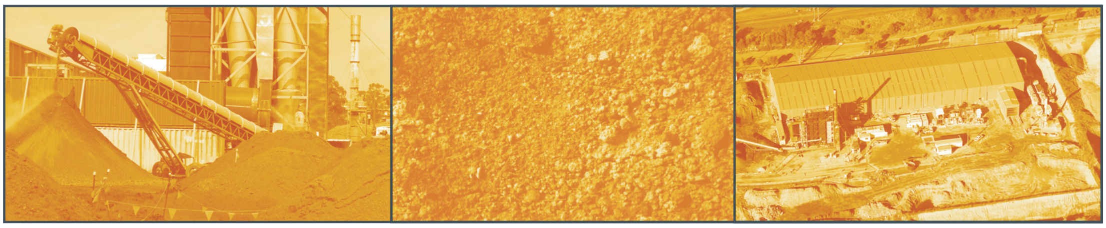

a p p e n d i x g

preliminary hazard analysis

PRELIMINARY HAZARD ANALYSIS

PROPOSED CAR PARK WASTE ENCAPSULATION REMEDIATION

DIRECTLY-HEATED THERMAL DESORPTION TECHNOLOGY

BOTANY INDUSTRIAL PARK, NSW

ORICA AUSTRALIA PTY LTD

PREPARED FOR	:	**Orica Australia Pty Ltd**
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Title:	QA Verified:
Preliminary Hazard Analysis **Proposed Car Park Waste Encapsulation Remediation** **Directly-Heated Thermal Desorption Technology** **Botany Industrial Park, NSW**	K BROOKES **Date: 30 May 2007**

sherpa consulting

CONTENTS

TABLES

ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
ADG	Australian Dangerous Goods (Code)
AS	Australian Standard
ASFSO	Automatic Soil Feed Shut Off
BCA	Building Codes Australia
BERT	Botany Emergency Response Trailer
BIP	Botany Industrial Park
BLEVE	Boiling Liquid Expanding Vapour Explosion
CCO	Chemical Control Order
Cl_2	Chlorine
CHCs	Chlorinated Hydrocarbons
CO	Carbon Monoxide
CPWE	Car Park Waste Encapsulation
DEC	(NSW) Department of Environment and Conservation
DG	Dangerous Good
DoP	(NSW) Department of Planning
DTD	Directly-heated Thermal Desorption
DUAP	(NSW) Department of Urban Affairs and Planning (now NSW DoP)
EA	Environmental Assessment
ECS	Emission Control System
EDC	Ethylene dichloride
EHC Act	(NSW) Environmentally Hazardous Chemicals Act
EPA	(NSW) Environmental Protection Authority (now part of DEC)
EPL	Environmental Protection Licence
ERP	Emergency Response Plan
ERPG	Emergency Response Planning Guidelines
ESB	Excavation Soil Building
FHA	Final Hazard Analysis
FRMP	Fire Risk Management Plan
FSB	Feed Soil Building
FSS	Fire Safety Study
GTP	Groundwater Treatment Plant
HAZID	Hazard Identification
HAZOP	Hazard and Operability Study
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCE	Hexachloroethane
HCl	Hydrogen Chloride
HDPE	High Density Polyethylene
HHIA	Human Health Impact Assessment
HIPAP	Hazardous Industry Planning Advisory Paper

HIRAC	Hazard Identification Risk Assessment and Control
HS	Hazard Study
HV	High Voltage
IBC	Immediate Bulk Containers
ID	Induced Draft (Fan)
IRP	Independent Review Panel
ISO	International Standards Organisation
LEL	Lower Explosive Limit
LWC	Lost Workday Case
MCC	Motor Control Centre
MSDS	Material Safety Data Sheet
MTC	Medical Treatment Case
NG	Natural gas
NO_x	Oxides of nitrogen
NSW	New South Wales
OCS	Octachlorostyrene
OEL	Occupational Exposure Limit
OH&S	Occupational Health & Safety
PAE	Pacific Air and Environmental
PCE	Tetrachloroethene (also known as perchloroethylene)
PHA	Preliminary Hazard Analysis
PHS	(Orica) Periodic Hazard Study
PG	Packaging Group (I – III) with I highest hazard, III lowest.
POEO Act	NSW Protection of the Environment Operations Act
PPE	Personal Protective Equipment
Ref	Reference
SEPP	(NSW) State Environmental Planning Policy
SH&E	Safety Health and Environment
SR	Subsidiary Risk
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEEL	Temporary Emergency Exposure Levels
TEQ	Toxic Equivalents
TO	Thermal Oxidiser
UN	United Nations
VC	Vinyl Chloride
WTP	Water Treatment Plant
XSFV	Excess Flow Valve

