

ENVIRONMENTAL AUDIT REPORT (S53V)

18-22 Hamlet St, Cheltenham

EXECUTIVE SUMMARY

Lane Piper Pty Ltd (Lane Piper) was engaged on 11th May 2007 by the site owner Nuplex Industries (Aust) Pty Ltd to provide the services of Mr Anthony Lane, an EPA-appointed Environmental Auditor. This was in response to a Clean Up Notice issued under section 62A of the *Environment Protection Act 1970* (the Act) to the site owner on the 30th July 2007.

The site is located at 18-22 Hamlet St, Cheltenham (Figure 1, Appendix A). The Auditor was requested to carry out an audit under section 53V of the Act in relation to the risk of any possible harm or detriment to the land and groundwater caused by the activities conducted at the premises.

The summary information on this audit is presented in the following table, in accordance with EPA Pub 1147:

Table 1: Summary of Audit Information

EPA File Reference No.	62617-1
Auditor	Anthony Lane
Auditor Term of appointment	29 July 2009 to 30 May 2014
Name of Person Requesting Audit	John Heke
Relationship to Premises/Location	Site Manager of Nuplex Industries (Aust) Pty Ltd
Date of Request	31 July 2007
Date EPA Notified of Audit	7 August 2007
Completion Date of Audit	8 September 2011
Reason for Audit	CUN EPA Ref: NO9097
Description of Activity	Chemical storage and distribution
EPA Region	South Metro Region
Dominant - Lot on title plan	Lot 1 TP518231
Additional - Lot on plan(s)	
Site / Premises name	
Building / Complex Sub-unit No.	
Street / Lot - Lower No.	18
Street / Lot - Upper No.	22
Street Name	Hamlet
Street Type (road, court, etc)	Street
Street Suffix (North, South etc)	
Suburb	Cheltenham

Postcode	3192
GIS Coordinate of Site Centroid	
Longitude	145.040568
Latitude	37.957236
Members and Categories of Support Team Utilised	• Wendy Morrison – Hydrogeology; Remediation and geotechnology; and Contaminant transport and assessment of exposure pathways and risk. • Peter Gringinger – Hydrogeology; Remediation and geotechnology; and Contaminant transport and assessment of exposure pathways and risk.- • Jon Bartley – Hydrogeology • John Frangos – Human toxicology, Contaminant transport and assessment of exposure pathways and risk.
Outcome of the Audit	Soil contamination was most evident in the South Eastern Corner (SEC), where it was contaminated by Volatile Chlorinated Hydrocarbons (VCHs). It is likely that VCH-contaminated soil extends from the site to the south and possibly also the east. Soil investigations in other areas of the site has not been sufficient in other areas where historical release of these chemicals is suspected. Light Non-Aqueous Liquid (LNAPL) or hydrocarbon sheens were not observed on the water table. Dense Non-Aqueous Liquid (DNAPL) has not been observed visually at the site. Multiple lines of evidence reveal the presence of residual DNAPL in the soil which is also an ongoing source of contamination of groundwater at the site (and potentially off-site). The SEC is the most significant source zone for VHC, with other source areas in the southwest (former UST), the Northern (Former Drum Storage Area) and North Central (former ASTs and TIT1). Groundwater flow direction is not simple or uniform and uncertainty remains. It appears to be generally flowing in a southerly direction, but with westerly or easterly components. A revised monitoring well network is required to better define groundwater flow and delineation of contamination. The major contaminants are VCHs, TPH and BTEX. These contaminants were detected across the site, with the exception of an approximately 30 m wide strip on the northern boundary of the site. Groundwater contamination extends approximately 90m off site to the south to at least Phillip Street. Deeper contamination by VCHs has not been investigated. Some metals are slightly elevated within groundwater at the site, which is believed to be caused by a combination of natural background and further elevated due to site activities. The beneficial uses of land were found to be protected for commercial and industrial uses assuming the current configuration of buildings is largely unaltered (no enclosed structure intended for human occupation

