soil. The air/soil concentration ratio depends on the complex processes by which soil particles become airborne by resuspension and are transported to the exposure point. It is also used in the food chain pathways for the foliar deposition component. Modelling of the airborne pathway component is divided into two parts. The first is the modelling of the process by which the radionuclides become airborne. This step gives the ratio of the concentration in the air near the source, before it is dispersed and diluted to the concentration in the resuspendable soil layer. The second step gives the ratio of the airborne concentration at the point of exposure to the undiluted airborne concentration at the source. The inhalation component is characterised by an occupancy factor in a contaminated air zone and an inhalation rate, which is linked to age and physical activity.

The food pathway considers four separate chains: plant foods, meat, milk and fish. The plant food pathway is comprised of a further four components:

- i) root uptake from any crops grown in the contaminated zone;
- ii) foliar uptake from contaminated dust deposited on foliage;
- iii) root uptake from contaminated irrigation water; and
- iv) foliar uptake from contaminated irrigation water.

The plant food pathways are also applicable to animal fodder, such as grass growing in contaminated water. Hence, they apply to the pathways through which meat from chickens, etc, could become contaminated by ingestion of contaminated fodder. For the meat pathway there is also the more direct pathway of ingestion of contaminated water by the livestock. The aquatic food pathway is for the ingestion of fish and any crustaceans and molluscs from the surface of the adjacent River Lee and its tributaries, which could become contaminated by radionuclides leached from the contaminated zone. This would apply to fish caught in water linked to the contaminated zone through the groundwater pathway. The food pathways are primarily linked to any crops grown in or close to the contaminated zone, especially if also irrigated with contaminated groundwater.

The time dependence of these pathways is controlled by that of the radionuclide concentrations in the contaminated water, as determined by the hydrological model used for the groundwater pathway. A fraction of each radionuclide will potentially have been leached from the root zone before the radionuclide first reaches a point of water withdrawal in above background concentrations (break-through time). Hence, the contributions to the dose from the water-dependent and water-independent pathways will occur at different times.

After breakthrough the contaminated irrigation water would create a new contaminated zone as it percolates through the soil. The contribution of this secondary contaminated zone to pathways other than that for food is judged to be small and has not been considered further.

4 Significance of Individual Pathways to THE RECEPTOR Groups

4.1 Road maintenance workers

Historically, once created roads have tended to have lifetimes extending into centuries and even millennia. During this period maintenance will be undertaken on timescales of 10-20 years on the surface of the roadway and any services placed below that surface. Maintenance of the roadway and services will involve the construction of holes and trenches, likely ~ 1-2 m in depth. In these circumstances the amount of shielding afforded by the clean cap will be markedly reduced. The road maintenance staff will then be exposed to higher levels of direct external radiation, inhalation of contaminated dust and radon and possible intakes through any open wounds routes. They should not be exposed through ingestion of contaminated food or drinking water, as their food will not be derived from the site and all drinking water is derived from surface water sources at least 10 km from the site. Road and services repair and replacement over an area the size of the disposal cell would be expected to last a maximum of 8 weeks in one year in 10-20 years. The dose received in that year, assuming a 10 hour working day, has been assessed.

4.2 Future on-site Residents

Given the location of the disposal cell within a raised ramp of a roadway, the probability of a future dwelling on this site with a garden producing produce for home consumption is low. Hence this may be seen and used as a very conservative case of potential residential exposure. It is assumed that the house is constructed on the top of the soil cap above the disposal cell, i.e. with the proposed roadway removed. The house can be expected to have a base slab, but with openings for mains services. The services will likely be constructed up to 1 m below the ground surface, i.e. still within the clean cap. The main pathways by which the inhabitants could receive exposures are through inhalation of radon, permeating through the soil cap, by direct irradiation and through the ingestion of contaminated food. The external radiation pathway is likely to be very limited due to the shielding afforded by the thickness of the remaining soil cap, supplemented within any house by the base slab. It also drops off rapidly with distance to attain negligible proportions within a few metres of the contaminated areas. The roots of green vegetables, grass, etc, will not penetrate the 2-2.5 m to the contaminated zone, although the roots of fruit trees could. Inhalation of contaminated dust is much less likely to be significant, given both the remaining clean cover and the fact that it will diffuse and disperse readily. The dust pathway to any exposed population will be strongly influenced by the speeds and directions of the winds and the distance of that population from the contaminated source area.

4.3 Future Site Visitors and other Workers

The exposures of future site visitors and site workers, who use the roads and bridges to traverse the site, are likely to be very limited. The bridge will be a vantage point to survey the site for visitors. Given the areal extent of Olympic Park and the absence of items of interest above the disposal cell, it is likely that general residence above the cell will be extremely limited. In addition, most visitors are only likely to visit the site one to a few times per year. It is assumed that the most exposed visitors will be local dog walkers and joggers, etc. It has been conservatively assumed that they may be above the disposal cell for up to 10 minutes per and each day. They will be present, when the roadway is there. This will provide both an extra 0.5 m of shielding against external radiation and an additional barrier against upward diffusion of radon gas. This will reduce exposures from both of these pathways. The exposures of general site workers will be very similar. It is assumed that a site worker, such as the grounds maintenance staff, may pass along the road above the disposal cell in up to 20 return trips per day. The worst case would be on foot. On the basis of 1 m/s walking speed and 40 m traverse across the disposal cell area, this would represent a daily residence of 27 minutes. With 5 day/week and 46 week/year working this would lead to an annual exposure time of 102 hours. This may be compared to ~56 hours for the dog walker/jogger. It is to be appreciated that the exposure scenarios of these two groups of receptors are very similar, differing only in the total exposure time.

5 Results

5.1 Base cases

The RESRAD model has been used to determine the magnitude of the potential doses from each pathway at the site for each of the key receptors, assuming exposure to each pathway proportionate to their assumed exposure time. The results are compared to a 300 µSv/a constraint level for a disposal site for the most exposed individuals[(5)]. This corresponds to an annual risk of death or serious harm of ~10^{-5}. They are also compared against the ALARP de minimus level of 20 µSv/a, which corresponds to an annual risk of death or serious harm of ~10^{-6}. This represents the level below which further optimisation to reduce exposures does not warrant the expenditure of significant resources.

5.2 Exposures of above-site Residents

Figures 5 and 6 show the predicted exposures for a future resident living over the disposal cell and consuming green produce and meat (chicken, etc.) from the garden. Figure 5 shows the exposures attributable to all and each key radionuclide, summed over all of the exposure pathways. Figure 6 shows the exposures attributable to all and each exposure pathway, summed over all of the radionuclides. Figure 7 shows the lifetime excess cancer risk summed over all pathways for individual radionuclides. These results are summarised in Table 3.

The results show that in all cases the dominant exposure pathway is through radon inhalation with external radiation being very much lower. At time 0 years the radon dose is estimated to be 8.6 x 10^{-1}mSv/a with the external radiation dose at 3.3 x 10^{-15}mSv/a. The contributions of other pathways are very much lower still and make no significant contribution. This situation persists until 30-100 years, when the water pathway results in doses from the consumption of vegetables grown and meat reared on-site. This presumes that contaminated water is abstracted to water the garden. These pathways have no significance, if mains water is used. If contaminated water is abstracted, by 100 years the doses from plant and meat consumption would be 4.51 x 10^{-2} and 1.25 x 10^{-3}mSv/a respectively, rising to 7.45 x 10^{-1} and 1.64 x 10^{-2}mSv/a by year 1000. By comparison the exposures received through the dust pathway are negligible, i.e. <10^{-15}mSv/a over the whole time period due to the maintenance of the disposal cell cap. Under the worst case conditions of crops being grown in the contaminated areas exposures via the plant pathway could rise to some ~40% of the total exposure by year 1000. The total dose over the period 0-1000 years increases from 0.86 to 1.98 mSv/a. These results are based on very conservative assumptions. Under any credible scenario they are likely to be at least two orders of magnitude lower.

Table 5 Summary of exposure Components in mSv/a for an Inhabitant living directly above the Site and consuming Produce grown on the Site

Pathway	Year 0	Year 1	Year 10	Year 30	Year 100	Year 300	Year 1000
External radiation	3.34E-15	7.56E-15	1.85E-14	2.37E-14	5.27E-14	5.16E-13	1.62E-9
Dust inhalation	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18
Radon	8.58E-1	8.58E-1	8.59E-1	8.61E-1	8.68E-1	8.99E-1	1.17
Radon(Water)	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18	<1.0E-18	5.47E-3	7.45E-1
Ingestion-Plant	<1.0E-18	<1.0E-18	<1.0E-18	6.44E-4	4.51E-2	2.35E-1	7.45E-1
Ingestion-Meat	<1.0E-18	<1.0E-18	<1.0E-18	1.08E-5	1.25E-3	4.30E-3	1.64E-2
Total	8.58E-1	8.58E-1	8.59E-1	8.61E-1	9.14E-1	1.14	1.98

Radon exposures can be mitigated very substantially through house design. In particular, the use of either a sealed or externally ventilated base to any house is standard practice in affected areas. If the radon doses are excluded and abstracted contaminated water from below the site is not used to irrigate the garden, the doses to residents are completely negligible. They will be much below the de minimus level of 2 x 10^{-2}mSv/a.

5.3 Exposures to Road Maintenance Workers

Figures 8 and 9 show the predicted exposures for a road maintenance worker, working over the disposal cell. Figure 8 shows the exposures attributable to all and each key radionuclide, summed over all of the exposure pathways. Figure 9 shows the exposures attributable to all and each exposure pathway. The key results are summarised in Table 6. The modelling shows that the only significant exposure pathways are those associated with radon inhalation and external radiation. However, even the doses derived from these pathways are very low, being ~2.5 x 10^{-6} mSv/a for radon inhalation and ~5 x 10^{-8} to 2.7 x 10^{-6} mSv/a for external radiation. The net consequence is that the total exposure to the maintenance worker is only predicted to vary from 2.5 x 10^{-6} -5 x 10^{-6} mSv/a over the 1000 year timescale. It is always very much below the lower threshold for optimisation of 2 x 10^{-2}mSv/a. Hence the disposal cell presents no significant risk to road maintenance workers.

Table 6 Summary of exposure Components in mSv/a for a Road Maintenance Worker

Pathway	Year 0	Year 1	Year 10	Year 30	Year 100	Year 300	Year 1000
External radiation	4.36E-8	5.27E-8	6.42E-8	7.95E-8	1.02E-7	2.38E-7	2.73E-6
Radon	2.45E-6	2.45E-6	2.45E-6	2.45E-6	2.46E-6	2.48E-6	2.57E-6
Total	2.50E-6	2.50E-6	2.52E-6	2.53E-6	2.56E-6	2.72E-6	5.30E-6

5.4 Exposures to Site Visitors and General Workers

Figures 10 and 11 show the predicted exposures for a site worker, who uses the road over the disposal cell periodically during the day. Figure 10 shows the exposures attributable to all and each key radionuclide, summed over all of the exposure pathways. Figure 11 shows the exposures attributable to all and each exposure pathway. The key results are summarised in Table 5. The modelling shows that the only significant exposure pathways are those associated with radon inhalation and external radiation. However, even the doses derived from these pathways are very low, being ~7 - 10 x 10^{-8} mSv/a for radon inhalation and ~1.9 x 10^{-19} to 9.7 x 10^{-14} mSv/a for external radiation. The net consequence is that the total exposure to the general site worker is only predicted to vary from 7.4 x 10^{-8} – 1.0 x 10^{-7} mSv/a over the 1000 year timescale. It is always very much below the lower threshold for optimisation level of 2 x 10^{-2}mSv/a. Hence the disposal cell presents negligible risk to general site workers.