1. SUMMARY

Background, Purpose and Scope

Chlorinated solvents were manufactured at the Botany Industrial Park (BIP) from the 1960s to 1991. Prior to 1979, by-product wastes containing chlorinated compounds such as hexachlorobutadiene (HCBD) and hexachlorobenzene (HCB) were also produced and stored on site. Leakage from drums of these wastes resulted in contamination of the storage area. Approximately 45,000 m^3 of contaminated material was excavated from the storage area, and encapsulated in a synthetic liner in an area in the north east of the BIP. This is known as the Car Park Waste Encapsulation (CPWE). Orica Australia Pty Ltd (Orica) is now applying for approval to remediate this material using Directly-heated Thermal Desorption (DTD) technology.

The remediation process will involve excavation of encapsulated material in an Excavation Soil Building (ESB) fitted with an Emission Control System (ECS), feed soil preparation activities in a Feed Soil Building (FSB) also provided with an ECS, and destruction of contaminants in the DTD Plant which comprises a Thermal Oxidiser (TO) and an associated ECS. These facilities will all be located on the BIP.

As part of the planning process, community consultation has been undertaken by Orica, and hazard and risk was highlighted as an area of potential concern. The New South Wales (NSW) Department of Planning (DoP) Requirements for the Environmental Assessment (EA) for the project therefore specified that a Preliminary Hazard Analysis (PHA) prepared in accordance with the DoP guidelines *Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 Guidelines for Hazard Analysis* and *Multi-level Risk Assessment* be included in the EA.

Major Findings and Recommendations:

Hazardous Incidents

Hazardous incidents were identified in hazard study workshops, by review of previous studies covering HCB waste storage and handling, and by drawing on designer experience with existing excavation, soil handling and DTD Plant operations at other remediation sites. From a land use planning perspective, the potentially significant incidents identified were all associated with the DTD Plant. No significant incidents associated with the soil excavation or feed preparation activities were identified.

Identified incidents associated with the DTD Plant include:

- Operational malfunction or utilities failure in the TO that results in incomplete combustion of contaminants, unwanted by-product formation and release of contaminants to atmosphere (including untreated chlorinated hydrocarbons and potentially dioxins) from the DTD Plant stack.

- Power failure (including loss of backup power), resulting in very hot, untreated emissions from the DTD Plant equipment (primarily at ground level rather than through the stack).
- Failure of acid gas scrubber system resulting in hydrogen chloride (HCl) breakthrough to atmosphere from the DTD Plant stack.

Dispersion modelling of these upset events was carried out by Pacific Air and Environment Pty Ltd (PAE) as part of the Air Quality Impact Assessment for the project, and the dispersion results used to inform the risk assessment within the PHA.

Risk Results

Assessment of the risks associated with the project was largely qualitative. Orica's internal risk matrix was used to rank the risk associated with the identified hazardous incidents, and supplemented by quantitative calculations where additional detail was required. This approach is consistent with the Level 2 assessment described in *Multi-Level Risk Assessment.*

The hazardous incidents identified did not have the potential to have a significant effect (safety, health or environmental) outside the immediate incident area. No incidents were identified with an off-site (i.e. outside Orica property) fatality risk, or an acute injury or irritation effect in any off-site areas, including Qenos Pty Ltd (Qenos) the nearest BIP neighbours, and residential areas. A number of scenarios have potential to result in chronic human health effects. These are assessed separately as part of the Human Health Impact Assessment (HHIA) prepared by URS Australia Pty Ltd (URS).

There are a number of food manufacturing facilities located in the areas surrounding the BIP. Therefore potential contamination of food products may be a concern. Based on maximum off-site concentrations predicted in the dispersion results, the quantity of contaminants that could potentially affect outdoor material / ingredient stockpiles (which are not known to be present at any of the identified food industries) or be drawn into factory air intakes is small (a total of less than 1 g for exposed surfaces up to $1000m^2$).

It is therefore difficult to envisage any significant contamination in food manufacturing processes given the small quantities of emissions that could occur in a Plant upset condition, and the short duration of any such event.

As there are no significant acute off-site impacts, the quantitative risk criteria suggested by the DoP in HIPAP No. 4 *Risk Criteria for Land Use Planning,* are satisfied. The risk level is also in the "acceptable" or "As Low As Reasonably Practicable" band for identified issues with the potential to have an off-site impact when assessed against Orica's corporate risk matrix.