	should be built on the SEC without remedial works) and an appropriate management plan is implemented, primarily to protect persons from potential exposures if the site covering is breached. With the exception of Maintenance of Aquatic Ecosystems, all other protected beneficial uses of groundwater were found to be precluded by contamination arising from the site.
Further Work or Requirements	A number of detailed recommendations are provided in Audit Report (grouped by aspect or issue). A summary of the key aspects with recommendations is as follows: • Conduct additional soil and groundwater investigations to identify the nature and extent of contamination at potential source zones other than the SE Corner (e.g. former drum storage) • Perform further assessments of human health risks associated with the current use of the site, areas immediately to the south and possible future use complying with the current land use zone is required using the current data and the data to be gained in further investigations (on- and off-site risks). This must lead into OHS management measures in a Site Management Plan (SMP) for the purpose of avoiding and managing unacceptable risks due to contamination (update based on additional relevant data). Conduct an evaluation of the monitoring well network and decommission wells not adequately constructed. Additional wells may be required to replace decommissioned wells, investigate potential sources in the northern portion of the site and investigate deeper aquifers. • Develop a numerical groundwater model. This should be used to evaluate the potential for impacted groundwater to be captured by local groundwater extraction wells and to assist with remediation feasibility and planning • A Remediation Feasibility Study (RFS) is required to evaluate short-term options for interim management. This will require revision to evaluate short-term options • The risks posed to off-site workers require immediate re-assessment. This includes the collection of additional data and additional risk modelling. • The SMP for on-site intrusive workers, recommended by GHD, should be implemented as soon as possible after the date of this report. The SMP shall include measures to manage odours, acute and lifetime health risks, and should be revised as the Conceptual Site Model is updated.

Table 2: Physical Site Information

Groundwater Segment	A1
Surrounding Land Use	North: Bay Road borders the northern area of the site. Across Bay Road, a car wash facility is located to the north east and an industrial estate currently under construction to the north of the site. East: Chandos Street borders the site to the immediate east which is followed by the Laminex industrial facility. South: Commercial and industrial warehouses are present to the south of the site consisting of an auto technical and machinery location facility. West: Hamlet Street borders to the west of the site with commercial properties and industrial warehouses beyond Hamlet Street. This includes a toolmaker, Austral Injections, an electrical contractor, an ambulance station and furniture outlet.

The practical purpose of this audit is to provide advice and an opinion regarding the condition of land and groundwater at the site and the potential requirement for ongoing groundwater monitoring or remediation of site.

The Auditor has assessed the groundwater and land quality in this instance by a review of the environmental site assessment report provided by the environmental consultant, GHD (the Assessor).

Audit Findings

Summary of Soil and Groundwater Contamination

Soil contamination was observed to varying degrees within the premises. The historical operations conducted at the site over at least the past four decades has provide for potential soil contamination at several areas of the site due to fixed infrastructure and also manual handling and loading practices. Soil contamination was most evident in the SEC, where it was contaminated by VCHs. The maximum soil contaminant concentrations were detected at the eastern and southern boundaries of the soil investigation; approximately 15 m from the eastern site boundary and adjacent to the southern site boundary. It is likely that VCH-contaminated soil extends from the site to the south and possibly also the east. However, the Auditor also notes that soil delineation in other areas of the site has not progressed with sufficient resolution to rule out with any certainty other surficial release areas (such as the Former Drum Storage Area and the TIT). As soil vapour impacts have been identified with the current low-resolution monitoring and as other source zones are possible, the Auditor has recommended a revised soil vapour monitoring network to address the above-noted issues.

LNAPL or hydrocarbon sheens were not observed on the water table. However, the Auditor notes that the USTs operated for decades and as there are no records of replacement of these USTs, there is the potential that leakage occurred over a significant period of time. Further, the continued presence of PHCs in groundwater is indicative of continuing sources within the subsurface. Therefore, there may be areas where the LNAPL has not been identified as it has migrated deep to the water table and/or that matrix diffusion into the clayey media has

provided a long-term source of PHCs that is partitioning back into groundwater. As degradation of VCHs is occurring to some degree at the site, there is the potential for some of the mass of PHCs to be driving this degradation.

