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Integrated Practical Solutions

Site Audit Report
psm-N-17

Kent Road Public School Redevelopment
126 Kent Road, Marsfield, NSW

Prepared for
Department of Education/
Schools Infrastructure NSW

Project 95407.00
20 July 2020

Douglas Partners
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author	 	20 July 2020
Reviewer		

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Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
231 Normanby Road
South Melbourne VIC 3205
PO Box 5051
South Melbourne VIC 3205
Phone (03) 9673 3500

Executive Summary

This Site Audit Report (SAR) was commissioned by Chris King of Schools Infrastructure New South Wales (the site owner). The subject of this SAR is part of the site occupied by Kent Road Public School, located at 126 Kent Road, Marsfield, NSW, 2122.

The Audit Site is intended to be redeveloped by the construction of three new school buildings, and associated hard paved open space. It falls within the planning jurisdiction of the City of Ryde, but the proposed redevelopment was approved by State Significant Development Approval 9344 (the SSDA) issued by the Department of Planning, Industry and Environment. It contains several clauses (B8 and B9, D27 and D28) which require the involvement of an EPA-accredited Site Auditor.

This SAR has been prepared in general accordance with the provisions of the *Guidelines for the NSW Site Auditor Scheme (3rd Edition*), (EPA 2017). The Audit documentation has been prepared by Paul Moritz, who is accredited as a Contaminated Sites Auditor by the NSW EPA (Auditor No. 1503) under the provisions of the *Contaminated Land Management Act* 1997 (the CLM Act). It is based on the results of contamination investigations and remediation works undertaken, and related reports prepared by, Arcadis Asia Pacific Pty Ltd between April 2018 and May 2020

The Scope Objective of this SAR was to demonstrate that the site is suitable for its intended (ongoing) use as a primary school.

The Audit Site forms part of the greater Kent Road Public School site located approximately in the centre of the larger school site. To the north of the school site, there are residential properties adjacent to the intersection of Kent and Herring Roads. Other residential properties adjoin the school site to the south west and south east. During a site inspection by Arcadis in April 2018 the various school buildings were generally of brick construction with either tile or galvanised steel roofing. Cement sheeting considered potentially asbestos-containing was noted in some parts of the buildings, and paintwork in various stages of degradation was also noted. There were raised garden beds observed, which were considered to contain uncontrolled fill. Most of the Audit Site was covered with hard paved surfaces at that time.

The school site was described as sloping towards the south / south east, in the general direction of Shrimpton's Creek, and with an elevation of approximately 60 m Australian height Datum, and is underlain by Triassic-aged Ashfield shale of the Wianamatta group. Soil conditions at and near the site comprise Glenorie Soil landscapes.

The site has been used as a primary school since the late 1950's, and prior to that the of the school site was either open grassland or woodland, with no evidence of any structures being present, either residential or other. Aerial images from 1943 and 1956 show orchards to the immediate south, and a market garden to the south east. On the basis that an orchardist owned the property between 1911 and 1925, Arcadis considered agricultural chemicals as potential contaminants of concern, in addition to the contaminants usually associated with uncontrolled fill.

Asbestos, copper, nickel, zinc, and the hydrocarbon fractions TRH F2 and F3 were the only CoPCs detected in soil at concentrations above any of the Audit criteria. However, statistical analysis of the results for copper, nickel and zinc indicated that these contaminants were unlikely to pose an unacceptable risk to human health or the environment.

Fragments of asbestos–containing materials (ACM) were identified at the surface of the Audit Site, notably the garden bed area, and in some of the sub-surface test put samples. The area thus impacted was at the south-western end of the Audit site. Arcadis identified an ACM-impacted area which required remediation, and on-site retention of the affected fill in a long term containment cell was adopted as the preferred remediation option. The Auditor endorsed a remediation action plan to address the management of on-site contamination and including design specifications for the on-site cell.

Fill from the ACM-impacted area was placed in the containment cell, observed by a member of the Auditor's team Additionally, approximately 600 m^3 of ACM-contaminated fill from elsewhere on the school site (outside the Audit Site) was also placed in the containment cell, after consultation with the Auditor, and an increase in the volume of the cell.

The concentrations of the petroleum hydrocarbon fractions TRH F2 exceeded human health-based (for indoor air vapour inhalation) and ecologically-based Audit criteria in two locations, and the concentration of TRH F3 exceeded the ecologically-based Audit criterion in one location. It was originally intended that the affected soil would be disposed off-site in an appropriately-licensed facility, but the TRH concentrations exceeded the acceptance limits for the intended facility, and the soils were placed into the on-site containment cell.

During validation of the ACM-impacted area, and sampling for waste classification of areas containing non-asbestos anthropogenic wastes, fibrous asbestos (FA) was identified in soil outside the ACM-impacted area. The fill contaminated by FA was removed from site and disposed at an appropriately-licensed facility

A member of the Auditor's team observed piling works through the containment cell covering layers (site-sourced VENM and a geofabric marker layer) to support the concrete cap which was to comprise the top layer of the containment cell, and also provide the floor slab for the building which is to sit above the cell. Spoil from the piling, comprising ACM-impacted fill, was also removed from the site to an appropriately-licensed facility.

An asbestos clearance certificate, for areas of the site where asbestos materials had been identified was provided by a Licensed Asbestos Assessor.

The Auditor is satisfied that the waste transport and disposal documentation provided a satisfactory record of the movement of material from site, taking into account the inherent uncertainties in correlating masses and volumes of transported material

The Auditor endorsed a long term environmental management plan (LTEMP) for the on-site containment cell. The LTEMP contains a requirement that the concrete slab above the cell not be pierced without express approval from manager of the site, the Asset Management Unit of Schools Infrastructure NSW. It also provides for regular (annual) inspections of the concrete cap to ensure its ongoing integrity.

As a result of the Site Audit, the Auditor has concluded that the Audit Site is, and will be, suitable for use as a primary school, pre-school, children's daycare centre and secondary school, subject to the Condition that the environmental management plan, *Long Term Environmental Management Plan 126 Kent Road, Marsfield NSW 2122.* Arcadis Report No. 10035770_LTEMP V3, dated 29 June 2020, is implemented and applied on an ongoing basis. Accordingly, the Auditor has issued a Site Audit

Statement to this effect. The Auditor notes that this conclusion is reached, in part, in the basis of the ongoing involvement of public authorities in managing the site and the implementation of the LTEMP.

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1. Introduction

1.1 Background

This Site Audit Report (SAR) was commissioned by Chris King of Schools Infrastructure New South Wales (the site owner) in an email dated 16 September 2019, and was undertaken in accordance with Douglas Partners' proposal MEL190392 dated 29 August 2019. The subject of this SAR is part of the site occupied by Kent Road Public School, located at 126 Kent Road, Marsfield, NSW, 2122 (hereinafter referred to as the Audit Site).

The Audit Site falls within the planning jurisdiction of the City of Ryde. However, the proposed redevelopment of the site was approved by State Significant Development Approval 9344 (the SSDA) issued by the Department of Planning, Industry and Environment. The full SSDA is included in Appendix F. It contains several clauses which require the involvement of an EPA-accredited Site Auditor, the most significant being clauses B8 and B9, D27 and D28, as shown below.

Site Contamination

B8. Prior to the commencement of earthworks below 0.3 metres of the existing ground level, the Applicant must:

(a) undertake a detailed site investigation in the areas where excavation is proposed to occur more than 0.3 metres below existing ground level in accordance with the recommendations of the Due Diligence Soil Contamination Assessment and Indicative Waste Management Report prepared by Arcadis, dated 30 June 2018; and

(b) should the results of the detailed site investigation required under a) above confirm remediation is required, the Applicant shall prepare a Remediation Action Plan (RAP) and Validation Sampling and Analysis Quality Plan and submit it to an EPA Accredited Site Auditor for review prior to the commencement of remediation works.

B9. An Asbestos Management Plan (AMP) must be prepared in accordance with Work Safe NSW requirements. Should the results of any detailed site investigations undertaken in accordance with Condition B8 identify soils below 0.3 metres below existing ground level require remediation works comprising the removal of asbestos containing material, the AMP must be submitted to an EPA Accredited Site Auditor for review prior to the commencement of remediation works.

Site Audit Report and Site Audit Statement

D27. Should remediation works be required under Condition B8, the Applicant must obtain from an EPA accredited Site Auditor, a Site Audit Statement and a Site Audit Report which demonstrates that the site is suitable for its intended use(s).

D28. Should remediation works be required under Condition B8, the Applicant must demonstrate to the satisfaction of the Certifying Authority that the Site Auditor has submitted a Site Audit Report and Site Audit Statement to EPA in accordance with the requirements of

EPA's Guidelines for the NSW Site Auditor Scheme (3rd Edition) 2017 within two months of the submission of the Validation Report required by Condition D26

Hence, as the Audit site is subject to development consent, this Audit is deemed to be statutory in nature, as defined under the provisions of Part 4 of the *Contaminated Land Management Act* 1997 (the 'CLM Act').

The Site Audit is based on the results of contamination investigations and remediation works undertaken, and related reports prepared by, Arcadis Asia Pacific Pty Ltd ('Arcadis') between April 2018 and May 2020

This SAR has been prepared in general accordance with the provisions of the *Guidelines for the NSW Site Auditor Scheme (3rd Edition*), (EPA 2017). The Audit documentation has been prepared by Paul Moritz, who is accredited as a Contaminated Sites Auditor by the NSW EPA (Auditor No. 1503) under the provisions of the *Contaminated Land Management Act* 1997 (the CLM Act), and hereinafter referred to as 'the Auditor'.

1.2 Involvement of Consultants and Auditor

Arcadis was engaged by the site builder (St Hillier's) to undertake contaminated land investigation, remediation and validation works. Specialist asbestos work was undertaken by Greencap Pty Ltd and Pure Contracting Pty Ltd.

The preliminary site investigation (PSI), and the early stages of detailed site investigation (DSI) work were undertaken by Arcadis prior to the engagement of the Auditor.

The Auditor has reviewed the information provided in the various investigation reports provided (as listed in section 1.4), taking account of the EPA guidance contained in:

- *Guidelines for Consultants Reporting on Contaminated Land* (EPA 2020);
- *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 2011), and;
- Appendices A and D of the *Guidelines for the NSW Site Auditor Scheme* (3rd Edition) (EPA 2017).

In completing this SAR, and accompanying Site Audit Statement (SAS), the Auditor completed the following activities:

- Notified the NSW EPA on 20 September 2019;
- Reviewed preliminary site investigation (PSI) and detailed site investigation (DSI) reports prepared for the school site prior to commencement of the Audit;
- Attended an Audit initiation meeting at the school site, with representatives of the investigation consultant (Arcadis), site owner (Schools infrastructure NSW – 'SINSW'), builder, and development project manager;
- Reviewed (with comments) and endorsed a sample and analysis quality plan (SAQP) prepared by Arcadis following the Auditor's comments on the PSI and initial DSI reports;

- Reviewed (with comments) a further DSI report, prepared after the implementation of the SAQP;
- Reviewed (with comments) and endorsed a remediation action plan (RAP), an unexpected finds protocol (UFP) and asbestos management plan (AMP) for the Audit Site;
- Arranged for members of the Auditor's team to visit the Audit Site during investigation and remediation works between September 2019 and April 2020;
- Following completion of remediation works, reviewed and endorsed the validation report and long term environmental management plan (LTEMP);
- Provided Interim Audit Advice following review of documents, as follows:
    - 30 October 2019 – Comments on the further DSI report
    - 22 November 2019 – Comments on RAP
    - 20 May 2020 – Comments on validation report
    - 5 June 2020 – Comments on draft LTEMP
- Prepared a draft SAR and SAS and provided a copy to SINSW for comment;
- Completed this SAR and accompanying SAS.