The risk level to surrounding land users (both to other users on the BIP site and external to the BIP boundary) from the proposed remediation facility is therefore assessed as low.

Safeguards

For all the identified scenarios, hardware safeguards are included in the design which are aimed at reducing the likelihood and/or consequence of an incident. Key controls include:

- Temperature control of TO and rapid quench to maximise contaminant destruction efficiency and minimise unwanted by-product formation.
- Redundant systems, including backup diesel generator power supply and backup water tank, to maintain function of key DTD Plant emission control equipment (cyclone, quench, baghouse, induced draft fan and acid gas scrubber) in the event of a utilities failures (i.e. natural gas, water or power supply interruption).
- Automatic isolation of soil feed to DTD Plant in the event of a plant upset and controlled shutdown sequence to minimise the quantity of contaminants that can be released.

Effect on Cumulative Risk from the BIP

The project will not increase the off-site fatality risk, hence does not increase the societal risk contribution to the area from the BIP site.

Recommendations

The PHA indicates that the acute injury or irritation risks to surrounding land uses associated with the proposed remediation project will be low and below the NSW criteria given in HIPAP no 4.

As the design is still preliminary and a number of options are being investigated specific design recommendations have not been made. However to ensure that additional risk reduction opportunities are identified and implemented as the design progresses, the following activities should be completed:

1. Conduct a Construction Safety Study (which has been included in Conditions of Consent by the DoP for previous development applications).

2. Develop a Fire Safety Study (which has been included in Conditions of Consent by the DoP for previous development applications).

3. Complete a Hazard and Operability (HAZOP) study once detail design is close to complete

4. Ensure that the Emergency Response Plan (ERP) for the facility is prepared, integrated with the ERPs for the nearby Qenos Olefines Plant and the ABB

facilities, and with the BIP ERP, and also that the Fire Brigade has the opportunity to provide input as required by the NSW Dangerous Goods (DG) regulations.

5. The PHA and hazard study process also highlighted a number of areas where potential risk levels to personnel working at the remediation facility may be relatively high. While this does not alter the PHA study conclusions with respect to off-site risk, it is recommended that a more detailed employee risk assessment be completed to ensure that the operator's duty of care obligations to employees under the NSW Occupational Health and Safety (OHS) Regulations are met.

2. INTRODUCTION

2.1. Background

Chlorinated solvents were manufactured at the Botany Industrial Park (BIP) from the 1960s until 1991. By-product wastes (collectively referred to as "Heavy Ends") containing chlorinated compounds such as hexachlorobutadiene (HCBD), hexachlorobenzene (HCB), octachlorostyrene (OCS) and tetrachloroethene (PCE) were also produced.

Prior to 1979 these wastes were drummed and stored on a bed of boiler ash at the BIP. However deterioration of the drums led to contamination of the ash and underlying sandy soil. Remediation options were investigated, however at that time a suitable treatment technology could not be found. Hence to prevent migration of the contaminants, the soil was encapsulated in a new location for later treatment, should an appropriate technology become available.

Approximately 45,000 m^3 of contaminated ash, peat and soil was excavated and transferred to a vacant area in the north east of the BIP, close to where the Qenos Pty Ltd (Qenos) Olefines Plant is currently located. The material was encapsulated in a synthetic liner (Hypalon®) and capped with sand and a bitumen surface. This is known as the Car Park Waste Encapsulation (CPWE).

Ongoing monitoring and management of the CPWE is the responsibility of Orica Australia Pty Ltd (Orica, one of the owner / operators of facilities on the BIP). Recent monitoring of the soil and groundwater surrounding the CPWE indicates that contamination is present. Atmospheric emissions are also regularly monitored. Current monitoring results indicate that the contamination in the surrounding soil or groundwater and concentrations in the air do not pose an unacceptable risk to human health or the environment.

Orica has an ongoing strategy to remediate the BIP to a level suitable for ongoing industrial use, and Orica's Environmental Protection Licence (EPL No 2148) also requires that the CPWE be remediated in accordance with an identified timetable. Therefore Orica has undertaken an evaluation process to identify and assess appropriate remediation technologies for the CPWE. The evaluation of remediation options covered factors such as the extent of commercial application, likelihood of regulatory approval, implementation timeframe and the likely capital and operating costs.