DNAPL has not been observed at the site. As DNAPL is generally not observed, indirect lines of evidence have been used to assess the presence of DNAPL for the purpose of this audit report. The results have indicated the likely presence of DNAPL as an ongoing source of contamination at the site (and potentially off-site). The very high concentrations of VCHs (especially in the SEC) and the known DNAPL behaviour of such material, suggests the prospect for DNAPL to occur beneath the source areas. The presence of DNAPL is in non-compliance with SEPP(GoV), and contributes to detriment of beneficial uses. As site operations have included the loading, storage and handling of DNAPLs (such as PCE, TCE, CF, DCM, and TCAs) since 1949 at this relatively small site, there is a strong possibility for long-term release locations. Although data gaps exist in site historic operations (from 1949), the data compiled interviews with employees and site inspections together provide adequate documentation for such long-term DNAPL releases. The above provide adequate time and opportunity for deeper migration of DNAPL into the Brighton Group Aquifer (and potentially into the Fyansford Formation Aquifer). Subsequently, multiple suspected DNAPL source zones exist across the site (with the exception of the northern ~30m). The most significant source zone is in the SEC (former USTs and ASTs, concrete sump, decanting, drum storage in the Former Drum Shed, and refrigerant storage); with other source areas in the southwest (former UST), the Northern (Former Drum Storage Area) and North Central (former ASTs and TIT1).

Groundwater flow direction is not well defined and appears to be generally southerly, but also have westerly or easterly components (in particular within the Former Drum Storage Area that may take impacted groundwater off-site in this area). Mounding, which is occurring across the site in a few areas, is also complicating the flow pattern. The monitoring well network has been evaluated and a revised monitoring well network is considered by the Auditor to be required to provide adequate data on groundwater flow and delineation of contamination. Due to the historical operations conducted at the site over at least the past four decades, groundwater contamination occurs throughout the site. The major contaminants are VCHs, TPH and BTEX. These contaminants were detected across the site, with the exception of the northern ~30 m of the site. The contaminant plumes overlap with plumes from adjoining source areas (this can be particularly observed for plumes from that appear to originate north of the Poisons Store that overlap with those in the SEC). There is a lack of adequate data (and data quality issues) in relation to the potential for degradation in the Brighton Group Aquifer at the site (i.e. whether one or more aquifer 'types' exist). This and the processes of biodegradation and groundwater flow issues complicate the contaminant hydrogeology at this site. Groundwater contamination extends off site to the south to at least Phillip Street. Deeper contamination by VCHs has not as yet been investigated. The Auditor has recommended a revised groundwater monitoring well network to address the above-noted issues.

Some metals are slightly elevated within groundwater at the site, which is believed to be caused by a combination of natural background and further elevated due to site activities.

Land Contamination and Risks

Following a review of the data provided by the Assessor, and having regard to the SEPP *Prevention and Management of Contaminated Land*, the Auditor has assessed the impacts on the protected beneficial uses of the land.

Maintenance of Land Ecosystems: The contamination of surface soil may be a significant impediment to this beneficial use of the land, especially in the south eastern portion of the site. Soil assessment has been focused on locations where groundwater contamination has been

observed; thus a complete assessment of soil contamination across the remainder of the site is not possible.

Buildings & Structures: The Auditor has not identified soil characteristics that are clearly likely to affect buildings or structures across the site. However, the presence of residual DNAPL suspected to be present in the south east portion of the site may have a detrimental effect (related to vapour and/or groundwater impacts) on utility conduits (especially plastic pipes and insulation), which may adversely affect their integrity. This aspect may require further consideration and management.

Aesthetics: Odorous material was identified at the site during the assessment. Intrusive works will require management to avoid unacceptable aesthetic impact (i.e. odours) if and when remediation occurs or any subsurface maintenance work is conducted.

Production of Food, Flora & Fibre: This is not a protected beneficial use on industrial land and is therefore not considered further.

Human Health: The results of soil assessments indicate that the relevant investigation levels for human health criteria for petroleum hydrocarbons (mainly chlorinated hydrocarbons) in soil have been exceeded. Human health exposures due to inhalation of vapours from contaminated soil and groundwater or NAPL is a potentially significant risk pathway. The Auditor is of the opinion that the VHC impacts currently identified require further assessment to confirm the results of the assessors Health Risk Assessment for on and off-site receptors. Any change to site use involving more frequent or longer duration occupation or redevelopment of the site would represent a potentially unacceptable risk.

In summary, the beneficial uses of land were found to be protected for commercial and industrial uses assuming the current configuration of buildings is largely unaltered (no enclosed structure intended for human occupation should be built on the SEC without remedial works) an appropriate management plan is implemented, primarily to protect persons from potential exposures if the site covering is breached.

Groundwater and Surface Water Contamination and Risks

In accordance with the SEPP *Groundwaters of Victoria* the protected beneficial uses of groundwater in the Area of Interest (i.e. the Segment under audit) which are defined as Segment A1 groundwater have been assessed.