Table 7 Summary of exposure Components in mSv/a for a Site General Worker

Pathway	Year 0	Year 1	Year 10	Year 30	Year 100	Year 300	Year 1000
External radiation	1.93E-19	4.77E-19	1.21E-18	1.55E-18	3.44E-18	3.33E-17	9.73E-14
Radon	7.41E-8	7.41E-8	7.43E-8	7.44E-8	7.51E-8	7.77E-8	1.02E-7
Total	7.41E-8	7.41E-8	7.43E-8	7.44E-8	7.51E-8	7.77E-8	1.02E-7

As indicated in Section 4.3 the exposure scenarios for the site visitors are identical to those for the site general workers. The only difference lies in a reduced occupancy. The maximum visitor occupancy over the disposal cell is likely to be a factor ~0.55 of that for the site workers. The doses will scale in linear proportion in Table 7 to give the potential visitor exposures. Hence the maximum total exposure to the visitor is only predicted to vary from 4.1 – 5.6 x 10^{-8} mSv/a over the 1000 year timescale. It is always very much below the lower threshold for optimisation of 2 x 10^{-2}mSv/a. Hence the disposal cell presents a negligible to site visitors. The site visitor exposures are summarised in Table 8 below.

Table 7 Summary of exposure Components in mSv/a for a Site Visitor

Pathway	Year 0	Year 1	Year 10	Year 30	Year 100	Year 300	Year 1000
External radiation	1.06E-19	2.62E-19	6.66E-19	8.53E-19	1.89E-18	1.83E-17	5.35E-14
Radon	4.08E-8	4.08E-8	7.43E-8	4.09E-8	4.13E-8	4.27E-8	5.61E-8
Total	4.08E-8	4.08E-8	7.43E-8	4.094E-8	4.13E-8	4.27E-8	5.61E-8

6 Conclusions

1. The results show that wastes in the proposed design of disposal cell present a negligible risk to roadway maintenance staff, general site workers or visitors to Olympic Park today or likely in the next 1000 years. All potential exposures will be very much below the lower threshold level for optimisation of 2 x 10^{-2}mSv/a.

2. Should the disposal cell area at sometime in the future be used for housing, the same conclusion will generally apply. Bar a restriction on radon exposures, doses to the occupants from all other sources would always be below the lower threshold level for optimisation of 2 x 10^{-2}mSv/a. Even without any restrictions for radon, the exposure to the resident would only be ~0.9 mSv/a over the first 100 years. The public dose limit is 1 mSv/a. The dose from radon could then rise to 2 mSv/a by year 1000. Radon control measures would be advised. They would be sufficient to ensure that total doses were always much below the public dose limit.

3. It may be concluded, therefore, that the disposal cell is fully fit for the purpose of disposing of the NORM waste arising from the redevelopment works at Olympic Park. It not only meets all relevant dose criteria, but the cell has been optimised such that calculated prospective doses are substantially lower than the thresholds for optimisation.

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5. ENVIRONMENT AGENCY, SCOTTISH ENVIRONMENTAL PROTECTION AGENCY AND DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND. Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Guidance on Requirements for Authorisation, London, 1996.

APPENDICES

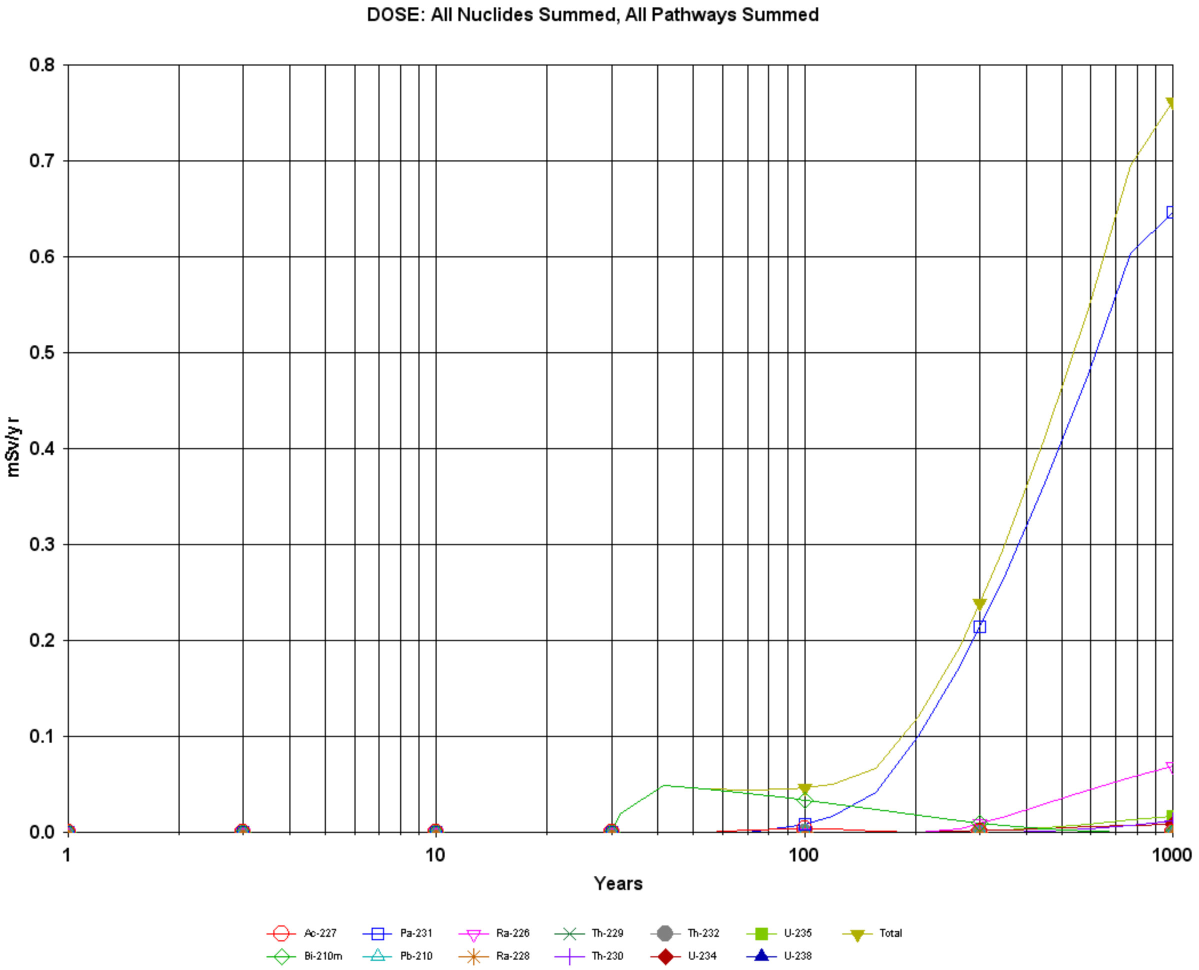


Figure 5 The predicted radiation exposures for a resident living over the contaminated area and consuming green produce, etc, from the garden. (Exposures summed over all pathways for individual radionuclides)

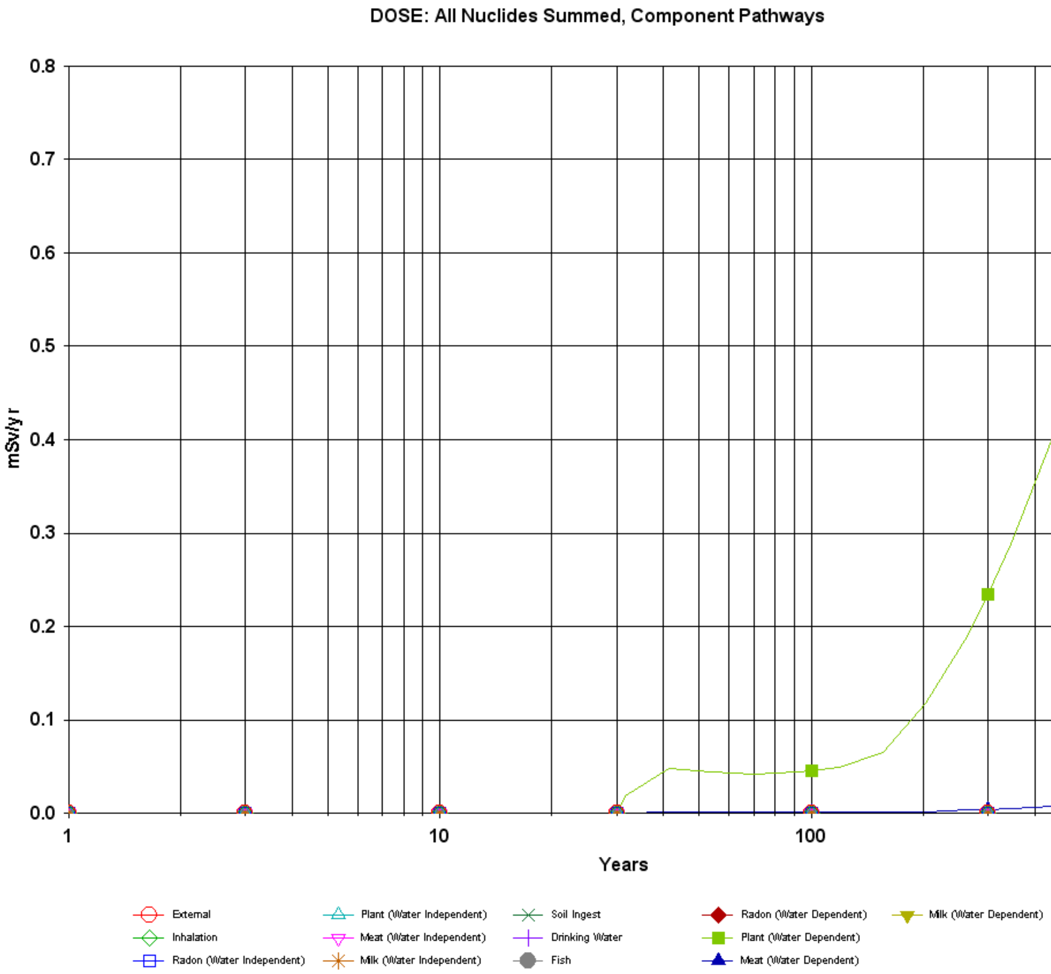


Figure 6 The predicted radiation exposures for a resident living over the contaminated area and consuming green produce, etc, from the garden. (Exposures given per pathway, summed over all radionuclides)

