

HAZARDOUS WASTES AND
CONTAMINATED SITES SECTION

15 MAY 1997

Mobil Oil Australia Limited

**Health Risk Assessment,
Former Fuel Depot, Corner
Dutton Street East and
Salisbury Street Murgon
Queensland**

April, 1997

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Executive Summary

Mobil Oil Australia commissioned Rust PPK Pty Ltd (Rust PPK) to conduct a health risk assessment (HRA) and recommend risk based corrective actions (RBCA) on data obtained at the former fuel depot located on the corner of Dutton Street East and Salisbury Street Murgon, Queensland.

Site investigations undertaken indicate that the site has been used for the storage and distribution of fuel products since 1954. Previous site facilities included;

- ▶ a covered drum storage platform with adjoining office;
- ▶ three fuel/oil transfer stations (located on the drum platform);
- ▶ four ASTs within an earthen bund wall
- ▶ one AST on a cradle located to the east of the drum store;
- ▶ a rail unloading facility
- ▶ an interceptor located north west of the AST farm;
- ▶ a main pumping station with above ground product lines; and
- ▶ an in-ground hoist located adjacent to the rail unloading facility.

Previous site investigations have identified elevated concentrations of xylene and TPH concentrations in soil over various areas of the site.

The assessment performed on the site is consistent with American Society for Testing and Materials Standard E1739-95.

The intended future use of the site has been designated as commercial. An application to obtain a restricted classification based on future commercial activities on site will be made to the Queensland Department of Environment. Information contained in the HRA will be used to support the application to obtain a restricted classification for commercial use.

Completed exposure pathways identified and assessed include:

- ▶ The exposure of on-site commercial workers to vapours and particulates emanating from the surface and subsurface soil to ambient air.
- ▶ The exposure of onsite commercial workers to vapours emanating from the surface and subsurface soil to indoor air within buildings.

For all completed pathways site specific target levels (SSTL) were derived for contaminants which exceeded the DoE investigation criteria. The target risk levels adopted in this assessment were as follows:

- ▶ Increased lifetime cancer risk of 1×10^{-5} ,
- ▶ Target hazard index of 1.

Groundwater was not identified during exploratory works onsite to a depth of 25 metres and therefore has been dismissed as a potential medium for the transport of contaminants off-site.

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Site specific target levels for surface and subsoil concentrations of xylene were calculated for all completed pathways. Target levels for benzene, toluene, and ethylbenzene were not calculated as the levels detected were below recognised investigation threshold levels. The SSTL for xylene was at a residual level ($> Res$) indicating that the SSTL is at extremely high levels and therefore the current concentration of xylene present within subsurface soil on the site does not represent a health or environmental hazard.

The applicable SSTL calculated for the individual pathways therefore, is in excess of the applicable representative site concentrations for xylene in both the surface and subsurface soils (18 mg/Kg and 56 mg/Kg respectively). Minimal risk is therefore presented due to the presence of xylene within the subsurface soil.

Elevated levels of TPH remain within the contaminated soil plume within the soil matrix at levels ranging from 159mg/Kg to 8000mg/Kg. The potential for the off-site migration of TPH through the action of groundwater is considered remote due the absence of groundwater during site drilling works and the low permeability of the site due to the high clay content within material located on site which would serve to limit surface water infiltration.

The potential for adverse health impacts associated with TPH at depth on the site is considered low. Volatiles within the soil structure (xylene) were modelled using completed exposure pathways and the potential risks identified were well within USEPA guidelines. Exposure pathways for TPH at depth are limited and pose minimal hazard based on the intended future use of the site.

Within the limits of the site investigation scope of works, and taking into consideration the conservatism of the modelling, it is considered that the degree of petroleum hydrocarbon impact identified on the site is unlikely to cause a risk to human health above the "acceptable" target risk/hazard values.

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Abbreviations Commonly Used in Health Risk Assessment

ACRONYM	DEFINITION
ACGIH	American Conference of Governmental Industrial Hygienist
APOC	Alternate Point Of Compliance
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BGS	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAS	Chemical Abstracts Service
COC	Constituent(s) Of Concern
CRF	Constituent Reduction Factor
EPA	Environmental Protection Authority
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HRA	Health Risk Assessment
IRIS	Integrated Risk Information System (EPA)
LMS	Linearised Multistage Model (EPA)
MCL(s)	Maximum Constituent Level(s)
MLE	Most Likely Exposure
NAF	Natural Attenuation Factor
NAPL	Non-Aqueous Phase Liquids
NTIS	National Technical Information Service
OSHA	Occupational Safety & Health Administration
PELs	Permissible Exposure Limits
POC	Point Of Compliance
POE	Point Of Exposure
RBCA	Risk-Based Corrective Action
RBSL(s)	Risk-Based Screening Level(s)
RCS	Reasonable Case Scenario
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RWCS	Reasonable Worst Case Scenario
SF	Slope Factor
SSTL(s)	Site Specific Target Level(s)
TLV	Threshold Limit Value
UCL	Upper Confidence Limit

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1. Introduction

Mobil Oil Australia commissioned Rust PPK Pty Ltd (Rust PPK) to conduct a Health Risk Assessment and recommend risk based corrective actions (RBCA) on data obtained at the former fuel depot located on the corner of Dutton Street East and Salisbury Street Murgon, Queensland.

1.1 Background Information

Site investigations undertaken indicate that the site has been used for the storage and distribution of fuel products since 1954. Prior to this the site was used as grazing and pasture land. The site has been recorded as a 'probable' site on the Queensland Contaminated Sites Register.

The site has a slight 3-5° gradient to the west, towards Murgon Creek located approximately 50 metres from the site. Murgon Creek is a perennial stream and is the nearest sensitive ecological receiver to the site.

Surrounding land uses include two operational fuel depots to the east and north east; vacant railway reserve and grazing land to the west; a railway line and residential land to the south and a commercial storage garage and recycling transfer facility to the north.

The site is underlain by weathered volcanic material which essentially comprises banded shale. The bedrock extends to a depth of approximately 6 metres where a layer of low permeability unweathered tuff is first encountered.

Groundwater wells were drilled at two locations to a maximum depth of 25 metres. Groundwater was not present at this depth and investigations into the regional hydrogeology of the area indicated potential groundwater at 45 metres BGL.

Discussion with the Department of Natural Resources identified that the groundwater is suitable for most purposes but marginal for human consumption, with a flow in the region of 0.5-1.5 litres/second.

The approximate boundaries of the site are shown in Appendix A Site Layout.

Prior to the commencement of demolition activities the site comprised a typical fuel depot facility which included:

- ▶ a covered drum storage platform with adjoining office;
- ▶ three fuel/oil transfer stations (located on the drum platform);
- ▶ four ASTs within an earthen bund wall
- ▶ one AST on a cradle located to the east of the drum store;
- ▶ a rail unloading facility
- ▶ an interceptor located north west of the AST farm;
- ▶ a main pumping station with above ground product lines; and
- ▶ an in-ground hoist located adjacent to the rail unloading facility.

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Site investigation works conducted between September and December 1996 revealed that contaminants were present in the soil at concentrations in excess of the DoE health based investigation guidelines. A summary of the results follows:

- ▶ September 1996: 67 samples were analysed for TPH, BTEX and lead. TPH concentrations in 16 samples exceeded DoE investigation guidelines and 11 samples exceeded total TPH levels of 1000ppm. The maximum TPH concentration was 8000 mg/kg. Concentrations of xylene were obtained in two samples, with a maximum concentration of 54 mg/kg.
- ▶ 1 November 1996: Six validation samples were taken from the walls and floor of the interceptor excavation, one from each of its four walls and two from its base. TPH concentrations in two samples exceeded DoE investigation guidelines. The maximum TPH concentration was 638 mg/kg.
- ▶ 26-30 November 1996: Further excavation was undertaken with 37 soil samples being taken for validation purposes. Of these, 9 samples contained TPH concentrations above DoE investigation threshold levels with a maximum concentration of 3590 mg/kg.

1.2 Methodology

The Fate and transport modelling and health risk assessment (HRA) performed on the site data is consistent with American Society for Testing and Materials (ASTM) Standard E1739-95⁽⁸⁾. The Risk Based Correction Action (RBCA) process involves the characterisation of impacted sites in terms of sources, transport mechanisms and receptors, to define the extent of human or environmental exposure to harmful levels of compounds identified at the site and to define remediation goals should they be required. The process characterises chronic risks/hazards, and assumes that acute hazards have been addressed. ASTM E1739-95 allows a three-tiered approach, dependent on the site specific information available and the fate and transport/HRA modelling effort required:

Tier 1: The Tier 1 process involves comparison of site constituent concentrations to generic risk based screening levels (RBSLs) at the source zone only (ie on-site) derived from standard exposure equations and reasonable maximum exposure (RME) estimations consistent with US EPA guidelines. Where site constituent concentrations exceed the RBSLs, remediation actions can be implemented, or a Tier 2 analysis performed to provide further evaluation.

Tier 2: The Tier 2 process involves the development of Site Specific Target Levels (SSTLs) using site specific data and analytical models consistent with US EPA practices. SSTLs differ from RBSLs as follows:

- ▶ Site specific data is used
- ▶ Human exposure can be modelled at a point of exposure (POE) remote from the source zone (not applicable in this assessment)

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- The effects of natural attenuation during transport can be considered

Where SSTLs are exceeded, remedial actions may be taken. Alternatively, for certain sites, a more detailed Tier 3 analysis may be required.