Maintenance of Aquatic Ecosystems: Although aquatic ecosystem protection is considered “relevant” under the policy, the contamination in groundwater seems unlikely to represent pollution with respect to aquatic ecosystems due to the attenuation opportunity in the aquifer provided by the distance to the nearest surface water body (Port Phillip Bay). However, there is considerable uncertainty in this assessment and further investigations and monitoring are required.

Potable Water: The water quality criteria for potable water are greatly exceeded. However, this beneficial use is not a relevant use due to the low likelihood of the use being realised by a bore owner pumping groundwater for consumption.

Stock Water: The water quality criteria for toxicants such as benzene default to human drinking water objectives, which are greatly exceeded. However, this use is not relevant due to the low likelihood of people keeping livestock and watering them from a groundwater bore in this vicinity.

Industrial Water Use: Similarly the groundwater contamination can be shown to preclude a number of potential industrial uses, although these are limited and the likelihood of them being realised in this vicinity is low - but still relevant.

Primary Contact Recreation: This use also defaults to human drinking water quality objectives which are clearly exceeded within the site. However, it is considered by the Auditor not a relevant use due to the low likelihood of the use being realised either by a bore owner pumping groundwater into a swimming pool, or the groundwater discharging to a surface water body used for swimming in the vicinity.

Buildings & Structures: To the extent that contaminated groundwater and NAPL at the site can impact on underground structures then this use is not protected. While this is possible and should be guarded against, it is a low risk due to the 9 m depth to the water table.

In summary, with the exception of Maintenance of Aquatic Ecosystems, all other protected beneficial uses of groundwater were found to be precluded by contamination arising from the site.

Contamination in Surrounding Areas

Chlorinated hydrocarbon contamination has been identified offsite to the south in the adjoining properties (MW26 and MW34) an up to 150 m off-site at Philip Street. BTEX compounds have been identified to the southwest of the site, but are considered to be of lower significance than the VCHs.

Groundwater flow directions are generally southerly, but also have easterly and westerly components. Thus the southern, eastern and western boundaries should be considered to be the hydraulically downgradient boundaries at the site for the purposed of further assessment or management.

Health Risk Assessment

A Health Risk Assessment (HRA) was conducted by GHD (2009) to assess the potential risk to human health associated with the inhalation of vapour emissions from contaminated soil and groundwater at the site. The assessment followed the approach outlined in the NEPM.

The HRA was conducted using the highest soil vapour and groundwater concentrations, which were typically obtained in the SEC. GHD found that there were no unacceptable risks posed to on-site or off-site workers under the current site configuration. However, risks to human health may exist for underground maintenance workers, or if the site is redeveloped. These potential risks should be managed with an SMP. The Auditor considers that additional investigation is required, especially to characterise the risks to off-site workers.

Recommended Measures

The objectives and scope of the Audit in compliance with EPA CUN the Auditor is to recommend measures to reduce and manage risks to beneficial uses at acceptable levels (and also cognisant of the Auditor's discussion of the principles and "drivers" for remediation). The Auditor's recommendations and proposed timelines are as follows (these have been grouped by aspect rather than the numerical order in which they occur in the text of the report):

Table 3: Recommended Measures and Implementation Timetable

Aspect	Recommendation		Recommended Completion Timetable
General Site Investigations			
Site Plan	7	An accurate site plan be constructed and used for future reporting requirements. The site plan should be constructed by a licensed surveyor and include the location of the site boundary, roads, buildings, services and permanent sample locations.	4 Months
Hydraulic Control – Groundwater Flow Directions	28	On and offsite services be investigated to determine if they are leaking and effecting the groundwater flow pattern and contaminant transport	6 months
Groundwater Resources - Unregistered Bore Search	31	Conduct a search for unregistered bores (field event) downgradient of the site – and door knocking (if required).	6 months
Groundwater Resources – Supply Well Information	32	Seek to obtain groundwater extraction and water supply well information for the above-noted wells.	6 months
Mounding and TDS variations	30	Investigate the source(s) of the variation of TDS to show whether the site groundwater is actually other than Segment A1. This includes the areas of mounding noted at the site in the vicinity of monitoring wells MW3, MW12 and MW18.	6 months
Soil Vapour Monitoring			
Soil Vapour Data Gaps	3	Areas with impacted soil vapours (i.e. the SEC and the Former Drum Storage Area, sump in the Poisons Store, and the Area 2 USTs) require further delineation using field screening with temporary locations and analytical laboratory data at permanent monitoring locations. The Auditor notes that the preliminary soil gas survey data are indicative of surficial releases, which should be further investigated.	6 Months
Soil Vapour – Monitoring Network	20	The Auditor recommends the inclusion of a revised soil vapour monitoring network to enable sufficient resolution in line with the on-site and off-site risks posed by the migration of volatile site contaminants. This should be part of an ongoing program in association with groundwater monitoring that takes into account the weathering from source zones over time and preferential pathways with high concentrations (i.e. mass flux).	Commence immediately to develop the monitoring network plan for auditor endorsement and implement within six months.
Soil Vapour Monitoring Event	54	An additional vapour monitoring event (soil vapour and indoor air) should be scheduled as soon as practicable to confirm the current data.	6 Months