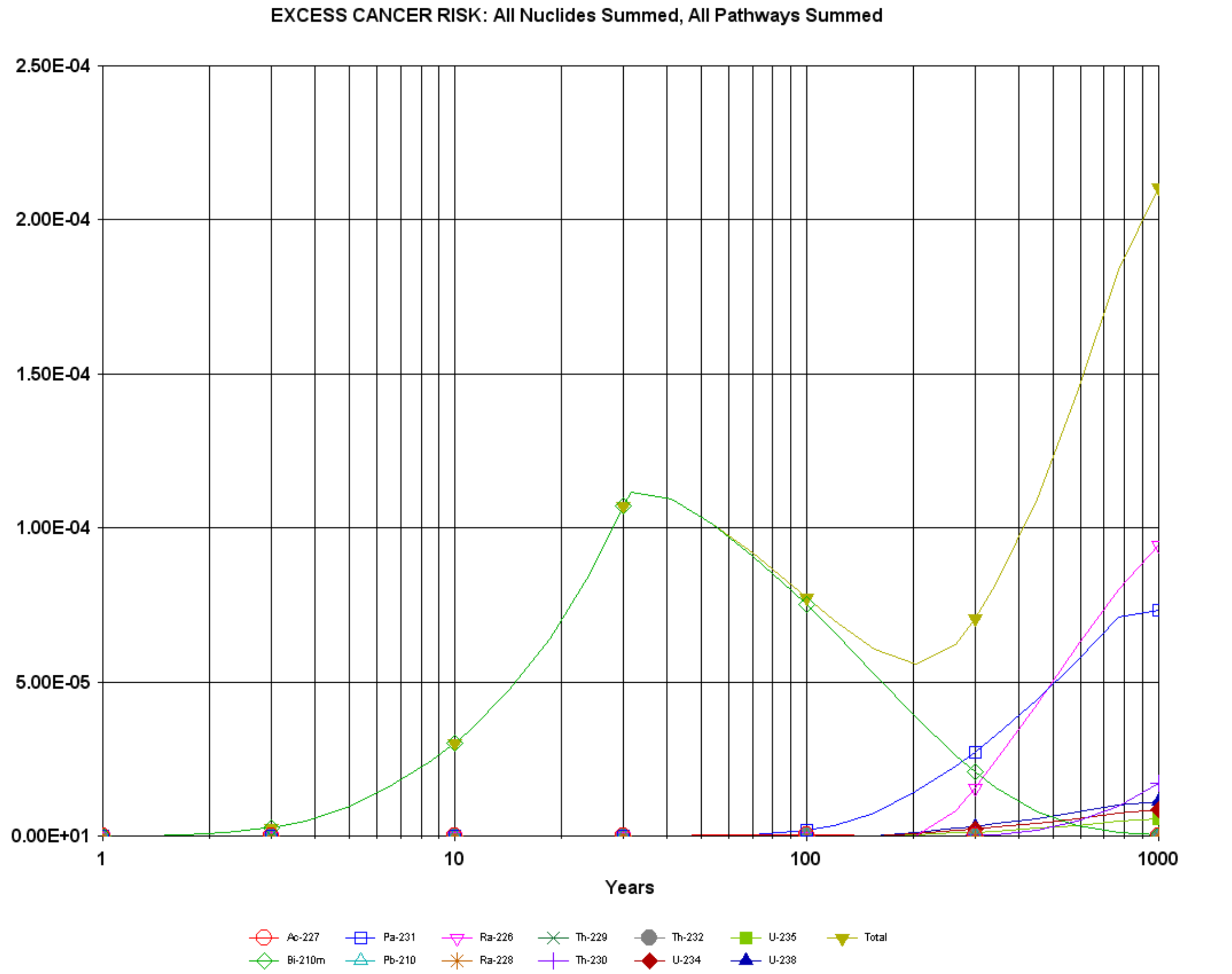


Figure 7 The predicted excess cancer risk for a resident living over the contaminated area and consuming green produce from the garden. (Exposures summed over all pathways for individual radionuclides)

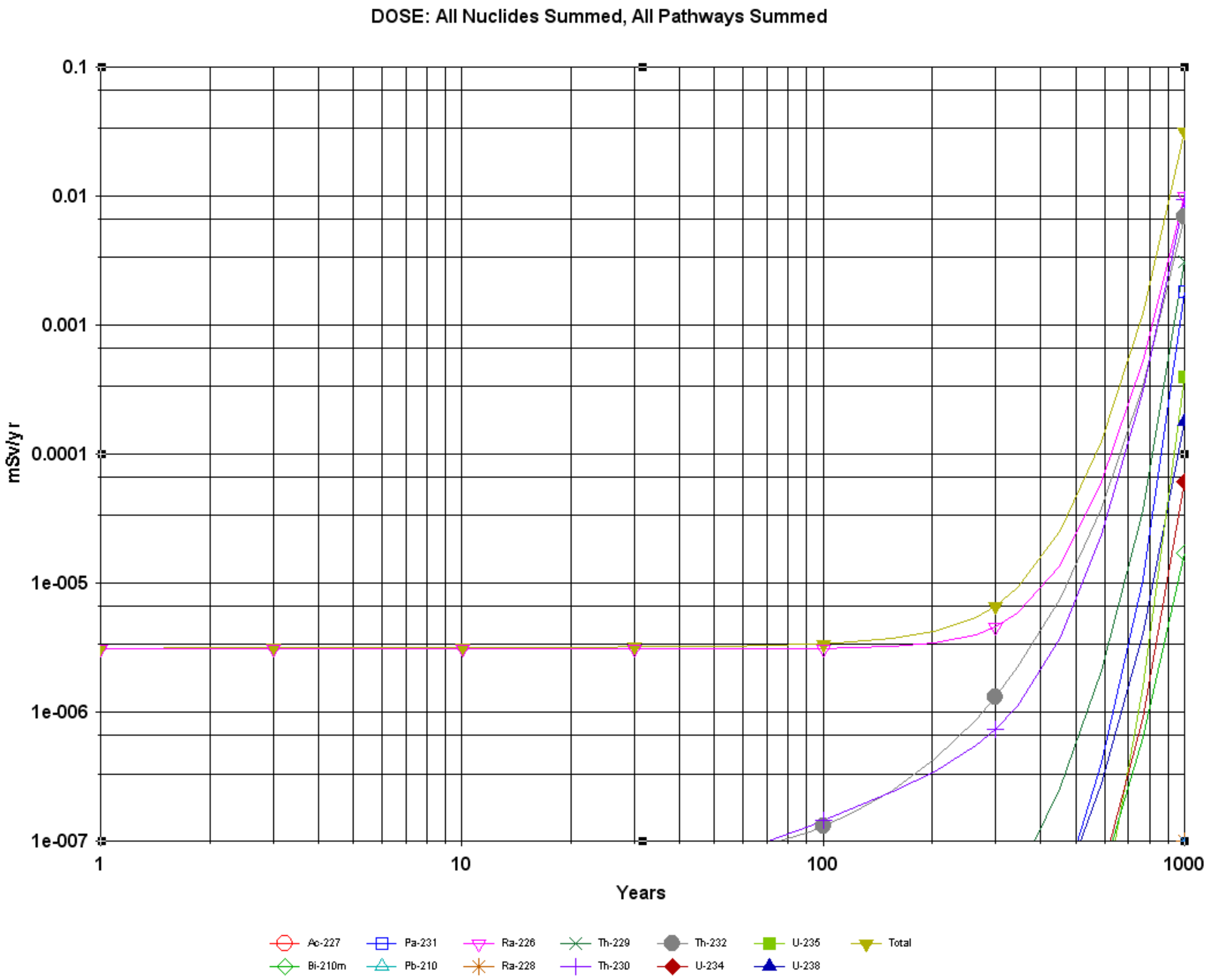


Figure 8 The predicted radiation exposure for a road maintenance worker involved in road/service repair. (Exposures summed over all pathways for individual radionuclides)

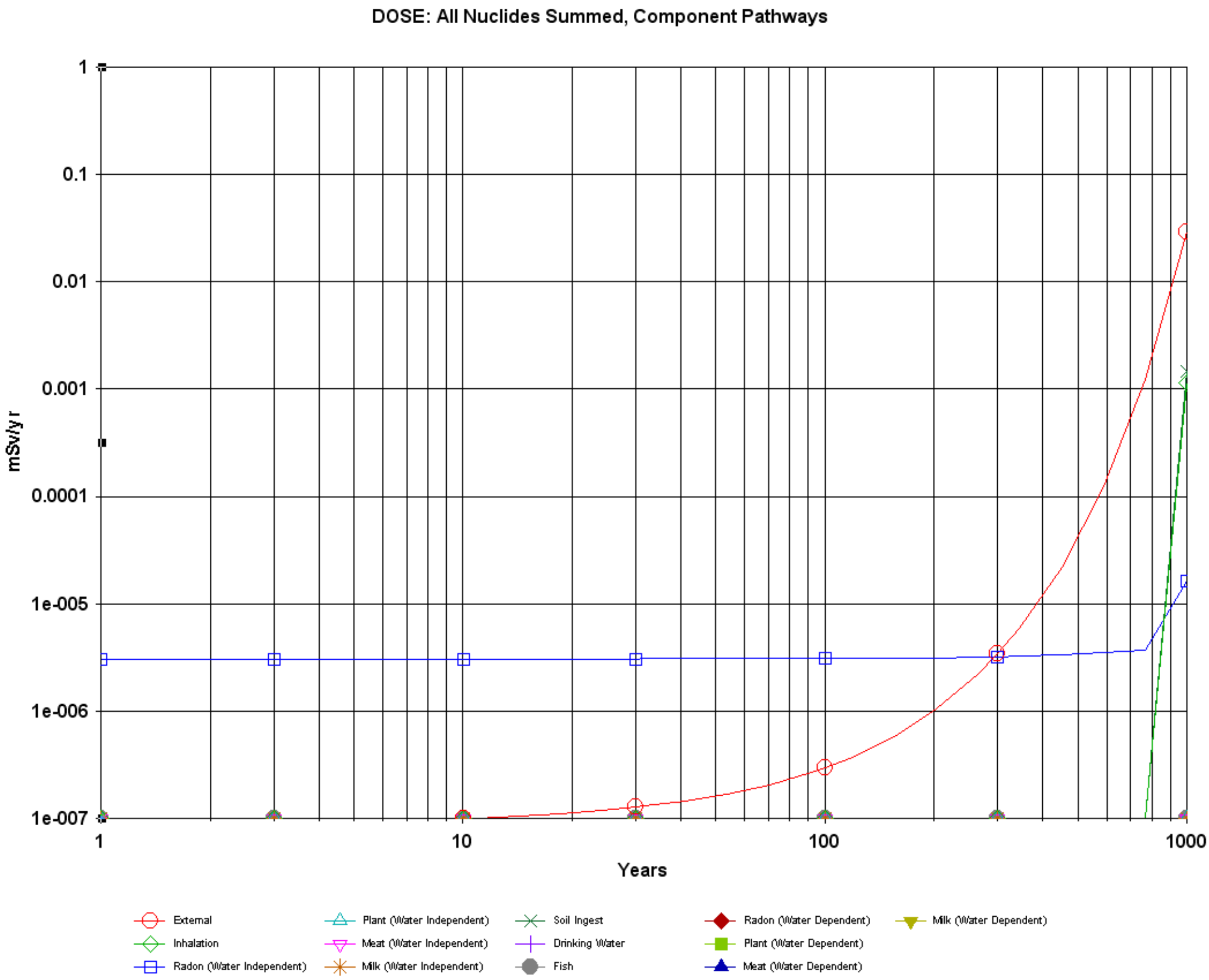


Figure 9 The predicted radiation exposure for a road maintenance worker involved in road/service repair. (Exposures summed over all radionuclides for individual pathways)