Tier 3: The Tier 3 process again involves the development of SSTLs, but utilises more sophisticated data analysis and possibly numerical fate and transport modelling.

In the HRA described herein, a computer based model (Groundwater Services Inc. RBCA Tier 2 Tool Kit Version 1.0) has been utilised to perform the Tier 2 analysis of the site.

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2. Health Risk Assessment

2.1 Data Evaluation

Site specific data used in this assessment is outlined below. Where no site specific information was available, default values consistent with ASTM E1739-95 and RBCA guidance notes (8,9) have been used.

2.1.1 Constituents of Concern

Constituents of Concern (COC) identified at the site are consistent with a petrochemical source such as a fuel depot or service station facility. The indicator COC used in this assessment was xylene. Total levels of TPH in exceedance of the Queensland Department of Environment guidelines were identified during the site investigation and are documented within the Rust PPK site assessment report dated April 1997. Modelling of the TPH fractions is not possible using the RBCA model and therefore a qualitative assessment has been undertaken using geological and groundwater information obtained during site investigations and documented health based threshold levels.

Site maps indicating the areas impacted by hydrocarbon contamination and the subject of this assessment have been included in Appendix G. The contaminant plume has been estimated based on the results of soil samples taken over the entire site including TPH and xylene which represents a conservative scenario for the site as xylene was not distributed evenly within the contaminated areas.

The source zone concentrations for maximum soil concentrations of xylene have been calculated using results obtained from the following sampling locations:

- ▶ Surface Soil (<1 metre BGS) - SS41;1;1.0
- ▶ Subsurface Soil (> 1 metre BGS) - SS29;1;1.2

Sample results have been compiled into mean concentrations and maximum concentration for site specific contaminant levels and are contained in Table 1. Where limited data has been collected and the statistical value of the data range is limited, the maximum value has been used to provide a conservative analysis.

Estimates for surface soil concentrations of xylene (<1 metre BGL) have been made using the worst case result obtained from SS41 at 1.0 metre.(18mg/kg)

Subsurface soil concentrations(> 1 metre BGL) of xylene have been based on the worst case concentration obtained in SS29 at 1.2 metres BGL.(54mg/kg)

TPH values used in the qualitative risk assessment have been based on the sample results which exceeded the Department of Environment guidelines for TPH for all samples taken on the site. A total of 30 out of a total of one hundred and ten samples contained levels of TPH which exceeded the DoE guideline levels. The results have been reported within Table 2.

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Table 1 - RBCA Source Zone Concentrations

Sample ID	Sample Date	Depth (mBGL)	Benzene	Toluene	Ethyl Benzene	Total Xylene
SS41;1;1.0	16/10/96	1.0	-	-	-	18
SS29;1;1.2	16/10/96	1.2	-	-	-	54
SS34;1;1.2	16/10/96	1.2	-	-	-	36
Maximum		-	-	-	-	54
Mean		-	-	-	-	36

Note: All Concentrations in mg/kg

Table 2 - Elevated Site Investigation Results (Total TPH)

Sample ID	1996	Strata	Depth (mBGL)	TPH C ₆ -C ₉	TPH C ₁₀ -C ₁₄	TPH C ₁₅ -C ₂₈	TPH C ₂₉ -C ₃₆	Total TPH
SS04;1;0.5	19/10		0.5	<2	52	3850	432	4334
SS41;1;1.0	19/10		1.0	29	2200	3400	<100	5629
SS42;1;1.0	19/10		1.0	<20	1200	6800	<100	8000
TP2;1;1.0	19/10		1.0	<20	380	420	<200	800
SS60;1;0.5	30/11		0.5	92	585	774	<100	1451
SP2;1;0.1	30/11		0.1	2	474	2600	270	3346
SP2;2;0.1	30/11	Surface	0.1	2	435	3530	206	4173
SS44;1;1.0	19/10	soil	1.0	<20	690	2300	<100	2990
SS45;1;1.0	19/10	< 1m	1.0	<20	760	1600	<100	2360
SS10;2;4.0	19/10	Sub	4.0	<2	36	251	<100	387
SS11;2;4.0	19/10	Surface	4.0	<2	370	906	<100	1276
SS12;1;2.0	19/10	Soil	2.0	8	2430	5050	<100	7488
SS14;1;4.5	19/10	> 1m	4.5	8	328	554	<100	885
SS29;1;1.2	19/10		1.2	89	4200	7901	<100	5079
SS29;1;1.2*	19/10		1.2	100	1540	344	<100	1984
SS34;1;1.2	19/10		1.2	58	2100	920	<100	3078
SS39;1;3.4	19/10		3.4	<20	220	450	<100	670
SS43;1;1.0	19/10		1.0	<20	470	460	<100	920
SS45;1;1.2	19/10		1.0	47	1290	2780	195	4312
SS14B;1;5.5	1/11		5.5	<2	105	251	<100	356
SS14B;2;5.5	1/11		5.5	<2	185	453	<100	638
SS50;2;2.0	30/11		2.0	25	134	<100	<100	159
SS52;1;2.5	30/11		2.5	7	169	311	<100	487
SS53;2;4.3	30/11		4.3	20	929	2060	<100	3009
SS56;1;2.0	30/11		2.0	<20	400	1300	<100	1700
SS56;2;2.0	30/11		2.0	9	203	530	<100	742
SS57;1;4.0	30/11		4.0	60	1100	2430	<100	3590
SS58;3;5.5	30/11		5.5	2	125	362	<100	489
SS60;2;2.5	30/11		2.5	43	422	489	<100	954
SS65;1;1.2	30/11		1.2	59	813	1260	<100	2132
Maximum								8000
Mean								2447
Adopted DoE Threshold				100	100	1000	1000	

* Duplicate Sample

Note: All Concentrations in mg/kg

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2.1.2 Site Specific Soil Data

Soil Parameters

Soil porosities reported for tuff, shale and sandstone materials range from 0.06-0.41⁽¹⁰⁾. A conservative value of 0.39 has been assumed based on site observations.

The depth of estimated surficial soil has been estimated as 1.0 metre. Surficial soil is the area of soil located directly below ground level and which may interact directly with surface wind and water.

The depth to the uppermost affected subsurface soil has been estimated as 1.0 metre. The depth of the soil contamination plume has been estimated based on soil sample results as 4.5 metres.

The dimensions of the area impacted by contamination have been calculated and a surface area of 610 m² used to define the lateral extent of the plume. Soil density has been estimated as 1.7g/cm³ and soil pH at 6.5.

The length of affected soil parallel to the assumed wind direction (south west) has been calculated as 39 metres and is used to determine the potential impacts associated with volatilisation produced via surface wind action on the plume.

Volumetric water contents of the vadose zone and foundation cracks were assumed to be 0.12 and 0.12 respectively. Volumetric air contents of the vadose zone and foundation cracks were assumed to be 0.27, and 0.27 respectively. These were based on the porosity figure of 0.39 and default ratios for water/air contents.

Air Parameters

Conservative default settings⁽⁹⁾ specified within the RBCA program have been used in calculating the potential impacts associated with surface soils and subsurface volatilisation from subsurface soils. The settings are specified as follows;

The air mixing height associated with the representative breathing zone above ground level has been estimated at 2 metres. The ambient air velocity in the mixing zone is estimated at 2.25 metres per second and the particulate aerial emission rate from soil is estimated at 2.17×10^{-10} g/cm²/s.

2.1.3 Site Specific Groundwater Data

Photoionisation Detector (PID) headspace results obtained during the drilling of wells to investigate site groundwater revealed BTEX concentrations at marginal levels below 100ppm down to 25 metres. Bore hole one was located upgradient from the identified contaminant plume. Bore hole two was located downgradient from the contaminant plume near the outer perimeter of the site.

Groundwater was not identified within the two test bores drilled on the site. Due to the nature of the geology on the site it has been concluded that groundwater is absent from the site.

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Infiltration of water ie precipitation is considered the only source of potential groundwater on the site and the rate of infiltration is considered to be low due to the volcanic nature of the substrata and clay material on the site.

2.2 Exposure Assessment

At the time of the assessment potential hydrocarbon sources such as the underground storage tanks had been removed from the site. As a result the contaminant source has been removed and the process of natural attenuation is assumed to have commenced on this site.

Allowance has not been made for the possible migration of petroleum hydrocarbons along preferential pathways such as those provided by underground cables and services. This is considered unlikely due to the isolated nature of the site ie no identified preferential pathways, and the absence of groundwater on the site to act as a mode of transport.

For the source zone, two exposure scenarios were considered ie a reasonable case scenario (RCS) based on current land usage, proposed use of the site for commercial purposes and existing facilities in the area and a reasonable worst case scenario (RWCS) based on the use of the site for residential purposes and where relevant, potential beneficial use of groundwater on adjacent properties. In this assessment, the use of the site for residential purposes has been used to assess potential risks posed to a nearby residential property identified as an exposure point. Modelling was undertaken for on-site residential use on the assumption that should the assessment reveal acceptable risk levels for onsite residential use then offsite residential activities would be within acceptable risk guidelines.

Potential beneficial use of groundwater on adjacent properties is usually considered within the worst case scenario, however due to the absence of groundwater in the area was not included within this assessment.

2.2.1 Reasonable Case Scenario Exposure Pathways

The following complete exposure pathways have been considered within this assessment:

- ▶ The exposure of on-site commercial workers to vapours and particulates emanating from the surface and subsurface soil to ambient air.
- ▶ The exposure of onsite commercial workers to vapours emanating from the surface and subsurface soil to indoor air within buildings.