Aspect	Recommendation		Recommended Completion Timetable
Health Risk Assessment			
Soil Vapour – Intrusion Risk	21	Further consideration needs to be given to possible vapour intrusion risk to persons occupying buildings off-site (and potentially on-site depending on future investigation results) including incorporation of the recommendation for an enhanced soil vapour monitoring network.	5 Months
Human Health Risk Assessment – Short-Term	4	A detailed assessment of human health risks associated with the current use of the site and areas immediately to the south and possible future use complying with the current land use zone is required using the current data and the data to be gained in further investigations (on- and off-site risks). This must lead into OHS management measures in a Site Management Plan (SMP) for the purpose of avoiding and managing unacceptable risks due to contamination (Commence immediately and update based on additional relevant data).	9 Months
Human Health Risk Assessment – Longer-Term	57	The human health risk assessment should be redesigned and repeated to include all relevant exposure pathways across the site (and those with identified and potential site-related impacts off-site) following adequate delineation and update of the CSM.	Following delineation (upon endorsement by Environmental Auditor).
Risk Modelling	58	Additional risk modelling should rely on the existing soil vapour data and those gleaned from monitoring of the revised network, such that the soil source as well as the groundwater source is included in the modelling.	Commence within 3 months, report with risk assessment (item 4)
Risk Profile – Changing Over Time	59	An assessment of how the risk profile may change with time should be conducted (including partitioning effects such as effective solubilities).	Commence within 3 months, report with risk assessment (item 4)

Aspect		Recommendation	Recommended Completion Timetable
Risk to Off-Site Workers	60	The risks posed to off-site workers require immediate re-assessment. This includes the collection of additional data as recommended above and additional risk modelling.	Commence within 3 months, report with risk assessment (item 4)
Source Zone Investigation			
Source Zones - Investigation	1	Identify potential source zones (Former Drum Storage Area, North Central ASTs, sump in the Poisons Store, and others). Conduct targeted source zone investigations in the northern half of the site to confirm whether there are ongoing sources of contamination in these areas (nature and extents), and if so what management strategies are required.	12 Months
Delineation of VCH Impacts related to Source Zones	38	Investigate other sources of VCH impacts in the subsurface (including areas with upgradient impacts such as the northern half of the site) by soil, soil vapour and groundwater investigations (including installation of wells in the revised monitoring well network).	12 Months
Groundwater Data Gaps	2	Groundwater data gaps in the Northern and Central Areas are to be investigated to delineate sufficiently and to assist in identifying whether there are ongoing sources of contamination in these areas.	12 Months
Revised Monitoring Well Network			
Permanent Monitoring Well Network – Plan and Implementation	11	Develop a plan for and install a revised permanent monitoring network both on- and off-site to evaluate the geology and hydrogeology of the deeper portions of the BGA and into the FFA, as well as the hydraulic connection between these units, assess groundwater flow and dissolved phase contaminant migration within the aquifer(s). Designed meet the intended use and goals to be achieved (delineation and assessing risk).	9 Months
Conceptual Site Model – Delineation of Plumes	33	Use the CSM presented by the Auditor to develop a revised monitoring well network, which has been recommended by the Auditor, to delineate the groundwater plume(s).	9 Months
Delineation of Chlorinated Solvent Impacts	35	Improve the density and quality of the monitoring well network as indicated in Recommendation 11 to gain data that are suitable to be used to evaluate the depth of impact of chlorinated solvents on-site and off-site.	12 Months
Degradation of Chlorinated Solvents - Data	48	Improve the density and quality of the monitoring well network as indicated in Recommendation 11 to gain data that are suitable to be used to evaluate degradation of chlorinated solvents on-site and off-site – including aquifer 'type' and plume stability.	12 Months