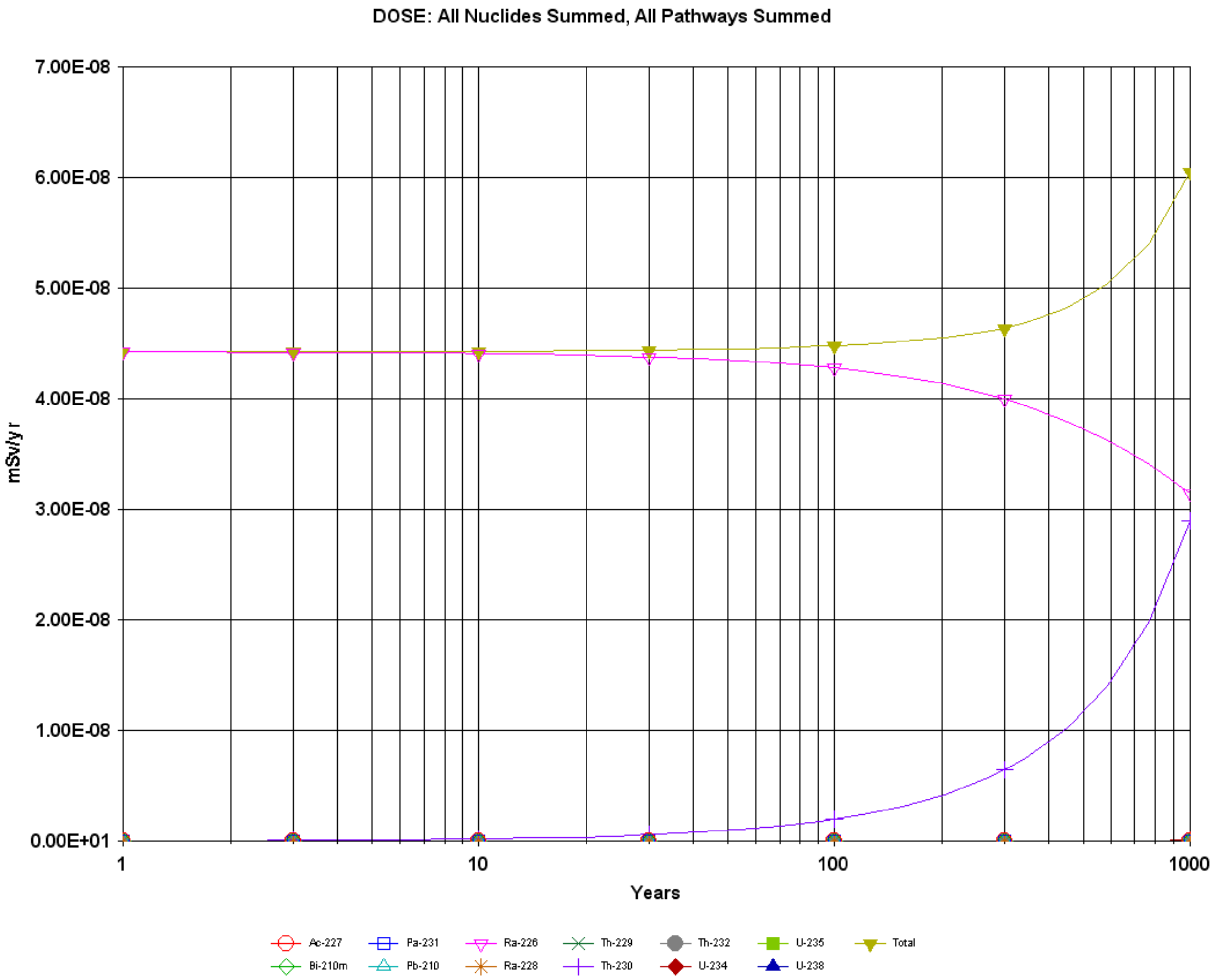


Figure 10 The predicted radiation exposure for a site general worker. (Exposures summed over all pathways for individual radionuclides)

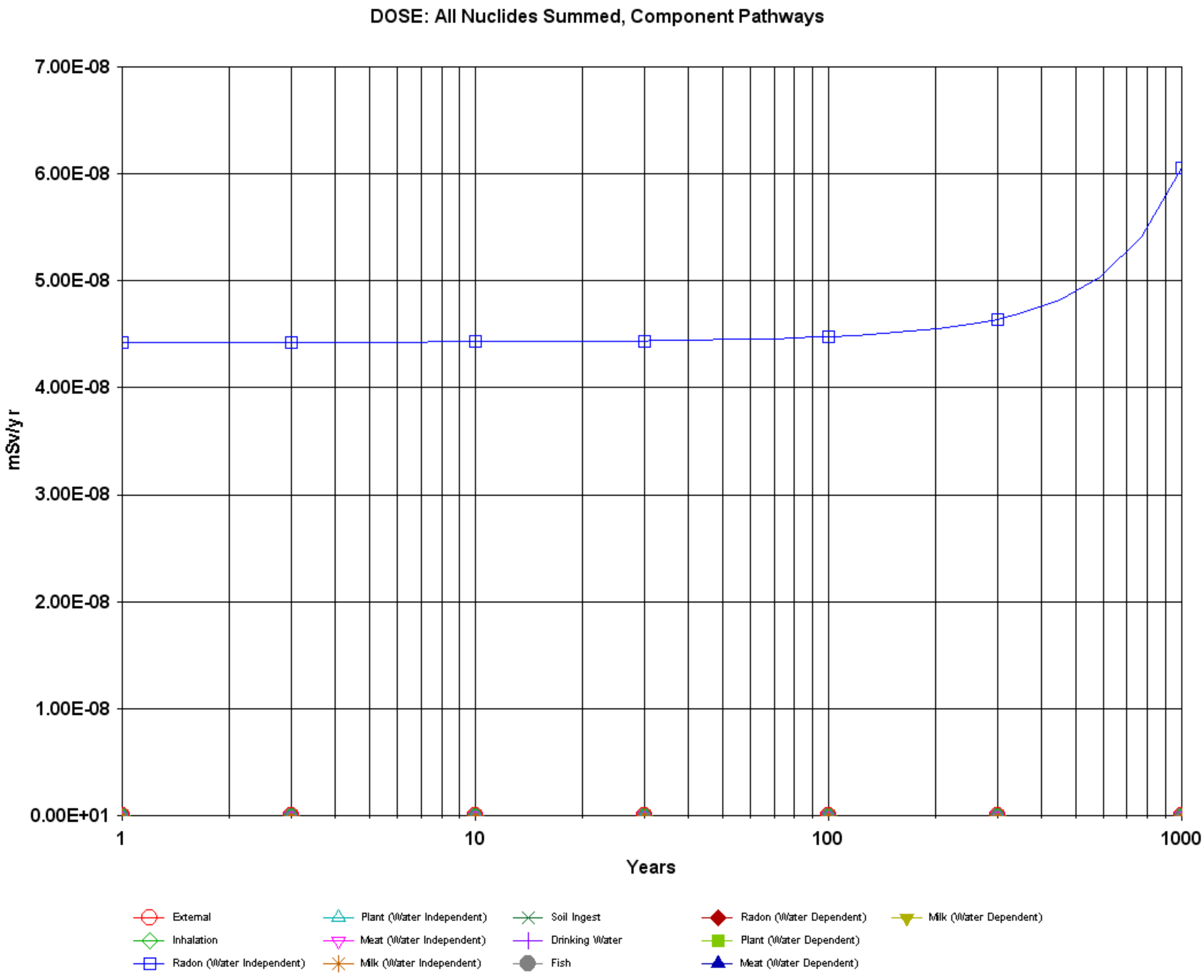


Figure 11 The predicted radiation exposure for a site general worker. (Exposures summed over all radionuclides for individual pathways)

Appendix B

Acceptance / Sign Off sheets

ACCEPTANCE FORM

Method Statement / Risk Assessment

Olympic Park – Storage of radioactivity contaminated soils at 6a

I Have Read the Method Statement No. 2140/CN/06A-00

Olympic Park – Deposition of assayed soils at zone 4

I agree to abide by the Method Statement Described and will seek Approval of my Supervisor Prior to Undertaking any Deviation

Name: Signature

Contract Name:	Olympic Park Stratford,				
Operating Unit:	Earthworks Zone 6A				
Contract Number:	2140		Date:		
Briefing Start time			Briefing Finish time		
Briefing Type:	Method Statement				

*Delete as Required

Briefing Title(s) / Reference(s):	**Olympic Park – Deposition of assayed soils at zone 4**				
If Method statement briefing and Safety Critical Operation	Tick as appropriate	YES		NO	x
Briefing Given By:					

Name	MCSL	LO S/C	Other	Signature:

Appendix C

Hospital Route
(Homerton Hospital)

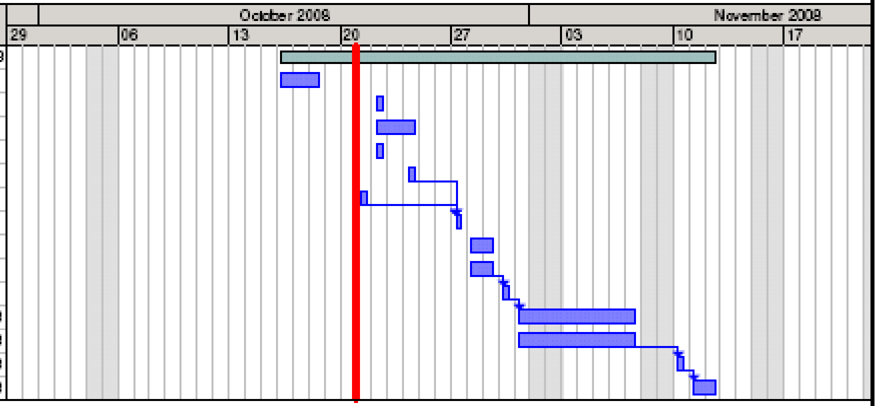
ROUTE TO HOSPITAL

Appendix D

Programme of Works

MORRISON CONSTRUCTION
OLYMPIC PARK REMEDIATION WORKS
DISPOSAL AND DEPOSITION OF EXEMPT & LL RADIOLOGICAL WASTE

ID	Name	Dur	Start	Finish
091	Radioactive soils disposal from CZ6a to L03	24d	16 Oct 08	12 Nov 08
1	Transfer exempt material from bags onto stockpile (at CZ 6a)	3d	16 Oct 08	18 Oct 08
2	Handover area from Nuttalls to Morrison	1d	22 Oct 08	22 Oct 08
3	Demarcate area/set up site compound &decontamination unit at L03	3d	22 Oct 08	24 Oct 08
4	Pre commencement radiological survey of prepared area at L03	1d	22 Oct 08	22 Oct 08
5	Carry out inductions /identify agreed wagons route.	1d	24 Oct 08	24 Oct 08
6	Set up air samplers at CZ6a and deposition area	1d	21 Oct 08	21 Oct 08
7	Transfer LLW bags from 6a to L03/transfer notes implementation	1d	27 Oct 08	27 Oct 08
8	Transfer and deposit exempt/JK contaminated spoil to L03(1000m3)	2d	28 Oct 08	29 Oct 08
9	Carry out geotechnical testing of placed soil	2d	28 Oct 08	29 Oct 08
14	Cover JK contaminated soils with barrier membrane and seal.	1d	30 Oct 08	30 Oct 08
10	Continue with disposal /deposition of Rad material from CZ6a to L03(2000m3)	6d	31 Oct 08	07 Nov 08
11	Carry out geotechnical testing	6d	31 Oct 08	07 Nov 08
12	Cover exempt soils with clean layer.	1d	10 Nov 08	10 Nov 08
13	Final walkover survey clearance/clear site	2d	11 Nov 08	12 Nov 08