The following exposure pathways were considered incomplete and were not included in the assessment:

- ▶ Direct ingestion or dermal contact with impacted groundwater due to the absence of groundwater on the site.

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- ▶ Construction workers on-site have not been considered as receptors. It is assumed that construction staff would be made aware of potential hazards due to the "restricted" nature of the site and would take precautionary measures.
- ▶ Surface water exposure pathways and the leaching of subsurface soils to groundwater due to the absence of groundwater on the site and the minimal potential for contaminants to be transported from the site

2.2.2 Reasonable Worst Case Exposure Pathways

For the reasonable worst case scenario, the use of the site for residential purposes was assumed and the existing pathways remodelled.

The following complete exposure pathways have been considered within this assessment:

- ▶ The exposure of on-site residential inhabitants to vapours and particulates emanating from the surface and subsurface soil to ambient air.
- ▶ The exposure of on-site residential inhabitants to vapours emanating from the surface and subsurface soil to indoor air within buildings.
- ▶ The exposure of on-site residential inhabitants via soil ingestion and dermal contact with surface soils.

The following exposure pathways were considered incomplete and were not included in the assessment:

- ▶ Direct ingestion or dermal contact with impacted groundwater due to the absence of groundwater on the site.
- ▶ Construction workers on-site have not been considered as receptors. It was assumed that construction staff would be made aware of potential hazards due to the "restricted" nature of the site and would take precautionary measures.
- ▶ Surface water exposure pathways and the leaching of subsurface soils to groundwater due to the absence of groundwater on the site and the minimal potential for contaminants to be transported from the site.

2.2.3 Exposure Factors

For commercial workers exposure factors consistent with USEPA or American Industrial Health Council guidance and where appropriate, Australian National Environmental Health Forum⁽¹²⁾ have been used in this assessment.

Exposure factors differing from USEPA default settings for RBCA have been identified in Table 3.

Impacts on the Murgon Creek, located an estimated 50 metres downgradient from the site have been indirectly assessed through the use of test pits and investigations into potential contaminant transportation medium such as groundwater.

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Table 3 - Exposure Factors

Exposure Parameter	Parameter	Factor
Averaging time for non-carcinogens	Adult	70 years
Averaging time for non-carcinogens	Commercial/industrial-chronic	30 years
Exposure duration	Adult	70 years
Exposure duration	Commercial/industrial - chronic	30 years

Note: all other exposure factors used are consistent with USEPA guidelines.

2.3 Toxicity Assessment

Toxicity and chemical data used in this assessment is listed in Appendix B.

2.4 Risk/Hazard Classification

2.4.1 "Acceptable" Risk/Hazard

Risk analysis and assessment undertaken within the HRA requires the use of risk criteria.

The following risk criteria have been used:

- ▶ An excess lifetime carcinogenic risk value of 1×10^{-5}
- ▶ A hazard index of 1.0

USEPA have established that an "acceptable" factor for the increase in cancer rates is one event per 100,000.

The total hazard index is a summation of the individual hazard quotients calculated for the site and is useful in determining if the risk level is such that clean up is required. Hazard quotients can be used in determining cleanup criteria for certain contaminants provided that a relationship has been established between estimates of exposure point concentrations and soil/groundwater concentrations. A total hazard index of less than 1.0 is deemed to be acceptable to the USEPA.

2.4.2 Reasonable Case Scenario

A model of reasonable case scenarios for subsurface soil SSTL's for all completed pathways was run for each source zone location to provide baseline data for existing and proposed commercial uses of the site. The results of the model runs are presented in Table 4 and 5.

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Table 4 - Reasonable Case Scenario Site Specific Target Levels (SSTL's) for Surface Soils (<1 metre BGS)

Constituent of Concern	Site Concentrations (mg/kg)	SSTL - Complete Pathways	Applicable SSTL	SSTL Exceeded
Xylene	18	Inhalation of volatiles and particulates - commercial > Res	> Res	No

Note: All concentrations shown in mg/kg

Table 5 - Reasonable Case Scenario Site Specific Target Levels (SSTL'S) for Subsurface Soils (<1 metre BGS)

Constituent of Concern	Site Concentrations (mg/kg)	SSTL - Complete Pathways		Applicable SSTL	SSTL Exceeded
		Soil volatilisation to indoor air commercial (on-site)	Soil volatilisation to outdoor air (on-site)		
Xylene	54	> Res	> Res	> Res	No

Note all concentrations shown in mg/kg

NA: not applicable, > Res: Residual Levels only

Hazard Index Calculations

The RBCA program has calculated a hazard index consisting of all complete exposure pathways for the reasonable case scenario. Calculations were made based on both surface and subsurface soil concentrations of xylene for the site. Hazard index results have been reported for both soil and air mediums.

RBCA calculated potential hazard levels as a result of onsite xylene concentrations as 2.6×10^{-4} for soil, and 3.2×10^{-4} for air. Hazard index levels of less than 1 for all sources are considered acceptable to the USEPA. No carcinogenic risks were associated with xylene as this compound is not known to be carcinogenic. Appendix E contains graphic representation of the baseline risk calculations for the RCS.

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2.4.3 Reasonable Worst Case Scenario

The reasonable worst case scenario results for subsurface soils are shown in Table 6 and 7 following.

Table 6 - Reasonable Worst Case Scenario Site Specific Target Levels (SSTL's) for Surface Soils (<1 metre BGS)

Constituent of Concern	Site Concentrations (mg/kg)	SSTL - Complete Pathways	Applicable SSTL	SSTL Exceeded
Xylene	18	Ingestion, inhalation and dermal contact - residential on-site > Res	> Res	No

Note all concentrations shown in mg/Kg

Table 7 - Reasonable Worst Case Scenario Site Specific Target Levels (SSTL'S) for Subsurface Soils (<1 metre BGS)

Constituent of Concern	Site Concentrations (mg/kg)	SSTL - Complete Pathways		Applicable SSTL	SSTL Exceeded
Xylene	54	Soil volatilisation to indoor air residential (on-site) > Res	Soil volatilisation to outdoor air residential (on-site) > Res	> Res	No

Note all concentrations shown in mg/Kg

NA: not applicable, > Res: Residual Levels only

Hazard Index Calculations

As with the Reasonable Case Scenario the RBCA program has calculated a hazard index consisting of all complete exposure pathways for the Reasonable Worst Case Scenario. Calculations were made based on both surface and subsurface soil concentrations of xylene for the site. Hazard index results have been reported for both soil and air mediums.

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RBCA calculated potential hazard levels as a result of onsite xylene concentrations as 3.7×10^{-4} for soil, and 1.9×10^{-4} for air. Hazard index levels of less than 1 for all sources are considered acceptable to the USEPA. No carcinogenic risks were associated with xylene as this compound is not known to be carcinogenic. Appendix F contains graphic representation of the baseline risk calculations for the RWCS.

2.4.4 Qualitative Assessment of TPH Contaminant Plume

Threshold Levels

The South Australian Health Commission have derived human health-based investigation levels for a range of land uses including open space/recreation and commercial/industrial uses (Imray and Langley 1996).

Table 8 Commercial/Industrial Threshold Levels (Imray and Langley 1996)

Contaminant	Dutch Investigation Level ⁽²⁾	SA Health Commission ⁽¹⁾	
		Park	Industrial
TPH C ₆ -C ₉	-	-	-
TPH C ₁₀ -C ₃₆	1000	2000 ⁽³⁾	5000 ⁽³⁾

Note: (1) Imray and Langley 1996
(2) Target + Intervention/2 Environmental Quality Objectives in the Netherlands 1994
(3) Extrapolated ratio of contaminants based on identified residential threshold levels

Investigation levels have been identified for a number of contaminants including heavy metals and PAH's, however no levels have been developed for hydrocarbons. The ratio applied by Imray and Langley to residential threshold concentrations of other contaminants to obtain industrial/commercial investigation concentrations is a factor of five. Given that the Dutch Investigation level for hydrocarbons C10-C36 is 1000 mg/kg the industrial threshold level would be 5000mg/kg.

The contaminants associated with the site fall within the C10-C28 range which is consistent with the Dutch intervention levels. The contaminants also contain low levels of volatile compounds such as BTEX and therefore the 5000mg/kg level can be expected to be conservative.

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Exposure Pathways

Potential human exposure pathways associated with the use of the site for commercial activities are limited. Expected pathways would include limited dermal contact, and the inhalation of contaminants from the volatilisation of compounds to the ambient air. Recommended actions for burial of TPH contaminated material below one metre in existing onsite excavations and the covering of the site with one metre of clay material sourced on-site would effectively cap the site and further limit both the potential for volatilisation and dermal contact with TPH contaminated soil.

The potential migration of TPH contaminants off-site is limited due to the absence of groundwater and preferential pathways and the underlying low permeability strata.

Relative Risk Levels

The mean concentration of samples analysed for TPH above DoE investigation levels was 2447mg/kg. Four results, from samples SS41, SS42, SS12, SS29, (5629mg/kg, 8000mg/kg, 7488mg/kg, and 5079mg/kg respectively) were above the 5000 mg/kg threshold level established for TPH. The elevated results were obtained from samples at depth. A peak value of 8000 mg/kg was obtained however given the area of the site was relatively isolated and will be effectively diluted within the material to be reinstated below one metre on site. As a percentage of the total number of samples above the established criteria of 5000mg/kg the four samples represent a 13% exceedance.