Aspect		Recommendation	Recommended Completion Timetable
Risks posed by Groundwater Impacts	56	The revised monitoring network recommended by the Auditor should include locations that are installed to characterise the potential risks at beyond the SEC (Former Drum Storage Area and the Office) and to provide additional information on the risks posed to offsite receptors.	Following endorsement of the plan for the network by Environmental Auditor.
Mass Flux Approach for Monitoring	22	The Auditor recommends a mass flux plane approach for management of contaminant transport (soil vapour and groundwater). This could be accomplished using a mass flux plane approach if sufficient access becomes available down-gradient of the source or a numerical modelling approach matched to field data. The flux plane approach can include monitoring of contaminants across transects perpendicular and parallel to flow. This may require transects off-site, as possible; and will need to take into consideration the implications for monitoring near the source zones. Alternatively the modelling approach would match the groundwater flow behaviour and contaminant behaviour with calibration accomplished by adjusting source parameters to match contaminant concentrations in the monitoring wells	Commence immediately to develop the monitoring network plan for auditor endorsement and implement within 12 months.
Mass Flux Approach - Transects	23	Mass flux approach is to include: Transects (T1 to T4) with both soil vapour and groundwater depth-discrete locations. T1 (full east-west profile) south of the Former Drum Storage Area. T2 (full east-west profile) north of the SEC. T3 from Bay Road to Philip Street. T4 along the lower boundary of SEC (using telescopic methods) to identify secondary sources. Following installation of deeper wells to evaluate the continuity and potential for the silty clay layer at 20 mBGS to limit vertical migration of DNAPL.	12 Months
Mass Flux - Transects	53	Evaluate the use of mass flux from source areas (soil vapour and groundwater) and along the groundwater flow path of plumes using the four transects recommended by the Auditor (soil vapour and groundwater depth-discrete sampling locations).	12 Months
Permanent Monitoring Well Network - Requirements	12	This revised permanent monitoring network is to include the shallow, intermediate and deep portions of the aquifer(s). Based on this recommendation and the Auditor's review of site data, the remaining wells would consist of MW19, MW20, MW22, MW24A, MW24B, MW24C, and MW25 through MW42. As many of these remaining wells have water levels above the well screen, additional wells across the water table would be required (in addition to deeper wells within the aquifer).	12 Months

Aspect	Recommendation		Recommended Completion Timetable
Continuous Low Permeability Unit	13	Obtain sufficient evidence (geological, hydrogeological and geochemical) for the presence of a locally significant low permeability unit that would limit the hydraulic connection between these units (and potentially DNAPL migration).	During installation of monitoring wells, within 12 months
Monitoring Well Network – Shallow Wells	14	As many of the remaining wells have water levels above the well screen, additional wells across the water table would be required (in addition to deeper wells within the aquifer).	Ongoing during planning for well installation
Monitoring Well Network - DNAPL	15	Construction of monitoring wells will need to include consideration of presence of DNAPLs (refer to Figure 4-3) including: well location, well screening (elevation, length and slot size), the filter pack (potentially including fine mesh wire) and seal through fill layers); this is to identify DNAPL migration into the well, decrease well artefacts and provide samples representative of the aquifer. As noted above, the Auditor considers that deeper migration of DNAPL(s) at the site is likely to have occurred. Therefore, new wells would need to incorporate this issue.	Ongoing during planning for well installation
Aquifer Media Sampling	16	Collect aquifer media (soil) samples for organic carbon content, density, grain size, and other relevant physical parameters at boreholes for wells advanced in the BGA and FFA.	During installation of the revised monitoring network, within 12 months
Precautions in Source Zones - DNAPLs	36	Use appropriate pre-cautions during DNAPL investigations, including the installation of sumps at the bases of monitoring wells, where needed.	Ongoing during well installations.
DNAPL Observation - Source Zones	37	Use the above-noted methods for observing the presence of DNAPL including Flute [®] liners during installation of monitoring wells.	Ongoing during borehole advancement (for deeper soil and/or groundwater characterisation).
Assessment of Aquifer Properties			
Down-hole Geophysics	8	Conduct down-hole geophysics on any newly installed wells (refer to Auditor recommendations below) in the BGA and FFA and use this information to inform the revised CSM.	15 Months
Hydraulic Aquifer Response Testing	18	Conduct groundwater pumping tests and slug tests in the BGA and FFA to evaluate the hydraulic conductivity (K), transmissivity (T), and hydraulic connections of these aquifers.	15 Months.