Detail Normal | Summary Normal | Detail Critical | Summary Critical | Detail Super-Critical | Summary Super-Critical | Baseline1 | Project | Percent Complete | Mi

Appendix E

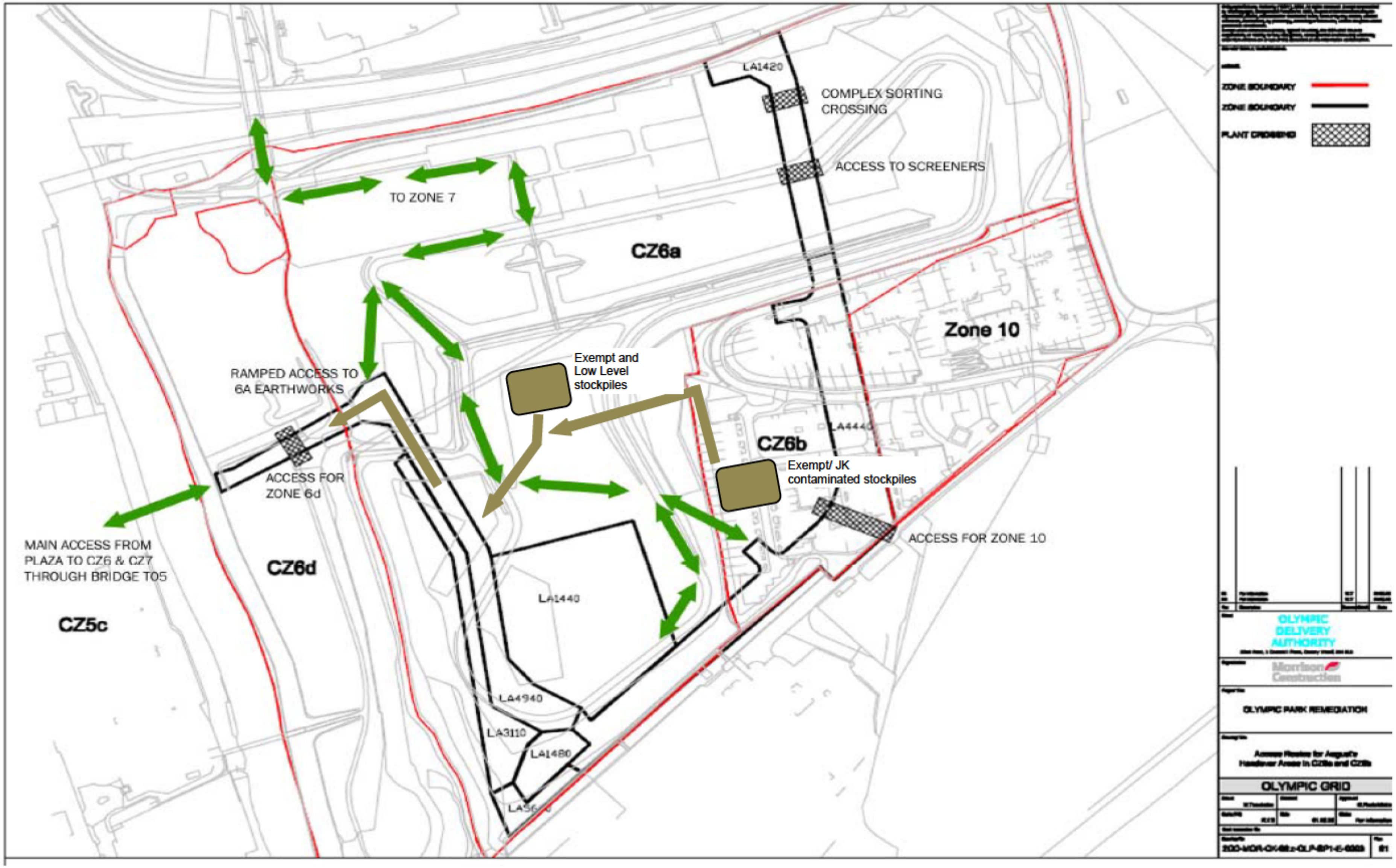
Test and Inspection Plan

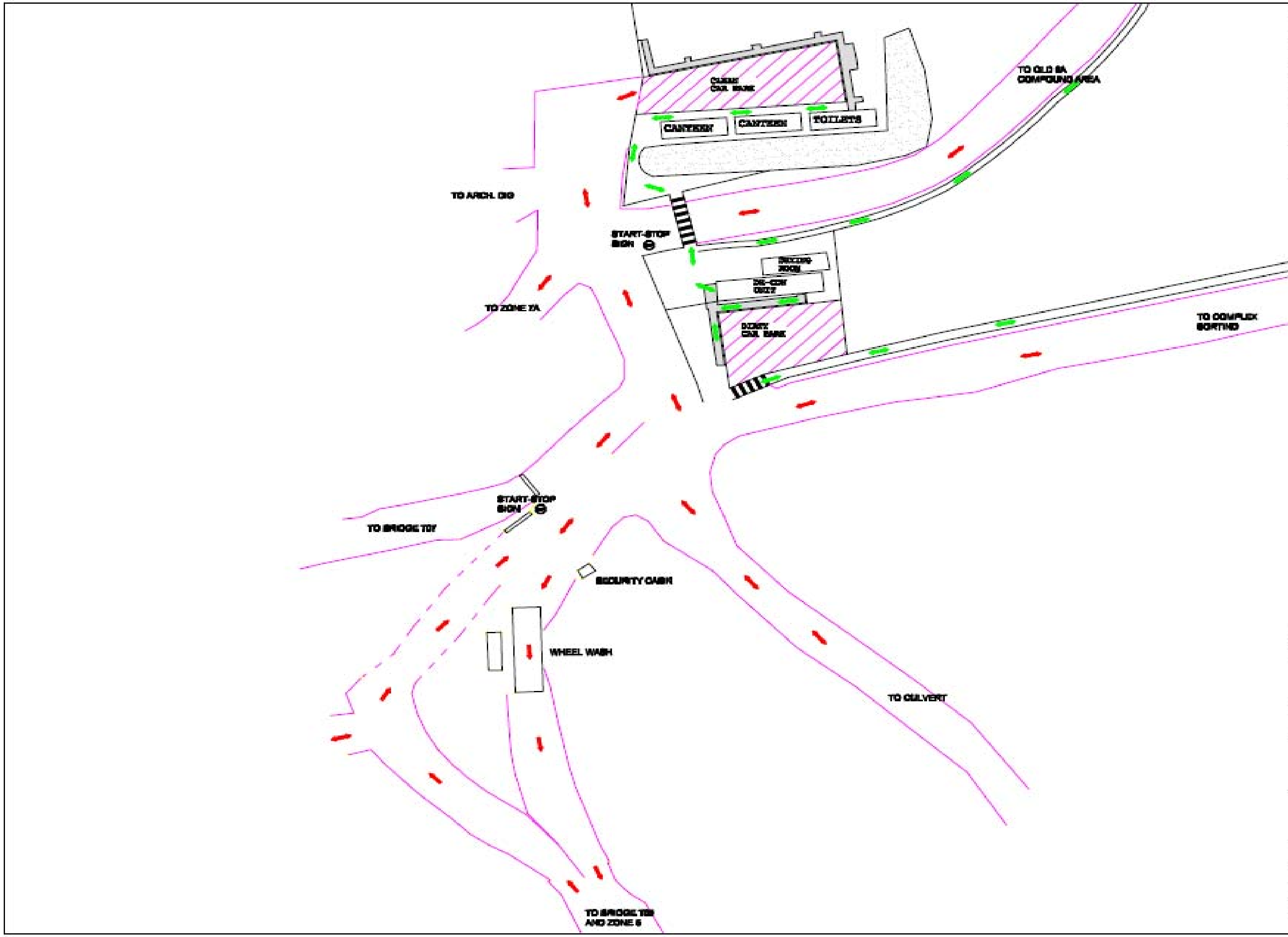
ITEM		T=Testing I = Inspection B = Both testing & Inspection.				Acceptance Criteria (results required)	Verification (method of checking)	Hold Point	Records	Comments and Actions (Who is responsible, frequencies of tests or inspections, sampling, instructions in case of failure etc)
No	Description	At source	At delivery	In process	Final					
1	Deposition control of assayed waste at LO3.			I		Waste transfer tickets	Visual inspection		Copies of Waste transfer ticket/return of signed tickets to despatching Health Physics Surveyor.	Control/traceability of waste from loading point to deposition.
2	Recording of radiation levels at deposition area.	T	T			<900 cps	GroundHog probe	>900cps	HPS Report	Pre and post placement survey. Ensure the area is at general background levels.
3	Approval of Method Statement	I				Approval by PM if safety critical. See MST-MOR-CK-06a-OLP-SP1-E-000	Signed by person responsible for approval.		Updated on iPronet.	Prior to work commencing.
4	Approval of Construction Phase H&S Plan	I				Approval by Arup's CDM Coordinator.	Signature of Arup's CDM Coordinator.		Updated on iPronet	Prior to work commencing.
5	Setting out	I				As per drg.ENW-ATK-4-SP1-DR-C-3-H11-0011.Setting out to comply with Specification for Highway Works ,series 100 preliminaries, Ciria Special Publication 145 setting out procedures to be used as guidance.	All work to be checked by competent person ie critical levels and positions to be checked by another engineer .Level check sheet (CS-CON-025) to be performed at max. Interval of every week.		As built drgs. Uploaded in iPronet and included in H&S File.	Prior to commencement of Earthworks.

ITEM		T=Testing I = Inspection B = Both testing & Inspection.				Acceptance Criteria (results required)	Verification (method of checking)	Hold Point	Records	Comments and Actions (Who is responsible, frequencies of tests or inspections, sampling, instructions in case of failure etc)
No	Description	At source	At delivery	In process	Final					
6	Earthworks/ Placing of fill.	I				Baseline Earthworks Specification /Specification for Highway works series 600	Waste transfer notes/ Sub formation inspection sheets.		Survey book, site diary and as built records.	Record areas where material originated from and area of deposition; destination tracking.
7	Geotechnical testing of soils.			B		Baseline Earthworks Specification, Table 6/1, Appendix 1/5(Frequency of testing) Table 6/4 method of compaction.	Lab sampling reference /CoC. Fill check sheet CS02		.Geotechnical Lab reports	
8	Chemical acceptability of soils.			B		Site Specific Remediation Targets/Site Specific Assessment Criteria. Atkins SSRS	Lab sampling reference/ Hyder CoC forms.		Chemical Lab reports.	