1.3 Scope of the Site Audit Report

The purpose of this SAR was to meet the requirements of the SSDA for the Audit Site, and to determine:

- The nature and extent of any contamination on the Audit Site;
- The nature and extent of any management of any actual or potential contamination on the Audit Site;
- Whether the Audit Site is suitable for the proposed use, and;
- What management is remains necessary for the Audit Site to be suitable for its proposed use.

The Scope Objective of this SAR was to demonstrate that the site is suitable for its intended (ongoing) use as a primary school.

The scope of this SAR was determined by the SSDA which required it to be completed. Particularly:

- The Audit Scope was limited to the Audit Site area, comprising the area of the school site proposed for redevelopment (see section 2.1, below);
- The Site Audit only considered the conditions of soil and fill at the site. Consideration of groundwater contamination was not included in the Audit Scope (see sections 2.5 and 4.3.2 below).

The Purpose of the Audit was to

1.4 Associated Reports and other Materials Referenced

The reports and documents reviewed for this Audit were as follows:

- *Preliminary Site Investigation Kent Road Public School 126 Kent Road, Marsfield NSW*. Arcadis Report No. 10019954RP01. Dated 27 April 2018. ['the PSI report']
- *Due Diligence Soil Contamination Assessment and Indicative Waste Classification. Proposed Development at Kent Road Public School - 126 Kent Road, Marsfield NSW*. Arcadis Report No. 10023978L01. Dated 30 July 2018. ['the initial DSI report']
- *126 Kent Road, MARSFIELD Mini SAQP*. E-mail from Arcadis (Emma Bradbeer) to the Auditor. Dated 23 September 2019. ['the further sampling plan']
- *Further Supplementary Soil Contamination Assessment. 126 Kent Road, Marsfield NSW 2122*. Arcadis Report No. 10035770. Dated 11 November 2019. ['the further DSI report']
- *Remediation Action Plan 126 Kent Road, Marsfield NSW 2122*. Arcadis Report No. 10035770_RAP. Dated 4 December 2019. ['the RAP']
- *Unexpected Finds Protocol 126 Kent Road, Marsfield NSW 2122*. Arcadis Report No. 10035770_UFP. Dated 29 November 2019. [the UFP']
- *Asbestos Management Plan 126 Kent Road, Marsfield NSW 2122*. Arcadis Report No. 10035770_AMP. Dated 4 December 2019.'['the AMP']
- *Validation Report 126 Kent Road, Marsfield NSW 2122.* Arcadis Report No. 10035770_Validation Report. Dated 19 May 2020. ['the site validation report']
- *Long Term Environmental Management Plan 126 Kent Road, Marsfield NSW 2122.* Arcadis Report No. 10035770_LTEMP V4. Dated 15 July 2020. ['the LTEMP']

The reports and Documents listed above are held on file by the Auditor.

1.5 Limitations

The Auditor has prepared this SAR and accompanying SAS for the purposes specified in the above sections and as defined by Regulation and by the NSW EPA. The project scope of works undertaken by the Auditor was developed specifically for the purpose of meeting the objectives outlined above.

The objectives and scope of works adopted by the contamination investigation consultants are understood to have been developed based on somewhat different objectives, without explicit reference to the Conditions of the Development Approval.

The auditing work and reporting undertaken has been carried out to a standard of care and diligence normally expected of professional engineers and scientists practicing in the areas of contaminated land investigation and management in New South Wales.

The degree of confidence in the findings and conclusions of the SAR and related SAS is governed by the typical limitations and constraints inherent to such audits. The audit is based entirely on the investigations undertaken by the contamination investigation consultants as well as on the reported relevance and quality of the information and data obtained during remediation planning and the subsequent remediation and validation program. Where there are shortcomings or limitations in

regard to the data obtained from the site or uncertainties in respect to the conclusions drawn from these data, such issues are identified in the SAR.

The audit undertaken reflects the condition of the site at the time of completion of the remediation works, under audit and is based on the related investigations. Therefore, no liability can be accepted for failure to identify site conditions or related environmental issues which may arise in the future from ongoing site uses, or which could not have reasonably been determined or envisioned based on the scope of investigation works undertaken and the data obtained during the investigation and/or site validation. In this regard it is noted that site conditions are determined by the consultant during the investigation, remediation and validation phase of investigations by means of both interpretative and statistical methods using data obtained during sampling, and it is noted that conditions between sampling locations may not be reflective of those actually sampled or analysed.

Accordingly, no liability is accepted by the Auditor for unidentified contamination or subsurface features or structures subsequently found to be present on the site where the investigations have been undertaken in substantial compliance with the guidelines made or endorsed by NSW EPA. The data used to support the conclusions reached in this SAR have been obtained by other consultants and have been audited with a reasonable level of scrutiny, care and diligence by the Auditor. No liability can be accepted for unreported omissions, alterations or errors in the data collected and presented by the consultants (site assessors). Accordingly, the data and information presented by others are taken and interpreted in good faith by the Auditor.

This SAR should not be used for purposes other than those indicated in the previous sections of this report. The report and attached SAS (No. psm-N-017, Appendix A of this SAR) should not be reproduced without the permission of Douglas Partners Pty Ltd. If additional copies of the SAR are required for any reason then the SAR should be reproduced in its entirety (including the SAS).

This Site Audit does not address the geotechnical or engineering suitability of the site, or any materials thereon, and accordingly it is recommended that suitable specialist advice in this regard is obtained. Similarly, the audit does not address the suitability of any materials for re-use in land which falls beyond the boundary of the Audit site.

2. Site Details

2.1 Site Description

A list of site details is provided in Table 1. A site location diagram is provided in Drawing 1, Appendix B[1] of this SAR and a plan showing the Audit Site is provided in Drawing 2, Appendix B, where it is designated as the State Significant Development Boundary. The plan showing the Audit Site is also attached to the SAS which is included in Appendix A of this SAR.

Table 1: Site Information

Site Name:	Kent Road Public School
Site Owner:	New South Wales Department of Education
Site Address:	126 Kent Road, Marsfield, NSW, 2122
Total Site Area:	5,500 m^2
Title Identification:	DP 1250772 (Consolidation of DP 8612, Lot 1, 2, 3, 4 & 5 - DP 12030, Lot 1 - DP 34283, and Lot 1 – DP 782254, which occurred after the Audit Notification was submitted to NSW EPA)
Geographical co-ordinates (approx) site centroid	GDA 94/Zone 56: 324934 m East 6259846 m North
Zoning:	SP2
Local Government Authority	City of Ryde
Previous Land Use:	Public School (recent) and possible agricultural use prior to 1958
Proposed Land Use:	Public School
Approved Development Approval	SSD 9934

The site is located in the Parish of Hunters Hill in the County of Cumberland.

2.2 Site Setting

The Audit Site forms part of the greater Kent Road Public School site located approximately in the centre of the larger school site. The school site is generally bounded to the north east by Kent Road, and to the north west by Herring Road. To the north of the school site, there are residential properties adjacent to the intersection of Kent and Herring Roads. Other residential properties adjoin the school site to the south west and south east.

The PSI report (Arcadis 2018a) described the condition of the school site during an inspection in April 2018. While there was no specific reference to the conditions in the Audit Site portion, it was noted that the various school buildings were generally of brick construction with either tile or galvanised steel roofing. Cement sheeting was noted in some parts of the buildings, considered potentially asbestos-

[1] Figures may have been extracted from reports prepared by others and figure numbers changed for internal consistency.

containing, and paintwork in various stages of degradation was also noted. There were raised garden beds observed, which Arcadis noted indicated the potential presence of fill on the site.

However, the PSI report presented an aerial image (as part of Figure 1) which identified an "area of interest" which was different, and removed, from the Audit Site. The Audit Site was generally vacant, being mainly garden areas / open space, with some paved handball courts present, and two buildings were evident at its north eastern end.

Several parks or public reserves were noted within 300 m of the site. A water course was noted approximately 70 m south east of the school and this was considered to be a tributary of Shrimpton's Creek, although the location of this waterway was not identified on any plans or maps contained in the PSI report.

Auditor's Opinion

The data provided enabled the Auditor to reach a conclusion about the environmental setting of the Audit Site.

2.3 Site Redevelopment

The Audit Site is intended to be redeveloped by the construction of three new school buildings, and associated hard paved open space. Details of the location and layout of the new buildings are also provided in Drawing 2, Appendix B. Detailed development plans are provided in Appendix F.

2.4 Topography, Drainage and Meteorology

The PSI report described the school site as sloping towards the south / south east, in the general direction of Shrimpton's Creek, and with an elevation of approximately 60 m Australian height Datum (AHD) (Arcadis 2018a). Additionally, a Lotsearch Report appended to the further DSI report (Arcadis 2019a) contained an extract of a topographic map which indicated that the Audit Site is at an elevation between 58 m and 60 m AHD. Several of the reports prepared by Arcadis indicated that surface drainage was to the south / south east, and this was confirmed by the topographic map from Lotsearch.

Arcadis provided no meteorological information about the site, particularly rainfall. The Auditor identified the Bureau of Meteorology Macquarie Park station as closest to the site (760 m north), and extracted historical rainfall data for that location. This is shown in Table 2.

Table 2: Monthly rainfall (mm) Macquarie AWS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
2015	188.8	52.2	77.6	361.8	118.4	68.8	33.2	42.4	55.2	54.4	131.8	68.8	1253
2016	369.6	39.8	84.0	33.0	7.0	345.8	102.4	148.6	60.4	27.8	26.8	71.2	1316
2017	31.8	129.4	362.9	62.4	17.6	158.5	1.8	23.0	0.8	73.6	32.8	59.2	954
2018	32.6	120.8	107.9	21.8	14.1	99.4	2.8	6.8	38.2	254.0	159.5	93.0	951
2019	59.2	90.0	271.6	34.2	11.2	116.8	48.2	100.5	135.8	62.0	23.0	1.0	954
2020	60.6	459.6	134.8										

Auditor's Opinion

The Auditor is satisfied the reviewed reports adequately characterised the site topography and drainage.

2.5 Geology, Hydrogeology and Soils

Both the PSI report (Arcadis 2018a) and the further DSI report (Arcadis 2019a) cited the Geological Survey 1:100,000 *Sydney* map to indicate that the site is underlain by Triassic-aged Ashfield shale of the Wianamatta group, which is described as "*…dark grey shale and laminate*." The same reference also indicates that, directly south east of the school site, there is "…*Triassic-aged medium- to coarse-grained quartz sandstone, with very minor shale and laminate lenses*."