Aspect	Recommendation		Recommended Completion Timetable
Groundwater Monitoring			
In-Situ Monitoring	24	As well and sampling artefacts have affected data quality at this site, in-situ measurement devices to monitor water levels and geochemistry data are required to be part of the program developed within the GQMP. This should include down-hole data loggers with water level, temperature, conductance, DO and redox (in the sandy clay and lower sandy portions of the aquifer(s) impacted by plumes and one upgradient location).	Commencing within six months
Hydraulic Control – Groundwater Flow Directions	26	Groundwater hydraulic control on-site and off-site is to be gained through the revised monitoring network and quarterly SWL monitoring (i.e. gauging) including downhole measurements of field parameters to assist in characterisation of groundwater quality.	Commencing within six months
Quarterly Static Water Level Monitoring	29	Use the quarterly water level monitoring (i.e. gauging) to evaluate the presence and nature of vertical gradients within the upper clay unit and the BGA, as well as between the BGA and FFA.	Commence immediately on the remaining wells and then ongoing for the revised network
Groundwater Monitoring Events (GMEs)	55	The revised monitoring network recommended by the Auditor should be initiated with annual monitoring and reporting to confirm that the risk profile of the site has not changed.	15 Months
In-Situ Monitoring	25	As matrix interference has affected data quality, the SMP should consider alternative sampling methods to reduce the LORs to acceptable levels. Non-detection levels (LORs) should be discussed and presented in tables and figures.	Next GME and ongoing
Elevated Limits of Reporting	5	Ensure that the data quality issues with elevated LORs are addressed and that the LOR values are plotted on summary figures and provided in summary tables, such that there is more transparency in regard to data quality and delineation resolution.	Next GME and ongoing
Addressing Matrix Interference via Partitioning	6	Collect groundwater samples for submission to the analytical laboratory, which enable partitioning to air and soil (depending upon the physical properties of the contaminants), with the intent to address the matrix interference causing elevated LORs. For example, collect half full sample jars for gas extraction at the laboratory and injection into the GC. This is to assist identification of highly volatile compounds that are vulnerable to negative sampling bias such as VC.	Next GME
Scan Sampling	17	Evaluate the use of methods such as ‘scan sampling’ (sampling during groundwater extraction) to enhance detection of chlorinated solvent plumes.	Following installation of the revised monitoring network, within 15 months.

Aspect	Recommendation		Recommended Completion Timetable
Degradation of Chlorinated Solvents – Indicators	51	Analyse groundwater samples for alcohols and fatty acids (indicators of aerobic oxidation - cometabolic) and use this as another line of evidence for the occurrence of degradation.	Following installation of the revised, monitoring network, within 15 months
Well Decommissioning			
Well Decommissioning	9	Decommission the following wells: multilevel wells (MW6 through MW17), long-screened wells MW3, MW4, MW5, MW21 and MW23, wells impacted by leakage (e.g. MW18), low recovery wells (e.g. MW2), any wells where the seal is not sufficiently protective, and finally any wells within source areas where dissolution of the PVC casing is possible (e.g. the SEC).	12 Months
Well Decommissioning	10	The replacement of wells with quality issues located in areas where high concentrations of chlorinated solvents have been detected (historic and recent) is recommended.	12 Months
Groundwater Modelling			
3D Numerical Groundwater Flow Model	27	Based on the CSM, develop a three-dimensional (3D) groundwater flow model (with water mass balance) as the basis of the flow and transport model, using suitable existing data and recommended quarterly monitoring data and the hydraulic response data. Conduct both steady-state and transient calibration for this model.	18 Months
3D Numerical Fate and Transport Model	46	Evaluate the potential for groundwater VCH impacts to reach and be captured by groundwater extraction in the local area using 3D numerical fate and transport modeling (using the recommended 3D groundwater flow model as the foundation for this work).	18 Months
Site Management Plan			
Current SMP - Implementation	61	The SMP for on-site intrusive workers, recommended by GHD, should be implemented within one month of the date of this report. The SMP shall include measures to manage odours, acute and lifetime health risks, and should be revised as the CSM is updated.	2 Months, reassessed and revised (if required) within 12 months