Appendix F

Access Routes
And
Traffic Management Plan


LA1420
COMPLEX SORTING CROSSING
ACCESS TO SCREENERS
TO ZONE 7
CZ6a
Zone 10
Exempt and Low Level stockpiles
RAMPED ACCESS TO 6A EARTHWORKS
LA4440
CZ6b
Exempt/ JK contaminated stockpiles
ACCESS FOR ZONE 6d
ACCESS FOR ZONE 10
MAIN ACCESS FROM PLAZA TO CZ6 & CZ7 THROUGH BRIDGE TO5
CZ6d
CZ5c
LA1440
LA4940
LA3110
LA1480
ZONE BOUNDARY
ZONE BOUNDARY
PLANT CROSSING
OLYMPIC DELIVERY AUTHORITY
OLYMPIC PARK REMEDIATION
OLYMPIC GRID



OLYMPIC DELIVERY AUTHORITY

Morrison Construction

OLYMPIC PARK REMEDIATION

CURRENT TRAFFIC MANAGEMENT PLAN AT ZONE 8a

OLYMPIC GRID

00

Appendix E Controlled Waters Assessment in Relation to the CZ 4 Defined Area for Deposit

ATKINS
The official engineering design services provider for the London 2012 Games

Olympic Delivery Authority

CZ4 Radioactive Defined Area for Deposit

Controlled Waters Assessment

January 2010

Notice

This document and its contents have been prepared and are intended solely for Olympic Delivery Authority's information and use in relation to the radioactive defined area for deposit on Construction Zone 4 on the Olympic Park, London UK site.

Document History

JOB NUMBER: 5060664			DOCUMENT REF: REP-ATK-CM-04Z-XXX-XXX-E-0002			
1		[redacted]	[redacted]	[redacted]	[redacted]	January 2010
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Contents

List of Tables

1. Introduction

Naturally occurring radioactive material (NORM), which has been discovered enhanced above natural levels in areas of construction zones (CZ) CZ3A, CZ6A and CZ6D, has been placed within a defined area for deposit (referred to herein as the 'deposit area') located within the western approach embankment to Bridge L03B on CZ4. It is likely that the radioactivity was enhanced above natural levels by past processing operations, such as phosphate-based fertiliser manufacture and metal processing which were known to have occurred on the site (Nuvia, 2009).

The Olympic Delivery Authority (ODA) has instructed its contractors to ensure that this deposit area represents no increased risk to members of the public during the legacy uses of the Olympic Park. In order to demonstrate one aspect of this, they wished to ensure that radioactive contamination does not appear in groundwater in significant quantities post-Olympics. This demonstration could be made either by groundwater sampling and analysis, or by way of modelling and assessment. The purpose of this technical note is therefore to assess the potential for the radioactive contamination within the deposit area to leach into pore water and ultimately into the underlying groundwater. This document investigates the potential leaching of contaminants and resulting pore water concentrations in the deposit area. In addition, potential groundwater concentrations and travel times within groundwater are calculated. However, these calculations only consider dilution and retardation in groundwater but do not provide a complete assessment of transport and attenuation of these contaminants along a potential pathway to the groundwater.

Based on the assessment results, a decision will be taken regarding whether or not groundwater sampling is necessary or likely to provide any useful information.

The Nuvia report 87216/TR/053 (Nuvia, 2009) states that approximately 7370.5 tonnes of radioactively contaminated spoil have been placed within the deposit area. Maximum activities measured in samples were:

- 40 Bq/g for ^{226}Ra;
- 15 Bq/g for ^{232}Th; and
- 72 Bq/g for ^{238}U.

Assays from monitoring of the soil prior to deposit indicate the mean activity for bagged waste to be:

- 3.84 Bq/g for ^{226}Ra;
- 4.64 Bq/g for ^{232}Th; and
- 3.87 Bq/g for ^{238}U.

For the purpose of this assessment it has been assumed that the mean activity is representative of all the radioactively contaminated material deposited in the deposit area.

2. Details of Deposit Area

Details of the deposit area presented in the Nuvia report (87216/TR/053) and Halcrow Group Limited's Human Health Validation Report (REP-ENL-CK-04Z-OLP-SP1-E-0278-02) dated September 2009 are summarised in the Table 2.1 below.

Table 2.1 - Deposit Area Details

Parameter	Value
Width (m)	38.11
Length (m)	35.6
Thickness (m)	4.25
Base of deposit area (m AOD)	6.09(NW) to 5.54(SE)
Top of deposit area (m AOD)	10.34(NW) to 9.79(SE)

The base of the deposit area was excavated to approximately 5.7 m AOD. An orange marker layer (TERAM 1000 NW 100HV) has been placed at the base and top of the deposit area. The deposit area has then been covered by a 300 mm non-active cover layer of general fill material comprising crushed rock and concrete. General fill was placed over the top of the non-active cover layer to bring the levels to Sub-Formation Levels where an additional marker layer has been placed prior to covering with 300 mm of human health separation layer which is beneath a road surface (approximately 500 mm thick) with bitumen top surface.

3. Site Geology and Hydrogeology

The geology of CZ4 comprises the sequence presented below. Specific details of the geology can be found in the SSRS for CZ4.

- Made Ground
- Alluvium
- River Terrace Deposits (RTD)
- Lambeth Group
- Thanet Sand
- Chalk

The deposit area is underlain by Made Ground. Physical parameters for the Made Ground on CZ4 are summarised in Table 3.1, alongside the parameters for Made Ground material from CZ3A, CZ6A and CZ6d which form the source material within the deposit area. Values have been taken from the SSRS reports for the respective construction zones. These values have been used for the calculations presented below as these data were not available for the material in the deposit. However, as this is Made Ground material, the chosen parameters are considered representative.

Table 3.1 - Made Ground Physical Parameters

Parameter	CZ4, CZ6A and CZ6D Made Ground	CZ3A Made Ground
Bulk Density (l kg^{-1})	1.6	1.61
Total Porosity (-)	0.46	0.3
Air Filled Porosity (-)	0.31	0.2
Water Filled Porosity (-)	0.15	0.1

It is assumed that the deposit area is unsaturated. The River Terrace groundwater level is approximately 2.5 m AOD, approximately 3 m below the base of the deposit area.

4. Radionuclide Partitioning

Theoretical pore water concentrations have been calculated based on calculated soil concentrations. No dilution, dispersion or attenuation along a migration pathway has been taken into consideration at this stage. The equation used tends to be conservative and assume all of the soil contaminant mass can take part in soil water partitioning. It is however not as conservative as the Batch approach which does not take porosity into consideration.

Literature K_d values have been applied in this assessment. Soil properties have been taken as presented for CZ3A from Table 3.1 in Section 3.

The assessment is based on theoretical calculations (Equation 1) for soil water partitioning.

Equation 1

$$C_p = \frac{C_s}{\left(K_d + \frac{\theta_w + \theta_a H}{\rho}\right)}$$

Where: C_p = pore water concentration (mg l^{-1})

C_s = soil concentration (mg kg^{-1})

K_d = soil water partition coefficient (l kg^{-1})

θ_w = water filled soil porosity (fraction)

θ_a = air filled soil porosity (fraction)

H = Henry's Law constant (dimensionless)

ρ = bulk density (g m^{-3})

4.1 Soil water partitioning coefficients (K_d)

The lowest of the K_d values from each literature reference have been summarised in Table 4.1 to 4.3 below. All values have been converted to litres per kilogram for consistency.

K_d values are contaminant specific and likely to vary according to the soil properties (e.g. mineral content and surface area); site specific conditions (e.g. soil pH and temperature); and contaminant concentrations in water. The literature K_d values considered appropriate for the site conditions (sandy soil, neutral pH) are presented.

Table 4.1 - Uranium^{238} Literature K_d Values

K_d	K_d (l kg^{-1})	Reference
0.05 m^3 kg^{-1}	50	Default values in RCLEA (Table 3 from EA. 2006)
50 cm^3 g^{-1}	50	Default Value in RESRAD (Table 32.2 from Yu et.al., 1993)
35 cm^3 g^{-1}	35	RESRAD value for Sand (Table 32.1 from Yu et.al., 1993)
100 ml g^{-1}	100	pH 6 (Table 5.17 from EPA, 1999)
63 ml g^{-1}	63	pH 7 (Table 5.17 from EPA, 1999)
0.5 ml g^{-1}	0.5	pH 8 (Table 5.17 from EPA, 1999)

Table 4.2 - Thorium^{232} Literature K_d Values

K_d	K_d (l kg^{-1})	Reference
3 m^3 kg^{-1}	3,000	Default values in RCLEA (Table 3 from EA. 2006)
60,000 cm^3 g^{-1}	60,000	Default Value in RESRAD (Table 32.2 from Yu et.al., 1993)
3,200 cm^3 g^{-1}	3,200	RESRAD value for Sand (Table 32.1 from Yu et.al., 1993)
1,700 ml g^{-1}	1,700	pH 5-8 Dissolved Th $<10^{-9}$ M (Table 5.15 from EPA, 1999)
300,000 ml g^{-1}	300,000	pH 5-8 Dissolved Th $>10^{-9}$ M (Table 5.15 from EPA, 1999)
20 ml g^{-1}	20	pH 8-10 Dissolved Th $<10^{-9}$ M (Table 5.15 from EPA, 1999)
300,000 ml g^{-1}	300,000	pH 8-10 Dissolved Th $>10^{-9}$ M (Table 5.15 from EPA, 1999)

Table 4.3 - Radium^{226} Literature K_d Values

K_d	K_d (l kg^{-1})	Reference
5 m^3 kg^{-1}	5,000	Default values in RCLEA (Table 3 from EA. 2006)
70 cm^3 g^{-1}	70	Default Value in RESRAD (Table 32.2 from Yu et.al., 1993)
500 cm^3 g^{-1}	500	RESRAD value for Sand (Table 32.1 from Yu et.al., 1993)
500 ml g^{-1}	500	Sand (Table 5.28 EPA, 2004)
289 ml g^{-1}	289	Lowest of Kd values (Table 5.27 EPA, 2004)

4.2 Soil Concentrations

Soil concentrations for the deposited material have been derived based on the mean activity values presented in Section 1, applying Equations 2 to 4.

Equation 2

$$N = \frac{A}{\lambda}$$

Equation 3

$$\lambda = \frac{Ln(2)}{t_{1/2}}$$

Equation 4

$$m = \left(\frac{N}{A_o}\right) G_a$$

Where: N is number of Atoms

A is activity in disintegrations per second (Bq g^{-1})

λ is decay constant per second

$t_{1/2}$ is Half Life in seconds

m is mass

A_o is Avogadro's number (6.022×10^{23} atoms per gram wt)

G_a is atomic weight in g

The calculated soil concentrations are presented in Table 4.4 below.

Table 4.4 - Soil Concentrations

Radionuclide	Mean Activity (Bq g^{-1})	Half Life (s)	Concentration (mg kg^{-1})
$Uranium^{238}$	3.87	1.41E+17	3.11E+02
$Thorium^{232}$	4.64	4.45E+17	1.15E+03
$Radium^{226}$	3.84	5.05E+10	1.05E-04

4.3 Calculated Pore Water Concentrations

The calculated pore water concentrations are provided in Table 4.5. The default K_d for RCLEA (see Table 4.1 to 4.3) have been used in the calculation. Pore water concentrations have then been converted back to Activity values (Bq l^{-1}) applying Equations 2 to 4 above.