The overall risk associated with TPH contamination is considered to be low due to the low number of samples showing levels of TPH above the established criteria identified by Imray and Langley, and the limited potential exposure pathways and the relative immobility of the contaminant plume.

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Murgon, Queensland.

3.0 Discussion of Results

3.1 Reasonable Case Scenario

The following conclusions were made in the reasonable case scenario (RCS):

- ▶ Complete exposure pathways were identified for the following
 - The exposure of on-site commercial workers to vapours and particulates emanating from the surface and subsurface soil to ambient air.
 - The exposure of onsite commercial workers to vapours emanating from the surface and subsurface soil to indoor air within buildings.
- ▶ Soil contamination levels for xylene exceeding recognised investigation threshold levels have been used as the CoC to undertake site modelling work using RBCA techniques.
- ▶ Site specific target levels for surface and subsoil concentrations of xylene were calculated for all complete pathways. Target levels for benzene, toluene, and ethylbenzene were not calculated as the levels detected were below recognised investigation threshold levels. The SSTL calculated for xylene was at a residual level indicating that the model was unable to calculate an SSTL due to the extremely low levels present on the site. The residual levels indicated by the SSTL calculated for the individual pathways therefore, indicates that the representative site concentrations of xylene in both the surface and subsurface soils (18 mg/kg and 54 mg/kg respectively) do not present a risk to human health.
- ▶ Elevated levels of TPH remain within the contaminated soil plume at levels ranging from 159mg/kg to 8000mg/kg with a mean concentration of 2447mg/kg. A qualitative assessment of the potential for off-site migration of TPH has been undertaken based on available groundwater, and geological data.
- ▶ Groundwater was not identified during exploratory works onsite to a depth of 25 metres and therefore has been dismissed as a potential medium for the transport of contaminants off-site.
- ▶ Surface water infiltration is reduced due to the clay and volcanic nature of site geology.
- ▶ Tests pits undertaken offsite at an assumed hydraulically downgradient location within 3 metres of the site boundary identified a low permeability layer of volcanic material or tuff underlying the site at depths ranging from 2 to 3.5 metres. Soil and PID readings taken during the excavation of the pits revealed low levels of BTEX and TPH within the test pits.

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- ▶ A water sample taken at depth in test pit 4 located 2 metres hydraulically upgradient from the Murgon Creek was analysed for the presence of BTEX, TPH and Lead. Results indicated levels below the limits of laboratory reporting within the groundwater associated with the Creek.
- ▶ The hazard index chart for both surface and subsurface soil concentrations of xylene for the site indicate potential hazard levels of 2.6×10^{-4} (soil), and 3.2×10^{-4} (air). Hazard index levels of less than 1 for all sources are considered acceptable to the USEPA. No carcinogenic risks were associated with xylene as this compound is not known to be carcinogenic

Discussion

Field works have identified that previous activities on the site have resulted in contamination of the site with TPH and isolated occurrences of xylene above recognised guidelines. The contaminant plume extends towards the western boundary of the site.

The nearest sensitive ecological receiver is the Murgon Creek located approximately 50 metres downgradient from the site. Residential receivers border the property and have been considered within the RWCS for residential on-site activity.

Test pits located hydraulically downgradient from the contaminant plume and within 3 metres from the site boundary did not reveal contaminant levels above the limits of laboratory reporting. The impermeable layer of volcanic material identified at 2-3.5 metres depth would provide an impermeable layer to onsite contamination continuing at depth and results obtained at the test pits excavated at the boundary support this conclusion.

The potential for lateral migration of the TPH contaminant plume is considered remote given the absence of groundwater on the site and the high clay content of surface material encountered on the site which would serve to reduce surface water infiltration rates. The lack of a suitable transportation medium such as groundwater or surface water infiltration, further supports the conclusion that lateral migration of contaminants from the site has not occurred.

RBCA results for the potential xylene exposure of on-site commercial workers, both indoors and outdoors, to vapours emanating from the subsurface soil have identified minimal hazards based on the existing site contaminant concentrations.

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Murgon, Queensland.

Reasonable Worst Case Scenario

The following points are concluded from the reasonable worst case scenario (RWCS):

- ▶ Complete exposure pathways were identified for the following
 - The exposure of residential inhabitants to vapours and particulates emanating from the surface and subsurface soil to ambient air.
 - The exposure of residential inhabitants to vapours emanating from the surface and subsurface soil to indoor air within buildings.
- ▶ Site specific target levels for surface and subsoil concentrations of xylene were calculated for all complete pathways. Target levels for benzene, toluene, and ethylbenzene were not calculated as the levels detected were below recognised investigation threshold levels. The SSTL calculated for xylene was at a residual level indicating that the SSTL is at extremely low levels. The applicable SSTL calculated for the individual exposure pathways therefore, does not exceed applicable representative site concentrations for xylene in both the surface and subsurface soils (18 mg/Kg and 56 mg/Kg respectively).
- ▶ Elevated levels of TPH remain within the contaminated soil plume within the soil matrix at levels ranging from 159mg/Kg to 8000mg/Kg.
- ▶ The hazard index chart for both surface and subsurface soil concentrations of xylene for the site indicate potential hazard levels of 3.7×10^{-4} (soil), 1.9×10^{-4} (air). Hazard index levels of less than 1 for all sources are considered acceptable to the USEPA. No carcinogenic risks were associated with xylene as this compound is not known to be carcinogenic

Discussion

Site specific target levels and hazard index calculations for xylene concentrations encountered within the contaminant plume indicate minimal hazard levels associated with on-site residential use.

TPH contamination is located at depth on the site and as identified within the qualitative assessment undertaken in section 2.4.4 poses minimal human and ecological risks to the surrounding environment.

3.2 Conservatism of Modelling

Due to the limited information available, and the theoretical uncertainties behind the modelling principles used, the results of the modelling exercise are likely to be conservative. These areas of conservatism are as follows:

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- ▶ Site specific parameters. Conservative site specific parameters have been used, particularly where limited data was available, or literature figures were used on the basis of site observations. These inputs include source zone subsoil concentrations, source zone width, thickness of impacted soils within the source zone and capillary fringe thickness.
- ▶ Default and standard parameters. Conservative default and standard parameters include the exposure factors used and the building parameters used to model the existing facilities.
- ▶ Model algorithms. Model algorithms are limited by current scientific understanding of the mechanisms involved in petroleum hydrocarbon migration within soils and groundwater, and the simple nature of the modelling used. Petroleum hydrocarbon migration within the groundwater excludes losses due to volatilisation into the overlying vadose zone. Recent criticism of soil vapour algorithms commonly used include:
 - The initial concentration of the contaminant is constant.
 - Little or no allowance is made for attenuation during vapour migration.
 - The immediate above ground concentration of petroleum vapours are assumed to be zero.

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Murgon, Queensland.

4.0 Recommendations

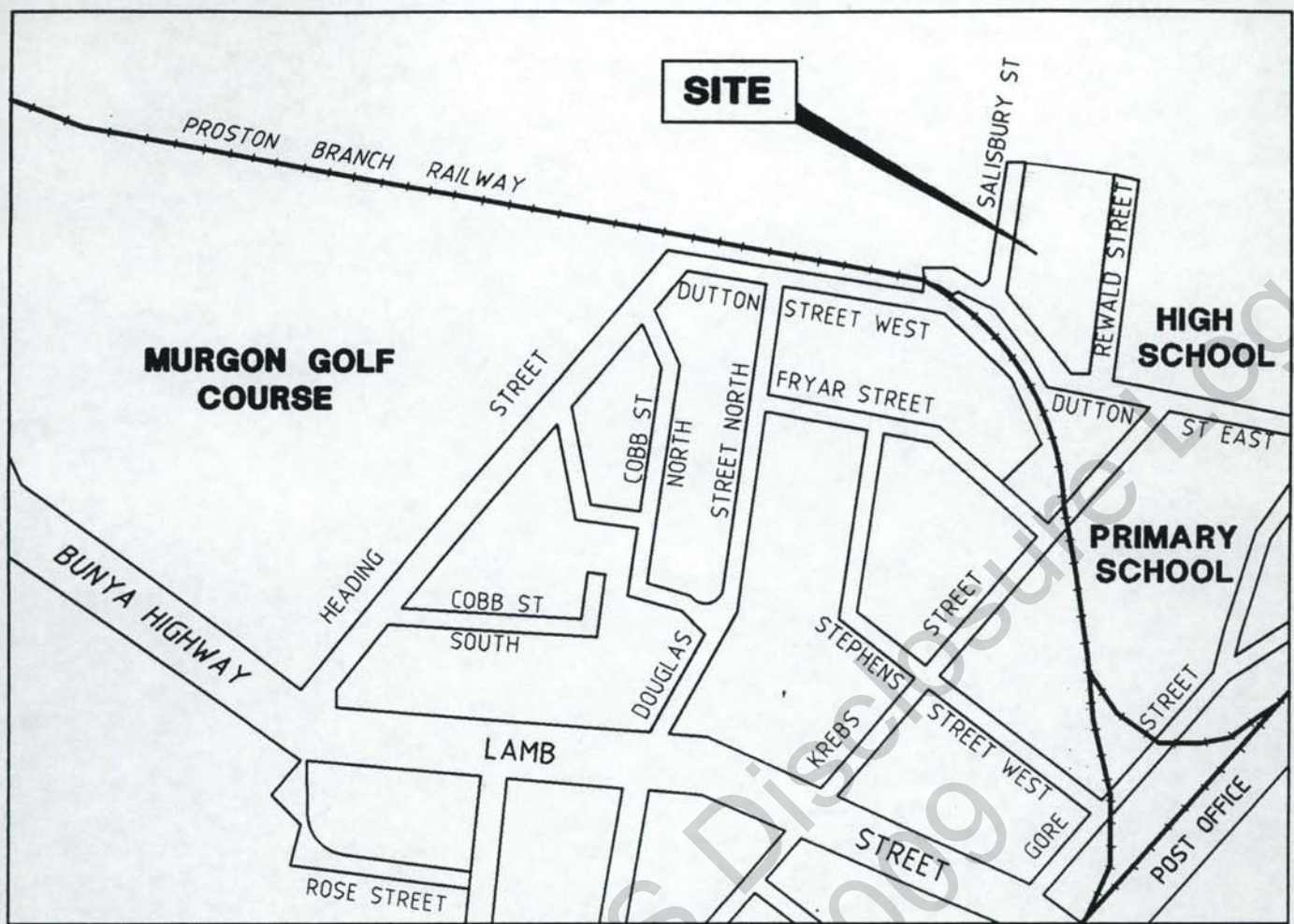
The following recommendations are made:

- ▶ An application be made for restricted use of the site for commercial purposes based on the results of the HRA and associated Site Remediation and Validation Report dated April 1997.
- ▶ TPH contaminated material identified within stockpiled areas be reinstated within the lower regions of the site. Excavated material from on-site with high clay content and low levels of contamination (ie outside of the contaminant plume area) should be used to cover the upper 1.0 metre of the site to provide an impermeable clay capping for the site. Such capping will limit the potential for surface water infiltration into the site and further reduce the potential for the transport of contaminants off-site.

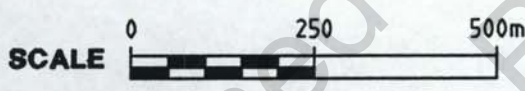
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Appendix A

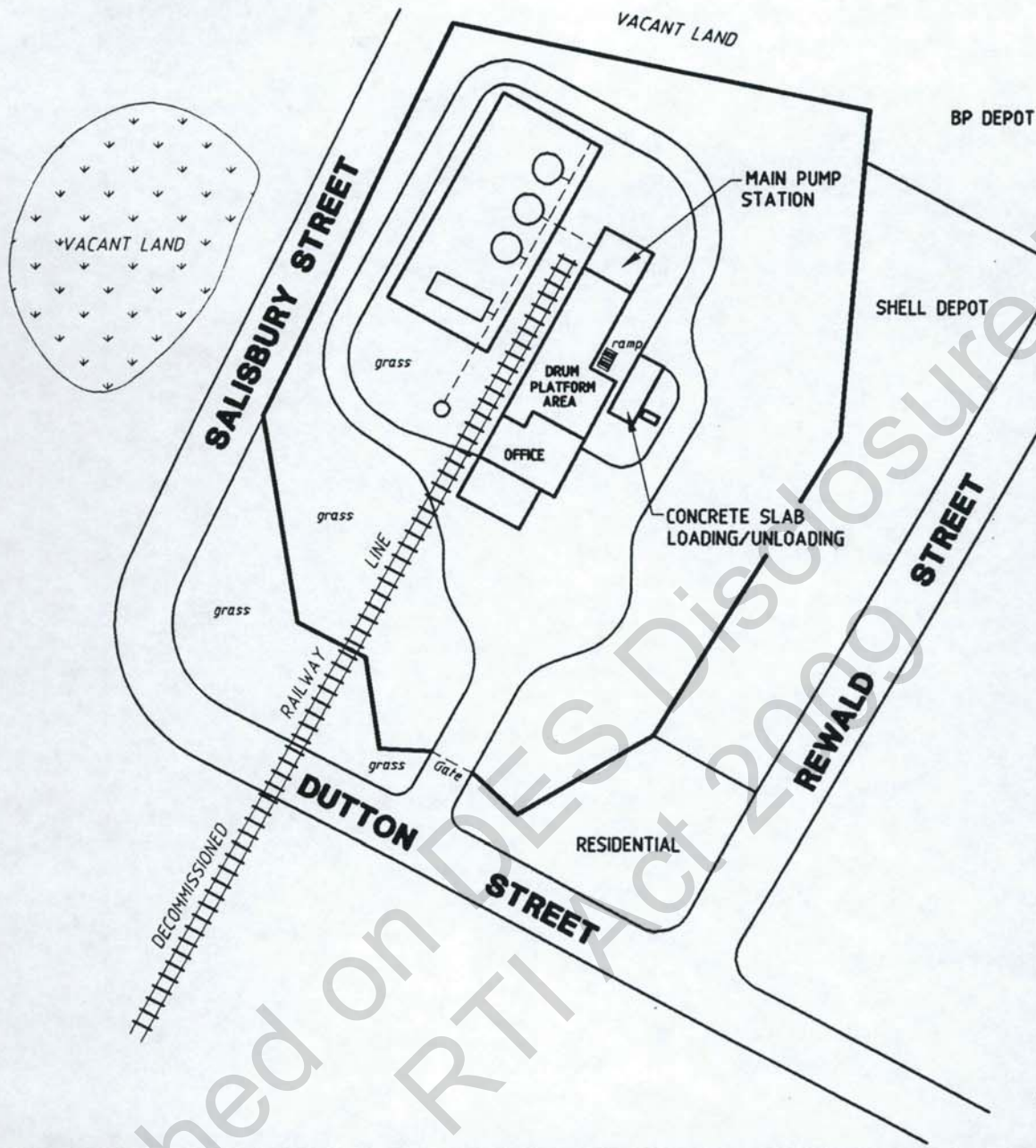
Site Plan



MURGON



Mobil



NOT TO SCALE

SITE CONFIGURATION

Mobil

CNR DUTTON AND REWALD STREETS
MURGON TOWNSHIP

FIGURE 2

RUST PPK Pty Ltd

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Murgon, Queensland.

Appendix B

Toxicity and Chemical Data

RBCA CHEMICAL DATABASE

Physical Property Data

CAS Number	Constituent	type	Molecular Weight (g/mole)		Diffusion Coefficients				log (Koc) or log(Kd) (@ 20 - 25 C) (l/kg)		Henry's Law Constant (@ 20 - 25 C) (atm-m3) (unitless)		Vapor Pressure (@ 20 - 25 C) (mm Hg) Pure		Solubility (@ 20 - 25 C) (mg/l) Pure		acid pKa	base pKb	ref
1330-20-7	Xylene (mixed isomers)	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	A	6.97E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5		

Site Name: Cnr Dutton Street a Site Location: Murgon Queenslan Completed By: 73(2)Irrelevant #VALUE!

Software version: v 1.0

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RBCA CHEMICAL DATABASE

Toxicity Data

CAS Number	Constituent	Reference Dose (mg/kg/day)				Slope Factors 1/(mg/kg/day)				EPA Weight of Evidence	Is Constituent Carcinogenic ?
		Oral RfD_oral	ref	Inhalation RfD_inhal	re	Oral SF_oral	ref	Inhalation SF_inhal	ref		
1330-20-7	Xylene (mixed isomers)	2.00E+00	A,R	2.00E+00	A	-	R	-	R	D	FALSE

Site Name: Cnr Dutton Str Site Location: Murgon Queensland Completed By: 73(2)Irrelevant #VALUE!

Software version: v 1.0

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RBCA CHEMICAL DATABASE

Miscellaneous Chemical Data

CAS Number	Constituent	Maximum Contaminant Level		Permissible Exposure Limit PEL/TLV		Relative Absorption Factors		Detection Limits				Half Life (First-Order Decay) (days)		
		MCL (mg/L)	reference	(mg/m3)	ref	Oral	Dermal	Groundwater (mg/L)	ref	Soil (mg/kg)	re	Saturated	Unsaturated	ref
1330-20-7	Xylene (mixed isomers)	1.00E+01	6 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	1	0.5	0.005	C	0.005	S	360	360	H

Site Name: Cnr Dutton Str Site Location: Murgon Queensland

Completed By: 73(2)Irrelevant #VALUE!

Software version: v 1.0

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Murgon, Queensland.