Aspect	Recommendation		Recommended Completion Timetable
Interim Action	41	Interim action (within six months) is recommended to: - keep the section of the site along the southern boundary in the SEC accessible to address interim measures and potentially longer-term remedial measures - cover the grassed area in the SEC to limit recharge through the uncovered and former UST excavation areas - install interim remedial measures to limit the off-site migration of contaminants in the vadose zone and below the water table (i.e. soil vapour and groundwater plumes).	To be completed within six months.
Monitoring Well Network - SMP	19	This revised monitoring network is to form part of an SMP, and is to be maintained until cessation of monitoring is approved by the EPA. The current SMP shall be: revised to include the revised network, follow EPA guidance, and be endorsed by an EPA appointed Environmental Auditor. In addition, the ongoing SMP is to be revised as further information comes to hand from studies and monitoring recommended in this audit report.	18 Months
Ongoing SMP – Long-Term Management Plan	45	Implement a long-term management plan for the site – e.g. an ongoing SMP for the current site built environment, with revisions as needed to take into account modifications and/or redevelopment.	18 Months
Evaluation and Reporting			
Conceptual Site Model - Ongoing	34	Use the CSM to develop future investigation plans, and revise and update this CSM as relevant information is gained during these future investigations.	Ongoing
Data Evaluation of DNAPL Presence	39	Conduct and report on a detailed evaluation of the presence of DNAPLs using the lines of evidence provided above.	18 Months
Shallow VCH Plumes	47	Evaluate/investigate the potential for shallow VCH plumes to intersect PHC contamination off-site in the surrounding commercial/industrial area downgradient of the site.	18 Months
Degradation of Chlorinated Solvents – Degradation Pathways	49	Provide an updated discussion on the potential degradation pathways (biotic and abiotic products) for the VCHs. Include figures showing the pathways and peer reviewed references. This is to be used for site characterisation, groundwater fate and transport modelling, risk assessment, remediation and ongoing management.	6 Months
Intrinsic Capacity of the Aquifer System	50	Further evaluate the importance of the intrinsic capacity of the aquifer system to degrade the volatile contaminants – short-term and longer-term.	15 Months

Aspect	Recommendation		Recommended Completion Timetable
Degradation of Chlorinated Solvents – Microbial Processes	52	Investigate the microbial processes (including microcosm studies) to assist in the understanding of biological degradation – to rule out or confirm the importance of intrinsic aquifer capability to degrade these contaminants (with respect to management of aquifer pollution – beneficial use).	15 Months
Remediation Feasibility Study			
RFS – Short-Term Options	40	A Remediation Feasibility Study (RFS) would be required to evaluate short-term options for interim measures (beyond those recommended by the Auditor).	To be completed within four months.
Revised RFS – Long-Term Options	42	The Auditor considers that a revised RFS would be required to evaluate the long-term clean up options and identify suitable and preferred approach. This approach will need to also contemplate the administrative tools available and effective to manage polluted groundwater to protect future groundwater users from intercepting the plume.	21 Months
Clean Up Plan			
Clean Up Plan	43	The Auditor recommends that the preparation of a Clean Up Plan subsequent to the achievement of adequate characterisation (including geochemical data and groundwater flow) and delineation.	24 Months
CUP in SEC – Consideration of Volatiles	44	The Auditor recommends that the Clean Up Plan for the SEC (e.g. remedial excavation) consider the broad list of volatile detections in soil (TPH C ₆ -C ₉ , chlorobenzene, PCE, TCE, cDCE, 1,1-DCE, 1,1,1-TCA and 1,1-DCA) and those detected in soil vapour including VC.	24 Months

Read in Conjunction with Audit Report

While this Executive Summary has endeavoured to accurately summarise the key points of the Audit Report, the latter shall take precedence and the Executive Summary must be read in conjunction with the full report of the Auditor (Lane Piper document ref. 207214Report01.2.docx).

About this Environmental Audit Report

While this Environmental Audit has been undertaken in accordance with the EPA Auditor Guidelines and current industry practice, there may be some limitations on the meaning and use of this report. The reader is advised to read this report in conjunction with the attached document *About Site Environmental Audits and Reports* (Appendix N).

In September 2007 EPA issues new guidance to Auditors (Publication 1147) which included the need to insert an information document in all audit reports. This document is titled *Information Regarding Environmental Audit Reports* and is included as Appendix M of this report.

Anthony P. Lane
Environmental Auditor
(Appointed pursuant to the *Environment Protection Act 1970*)