Table 4.5 - Calculated Pore Water Concentrations

Radionuclide	Soil Concentration (mg kg^{-1})	Pour Water Concentration (mg l^{-1})	Pore water activity (Bq l^{-1})
$Uranium^{238}$	3.11E+02	6.21	7.72E+01
$Thorium^{232}$	1.15E+03	0.38	1.55E+00
$Radium^{226}$	1.05E-04	2.10E-08	7.69E-01

The pore water concentrations provided in Table 4.5 have not been limited by solubility and are therefore considered conservative. EPA, 1999 considers the leaching of $Thorium^{232}$ to be limited by its solubility. The solubility for Thorium is approximately 10^{-9} M or 2.32×10^{-4} mg l^{-1}. Above this value, the K_d value is considerably increased above the value used in the calculation (see Table 4.2) and $Thorium^{232}$ will not go into solution. The solubility value is 2 orders of magnitude less than the calculated pore water concentration. If the $Thorium^{232}$ concentrations were limited by solubility then the equivalent pore water activity would be approximately 9.39×10^{-4} Bq l^{-1}.

4.4 Calculated Activity within RTD

The activities of the three radionuclides in the RTD groundwater beneath the deposit area have been calculated applying the Level 2 calculations presented in the Remedial Targets Worksheet, Release 3.1 (EA, 2006) which allows to consider dilution of the radionuclides within the groundwater. No additional attenuation processes in the unsaturated or saturated zone have been considered at this stage. The results are presented in Table 4.6. The aquifer properties applied in the calculation of the dilution factor were taken from Capita Symonds SSRS report version.1.1, Appendix 5 (CSL, 2007) for CZ4 and are presented in Table 4.7.

The calculations apply the infiltration rate used for CZ4 in the SSRS report (CSL, 2007). This is a conservative assumption as the deposit area will be covered by a road surface and the resulting infiltration rates and leaching of contaminants are considered to be significantly reduced. The calculations are based on the assumption that radionuclide activities attenuate by dilution in the same way as concentrations.

Table 4.6 - Calculated RTD Groundwater Concentrations

Radionuclide	Pore water activity (mg kg^{-1})	Dilution Factor (mg l^{-1})	Groundwater activity (Bq l^{-1})
$Uranium^{238}$	7.72E+01	10.8	7.15E+00
$Thorium^{232}$	1.55E+00	10.8	1.43E-01
$Radium^{226}$	7.69E-01	10.8	7.12E-02

Table 4.7 - Aquifer Properties Used in Dilution Calculation

Parameter	Unit	Value	Justification
Infiltration	m/d	3.56E-04	Appendix 5 (CSL, 2007)
Area of contaminant source	m^2	1600	Approximate area of deposit area
Length of contaminant source in direction of groundwater flow	M	40	Approximate length of deposit area
Saturated aquifer thickness	M	4	Appendix 5 (CSL, 2007)
Hydraulic conductivity of aquifer in which dilution occurs	m/d	25	Appendix 5 (CSL, 2007)
Hydraulic gradient of water table	-	1.40E-03	Appendix 5 (CSL, 2007)
Width of contaminant source perpendicular to groundwater flow	M	40	Approximate width of deposit area
Mixing Zone Thickness	M	4	Appendix 5 (CSL, 2007)

4.5 Groundwater vs. Radionuclide Flow Velocity

Calculation of groundwater flow velocity and contaminant flow velocity was calculated using the calculation sheet provided with the Remedial Targets Worksheet, Release 3.1 and applying the RCLEA default retardation factors presented in Table 4.1. The results are presented in Table 4.8 below.

Table 4.8 - Flow Velocities

Radionuclide	Flow Velocity (m s^{-1})	Travel time for 1 m (yrs)
RTD Groundwater	1.25E-06	2.54E-02
$Uranium^{238}$	5.07E-09	6.25E+00
$Thorium^{232}$	8.49E-11	6.22E+02
$Radium^{226}$	5.07E-11	3.73E+02

These results indicate that the radionuclides are retarded and transport velocities are much slower than flow velocities calculated for groundwater. According to the calculations presented in Table 4.8, it would take between 62 and 6220 years for the three radionuclides to travel 10 m within the River Terrace Deposits groundwater. The distance to the closest groundwater receptor for CZ4 which has been identified as the Waterworks River at the northern end of CZ8c (CSL, 2008), is approximately 700 m.

This calculation of travel times does not consider the travel time of the contaminants through the unsaturated zone to reach the groundwater in the River Terrace Deposits. An inclusion of the time for contaminant release from the deposit area and migration through the unsaturated zone would be expected to result in significantly longer travel times.

5. Concluding Summary

According to these calculations groundwater concentrations beneath the deposit area, assuming unit density of the groundwater, do not exceed 7.15 E-3 Bq g^{-1} for ^{238}U (cf 2.5 E-1 Bq g^{-1}); 1.43 E-4 Bq g^{-1} for ^{232}Th (cf 1.2 E-2 Bq g^{-1}); and 7.12 E-5 Bq g^{-1} for ^{226}Ra (cf 1.2 E-4 Bq g^{-1}). The figures in brackets are the approximate concentration thresholds derived from Schedule 1 of the Radioactive Substances Act 1993 (RSA 93). They are approximate (but conservatively estimated) because RSA 93 is couched in terms of radioelements, and some assumptions have to be made regarding which radionuclides are present in the overall radionuclide calculation.

Because everything in nature is, to some extent or other, radioactive, the Act defines what is 'radioactive' purely for the purposes of the Act. If this were not done, then everything in the earth would be deemed radioactive and subject to regulatory controls. This is obviously impractical. These figures, if you compare the calculated values with the thresholds in brackets, show that the groundwater beneath the deposit area would not be classified as 'radioactive' according to the Act.

Additionally, the transport calculations show that it would take between 62.5 and 6220 years for the three radionuclides to travel 10 m, however, the closest identified receptor at this site is approximately 700 m away.

We can therefore conclude the following:

1. predicted groundwater concentrations of Uranium^{238}, Thorium^{232}, and Radium^{226} beneath the deposit area do not exceed concentrations thresholds derived from Schedule 1 of the Radioactive Substances Act 1993;
2. monitoring of groundwater down hydraulic gradient of the deposit area on the Olympic Park over a period of years following closure of the deposit area would not detect any of the radionuclides in question deriving from the deposit area. Groundwater monitoring is therefore not considered to be required; and
3. even when the radionuclides appeared in groundwater, due to migration over decades, they would probably be at the limits of detection and in any case not distinguishable from background; that is, the measurements due to uranium and thorium and decay-chain daughters already present in the soils on the Park (and everywhere else, for that matter) would dominate the assay.

It is recommended that as a precautionary approach groundwater abstraction from the River Terrace Deposits should not be allowed within 50 m of the deposit area.

6. References

CSL, December 2007: Full Site Specific Remediation Strategy, Planning Delivery Zone 4 (Construction Zone 4), Version 1.1. ODA Reference: REP-CSP-VZ-04Z-OLP-XXX-E-0048.

CSL, 2008: CZ4 SSRS version 1.1 Addendum: Updated SSAC for Soil Leaching and Groundwater Migration. Memorandum.

EA, 2006: Hydrogeological risk assessment for land contamination: Remedial targets worksheet v.3.1.

EA, December 2006: The Radioactively Contaminated Land Exposure Assessment Methodology – Technical Report, CLR-14 Draft 1.1.

EPA, August 1999: UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, Kd, VALUES Volume II: Review of Geochemistry and Available Kd Values for Cadmium, Cesium, Chromium, Lead, Plutonium, Radon, Strontium, Thorium, Tritium (3H), and Uranium. Document Reference No. EPA 402-R-99-004B

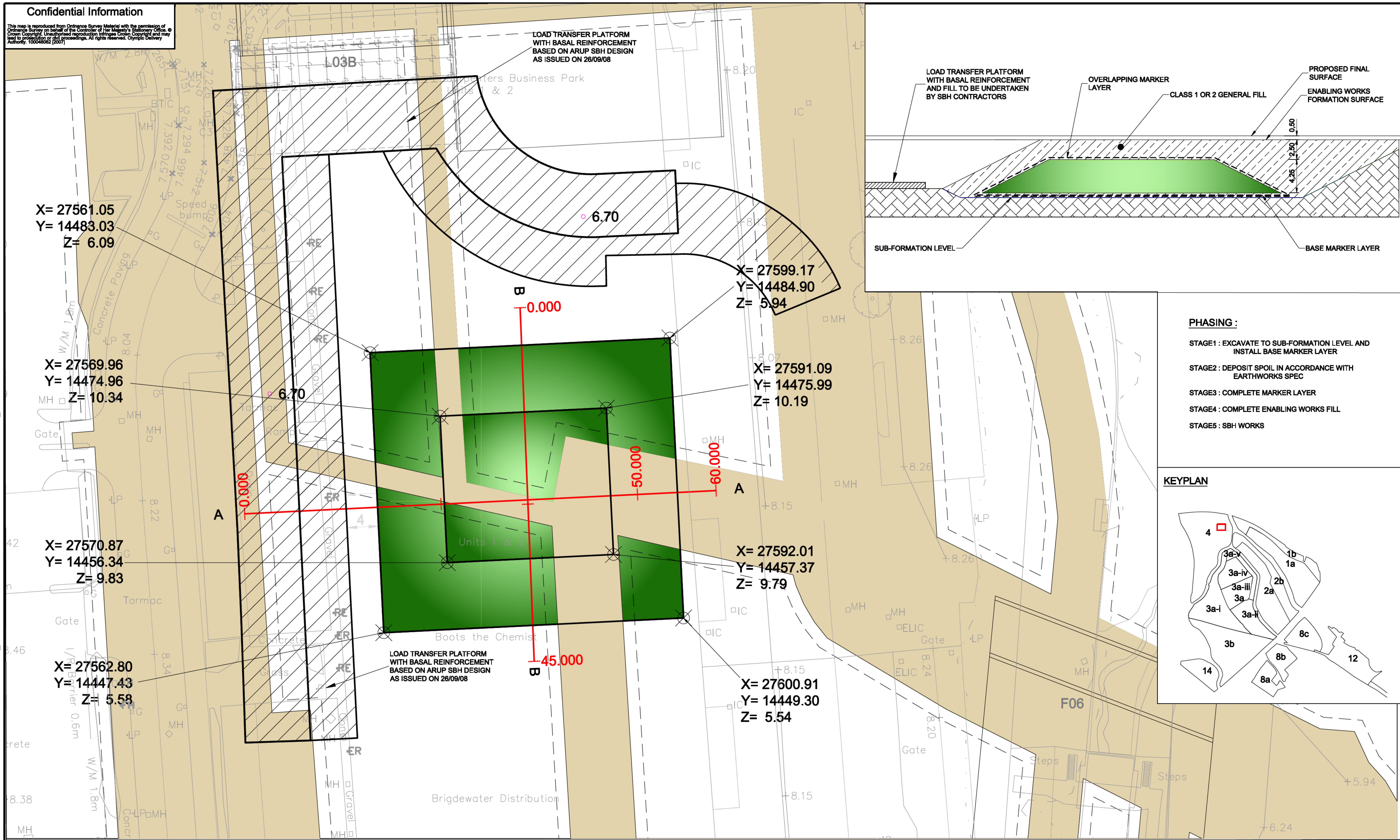
EPA, July 2004: UNDERSTANDING VARIATION IN PARTITION COEFFICIENT, Kd, VALUES Volume III: Review of Geochemistry and Available Kd Values for Americium, Arsenic, Curium, Iodine, Neptunium, Radium, and Technetium. Document Reference No. EPA 402-R-04-002C

Halcrow Group Limited, September 2009: Olympic and Paralympic Park Tier 1 Enabling Works, Construction Zone 4 (Planning Delivery Zone 4), CZ4 (Excluding Late Release Areas), Human Health Validation Report. ODA Reference: REP-ENL-CK-04Z-OLP-SP1-E-0278-02.