Citing the Soil Conservation Service of New South Wales 1:100,000 *Sydney* map (2nd edition, the Soil Landscapes Series Sheet 9310) the soil conditions at and near the site comprise Glenorie Soil landscapes.

The Lotsearch report appended to both the PSI report and the further DSI report quoted the *Hydrogeology Map of Australia* (Geoscience Australia), to indicate that on-site and off-site aquifers were "*Porous, extensive aquifers of low to moderate productivity*." Lotsearch reported that there were no registered bores within approximately 500 m of Audit Site, but that there were several within a 2 km radius. Standing water levels were presented for only two of the registered bores, 7.5 and 18.0 m below ground level (mbgl), respectively.

Auditor's Opinion

The background information on local geological and soil conditions is considered acceptable.

The Auditor has verified the identified soil conditions. There was only limited background information provided regarding hydrogeological conditions, and the Auditor has noted an apparent mis-print in the reviewed reports where it was stated that "*…the inferred groundwater flow direction is to the west / southwest, following the natural topography…*" The Auditor notes that the natural topography was stated to fall towards the east / south-east. Hydrogeological conditions can be variable, and are best confirmed by a local investigation. In this instance, the identified potential contaminants on site were not considered likely to migrate to groundwater and, so, a local intrusive investigation, which would have enabled confirmation of conditions was not completed, nor considered by the Auditor to have been necessary.

2.6 Site History and Contamination Potential

2.6.1 Site History Review

Based on the information provided in the PSI report (Arcadis 2018a), it is apparent that Audit Site has had various owners since 1900. Prior to 1958, these were private individuals, with no record of ownership by incorporated entities. Since 1958, it has been in public ownership, as Crown land until 1960, and then vested with the Minister of Education.

An orchardist owned the site from 1911 to 1925, apparently inherited from a family member who had been a school teacher/administrator. Subsequent owners had non-horticultural occupations. Arcadis stated that the land had been used for residential purposes prior to 1960, and educational purposes after that (Arcadis 2018a). This description of use after 1960 is consistent with the aerial photographs presented in the PSI report, but aerial images from prior to 1960 do not appear consistent with residential use. Most of the school site was either open grassland or woodland, with no evidence of any structures being present, either residential or other. Images from 1943 and 1956 show orchards to the immediate south, and a market garden to the south east. The market garden was also present until about 1965.

Various Council records were examined, although these were mostly of a contemporary nature, and not site-specific. The current zoning of the site was discussed, but no information was provided on previous zoning. However, given the site's relatively long period of uses as a school, it can be expected that no potentially-contaminating activities might have been allowed by previous zoning applicable to the site.

No EPA records pertaining to the site were identified, and Arcadis found no records to indicate that hazardous materials might have been manufactured on the site, or that fuels or other hazardous liquids might have been stored (either underground or above ground).

Arcadis noted anecdotal evidence that the site might have been used for poultry farming, but also indicated that no evidence had been provided to support this assertion.

Auditor's Opinion

The Auditor considers the site history study to be quite comprehensive, but that Arcadis's interpretations were not always consistent with the information presented. Only current day Council records were investigated, with no mention of an examination of building approvals being granted. However, the aerial photographs, over time, tend to indicate that the Audit Site has not previously been occupied by buildings, nor a poultry farm or orchard, despite a record of ownership by an orchardist. Hence, above ground activities are unlikely to have affected the Audit Site.

2.6.1 Hazardous Building Materials Survey

Arcadis noted additional anecdotal information that fragments of asbestos-containing materials (ACM) were found beneath buildings during previous construction works on site. No source of this information was recorded (Arcadis 2018a). Arcadis also noted that during the site inspection in April 2018, the awnings of several brick buildings on the school site appeared to be constructed of cement sheeting and, hence, potentially ACM. The Auditor considers that this is most likely a reference to the eaves of the buildings. Flaking lead paint was considered a possible source of lead contamination.

Auditor's Opinion

The Auditor also considers that ACM is the most likely hazardous building material to be present on the Audit Site. Although flaking paint was identified on the exterior of school buildings, the Auditor considers this to be an unlikely source of lead contamination, given that lead concentrations in building paint were reduced significantly prior to 1970, and again in the 1990s (DEE), and the likelihood that the buildings would have been painted in the past 30 years.

2.6.1 Potential contaminants

On the basis of its PSI report findings, Arcadis identified a range of potential contaminants at the Audit Site in the preliminary conceptual site model (Arcadis 2018a). The list of potential contaminant sources, and potential contaminants is reproduced in Table 3, below. All were considered on-site sources.

Table 3. Potential Contaminants and Sources Identified in the PSI Report.

Potential Contaminant Sources	Associated Contaminants
Fill material of unknown origin	Metals, polycyclic aromatic hydrocarbons (PAH); petroleum hydrocarbons (as TRH/TPH); organochlorine and organophosphate pesticides (OCP/OPP); polychlorinated biphenyls (PCB) asbestos
Building materials (ACM)	Asbestos
Lead paint	Lead
Market gardens/orchards	OCP, OPP

Auditor's Opinion

The Auditor has reservations about some of the potential contaminant sources, and potential contaminants identified by Arcadis.

In the Auditor's experience, fill material of unknown origin rarely contains OCPs or OPPs, particularly the latter contaminants which have a half-life in soil of the order of days rather than years. Also, given that the site was developed as a school in the late 1950's, it is less likely that OPPs would have been used prior to then, even in horticultural activities had occurred. Similarly, PCBs are rarely encountered, unless there are significant quantities of building rubble present in the fill. However, it is common to see this range of contaminants assumed to be present in uncontrolled fill.

Lead paint on the existing buildings is unlikely to be a contaminant source, given the age of the buildings and the likelihood of maintenance having occurred in the past 60 years, and the reductions in lead content in paint over that time. However, lead may be present in uncontrolled fill, and residual flakes of lead-based paints may also be present after previous maintenance.

There is little evidence that orchards or market gardens were present on site in the past. However, if they had been, several contaminants were missing from the list created by Arcadis. Metals (lead and arsenic) and fluoride should also have been considered as potential contaminants, based on their use as pesticides prior to the introduction of OCPs in the mid-1930's. The Auditor provided this comment to Arcadis prior to a second round of further DSI sampling.

Arcadis identified application of herbicides during horticultural activities as potential contaminants, although did not list any specific herbicides as contaminants. Subsequently, a generic suite of herbicides was analysed during the further DSI, but their introduction to use generally post-dates the development of the site as a school. Other than possible metal-based herbicides, no herbicides likely to have been used pre-1958 were included for analysis.

On this basis, the Auditor considers the most likely source of contamination at the site to have been fill of unknown origin, and is satisfied that metals, petroleum hydrocarbons, PAHs and asbestos are the most likely contaminants of potential concern (CoPCs).

3. Site Investigation and Remediation Criteria

3.1 Adopted Audit Investigation Criteria

The Auditor's adopted criteria for soils are listed in 4. The Auditor notes that while metals, petroleum hydrocarbons, PAHs and asbestos are considered the most likely potential contaminants, the list in Table 3 also includes potential contaminants nominated by Arcadis in the PSI report and for which analysis was undertaken in the course of intrusive investigations on the site.

The ecological-based criteria for the metals copper, chromium (III) nickel and zinc are those adopted by Arcadis during its intrusive investigation (Arcadis 2019a).

Table 4: Adopted Site Audit Criteria (soil, direct contact)

Contaminant	Audit Criteria (mg/kg)		Contaminant	Audit Criteria (mg/kg)	
	Health-Based[1]	Ecological		Health-Based[1]	Ecological
Arsenic	500	100[3]	Total PAH	400	
Cadmium	150	0.36[4]	Benzo(a)pyrene	-	0.7[9]
Chromium (VI)	50	-	Carcinogenic PAH (as B(a)P TEQ)	4	-
Chromium (III)	-	320[5]			
Copper	30,000	130[5]	Naphthalene	2,200[2]	170[3]
Lead	1,200	1,100[5]	Aldrin +Dieldrin	10	-
Manganese	14,000	450[7]	Heptachlor	10	-
Mercury (total)	120	6.6[8]	DDT	-	180[3]
Nickel	1,200	30[5]	DDT+DDD+ DDE	600	-
Zinc	60,000	180[5]	Chlordane	90	-
Benzene	140[2]	50[9]	Endosulfan	400	-
Toluene	21,000[2]	85[9]	Endrin	20	-
Ethylbenzene	5,900[2]	70[9]	HCB	15	-
Xylenes	17,000[2]	105[9]	Methoxychlor	500	-
Petroleum hydrocarbons			Mirex	20	
TRH C_6-C_{10}	5,600[2]	180[9]	Toxaphene	30	-
TRH >C_{10}-C_{16}	4,200[2]	120[9]			
TRH >C_{16}-C_{34}	5,800[2]	300[9]			
TRH >C_{34}-C_{40}	8,100[2]	2,800[9]	All forms of asbestos	No visible asbestos for	-

Contaminant	Audit Criteria (mg/kg)		Contaminant	Audit Criteria (mg/kg)	
	Health-Based[1]	Ecological		Health-Based[1] surface soil[10]	Ecological
PCB	1	-			
Phenol	45,000	-	Bonded ACM	0.01%[10]	-
Fluoride	3,100[11]	400[8]	Friable asbestos (FA) / asbestos fines (AF)	0.001%[10]	-

Notes:
1: NEPM Schedule B 1 HIL B Table 1A(1) (unless otherwise specified)
2: CRC CARE 2011 Health Screening Levels (direct contact)
3: NEPM Schedule B1 Table 1B(5)
4: USEPA 2005
5: Calculated, site specific based on NEPM Schedule B1, Tables 1B(1) – 1B(3)
6: NEPM Schedule B1 Table 1B(4)
7: USEPA 2007
8: CCME
9: NEPM Schedule B1 Table 1B(6)
10: NEPM Schedule B1 Table 7
11 Residential Soil table USEPA 2020

Auditor's Opinion

The Auditor has developed EIL values for the Audit Site by application of the NEPM Toolbox Calculator spreadsheet (NEPC 2013) because of reservations about the manner in which Arcadis had attempted to derive EIL values.

While the initial and further DSI reports did not provide details of how the EILs were derived, it is apparent to the Auditor that they were the Added Contaminant Limits (ACLs) derived from measured soil properties (pH, cation exchange capacity and % clay) at the site, as set out in Schedule B(1) of the NEPM (NEPC 2013). However, the NEPM also states that ambient background concentrations (ABCs) should be determined, and EILs derived by the addition of ACL and ABC values. Furthermore, there is evidence that Arcadis inappropriately applied the measured soil property values to calculation of EILs.

The adopted criteria are based on the exposure setting sets out in the NEPM for sensitive land use: low density residential, primary schools, preschools and children's daycare centres. These are the most sensitive of the exposure settings provided for in the NEPM and it follows that, if soil conditions indicate that the site is suitable for these sensitive land uses, it will also be suitable for less sensitive land uses such as high density residential, commercial and industrial land uses.