Appendix C

Reasonable Case Scenario -
Summary Input Data and
Results

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Cnr Dutton Street and Salisbury Identification: 84J058A
 Site Location: Murgon Queensland Date Completed: 25/3/97
 Completed By: 73(2)Irrelevant

Software: GSI RBCA Spreadsheet
 Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential		Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic
ATc	Averaging time for carcinogens (yr)	70			
ATn	Averaging time for non-carcinogens (yr)	<u>70</u>	6	16	<u>30</u>
BW	Body Weight (kg)	70	15	35	70
ED	Exposure Duration (yr)	<u>70</u>	6	16	<u>30</u>
EF	Exposure Frequency (days/yr)	350			250
EF.Derm	Exposure Frequency for dermal exposure	350			250
IRgw	Ingestion Rate of Water (l/day)	2			1
IRs	Ingestion Rate of Soil (mg/day)	100	200		50
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.7E+02			9.7E+01
IRa.in	Inhalation rate indoor (m ³ /day)	15			20
IRa.out	Inhalation rate outdoor (m ³ /day)	20			20
SA	Skin surface area (dermal) (cm ²)	5.8E+03		2.0E+03	5.8E+03
SAadj	Adjusted dermal area (cm ² -yr/kg)	5.4E+03			2.1E+03
M	Soil to Skin adherence factor	1			
AAFs	Age adjustment on soil ingestion	FALSE			FALSE
AAFd	Age adjustment on skin surface area	FALSE			FALSE
tox	Use EPA tox data for air (or PEL based)	TRUE			
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE			

Surface Parameters	Definition (Units)	Commercial/Industrial		
		Residential	Chronic	Construction
t	Exposure duration (yr)	70	30	1
A	Contaminated soil area (cm ²)	<u>6.1E+06</u>		1.0E+06
W	Length of affected soil parallel to wind (cm)	<u>3.9E+03</u>		1.0E+03
W.gw	Length of affected soil parallel to groundwater (cm)	1.5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	1.0E+02		
Pe	Particulate areal emission rate (g/cm ² /s)	2.2E-10		

Groundwater Definition (Units)		Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
f	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	2.5E+03
Ugw.tr	Groundwater Transport velocity (cm/yr)	6.6E+03
Ks	Saturated Hydraulic Conductivity(cm/s)	
grad	Groundwater Gradient (cm/cm)	
Sw	Width of groundwater source zone (cm)	
Sd	Depth of groundwater source zone (cm)	
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial	
			Chronic	Constructn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	FALSE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	TRUE	
SS.v	Volatiles and Particulate Inhalation	FALSE	TRUE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	TRUE	FALSE
S.I	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	TRUE	

Soil Definition (Units)		Value
hc	Capillary zone thickness (cm)	5.0E+00
hv	Vadose zone thickness (cm)	3.0E+02
rho	Soil density (g/cm ³)	1.7
foc	Fraction of organic carbon in vadose zone	0.01
phi	Soil porosity in vadose zone	<u>0.39</u>
Lgw	Depth to groundwater (cm)	3.0E+02
Ls	Depth to top of affected soil (cm)	1.0E+02
Lsubs	Thickness of affected subsurface soils (cm)	<u>3.5E+02</u>
pH	Soil/groundwater pH	6.5
		capillary vadose foundation
phi.w	Volumetric water content	0.342
phi.a	Volumetric air content	0.038

Matrix of Receptor Distance and Location on- or off-site		Residential		Commercial/Industrial	
		Distance	On-Site	Distance	On-Site
GW	Groundwater receptor (cm)		TRUE		TRUE
S	Inhalation receptor (cm)		TRUE		TRUE

Building Definition (Units)		Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s ⁻¹)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	<u>1.0E-05</u>	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	1	
Tier	RBCA Tier	2	

Dispersive Transport Parameters Definition (Units)		Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.1

Site Name: 0

Completed By: 0

Site Location: 0

Date Completed: 1/1/1904

1 OF 1

SURFACE SOIL SSTL VALUES (< 3 FT BGS)

Target Risk (Class A & B) 1.0E-6

☐ MCL exposure limit?

Calculation Option: 1

Target Risk (Class C) 1.0E-5

☐ PEL exposure limit?

Target Hazard Quotient 1.0E+0

SSTL Results For Complete Exposure Pathways ("x" If Complete)

CONSTITUENTS OF CONCERN			Representative Concentration	X	Soil Leaching to Groundwater			X	Inhalation of Volatiles and Particulates		Construction Worker	Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left			
1330-20-7	Xylene (mixed isomers)	1.8E+1	NA	NA	NA	NA	>Res	NA	>Res	☐	<1			

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Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: 0

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.2

Site Name: 0

Completed By: 0

Site Location: 0

Date Completed: 1/1/1904

1 OF 1

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-6

☐ MCL exposure limit?

Calculation Option: 1

Target Risk (Class C) 1.0E-5

☐ PEL exposure limit?

Target Hazard Quotient 1.0E+0

SSTL Results For Complete Exposure Pathways ("X" If Complete)

CONSTITUENTS OF CONCERN			Representative Concentration	X Soil Leaching to Groundwater			X Soil Volatilization to Indoor Air		X Soil Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Residential: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left	
1330-20-7	Xylene (mixed isomers)	5.4E+1	NA	NA	NA	NA	>Res	NA	>Res	>Res	☐	<1	

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Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: 0

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Murgon, Queensland.

Appendix D

Reasonable Worst Case

Scenario - Summary Input

Data and Results

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Cnr Dutton Street and Salisbury
 Site Location: Murgon Queensland
 Job Identification: 84J058A
 Date Completed: 25/3/97
 Completed By: 73(2)Irrelevant

Software: GSI RBCA Spreadsheet
 Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential		Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic
ATc	Averaging time for carcinogens (yr)	70			
ATn	Averaging time for non-carcinogens (yr)	<u>70</u>	6	16	<u>30</u>
BW	Body Weight (kg)	70	15	35	70
ED	Exposure Duration (yr)	<u>70</u>	6	16	<u>30</u>
EF	Exposure Frequency (days/yr)	350			250
EF.Derm	Exposure Frequency for dermal exposure	350			250
IRgw	Ingestion Rate of Water (l/day)	2			1
IRs	Ingestion Rate of Soil (mg/day)	100	200		50
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.7E+02			9.7E+01
IRa.in	Inhalation rate indoor (m³/day)	15			20
IRa.out	Inhalation rate outdoor (m³/day)	20			20
SA	Skin surface area (dermal) (cm²)	5.8E+03		2.0E+03	5.8E+03
SAadj	Adjusted dermal area (cm²-yr/kg)	5.4E+03			2.1E+03
M	Soil to Skin adherence factor	1			
AAFs	Age adjustment on soil ingestion	FALSE			FALSE
AAFd	Age adjustment on skin surface area	FALSE			FALSE
tox	Use EPA tox data for air (or PEL based)	TRUE			
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE			

Surface Parameters	Definition (Units)	Commercial/Industrial		
		Residential	Chronic	Construction
t	Exposure duration (yr)	70	30	1
A	Contaminated soil area (cm²)	<u>6.1E+06</u>		1.0E+06
W	Length of affected soil parallel to wind (cm)	<u>3.9E+03</u>		1.0E+03
W.gw	Length of affected soil parallel to groundwater (cm)	1.5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	1.0E+02		
Pe	Particulate areal emission rate (g/cm²/s)	2.2E-10		

Groundwater Definition (Units)		Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	2.5E+03
Ugw.tr	Groundwater Transport velocity (cm/yr)	6.6E+03
Ks	Saturated Hydraulic Conductivity(cm/s)	
grad	Groundwater Gradient (cm/cm)	
Sw	Width of groundwater source zone (cm)	
Sd	Depth of groundwater source zone (cm)	
BC	Biodegradation Capacity (mg/L)	
BIQ?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial	
			Chronic	Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	FALSE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	TRUE	FALSE	
SS.v	Volatiles and Particulate Inhalation	TRUE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	TRUE	FALSE	FALSE
S.I	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	TRUE	FALSE	

Soil Definition (Units)		Value
hc	Capillary zone thickness (cm)	5.0E+00
hv	Vadose zone thickness (cm)	3.0E+02
rho	Soil density (g/cm³)	1.7
foc	Fraction of organic carbon in vadose zone	0.01
phi	Soil porosity in vadose zone	<u>0.39</u>
Lgw	Depth to groundwater (cm)	3.0E+02
Ls	Depth to top of affected soil (cm)	1.0E+02
Lsubs	Thickness of affected subsurface soils (cm)	<u>3.5E+02</u>
pH	Soil/groundwater pH	6.5
phi.w	Volumetric water content	0.342
phi.a	Volumetric air content	0.038

Matrix of Receptor Distance and Location on- or off-site		Residential	Commercial/Industrial	
		Distance	On-Site	Distance

GW	Groundwater receptor (cm)	TRUE		TRUE
S	Inhalation receptor (cm)	TRUE		TRUE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	<u>1.0E-05</u>	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	1	
Tier	RBCA Tier	2	

Building Definition (Units)		Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s⁻¹)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters Definition (Units)		Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.1

Site Name: Cnr Dutton Street and Salisbury Street

Completed By: 73(2)Irrelevant

Site Location: Murgon Queensland

##

1 OF 1

SURFACE SOIL SSTL VALUES (< 3 FT BGS)

Target Risk (Class A & B) 1.0E-5

☐ MCL exposure limit?

Calculation Option: 1

Target Risk (Class C) 1.0E-5

☐ PEL exposure limit?