NUVIA, May 2009: Radiological Safety Assessment for the Disposal Cell in Bridge L03B Approach containing the Site's Arising of Exempt Waste. Document Reference No. 87216/TR/053

Yu et.al. 1993: User's Manual for RESRAD Version 6. Document Reference No. ANL/EAD-4.

Appendix F Drawing Showing Location and Details of Deposit Area



PHASING :

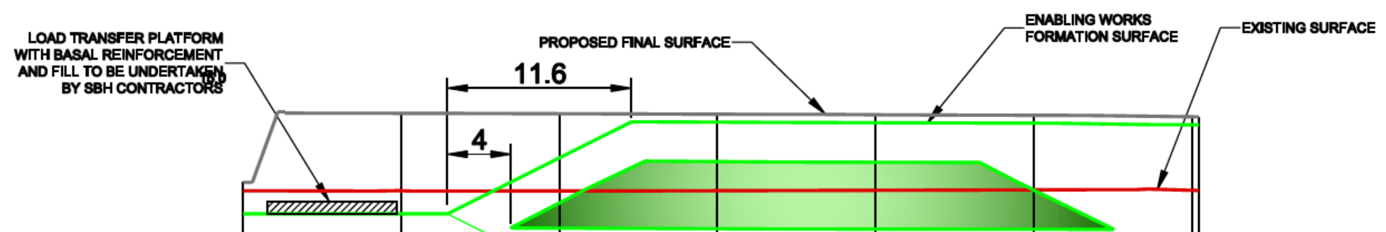
STAGE1 : EXCAVATE TO SUB-FORMATION LEVEL AND INSTALL BASE MARKER LAYER

STAGE2 : DEPOSIT SPOIL IN ACCORDANCE WITH EARTHWORKS SPEC

STAGE3 : COMPLETE MARKER LAYER

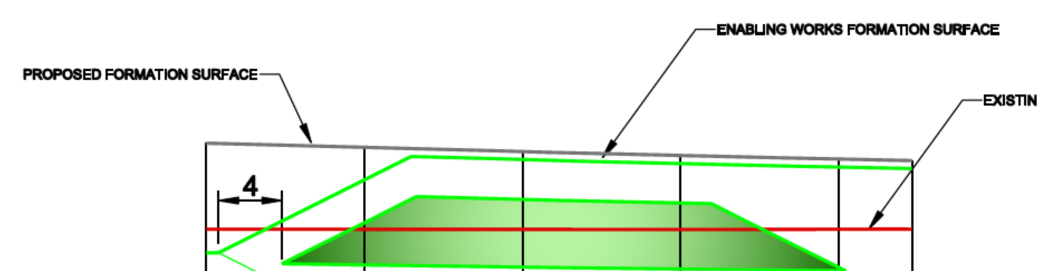
STAGE4 : COMPLETE ENABLING WORKS FILL

STAGE5 : SBH WORKS



Chainage	10.000	20.000	30.000	40.000	50.000	60.000
Scen 10 Level	13.06	13.03	13.00	12.96	12.93	12.84
Existing Ground Level	8.16	8.15	8.16	8.19	8.22	8.19

SECTION A-A
SCALE: HORIZONTAL 1:1000 VERTICAL 1:1000



Chainage	10.000	20.000	30.000	40.000
Scen 10 Level	13.37	13.10	12.86	12.63
Existing Ground Level	8.19	8.18	8.18	8.19

SECTION B-B
SCALE: HORIZONTAL 1:1000 VERTICAL 1:1000

LEGEND:

- VERY LOW LEVEL RADIOACTIVE SPOIL APPROXIMATE VOLUME = 3530 m³
- AREA REQUIRED FOR LOAD TRANSFER PLATFORM AND BASAL REINFORCEMENT
- PROPOSED SERVICE CORRIDOR

Do not scale this drawing.

Notes:

1. THE MATERIAL IS DERIVED FROM EXCAVATIONS ON CZ 3A, CZ 6A AND CZ6D.
2. THE MATERIAL HAS BEEN DETERMINED TO HAVE A LEVEL OF RADIOACTIVITY BUT BELOW THAT REQUIRED FOR IT TO BE MANAGED UNDER ANY REGULATIONS GOVERNING THE DISPOSAL AND MANAGEMENT OF RADIOACTIVE MATERIALS (RADIOACTIVE SUBSTANCES ACT 1993)
3. IT IS DETERMINED THAT THIS MATERIAL SHALL BE PLACED IN A DEFINED LOCATION, UNLIKELY TO BE DISTURBED BY FUTURE DEVELOPMENT
4. THE MATERIAL FOR RE-BURIAL ON SITE IS CLEARLY IDENTIFIED AND RECORDED IN RELEVANT SPOIL HEAPS IN ZONE 6. THE RELEVANT SPOIL HAVE BEEN ASSAYED USING GAMMA-SPECTROSCOPY EQUIPMENT, AND FULL RECORDS ARE AVAILABLE
5. THE MATERIAL FOR RE-BURIAL ON SITE WILL BE MOVED UNDER THE DIRECT SUPERVISION OF AN APPROPRIATE HEALTH PHYSICS SURVEYOR EMPLOYED BY THE CONTRACTOR. THE HEALTH PHYSICS REPRESENTATIVE WILL ALSO BE PRESENT TO ENSURE ALL THE RELEVANT SAFETY PROCEDURES ARE FOLLOWED AND TO CHECK MOVEMENTS AGAINST HIS ASSAY RECORDS TO ENSURE THAT THE CORRECT MATERIAL IS MOVED
6. THE CONTRACTOR SHALL PLACE A MARKER LAYER AT SUB FORMATION LEVEL PRIOR TO FILLING. THE MATERIAL SHALL BE PLACED IN A CONTINUOUS OPERATION, AND THEN COVERED BY A MARKER, THAT SHALL BE LAPPED WITH THE BASE MARKER LAYER
7. ONCE PLACEMENT IS COMPLETE THE OVERLAYING FILL OPERATIONS SHALL BE COMPLETED AS SOON AS POSSIBLE
8. THE ENABLING WORKS FORMATION SURFACE SHOWN IS GENERALLY 500mm BELOW THE SCENARIO 10 FINISHED SURFACE (AUGUST 2008)
9. FOR GENERAL EARTHWORKS AND REMEDIATION REQUIREMENTS REFER TO BASELINE EARTHWORKS AND REMEDIATION SPECIFICATIONS.
10. POSITIONING OF MATERIAL DETERMINED THROUGH COORDINATION WITH ARUP SBH AND BASED ON DWG NO'S. SBH-OAP-4-L03-DR-C-5-E5-0194 REVISION C.
11. UTILITIES SERVICE CORRIDOR BASED ON CURRENT UTILITIES SERVICE DRAWING.
12. CONTRACTOR TO SUBMIT METHOD STATEMENT FOR THE AGREEMENT OF THE MANAGER. SUCH AGREEMENT WILL NOT IN ANY WAY REMOVE OR ALTER RESPONSIBILITY OF THE CONTRACTOR TO COMPLETE THE WORKS IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT AND TO ANY OTHER RELEVANT REQUIREMENTS OF THE REGULATORS
13. THE CONTRACTOR SHALL ESTABLISH A DETAILED SAMPLING, TESTING, AND MONITORING REGIME TO CONTROL AND VALIDATE THE WORKS AND CONFIRM THAT THE MATERIAL AS DEPOSITED COMPLIES WITH THE REQUIREMENTS OF ANY CONTROL AND RESTRICTIONS ON ITS DEPOSIT AGREED WITH THE APPROPRIATE REGULATORS, INCLUDING THE ODA PLANNING DELIVERY TEAM (PDT) AND ENVIRONMENT AGENCY, (EA).
14. THE METHOD STATEMENT SHALL FORM AN EXTENSION TO THE REMEDIATION METHOD STATEMENT (RMS) FOR THE ZONE, AND AS SUCH SHALL BE SUBJECT TO THE APPROVAL OF THE ODA PLANNING DELIVERY TEAM (PDT), IN ACCORDANCE WITH THE RELEVANT PLANNING CONDITIONS PERTAINING TO THE WORKS". AMONGST OTHER THINGS THE METHOD STATEMENT SHALL DESCRIBE THE SAMPLING, TESTING AND MONITORING REGIME.
15. THE CONTRACTOR SHALL PRODUCE A VALIDATION REPORT AS A SUPPLEMENT TO THE ZONE VALIDATION REPORT AND SUBMIT THIS AND GAIN APPROVAL FOR THIS FROM THE PDT, AS PART OF THE ZONE VALIDATION PROCESS.

Rev	Description	Drawn	Chk'd	Date
C3	KEYPLAN ADDED & UTILITY CORRIDOR UPDATED	RA	PHK	18/01/10
C2	DEPOSIT VOLUME INCREASED TO 3500m²	MW	KMM	08/10/08
C1	FOR CONSTRUCTION	MW	KMM	04/07/08

Safety, Health and Environment Information

In addition to the hazards / risks normally associated with the types of work detailed on this drawing, note the following risks and information:

Construction	CI. HANDLING/CONTACT WITH CONTAMINATED GROUND Cii. HANDLING/CONTACT WITH VERY LOW LEVEL RADIOACTIVE MATERIAL CIII. UNEXPLODED ORDINANCE
Dismantling / Demolition (Future)	DI. HANDLING/CONTACT WITH CONTAMINATED GROUND DII. HANDLING/CONTACT WITH VERY LOW LEVEL RADIOACTIVE MATERIAL DIII.

For Information relating to Use, Cleaning and Maintenance see the Health and Safety File.

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Creator: Prepared by ATKINS On behalf of the ODA

Project Title: OLYMPIC PARK DESIGN

Drawing Title: ENABLING WORKS
ZONE 4
POSSIBLE LOCATION OF DEPOSIT AREA
FOR VERY LOW RADIOACTIVE MATERIAL

Drawn	Checked	Approved
MW	KMM	JC

Scale (A1)	Date	Status
1:250	27/06/08	A

Purpose of Drawing: CONSTRUCTION

Drawing No.: ENW-ATK-4-SP1-DR-C-3-H11-0011 Rev. C3

FILENAME: P:\GBEMF\CIVIL INFRASTRUCTURE\JOBS\5039677 OLYMPIC PARK INFRASTRUCTURE\03 CAD\0300 DSTRESOURCES\CLM_MICROSTATIONWORKSPACE\PROJECTS\LONDON2012\DGN\A1_LANDSCAPE PLOT DATE: — PLOT TIME: 10:49:11 AM