3.2 Remediation Validation Criteria

The presence of asbestos (as FA/AF and ACM) in soil created the need for remediation of the site.

The criterion adopted for validation of the remediation was the absence of visible evidence of asbestos or ACM, and the presence of ACM and FA/AF in soil at concentrations less than the adopted Audit criteria of 0.01% and 0.001%, respectively. This was expressed in the RAP (Arcadis 2019c) as:

- Visual inspections should be performed during excavation to identify any inconsistencies and evidence of contamination and unexpected finds.
- Visual inspection during excavation of soils must be by a suitably-qualified environmental consultant to note if any ACM will be observed in this material.
- Post–excavation and remediation work, another visual inspection must be undertaken by a suitably-qualified Environmental consultant to assess if all fill materials have been removed, and that natural materials are exposed.
- A clearance certificate should be provided by a licensed asbestos assessor after all excavation works are completed.

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Auditor's Opinion

The Auditor considers that the adopted validation criterion, that is, that soil remaining after excavation should be visually free of asbestos and ACM and meet the adopted Audit criteria for FA/AF, was appropriate to protect the health of future site users. The use of a licensed asbestos assessor to provide a clearance certificate provides another level of certainty about the qualitative criteria adopted.

4. Site Investigation

4.1 Investigation Programme

In section 2 above, the Auditor has described, and provided comment on, the preliminary site investigation. The following descriptions and comments are applicable to the several stages of intrusive on- site investigation which occurred.

4.1.1 Initial Detailed Site Investigation

The initial intrusive soil investigation was conducted in mid-2018, with the objective of providing *"....an indication of soil quality within the footprint of the proposed development areas and the likelihood of potential risk to human health (both workers and occupants/students) and ecological receptors.*" (Arcadis 2018b). The work was undertaken before the Auditor was engaged to undertake this Site Audit, so there was no opportunity to comment on the methodology to be used and the number and distribution of sampling locations.

Soil sampling was undertaken at eight locations across the school site, in unpaved areas. Figure 2 of the initial DSI report (reproduced as Drawing 3, Appendix B) showed these locations. Arcadis stated that "*…locations were selected using mixture of both targeted judgemental approach (based on the findings of the PSI) and a general systematic grid approach in accessible locations of the development area.*" The Auditor notes that this is a reference to the development area as it was then understood. Areas of the Audit Site which were, at that time, covered by paved surfaces were not sampled. Additionally, unpaved areas of the southern corner of the Audit Site were also not included in the sampling pattern.

Boreholes were advanced, using a hand auger, to a maximum depth of 0.3m below ground level (bgl). One soil sample from each borehole location was submitted for analysis of: TRH; benzene, toluene, ethylbenzene and xylenes (BTEX), PAHs, eight metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc); OCPs/OPPs, PCBs and asbestos. Additionally, one 10 litre soil sample was collected from each borehole location for assessment of ACM, and a 500mL soil sample was submitted for laboratory analysis of asbestos as FA/AF.

Replicate and blank QC samples were taken and analysed for the contaminants for which the primary samples were analysed.

More complete details of the sampling and testing procedures were provided in the initial DSI Report (Arcadis 2018b)

Auditor's Opinion

The Auditor considers that, in general, the initial DSI was undertaken in a satisfactory manner, taking into account that it did not fully cover the Audit Area/development site as it is now understood. The work also had the objective of providing a preliminary waste classification of soils for off-site disposal of soils, which was not of primary relevance to the current Site Audit.

4.1.2 Further Detailed Site Investigation

The stated objectives of the investigation (Arcadis 2019a) were to (*inter alia*):

- Close out the data gaps identified during the initial DSI (Arcadis 2018b).
- Provide an increased dataset, complying with WA DoH guidelines to better characterise ACM impacts in fill material.
- Provide a clearer indication of the likely volume of material impacted by ACM.
- Characterise the nature and depth of the fill in the proposed development area.
- Close out the potential for herbicides and fluoride-based pesticides from former market garden and orchard use.
- Determine whether the soils meet the required land use criteria for schools in accordance with the NEPM.

To meet these objectives, Arcadis installed test pits in two stages of investigation. The first eight were excavated in locations across the Audit Site prior to the start of the Audit, and results reported in a draft report dated 2 September 2019. Following review of the draft report by the Auditor, which confirmed that asbestos and ACM had been found in three test pits, a further 24 test pits were excavated across the Audit Site on a systematic basis, to bring the number of investigation locations into compliance with the minimum specified in the adopted guidelines for investigation of asbestos contamination (WA DoH 2009). The locations of these test pits are shown in Drawing 4, Appendix B.

Arcadis also reported that three test pits had been installed in a garden bed area, designated GB1, GB2 and GB3. However, the locations of these test pits were not recorded in the field and, consequently, are not shown on any of the figures provided by Arcadis.

Test pits were installed to various depths between 0.35 m bgl and 1.2 m bgl. The thickness of the overlying fill layer was generally in the range 0.1 m to 1.1 m. In three locations no fill was encountered, and in several locations there were two or more discernible layers of fill.

Samples were collected by hand, using nitrile gloves which were replaced between each sample to prevent cross contamination. A sample was taken from each discernible layer in the soil profile. Arcadis did not specify whether samples were taken from the walls of the test pits, or from the centre of the excavator bucket, but it did provide a description of the sample details which were recorded.

Bulk samples were also taken from the material excavated from the test pits, for the purpose of identifying the presence of asbestos and ACM. During the August 2019 sampling, a 10 litre sample was collected from the excavated spoil material upon completion of each test pit. However, during the sampling between 30 September and 2 October 2019, an error in the field resulted in representative samples being weighed to 10 kg rather than a 10 litre volume of soil being collected from the fill layer, and then weighed.

The 10 litre and 10 kg samples collected were assessed in the field for PACM by manually sieving through a 7 mm x 7 mm sieve, and visually inspecting any material left on the sieve for potential ACM, in accordance with the NEPM (NEPC 2013). Unsieved fill material was collected and placed into a 500 mL zip lock bag for laboratory analysis to determine the presence of FA and AF.

In addition to analysis of soil for asbestos and identification of ACM in sieved fragments, samples were analysed for the range of contaminants identified, by Arcadis, as potential contaminants on the basis of the PSI report (Arcadis 2018a)

Auditor's Opinion

The various drafts of the further DSI report described the taking and analysis of samples from within the Audit Site. This addressed the anomaly with the initial DSI report, where several of the samples taken did not relate to the area of the proposed redevelopment (*ie* the Audit Site) and a significant portion of the Audit Site had not been covered by the sampling pattern used.

The Auditor reviewed the first draft of the further DSI report and identified that, because of the detection of ACM fragments in test pits, a more intense sampling pattern was required in the Audit Site. The NEPM refers to the WA DoH guidelines (WA DoH 2009) which specify that when sampling on a site where the presence of asbestos or ACM has been confirmed, a systematic sampling programme should be undertaken at twice the density recommended by the NSW EPA *Soil Sampling Guidelines* (EPA 1995)

The use of 10 kg samples for sieving to identify ACM fragments, rather than 10 litre samples, was a departure from the process described in the WA DoH guidelines. It had the effect of providing a smaller sample to be sieved, and from which ACM fragments might have been identified. A possible outcome from this is that there might have been false negative results for the presence of ACM fragments. However, the Auditor considers that there is a low risk of consequent false negative results because the coarse sieve size would likely capture any ACM fragments in the soil for a sample size of the same order as that specified in the Method. Ultimately, the results of the sampling programme (discussed in section 4.3.2, below) did show that ACM was present across a large portion of the Audit Site, to the extent that ACM-impacted areas could be satisfactorily delineated.

The failure to record the locations of test pits GB1, GB2 and GB3 makes it difficult to place into context the results of sampling and analysis at these locations.

4.2 Overview of Analytical Testing

NATA-accredited laboratories were used for the analytical testing undertaken, and the results were reported in NATA-endorsed test reports. To the best of the Auditor's knowledge, standard and approved analytical methodologies were employed. In some instances, these might have been in-house Methods, based on standard Methods. Analytical testing targeted the CoPCs considered by the Auditor to be the most significant, as well as those considered by Arcadis to be CoPCs, but which the Auditor considered less likely. Following the first round of sampling for the further DSI, and presentation of the draft further DSI report, the Auditor requested that soil samples be analysed for fluoride, as a potential inorganic pesticide possibly used in horticultural activities (if any) prior to 1940.

Auditor also notes that hexachlorobenzene and herbicides were analysed in a range of samples, although they had not been listed as potential contaminants of concern at the Audit Site. Analysis of soil samples for manganese was not requested or undertaken, although it is recommended in Appendix A of Schedule B2 of the NEPM (NEPC 2013). In the Auditor's experience, it is common practice for investigation consultants to request '*metals*' analysis from the laboratory, without specifying the metals required. It is also apparent that most laboratories have not updated their default analytical suites for metals since the introduction of the 2013 amendment to the NEPM

4.3 Results of Site Investigations

4.3.1 Field Observations

Arcadis recorded field observations during the preliminary site investigation, and in the two subsequent phases of detailed site investigation. Observations described in the PSI report (Arcadis 2019a) are summarised in section 2.2 of this SAR. The initial DSI report contained descriptions of conditions across the broader school site (Arcadis 2018b). Observations of the Audit Site are taken from the further DSI report (Arcadis 2019a). Locations of test pits, from which observations were taken, are provided in Drawing 4, Appendix B.

Several raised garden beds were noted by Arcadis, and which appeared to contain poor quality imported fill material, with potential ACM visible on the surface at many locations, both within and beyond the garden beds. Arcadis reported these occurrences as "*Fragments of PACM were observed to be scattered across some of the surface of the site within the garden bed area.*"

During test pit sampling, the vertical extent of fill across the site varied in thickness, ranging from approximately 0.1 m to 0.9 m bgl. Most of the uncontrolled fill was observed within the western and southern sections of the site. Buried concrete (considered by Arcadis to be possibly an old footing) was observed at 0.3 m bgl at test pit TP4. At test pit TP7, near a matrix of buried services, reworked natural clays (backfill) were observed to a depth of 1.1 m bgl.

There were no olfactory or visual indicators of possible contamination (other than ACM fragments) noted during test pit excavations.

Photographs of test pit locations before excavation, and after services clearance, in Appendix C of the further DSI report, show the ground surface of the Audit site was either grassed, covered with hard paving (concrete, or asphalt in various conditions of degradation) or wood chip mulch.

Auditor's Opinion

The written and photographic record of site observations by Arcadis are consistent with aerial imagery of the site, and with other descriptions provided to the Auditor.

The Auditor and his team were unable to independently verify surface conditions before investigations began. Weather conditions during the Audit initiation meeting prevented the Auditor from inspecting the site. When the Auditor's field assistant visited the site during test pit installation, surface features, including plants, had been removed from the site. Some photographs from that time recorded degraded asphalt surfaces at some test pit locations.

4.3.1 Observed Soil Profile

The descriptions provided here are based on the further DSI report's discussion of the soil profile (Arcadis 2019a). Arcadis did not provide an overall summary of surface soil properties, but presented a description for each test pit location.