Target Hazard Quotient 1.0E+0

SSTL Results For Complete Exposure Pathways ("x" If Complete)

CONSTITUENTS OF CONCERN

CAS No.	Name	Representative Concentration (mg/kg)	Soil Leaching to Groundwater			Ingestion, Inhalation and Dermal Contact		Construction Worker	Applicable SSTL	SSTL Exceeded ?	Required CRF
			Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Commercial: (on-site)	(mg/kg)	"X" If yes	Only if "yes" left
1330-20-7	Xylene (mixed isomers)	1.8E+1	NA	NA	NA	>Res	NA	NA	>Res	☐	<1

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Serial: 0

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.2

Site Name: Cnr Dutton Street and Salisbury Street
Site Location: Murgon Queensland

Completed By: 73(2)Irrelevant
##

1 OF 1

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-5
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

☐ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 1

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN			Soil Leaching to Groundwater			Soil Volatilization to Indoor Air		Soil Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	Representative Concentration (mg/kg)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Residential: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left
1330-20-7	Xylene (mixed isomers)	5.4E+1	NA	NA	NA	>Res	NA	>Res	NA	>Res	☐	<1

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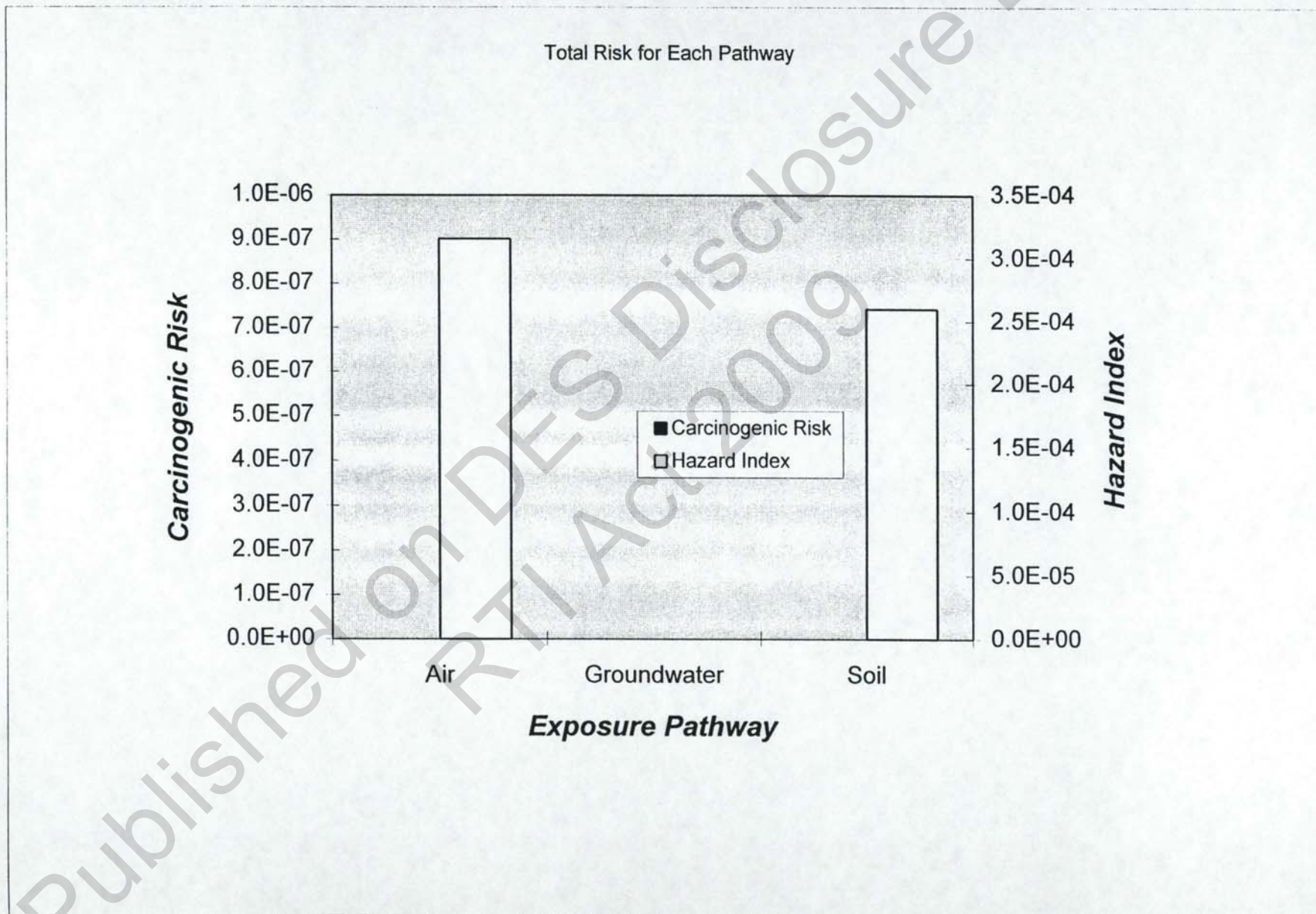
Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: 0

Health Risk Assessment, Former Fuel Depot,
Corner Dutton Street East and Salisbury Street
Murgon, Queensland.

Appendix E

Reasonable Case Scenario
- Baseline Risk Summary



RBCA SITE ASSESSMENT

Tier 2 Worksheet 8.3

Site Name: Cnr Dutton Street and Salisbury Street Completed By: 73(2)Irrelevant
Site Location: Murgon Queensland #VALUE!

1 of 1

TIER 2 BASELINE RISK SUMMARY TABLE

EXPOSURE PATHWAY	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
AIR EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-6	0.0E+0	N/A	☐	3.2E-4	1.0E+0	3.2E-4	N/A	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-6	0.0E+0	N/A	☐	0.0E+0	1.0E+0	0.0E+0	N/A	☐
SOIL EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-6	0.0E+0	N/A	☐	2.6E-4	1.0E+0	2.6E-4	N/A	☐
CRITICAL EXPOSURE PATHWAY (Select Maximum Values From Complete Pathways)										
	0.0E+0	1.0E-6	0.0E+0	N/A	☐	3.2E-4	1.0E+0	3.2E-4	N/A	☐

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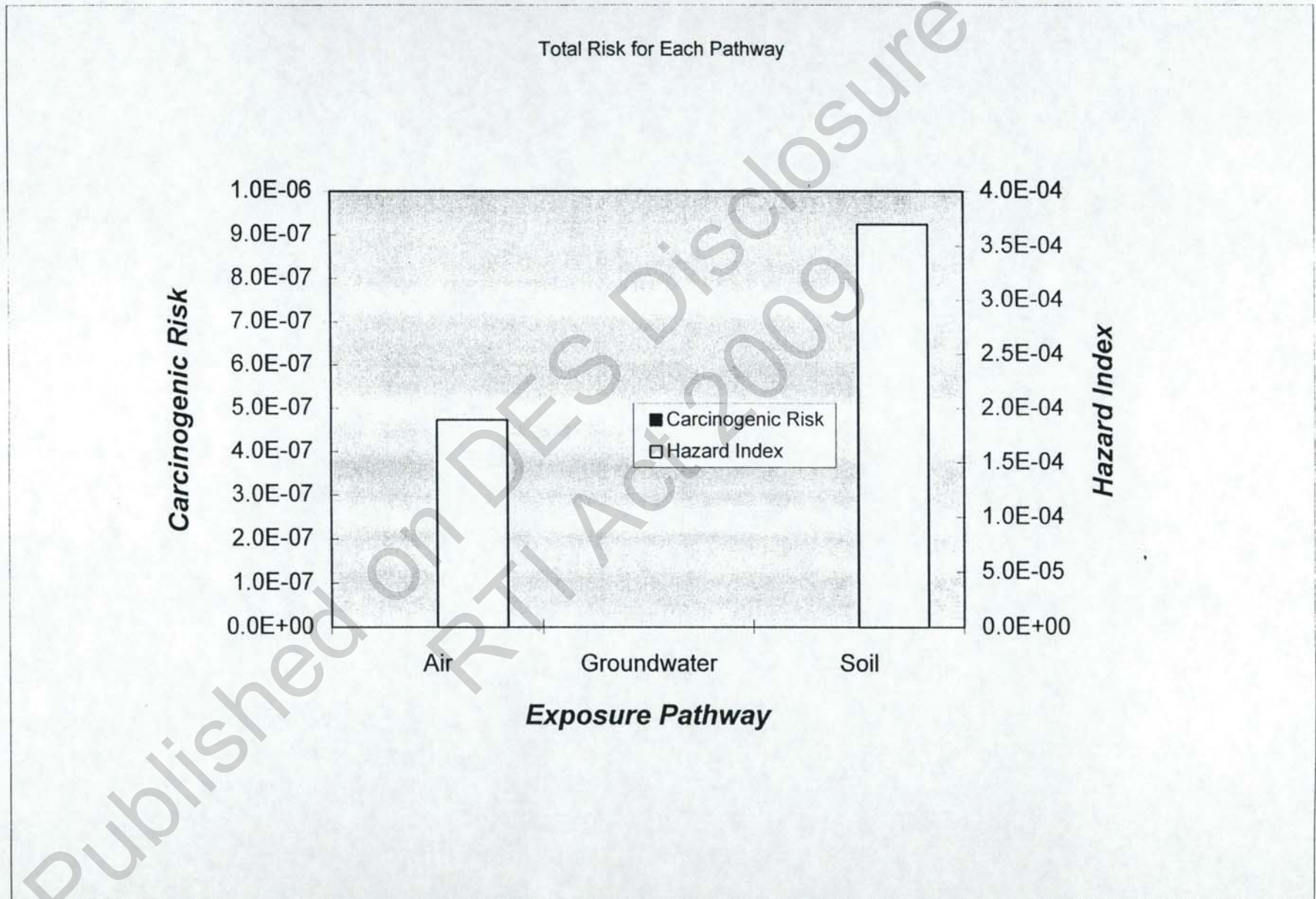
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Software: GSI RBCA Spreadsheet
Version: v 1.0

Health Risk Assessment, Former Fuel Depot,
Corner Dutton Street East and Salisbury Street
Murgon, Queensland.

Appendix F

Reasonable Worst Case Scenario
- Baseline Risk Summary



RBCA SITE ASSESSMENT

Tier 2 Worksheet 8.3

Site Name: Cnr Dutton Street and Salisbury Street
 Site Location: Murgon Queensland

Completed By: 73(2)Irrelevant
 #VALUE!