In two locations, TP1 and TP25, Arcadis described the surface layer as TOPSOIL. NATURAL soil was described at TP3, TP09, TP11 and TP13. Bitumen was described at TP7, and road base/aggregate at several more.

At other locations where the surface layer was FILL, there was variability in its described composition; from clay, through silty clay and sandy sits, to silty sand. The fill layer was generally moist and, in places, contained gravel or wood mulch inclusions.

The Auditor also notes that the presence of ACM fragments was recorded at several locations.

Arcadis described NATURAL material underlying fill as *"…generally comprised of Silty Clay/Sandy Silt/Fresh Shale, Red/Orange Brown, slightly moist, stiff non-plastic clays with some gravel and fresh shale inclusions.*"

Auditor's Opinion

The text descriptions of the observed soil profile were consistent with individual bore log entries describing fill composition.

4.3.2 Soil Sampling Results

Asbestos, copper, nickel, zinc, and the hydrocarbon fractions TRH F2 and F3 were the only CoPCs detected in soil at concentrations above any of the Audit criteria. Of the other CoPCs for which analysis was undertaken, all results were below the laboratory limit of reporting (LOR) for the TRH F1 and F4 fractions, BTEX compounds, PAHs, phenols, PCBs, OCPs, OPPs, cadmium and a range of herbicides. For other CoPCs, with concentrations above the laboratory LOR, all results were below all the adopted Audit criteria.

All soil investigation sampling results are presented in Appendix C, Tables C1 – C5.

4.3.2.1 Asbestos

ACM fragments were identified at the surface of the Audit Site, notably the garden bed area, and in some of the sub-surface test put samples.

Arcadis noted that "*Fragments of PACM were observed to be scattered across some of the surface of the site during the excavation of test pits between 30 September and 2 October 2019. Ten fragments were collected and given their similarity in appearance, three representative samples were analysed for asbestos. Laboratory analysis confirmed the material to be ACM…*". The surface samples included observations of ACM within the top 10 cm of the soil profile. However, Arcadis did not log, or otherwise identify, the locations as which ACM fragments were found. Fragments of potential ACM were also reported at the surface at test pit locations TP3 and TP12, but subsequently not confirmed as asbestos-containing.

Additionally, the presence of ACM was identified and confirmed by laboratory analysis in samples taken from test pits at depths greater than 0.1 m bgl. The results are summarised in Table 5. The results are based on analysis of fragments of ACM sieved from soil taken from those test pits.

Table 5. Concentrations of Asbestos in ACM in Test Pit Samples.

Location	Asbestos Concentration (%)
TP1	0.054
TP4	0.019
GB2	0.008

The Auditor notes that Arcadis did not record the location of test pit GB2.

No asbestos fibres were identified in the bagged samples of soil which were collected at the locations (test pits) where soil sieving occurred.

The presence of ACM at the surface means that the Audit criterion of *No visible asbestos for surface soil* was not met for part of the Audit Site. Additionally, the concentrations of bonded asbestos beneath the surface at TP1 and TP4 exceeded the Audit criterion of 0.01%. Arcadis identified an asbestos-impacted area, represented by red shading ('*Special Waste with GSW matrix*') in Drawing 5, Appendix B, taken from the further DSI report (Arcadis 2019a).

Arcadis also identified an area of the site containing non-asbestos anthropogenic materials. This was generally in the southern portion of the site ('*GSW CT1 recyclable*'), near test pit locations TP06, TP21, TP18, TP20, TP29 and TP30 (Arcadis 2019a), and represented by blue shading in Drawing 5.

4.3.2.1 Metals and TRH

Contaminant concentrations were above the Audit criteria in only a limited number of samples in all cases. One of the samples with a TRH F2 concentration above any of the Audit criteria, SB08, was not within the Audit Site, and the results from that location will not be discussed further in this SAR. A summary of the relevant results is provided in Table 6.

Table 6: Soil Samples with Contaminant Concentrations Exceeding Audit Criteria

Contaminant	Audit Criteria (mg/kg)		Sample	Concentration (mg/kg)
	Health - Based (Soil Contact)	Ecologically-Based		
Copper	30,000	95	TP4@0.2	113
Nickel	1,200	30	TP7@0.6	81
Zinc	60,000	180	TP1@0.2	186
			TP1@0.6	278
			TP4@0.2	215
	Health - Based (Vapour Intrusion)			
TRH F2	230	120	SB03	410
			SB07	270
TRH F3	n/a	1300	SB03	3000

The elevated concentrations of TRH fractions were localised, and all other results were less than the laboratory limit of reporting (LOR), so the Auditor considered that statistical treatment of the results was inappropriate. Consequently, the Auditor accepted Arcadis's description of the area of SB03 and SB07 as a 'TRH Hot Spot'.

The distributions of metals (copper, nickel, zinc) concentrations in the fill were amenable to statistical treatment, and the outcomes of the Auditor's statistical analysis are shown in Table 7. However, the statistical analysis for nickel is heavily influenced by the one result at TP7, with all other recorded nickel concentrations being below the adopted Audit criteria.

Table 7. Statistical Description of Metals Concentrations in Fill

	Concentrations (mg/kg)			
Contaminant	Ecologically-Based Audit Criteria	95% UCL*	Standard Deviation	Maximum
Copper	95	38.1	26	113
Nickel	30	33.3	19	81
Zinc	180	137	79	278

*95% upper confidence limit of the mean

The data in Table 7 indicate that copper and zinc concentrations pass the statistical tests provided in Schedule B (1) of the NEPM (NEPC 2013). That is:

- The 95% upper confidence limit of the mean (95% UCL) concentration was less than the Audit criterion;
- The standard deviation of data was less than 50% of the Audit criterion, and;

- There were nor concentrations greater than 250% of the Audit criterion.

For nickel, the results failed all three of the NEPM statistical tests. However, from closer examination of all data in the fill, it is apparent that this outcome is strongly influence by the one concentration at TP7. All other results were in the range 4 – 10 mg/kg.

Auditor's Opinion

The results of the soil sampling by Arcadis generally indicated that at least a portion of the Audit Site was contaminated by ACM, either visible on the surface or identified from sieving sub-surface fill material excavated from test pits, and would require remediation.

Most, but not all, test pit locations were identified in Figure 5 of the further DSI report. Arcadis stated that, in some cases, these locations were not logged in the field. Arcadis prepared a plan showing a general area that was believed to require remediation, roughly coinciding with the garden bed area which had been suggested as where most of the ACM was to be found (asbestos-impacted area in Drawing 6, Appendix B). Concurrently, Arcadis also identified an area of the Audit Site which contained non-asbestos anthropogenic materials in the fill.

The one location where remediation might have been warranted by the nickel concentration exceeding the ecologically-based Audit criterion was not coincident with the ACM-impacted area, but was in the area containing non-asbestos anthropogenic materials in the fill. However, given the need to remove fill from the site to achieve the required construction levels, the opportunity existed to ensure that this elevated (compared to other locations) nickel concentration did not affect future site use.

Soil conditions represented by the reported contaminant concentrations do not preclude sensitive land uses, such as: primary school, preschool and children's daycare centre, low density residential with accessible soil. The Auditor considers that the one location where the nickel concentration exceeded the adopted Audit criterion was an isolated example, and not expected to preclude plant growth or pose a risk to other environmental receptors. It follows from this that the Audit Site would also be suitable for other, less sensitive, land uses.

4.3.1 Potential for Off-site Migration of Contamination

In its various reports prepared for the Audit Site, Arcadis did not discuss the potential for off-site migration of contaminants identified on site. The preliminary conceptual site model presented in the PSI report (Arcadis 2018a) identified some exposure pathways which might have had the potential to result in off-site migration of contaminants. However, there was not further discussion of this in the DSI reports, once the presence of contamination had been confirmed.

The Auditor considers that, given the contaminants identified on site (heavier end hydrocarbon fractions and ACM), the potential for off-site migration of contaminants was limited. Hydrocarbons were identified in surface fill, close to the Audit Site boundary, but not in concentrations considered likely to result in impacts to groundwater.

ACM fragments were identified at the surface, and in sub-surface fill. However, while asbestos fibres may, potentially, be transported off site by the action of the wind, no AF or FA were identified in surface soils, and ACM at the surface is unlikely to become wind borne.

5. Conceptual Site Model

A conceptual site model (CSM) for the proposed development was initially prepared by Arcadis and presented in the PSI report (Arcadis 2018a). The CSM was developed further following site investigations, and summarised by the Auditor.

5.1 Potential Contamination Sources

The potential contaminant sources and contaminants identified by Arcadis are presented in Table 7 of this SAR (section 2.6.1). Those contaminants and sources considered by the Auditor be potentially present on site are presented below in Table 8.

Table 8. Potential Contaminants and Sources Considered Likely.

Potential Contaminant Sources	Associated Contaminants
Fill material of unknown origin	Metals, polycyclic aromatic hydrocarbons (PAH); petroleum hydrocarbons (as TRP/TPH); asbestos
Building materials (ACM)	Asbestos

In the PSI report Arcadis also identified a range of potentially-affected media. Following consideration of the DSI reports, the Auditor has refined that list, as indicated in Table 9.

Table 9. Potentially Affected Media at the Site

Potentially affected media (identified by Arcadis)	Auditor's Assessment of likely impact (following DSI)
Soil	Identified impact from ACM. Minor hydrocarbon contamination (isolated location).
Groundwater	Unlikely to be impacted by identified contamination.
Soil Vapour	Unlikely to be impacted by identified contamination.
Indoor air	Potential impact from airborne asbestos fibres due to degradation of ACM.

5.2 Receptors

Arcadis identified potential receptors of contaminants in the PSI report, as listed below.

- School students
- Site workers (education staff, and non-intrusive maintenance workers)

- Intrusive maintenance workers
- Demolition/construction workers
- Surrounding residents
- Groundwater users (off-site)

The Auditor considers this to be a comprehensive list of possible receptors, in the absence of indications of on-site contamination, such as at the completion of the PSI report. However, on considering the results of the PSI and DSI reports, the Auditor considers that there are unlikely to be off-site groundwater receptors within a range likely to be affected by on-site sources, and there are no identified mobile contaminants with potential to reach groundwater.

5.3 Exposure Pathways

In the PSI report Arcadis identified a range of potential exposure pathways. Following consideration of the DSI reports, the Auditor has refined that list, as indicated in Table 10.

Table 10. Potential Exposure Pathways

Potential Exposure Pathways (identified by Arcadis)	Auditor's Assessment of likely impact (following DSI
Direct contact with contaminated soil/groundwater.	Potential exposure pathway.
Inhalation of vapours.	Potential exposure pathway, but no volatile contaminants identified.
Vertical migration of spills/leaks to groundwater.	Mobile contaminants identified in surface layers only, and unlikely to migrate to groundwater.
Ingestion of dust/abstracted groundwater.	Inhalation and ingestion of dust possible pathways. Groundwater extraction unlikely.
Inhalation of asbestos fibres.	Potential exposure pathway.