1 of 1

TIER 2 BASELINE RISK SUMMARY TABLE

EXPOSURE PATHWAY	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
AIR EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-5	0.0E+0	N/A	☐	1.9E-4	1.0E+0	1.9E-4	N/A	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-5	0.0E+0	N/A	☐	0.0E+0	1.0E+0	0.0E+0	N/A	☐
SOIL EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-5	0.0E+0	N/A	☐	3.7E-4	1.0E+0	3.7E-4	N/A	☐
CRITICAL EXPOSURE PATHWAY (Select Maximum Values From Complete Pathways)										
	0.0E+0	1.0E-5	0.0E+0	N/A	☐	3.7E-4	1.0E+0	3.7E-4	N/A	☐

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Software: GSI RBCA Spreadsheet
 Version: v 1.0

Health Risk Assessment, Former Fuel Depot,
Corner Dutton Street East and Salisbury Street
Murgon, Queensland.

Appendix G

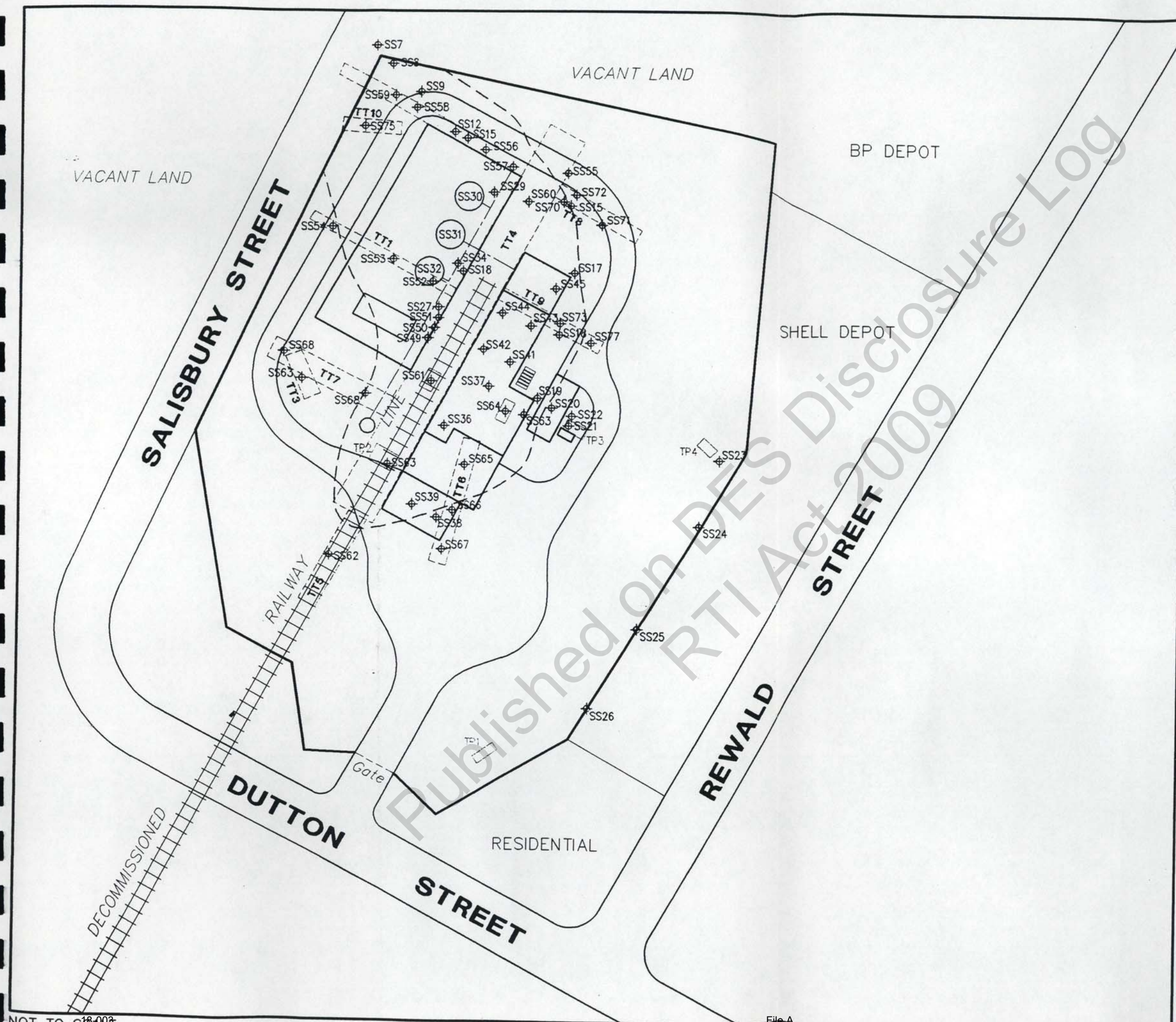
Site Contamination Plan
Borehole and Test Pit
Location Plan



LEGEND

- CONTAMINATION AREA
- TEST TRENCH
- SS10 SOIL VALIDATION SAMPLE

**SITE VALIDATION PLAN
FIGURE 4**





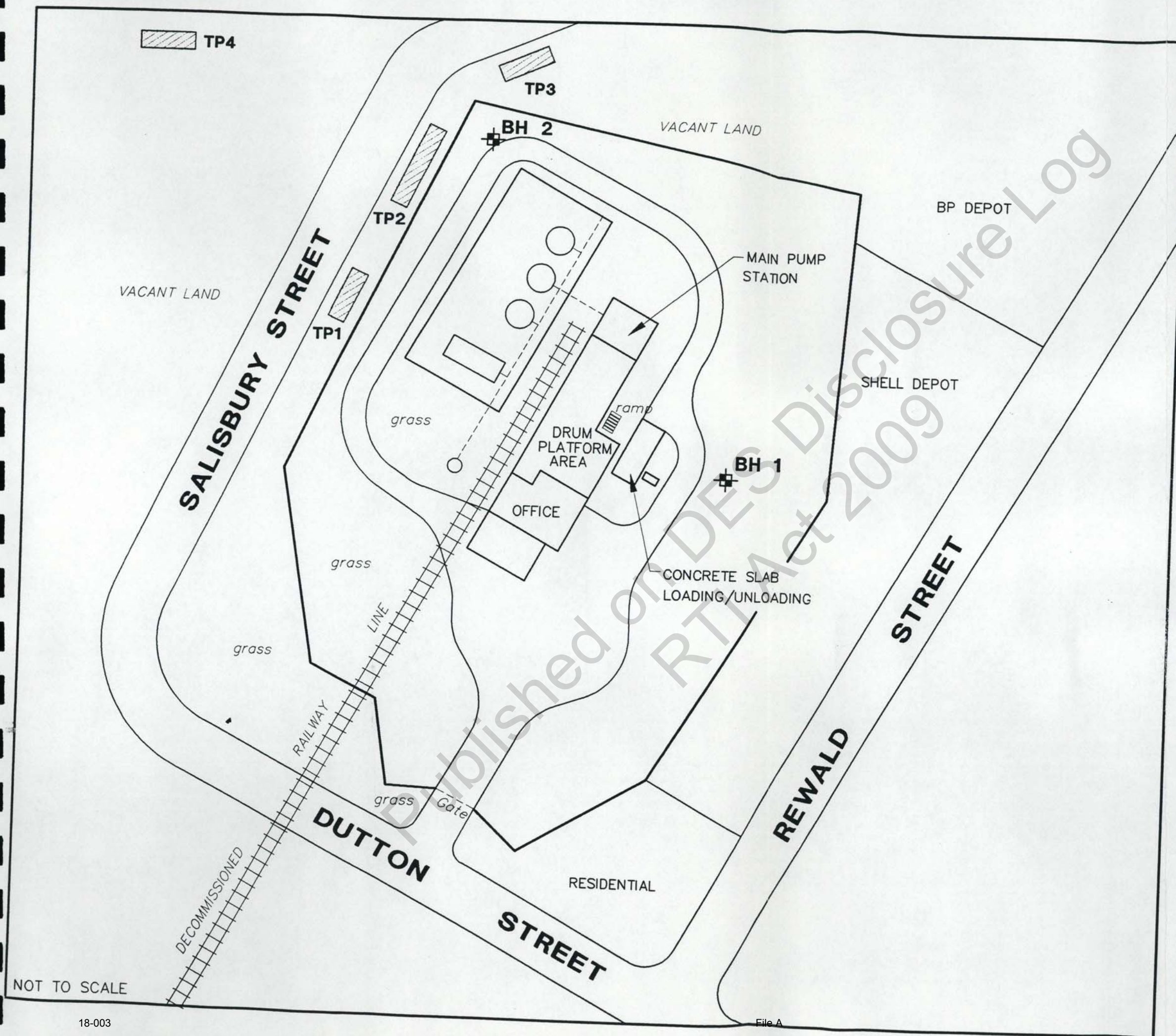
LEGEND



TEST PIT



BOREHOLE



**BOREHOLE AND TEST PIT
LOCATION MAP**

10th & 17th MARCH 1997

FIGURE 5

Health Risk Assessment, Former Fuel Depot,
Corner Dutton Street East and Salisbury Street
Murgon, Queensland.

Appendix H

Sensitive Environmental Receivers

Health Risk Assessment, Former Fuel Depot,
Corner Dutton Street East and Salisbury Street
Murgon, Queensland.



Photograph 1: Murgon Creek South-West of the Site



Photograph 2: Murgon Creek