Auditor's Opinion

Overall, the Auditor considers that Arcadis did not update its CSM to take account of on-site conditions reported in the DSI reports. The Auditor has refined the preliminary CSM prepared by Arcadis, and provided his opinion on potentially complete exposure pathways.

The Auditor considers that inhalation of asbestos fibres, from the degradation of ACM identified at the site, by site users (school students and staff, and construction/maintenance workers) was the only potentially complete exposure pathway at the Audit Site, prior to remediation.

While concentrations of TRH F2 above the Human Health (vapour intrusion) Audit criterion were observed at two locations (SB03 and SB07), those locations were in areas unoccupied by buildings under the proposed redevelopment plan. Hence, inhalation of vapours in indoor air would not be possible

Arcadis did not consider environmental receptors in its CSM. However, the results of sampling and analysis of soil did not indicate that such receptors were likely to be affected at the site. There were two sample locations where TRH F2 concentration, and one sample location where the TRH F3 concentration, exceeded the relevant ecological Audit criteria. However, there were no other locations at which concentrations of these contaminants were observed above the laboratory LOR, hence these concentrations are not considered representative of the site as a whole.

6. Site Remediation and Validation

6.1 Development of Remediation Action Plan

Arcadis prepared a RAP (Arcadis 2019c) following the completion of site investigation works. The adopted remediation strategy was as follows:

1) Fill within the Audit Site, which was impacted by ACM, was to be placed in a long term containment cell ('the containment cell') located beneath the proposed Block R in the redevelopment plan. Drawing 6, Appendix B, shows the location of Block R, and the containment cell.
2) The relatively minor amount of fill and soil in the TRH hotspot was to be transported off-site and disposed as General Solid Waste at an appropriately-licensed facility.
3) Fill not impacted by either ACM or petroleum hydrocarbons was to be transported off-site as General Solid Waste (GSW).

The RAP included an assessment of several options for management of the ACM-impacted fill. These were:

- Option 1. On-site treatment to reduce the hazard of the affected material;
- Option 2. Off-site treatment to reduce the hazard of the affected material, following which the treated material would be returned to site, and;
- Option 3. Consolidation and isolation of the material on site in an engineered structure with appropriate barriers to human contact with the contaminated material.

Option 3 was chosen as the preferred approach, on the basis of sustainability, and the technical difficulty of destroying the contaminants (asbestos) to remove the hazard. The Auditor endorsed this general approach in Interim Audit Advice, dated, 22 November 2019, and provided further comments for refinement of the RAP.

The RAP provided estimates of the volumes of the various soil/fill types in the Audit area, including the material intended to be deposited in the containment cell. These are summarised in Table 11, below.

Table 11. Arcadis's Soil/Fill Volume Estimates.

Area / Zone	*In situ* volume (m^3)
ACM-impacted zone	1,050
TRH hotspot	50
Area impacted by anthropogenic materials	1,920
Remainder of fill	690

However, further estimates of fill / soil volumes were provided by the waste classification letters which were presented in Appendix N of the validation report (Arcadis 2020a), and provided in January 2020, after the RAP had been endorsed. Those letters indicated the volume of fill in the GSW (unimpacted) area, including the TRH Hot Spot was 738 m^3, and that the volume of fill in the ACM-impacted zone was 550 m^3. In subsequently completing the validation report, Arcadis offered no explanation for the discrepancy.

The RAP also incorporated an unexpected finds protocol ('UFP') to manage soil excavation works during remediation (Arcadis 2019b) and an asbestos management plan ('AMP') intended to protect site workers during the remediation process (Arcadis 2019d). preparation of the AMP was a requirement of Condition B9 of the SSDA. Both the UFP and AMP were endorsed by the Auditor.

Auditor's Opinion

The Auditor provided comment on initial drafts and, ultimately, endorsed the RAP and its subsidiary documents (the UFP and AMP) on 5 December 2019, via e-mail to Arcadis. These documents were endorsed on the basis that the proposed remediation represented a practical approach to managing the identified contamination and potential risks to site users, taking account of technical and sustainability considerations.

Further comment on waste volume estimates is provided in section 6.4 below.

6.2 Site Remediation Works

The RAP provided an outline design and specifications for the containment cell, including details of the capping which was to be used in conjunction with the overlying building to control future access to the contained material. It provided details of the sources of fill materials which were to be placed in the containment cell, notably fill from the ACM-impacted area. See Drawing 5, Appendix B.

The containment cell was excavated prior to the excavation of the ACM-impacted area. The surface fill in the footprint of the containment cell was removed from site with the remainder of the uncontaminated fill from the area not affected by the presence of ACM. The underlying natural soil and rock was removed from site as VENM.

According to the RAP, the capping was to comprise a marker layer of geotextile or heavy-duty plastic, overlain by a layer of site–sourced soil classified as virgin excavated natural material (VENM) followed by the structural elements of the floor slab for Block R, (coarse sand and a concrete cap) (Arcadis 2019c). To support the concrete capping layer, and the structure of Block R, it was proposed that bored piles be installed through the deposited waste once the VENM cover layer was in place. The

RAP also provided that spoil from the installation of the bored piles was to be disposed off-site, and that protection measures be used during boring and pile installation to prevent residual ACM remaining on the top surface of the containment cell.

Installation of these features, and deviations from the RAP, were described in the site validation report (Arcadis 2020a). A member of the Auditor's team attended site to observe construction of the containment cell and placement of fill, on six occasions during various stages of the work.

The RAP also provided for the excavation and disposal of soil from the area designated as the TRH hotspot, in the vicinity of test pits TP21 and TP25 (see Drawing 5, Appendix B) on the north-western edge of the Audit Site. Uncontaminated soil and fill were excavated from around the hotspot, first, and disposed off-site as General Solid Waste (GSW), with a Waste Classification Letter provided in Appendix M of the validation report (Arcadis 2020a). Two validation samples were taken from the walls of the remaining soil in the hot spot, and analytical results confirmed the absence of contamination at the edge of the hotspot, indicating that material from the hotspot had not been excavated.

Additionally, there were portions of the site which were not considered impacted by TPH or ACM, but which were impacted by other anthropogenic materials, which needed to be removed as part of earthworks for the redevelopment (shown as the blue shaded portion on Drawing 6, Appendix B). These were not originally intended to be included in the provisions of the RAP, but Arcadis prepared a soil classification report based on the analysis of samples taken *in situ* during the site investigation phases. This included the location of TP7, where the nickel concentration was more than 250% of the ecologically-based Audit criterion. However, unexpected finds caused some of this material to be dealt with as contaminated soil. See section 6.2.4 below.

Auditor's Opinion

In general, the Auditor considers that remediation works were undertaken in accordance with the RAP, but the Auditor also identified several points at which the completed works varied from the RAP. These are discussed in subsequent sections of this SAR.

Arcadis's approach to removal of the TRH hotspot was unconventional, in that it is customary practice to remove an area of contaminated soil, and validate the excavation, before removing uncontaminated soil from around the excavation. In this case, the uncontaminated soil was removed first. The validation samples taken at the extent of the remaining soil in the TRH hotspot served to show that the contamination did not extend beyond the limits of soil remaining. The Auditor also has reservations about the number and placement of the validation samples. There were only two such samples, when it is customary to take at least four validation samples at the extent of excavation. The effect of this is that there is the potential for soil containing TPH contamination to have been disposed of as GSW. However, given the volumes of soil which were disposed of with this classification, the Auditor considers it unlikely that any material from the TRH hotspot which might have been disposed off-site would have affected the overall classification of the material disposed of as GSW.

The Auditor's reconciliation of initially-estimated soil/fill volumes with the final amounts managed is provided in section 6.4 below.

6.2.1 Additional Material in Containment Cell

Arcadis reported that prior to the start of remediation, the client requested that additional soil material contaminated with ACM, from the school site but outside the Audit Site boundaries, be accommodated in the containment cell (Arcadis 2020a). This material comprised three separate stockpiles with a total volume of approximately 600 m^3. As a consequence, the volume of the waste containment cell was increased by extending the excavation from the originally proposed depth of 3.2 m mbgl to 5 mbgl. The Auditor was consulted (via e-mail and telephone) on these variations to the RAP and endorsed the planned actions. In considering this proposed change, the Auditor took into account that the fill originated on the larger school site and was, thus, not a waste in the strict sense

Furthermore, the material present in the TRH hotspot, described in the RAP, was also placed in the containment cell. According to the RAP, the soil in the TRH hotspot was to have been disposed of with the GSW soils, not impacted by ACM but impacted by other anthropogenic wastes. However, the threshold value for TPH C_{10}-C_{36} at the facility chosen to receive the GSW material (MET Recycling Silverwater) was less than the concentration of TPH C_{10}-C_{36} in the hotspot (1,600 mg/kg vs 3,610 mg/kg, respectively). Hence, the material in the TRH hotspot was considered unacceptable for the MET Recycling facility. The hotspot soil was excavated and placed in the containment cell. This represented approximately 50 m^3 of additional material in the containment cell.

Auditor's Opinion

As the additional stockpiled material was originally present outside the Audit Site boundaries, the Auditor has not been provided with validation data to indicate that all the ACM-contaminated material was removed from its original location. The Auditor was not advised of its original source, and considers it beyond the scope of the current Site Audit to further pursue this aspect. This additional material was reported to have come from elsewhere on the school site. If this is the case, there was no placement of material sourced from off-site in the containment cell.

While placement of the TRH hot spot soil in the containment cell was not envisaged by the RAP, the Auditor considers it to have been an acceptable approach. It had the positive environmental benefit of minimising the off-site transport and disposal of waste. There is unlikely to be an unacceptable reaction or other interaction between the two types of contaminants placed in the containment cell.

6.2.2 Changes to Cell Cap Construction

The original containment cell design incorporated a layer of sand between the VENM which was placed over the marker layer and the underside of the concrete cap. However, during construction, and because of the additional excavation which occurred in constructing the containment cell (to accommodate the additional, stockpiled material and the TRH hotspot), a thicker layer of VENM (site-sourced) than originally envisaged was placed above the marker layer. Also, above the VENM layer, structural road base material (gravel), 200 mm thick, was used in place of sand.

The boring works for installation of the concrete piles were conducted with equipment standing on the gravel layer, and Arcadis reported that the top 100 mm was scraped away following boring works, to ensure that no ACM, potentially present in the boring spoil, remained above the marker and VENM

layers of the cell cap (Arcadis 2020a). The material scraped away was combined with the piling spoil and disposed off-site to an appropriately-licensed facility.

Auditor's Opinion

The Auditor does not consider that this change would materially affect the performance of the cap, and the use of road base material may possibly provide structural enhancement when compared to sand.

6.2.3 Lift Shaft and Stairwell Installation

Arcadis reported in the validation report that an excavation was made for a lift shaft and stairwell for Block R which intersected with the northern boundary of the containment cell (Arcadis 2020a). The material excavated was managed as if it contained ACM, and disposed off-site as GSW-Special (Asbestos). The exposed face of the containment cell was covered with geofabric to ensure containment of the deposited waste therein, and subsequently sealed with the concrete used to construct the lift shaft and stairwell. The validation report contains a drawing to show the extent to which the excavation encroached on the containment cell, and also contains photographs which record the installation of concrete for the structures concerned.

Auditor's Opinion

The Auditor was not consulted on this matter at the time it was dealt with, and had no opportunity to provide comment or endorsement prior to the fact. However, based on the description provided, and photographs contained, in the validation report, the Auditor is satisfied that the approach taken was adequate to address the risk of human exposure to the materials in the containment cell, and to ensure the integrity of the cell.

6.2.4 Unexpected Fibrous Asbestos (FA) Material

During validation sampling following excavation of the fill in the ACM-impacted zone, Arcadis identified FA in soil at three locations, generally to the south-east (Arcadis refers to it as being to the south) and at the edge of the ACM-impacted zone. This area was termed the FA-impacted area and is shaded purple in Drawing 5, Appendix B. This area had previously been assessed to contain soil and fill classified as GSW. The presence of FA had not been expected in this, or any area of the Audit Site, because it had not been identified in the earlier investigations, and the UFP was invoked.

Arcadis, in consultation with the site builder and design engineer, decided that off-site disposal of the soil and fill contaminated by FA was the most suitable course. The Auditor was consulted and endorsed this strategy. The validation report (Arcadis 2020a) documents the removal of this material off-site and provides records of the waste facility to which it was sent.

Auditor's Opinion

The Auditor considers that the offsite disposal of this material was appropriate in the circumstances. The Auditor considers that it would not have been appropriate to mix the FA with the ACM-contaminated soil in the containment cell, given the greater degree of ongoing management and control of the containment cell which would have been required. The Auditor would have serious concerns had such material been placed in the containment cell and pile boring ensued as planned.

6.3 Validation

Analytical data for validation sampling are presented in Tables C6 and C7, Appendix C.

6.3.1 Asbestos Contamination

Arcadis undertook visual inspections during the filling of the containment cell (Arcadis 2020a). Following excavation and remediation work, Arcadis completed a final visual inspection of the excavated area and concluded that fill materials from the ACM-impacted area and the FA-impacted area had been removed (either placed into the containment cell or disposed of appropriately off-site), and that natural materials were exposed.

Following the visual inspections by Arcadis, and completion of the piling works, Greencap completed a further visual inspection of the ACM-impacted area, and issued an Asbestos Clearance Certificate (ACC). That ACC was included as an Appendix to the validation report (Arcadis 2020a). In the ACC, Greencap noted that a small stockpile of friable asbestos material was present on the site when the inspection began on 23 January 2020. Greencap further noted that the stockpiled material was removed later that day by a Class A licensed friable asbestos removal contractor.

Greencap observed that non friable ACM-affected material had been removed from the site over the preceding two days, and provided the relevant waste transport certificates. A Greencap staff member (acting as a Licensed Asbestos Assessor) subsequently conducted a visual clearance inspection and concluded that there was no visible ACM in the inspection area.

Subsequently, Arcadis analysed three samples from the FA-impacted area (Val01, 03 and 03, locations indicated in Drawing 5, Appendix B) and these were confirmed to contain no asbestos. On this basis, Arcadis concluded that the FA-impacted area had been successfully remediated and validated.

Auditor's Opinion

The Auditor considers that the information provided in the validation report is sufficient to confirm that removal of asbestos (FA) and ACM from the Audit Site was carried out satisfactorily. Contaminated material was removed to either the containment cell on-site, or removed off-site to an appropriately-licensed facility.

6.3.2 Hydrocarbon Contamination

Two samples were taken from the walls of TRH Hot Spot (V20 and V21) after the removal of the surrounding GSW soil, and prior to removal of the hot spot to the containment cell. Analytical results for these two samples indicated that concentrations of hydrocarbon fractions were below the laboratory LOR and, hence, the remaining hot spot area was considered validated, laterally. Arcadis considered that the vertical extent of contamination in this area was delineated during the initial DSI (Arcadis 2018b).

Auditor's Opinion

The Auditor considers that the removal of the TRH hotspot from its original location is adequately demonstrated by the results of validation sampling and the previous delineation sampling. The Auditor's reservations about the number of validation samples are recorded in section 6.2, above.

6.3.3 Anthropogenic Waste

The validation report (Arcadis 2020a) indicated that the area containing non-asbestos anthropogenic wastes was removed from site as GSW (blue shaded area in Drawing 5, Appendix B). There were no records of inspections of this area to confirm or validate that all the anthropogenic waste had been removed. The Auditor also notes that this area also contained the test pit location (TP7) where the nickel concentration exceeded the ecologically-based Audit criterion. Based on the visual indications that this part of the Audit Site had been excavated, the Auditor concluded that this area of relatively high nickel concentration had also been removed from site.

6.4 Waste Tracking

Arcadis provided no information on the amount of material placed in the containment cell, other than (i) the estimates of material summarised above in Table 10 (comprising the ACM-impacted area and the TRH Hot Spot), and (ii) approximately 600 m^3 in the stockpiles from outside the Audit Site which was placed in the cell. However, on the basis of the validation sampling results, it is also apparent that no ACM-contaminated fill remained in the remediation area.

The Auditor has confirmed that the off-site waste disposal records are accurate to the extent allowed by the estimation of *in situ* soil volumes, and is satisfied that the affected material has been appropriately managed.

Arcadis did report on the off-site disposal of material from the site, generally, and from the construction of the containment cell (Arcadis 2020a). It provided a summary table (Table 7-3 of the validation report), which is reproduced below as Table 12.

Table 12. Summary of Materials Removed From the Audit Site

Material	Remediation Area	Mass Disposed (t)	Volume Disposed (m^3)	Facility Used (EPL Number)
Fill material classified as GSW.	Non-contaminated zone (including cell excavation).	2,052.68	1,140	MET Recycling Silverwater (EPL 20948)
Fill material impacted with friable asbestos (GSW – Special (Asbestos))	FA zone.	446.80	248	Bingo Waste Services Pty Ltd Eastern Creek Ecology Park (EPLs 13426 and 20121)

Material	Remediation Area	Mass Disposed (t)	Volume Disposed (m^3)	Facility Used (EPL Number)
ACM impacted material derived from piling through the Block R containment cell, the lift shaft and stairwell excavation, and the 0.1m scrape of road base	This material was temporarily stockpiled within the Block R footprint, before being transported directly to landfill.	613.70	341	Bingo Waste Services Pty Ltd Eastern Creek Ecology Park (EPLs 13426 and 20121)

The Auditor's team reviewed the waste transport certificate and waste receipt dockets provided in the validation report, and noted anomalies with the masses of waste reported by Arcadis in the original draft. The information was corrected in the final version provided. Additionally, Arcadis provided some commentary on discrepancies between information provided by the waste transport documentation.

Arcadis calculated the total volumes listed in Table 12 from the recorded masses, using a bulking density of 1.8. The Auditor acknowledges that there are some inherent uncertainties in such an approach, and has not attempted to verify the volume calculations. Given the uncertainties in the initial estimates of the volumes of fill and soil to be disposed, and that additional material requiring off-site disposal was generated by (i) operation of the UFP to deal with FA-impacted soil, (ii) the pile boring operation, and (iii) removal of material from the containment cell caused by installation of the lift shaft and stairwell, the Auditor considers that Arcadis did not act unreasonably by not attempting to reconcile estimated volumes with masses and assumed volumes removed.

Auditor's Opinion

The Auditor is satisfied that waste removal from site has been recorded to the extent practicable, and that apparent discrepancies between estimated and actual amounts of material removed can be attributed to the uncertainty inherent in estimating masses and excavated volumes from volumes measured *in situ*.

6.5 Long Term Environmental Management Plan

The LTEMP (Arcadis 2020b) outlines the steps to be taken to ensure appropriate and adequate management of the containment cell beneath Block R on the Audit Site. A copy is attached to the SAS which is presented in Appendix A of this SAR. As the site owner / site manager, SINSW (specifically the Asset Management Unit) will have ongoing responsibility for ensuring the provisions of the LTEMP are adhered to.

In addition to setting out what must be done, and by whom, to ensure that risks arising from the presence of ACM-impacted material in the cell are managed, the LTEMP also provides background information on the investigation and remediation works conducted prior to its construction, and on the site settings.

Essentially, long term management of the containment cell is intended to ensure that there is minimal opportunity for access to the cell contents by site users and workers, and that any necessary building and maintenance works which might be proposed in the vicinity of the containment cell, in future, will be managed so as to prevent uncontrolled access to the contents of the cell.

Chapters 5 and 6, respectively describe the necessary communication with stakeholders, and the management measures to control potential risks arising from the presence of the containment cell. Communications and stakeholder considerations include:

- Stakeholder Notification;
- A description of the structure of management measures and responsibility for those measures;
- Provisions for –
    - Maintenance of records and documentation;
    - Training and inductions;
    - Management of complaints
- Management of no-compliance with the plan;
- Legal enforcement, and;
- Approvals and licensing requirements.

Chapter 6 elaborates on the necessary management activities and controls. In general terms, these involve:

- A prohibition on piercing the cap of the containment cell (the lower floor slab of the block R building).
- A programme of inspections of the cap to ensure the integrity of the concrete surface is maintained.
- Procedures to be followed if it proves to be necessary to pierce the cap/concrete slab.
- Guidance on actions to take if some of the cell contents are removed.

The LTEMP contains no provision for monitoring of Environmental media at the site. Given the nature of the material contained within the cell, the Auditor considers that there is limited potential for contaminants to leach, or otherwise migrate, from the cell. In those circumstance, monitoring is limited to the programme of annual inspections of the integrity of the concrete cap.

Should maintenance work with the potential to affect the integrity of the cap be required, there is provision in the LTEMP for the relevant contractor(s) to provides Safe Work Method Statements to the site owner / site manager.

There are several mechanisms in place to ensure that the LTEMP is enforceable and will be enforced.

- The LTEMP is attached to the SAS required as a Condition of the SSDA issued by the Department of Planning, Industry and Environment.
- The existence of the LTEMP will be publicly notified on the section 10.7 Certificate maintained by the City of Ryde.

- SINSW will have ongoing responsibility for the management of the school site, and implementation of the LTEMP.

Auditor's Opinion

The Auditor provided extensive comment on the initial draft of the LTEMP. In the Auditor's opinion, that document placed an over-emphasis on the management of construction work at the Audit Site (including installation of the containment cell), at the expense of detailed requirements / obligations to be followed on an ongoing basis. The revised (final) version of the LTEMP satisfied the Auditor's concerns and is considered acceptable for managing ongoing risks to human health and the environment.

In particular, the Auditor is satisfied that the LTEMP is enforceable, principally because of the involvement of several public agencies in the approval of the redevelopment (and the conditions thereto), and ongoing involvement in management and use of the site, and in decisions regarding future land use management.

7. Completeness and Adequacy of Investigations

7.1 Sampling Strategy and Plan

The Auditor was unable to review sampling strategies and plans during the initial stages of the site investigation. However, the subsequent and further investigations which the Auditor required to be undertaken were as a result of data gaps identified in the reporting of those initial investigation stages.

The Auditor reviewed the SAQP prepared by Arcadis prior to the further detailed site investigation, and endorsed the contents of that plan. The Auditor is satisfied that the further DSI report reflects appropriate implementation of the endorsed SAQP

7.2 Sampling Procedures

Samples were taken during the investigation phases (PSI and DSI) using a combination of a standard sampling approaches. The Auditor considers that the sampling procedures used prior to the commencement of the Audit, as reported (Arcadis 2018b, 2019a), were undertaken in accordance with accepted Standards and Guidelines.

For the further detailed site investigation, the Auditor's team was able to observe sampling by Arcadis. In section 4.1.2, above, the Auditor notes that Arcadis did not comply with standard practice in that its field staff weighed 10 kg samples of fill for the sieving of ACM fragments, rather than taking 10 litre samples and weighing them. As noted in section 4.1.2, the Auditor does not consider that this non-conformance had a material effect on the reported outcome of sampling and analysis.

7.3 Data Quality Objectives and Data Quality Indicators

The *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 2011)[2] and *Guidelines for the NSW Site Auditor Scheme (2nd Edition)* (EPA 2015) outline how the process of setting Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs) is to be applied to contaminated land investigation work. They also specify that the application of these elements be described in site investigation and Audit reports.

A tabulated description of DQOs for the Site Audit is included in Appendix E of this SAR.

The PSI report (Arcadis 2018a) and initial DSI report (Arcadis 2018b) did not explicitly address the DQO process, or provide a description of the DQOs for those investigations.

The further DSI report (Arcadis 2019a) included a specific discussion of DQOs in section 5.1 and set out in Table 4 the DQO's for the investigation, which was generally acceptable, although the discussion did not explicitly address the relevant DQIs, as the published DQO process envisages. Consequently, the Auditor has reviewed Arcadis's discussion in the context of the DQIs, and concluded:

- For *Completeness*. The range of sampling and analysis set out in the SAQP was completed satisfactorily, although some anomalies in sampling were evident (as noted previously in this SAR). However, the failure to record (in the field) the locations of several sampling points means that there was a lack of completeness in understanding the extent of ACM contamination. However, subsequently, all of the garden bed area was remediated.
- For *Comparability*. The text of the report included consideration of sample results from within similar lithologies. The use of NATA-accredited labs supported comparability between data sets.
- For *Representativeness.* Different lithologies were sampled across the Audit site, and use of systematic sampling pattern also ensured representativeness. There was an over-emphasis on this DQI in the discussion of '*Optimise the design for obtaining data*'.
- *Precision* was discussed by Arcadis in terms of replicate sample analysis, but only in relation to repeatability (intra-laboratory replicate analysis) for all sampling. Reproducibility (inter-laboratory replicate comparisons) was not considered in the further DSI and validation reports.
- *Accuracy* (or bias). Laboratory spike and control sample results were used to indicate accuracy, but only a limited number of field blank samples was used to indicate sampling-induced bias / inaccuracy.

For the validation report (Arcadis 2020a), a similar approach was adopted, although the Auditor recognises that it was difficult to enunciate specific objectives in some circumstances due the qualitative / semi-quantitative nature of some of the decisions to be made in investigating the presence of ACM. For example, where the *Presence or Absence of ACM* could be nominated as a decision rule, a limit on decision error is difficult to describe. Furthermore, there was a lengthy discussion on *Identify decisions* which could have been put more succinctly in terms of ensuring the site was suitable for use and that the long term containment cell was; (i) suitably designed, and (ii) capable of being effectively managed in the long term.

[2] Applicable to all documents referred to, except the LTEMP

However, to the extent that the consideration of the DQO process by Arcadis impacts on the Auditor's ability to form conclusions about the suitability of the site condition for future use, and the sustainability of the selected management options, the Auditor is satisfied with Arcadis's consideration of DQOs in the latter stages of investigation and remediation work.

7.4 Quality Assurance (QA) and Quality Control (QC)

The Auditor's full consideration of Arcadis's data quality assurance and quality control is presented in Appendix E of this SAR. To some extent, quality assurance is also discussed in section 8, of this SAR.

The Auditor's conclusions in relation to data quality are summarised below.

7.4.1 Field QC Sampling

Arcadis only collected inter-laboratory replicate samples during the initial DSI field work (prior to the Auditor's engagement), but took intra-laboratory samples for sampling conducted other than between 30 September and 2 October 2019. On that occasion, only asbestos was a contaminant of concern, and not amenable to replicate sampling. Trip blank samples were only taken during the initial DSI sampling, and rinsate blank samples were only taken during waste classification sampling in December 2010.

The Auditor does not consider the lack of trip blank samples during the second and subsequent rounds of sampling to be a significant omission. The likelihood of cross contamination is considered to be low, given that (i) there was only one sample found to contain hydrocarbon contamination (in the second round of sampling), and; (ii) non-volatile contaminants (notably forms of asbestos) were of interest in the subsequent rounds.

Arcadis used new dedicated sampling equipment at each test pit location, including disposable gloves, and samples were collected either directly from the test pit wall or centre of the excavator bucket. In these circumstances, the lack of rinsate samples is not a significant omission.

Replicate analysis gave acceptable results, as shown by the data in Table 13

Table 13: Soil Replicate Sample Data

Date	Intra-laboratory Replicates		Inter-laboratory Replicates	
	RPDs Acceptable	% Acceptable	RPDs Acceptable	% Acceptable
13 Jul 2018	71/73	97%	62/62	100%
10 Aug 2019	76/76	100%	60/61	98%
11 Dec 2019	152/152	100%	-	-

The results of the replicate analysis indicate an acceptable level of precision for Arcadis' sampling programme.

Where blank samples were collected, acceptable results were obtained.

7.4.2 Laboratory QC

All results from internal laboratory QC testing were acceptable.

8. Reporting Standards

Reporting standards are, primarily set out in the NSW EPA publications *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 2011) and *Consultants reporting on contaminated land. Contaminated land guidelines* (EPA 2020). The former guidelines were applicable prior to the introduction of the latter on 5 May 2020. Only reports and plans prepared after that date are required to comply with the later guidelines.

The discussion below deals with the degree to which the investigation and validation reports, and the LTEMP, conform with the EPA Guidelines. Critical comment and discussion on those documents are provided in relevant sections of the SAR, above.

8.1 Conformity with the 2011 Guidelines

The Auditor checked the documents' conformity with the 2011 Guidelines by applying the relevant checklist included in those guidelines. The Auditor retains a copy of each completed checklist on file.

8.1.1 PSI Report

The PSI (Arcadis 2018a) generally met the requirements of the 2011 guidelines, although there were some omissions. There was no Executive Summary, and there were some minor issues regarding mapping and the presentation of figures (lack of scale on maps). As noted in section 7.3, the PSI report did not discuss the DQO process.

8.1.2 Initial DSI Report

The initial DSI Report (Arcadis 2018b) did not provide a summary of the site history identified in the PSI report. However, at the time of its preparation, its Objectives were focussed on waste classification, for which a standard collection of contaminants was selected for analysis, based on the requirements of the EPA waste classification guidelines (EPA 2014). As for the PSI report, there was no Executive Summary, and there were some minor issues regarding mapping and the presentation of figures (lack of scale on maps). Additionally, there was no graphical representation of exceedances of site investigation criteria. As noted in section 7.3, the initial DSI report did not discuss the DQO process.

8.1.3 Further DSI Report

The further DSI Report (Arcadis 2019a) generally complied with the requirements of the 2011 Guidelines. The Auditor did not identify any noteworthy non-conforming features of the report.

8.1.4 Remediation Action Plan

The RAP (Arcadis 2019c) generally conformed with the 2011 guidelines, although the lack of a statement of the remediation goal was a notable exception. However, the goal of remediation was apparent, particularly in the context of the background information provided regarding site conditions. Notably, the RAP also provided information on the validation plan to be followed following remediation. A requirement for this is a significant omission from the 2011 guidelines.

8.1.5 Validation Report

The validation report (Arcadis 2020a) generally conformed with the 2011 guidelines. The Auditor did not identify any significant features which limited his ability to rely on the report.

8.2 Conformity with the 2020 Guidelines

Only the LTEMP was completed after the introduction date of these guidelines.

The Auditor checked the LTEMP's conformity with the 2020 Guidelines by applying the relevant checklist included as Table 2.7 of those guidelines. The Auditor retains a copy of the completed checklist on file.

Given the passive nature of the long term management and containment of wastes in the containment cell, and the absence of any requirement for long term sampling and monitoring of the containment cell, there are several items of the checklist which are not relevant to cell's management. However, for those elements which are relevant to long term management in this case, the Auditor is satisfied that they have been included and adequately addressed in the LTEMP.

8.3 Auditor's Conclusion Regarding Reporting Standards

The Auditor concluded that the reports and other documents provided by the investigation and remediation consultant were of a suitable standard to be adopted in the Audit, and generally conforming to the guidelines published by NSW EPA.

9. Conclusions

Based on the information provided by the site investigation and remediation consultant, as discussed and analysed in this SAR, the Auditor concludes that potential environmental and human health risks identified in the site investigation works arose from the potential for exposure to asbestos-bearing materials (ACM and FA) identified on the site surface and in subsurface soil and fill.

There was an area where TRH contamination in fill exceeded health-based Audit criteria for vapour inhalation in indoor air, but that location was not proposed to be covered with a building, so there was no potential for a health risk from inhalation of indoor air. The fill in that location was excavated and placed in the on-site containment cell. However, the relative volume of fill from the TRH hotspot,

compared to the overall volume of material is such that the resulting concentration of TRH in the cell is unlikely to pose a vapour inhalation health risk.

While there was also an isolated location at which the nickel concentration in fill exceeded the ecologically-based Audit criterion, that location was excavated as part of the site re-development and the material disposed off-site at an appropriately-licensed facility.

The asbestos-impacted soils and fill materials have either been removed from site to an appropriately-licensed waste facility, or placed into the on-site long term containment cell beneath Block R of the redeveloped school site.

The Auditor is satisfied that the long term containment cell can be appropriately managed through the implementation of the LTEMP prepared for the site and described in this SAR.

Accordingly, the Auditor also concludes that the Audit Site is, and will be, suitable for use as a primary school, pre-school, children's daycare centre and secondary school, subject to the Condition that the environmental management plan, *Long Term Environmental Management Plan 126 Kent Road, Marsfield NSW 2122.* Arcadis Report No. 10035770_LTEMP V3, dated 29 June 2020, is implemented and applied on an ongoing basis. The Auditor notes that this conclusion is reached, in part, in the basis of the ongoing involvement of public authorities in managing the site and the implementation of the LTEMP.

However, because of the presence of the on-site containment cell, and the need to ensure that the it is managed effectively over the long term, the Audit Site is not considered suitable for other land uses, on the basis that other land uses would be incompatible with the need to ensure that the necessary long term management occurs.

10. References

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Douglas Partners Pty Ltd

Appendix A

Site Audit Statement

Appendix B

Drawings

Appendix C

Data Tables

Appendix D

Audit Communication

Appendix E

Data Quality Analysis

Appendix F

Development Plans and Approvals