Following extensive review of the available technologies and community consultation, Orica determined that Directly-heated Thermal Desorption (DTD) technology was the most appropriate option for remediation of the CPWE. DTD has been in use for over 20 years for remediation of contaminated sites in many countries. It is currently being employed at the former Allied Feeds site and has been approved for the Lednez site at Rhodes Peninsula, New South Wales (NSW). Similar plant and operations are being proposed for the CPWE site at the BIP by the same engineering contractor advising Orica (Thiess Services Pty Ltd, Thiess).

Orica is therefore applying for approval to remediate the area using DTD technology. Three approvals / licences are required for the proposal:

1. Project approval under the Part 3A of the NSW *Environmental Planning and Assessment* (EP&A) *Act 1979.* Part 3A requires an Environmental Assessment (EA) to be submitted with an application to the Director General of the NSW Department of Planning (DoP).

2. Technology Approval under the *National Protocol for Approval/Licensing of Commercial Scale Facilities for the Treatment / Disposal of Schedule X Waste* (Scheduled Wastes Management, July 1994 (Ref 1) and licensing under the NSW *Environmentally Hazardous Chemicals* (EHC) *Act 1985* administered by the NSW Department of Environment and Conservation (DEC)

3. An EPL for the remediation works under the *Protection of the Environment Operations* (POEO) *Act 1997*. It is likely that this will be incorporated into Orica's existing EPL (No 2148), however this has not been confirmed with DEC.

2.2. Requirement for Preliminary Hazard Analysis

As part of the planning process, Orica has undertaken community consultation, and hazard and risk has been highlighted as an area of potential concern. The DoP requirements for the project EA (Ref 2) require that a Preliminary Hazard Analysis (PHA) be prepared and included with the project approval application as per the following extract:

> **Land Use Safety --** the Environmental Assessment must include a Preliminary Hazard Analysis prepared in accordance with the Department's Hazardous industry Planning Advisory Paper No.6, *Guidelines for Hazard Analysis* (HIPAP 6 Ref 3) and *Multi-Level Risk Assessment* (Ref 4). The Preliminary Hazard Analysis must include:
>
> - a full description of the treatment process, together with process flow diagrams and other relevant information at various points in the process, such as temperatures, pressures, flow rates and contaminants with their physical state;
> - full descriptions and operating details of emission control systems such as water treatment, gas scrubbing, gas treatment and monitoring of exhaust to atmosphere;
> - details of the ventilation system proposed for the excavation and pre-treatment building. If the building is not intended to be maintained at negative pressure, the systems proposed to control fugitive emissions to the atmosphere must be outlined;
> - quantitative evaluation of the irritation and injury risks at surrounding residential areas and assessment of the risks against the criteria set out in the Department's Hazardous Industry Planning Advisory Paper No. 4 - *Risk Criteria for Land Use Safety Planning*. Failure modes of both detection and safe shutdown systems must be taken into consideration when evaluating risks;

- details of safe shutdown systems in the event of process malfunction including estimates of (quality and quantity) off-spec emissions prior to reaching a safe/stable condition; and
- the impacts on any food related industries in the area.

Orica retained Sherpa Consulting Pty Ltd (Sherpa) to prepare the PHA for inclusion in the EA, which has been prepared by HLA-Envirosciences Pty Ltd (HLA). This report documents the PHA.

2.3. Objectives

The objectives of the PHA are to:

- Develop a comprehensive understanding of the hazards, risks and adequacy of the safeguards associated with proposed CPWE remediation facility.
- Determine whether the risk levels associated with the project are acceptable when compared to appropriate criteria (as given in DoP HIPAP No. 4).
- Prepare a report that documents the identified hazards and risk assessment in accordance with HIPAP No. 6.

The risk assessment contained in the PHA report is also intended to:

- Fulfill Orica's internal requirement for hazard identification and risk assessment to be completed during the project design stage (as part of Hazard Study 2, HS 2).
- Be used as a basis for the risk assessment required to be included with the technology application for the project that must be made under the *National Protocol for Approval/Licensing of Commercial Scale Facilities for the Treatment / Disposal of Schedule X Waste* (Ref 1).

2.4. Scope

The PHA covers the operations associated with the proposed CPWE remediation process using DTD technology, including:

- Waste transport activities within the BIP site.
- Soil excavation and pre-treatment activities.
- Treatment of contaminated soil using DTD technology.
- Handling of treated soil.

The PHA does **not** cover:

- Construction activities.
- Decommissioning and plant removal activities after remediation is complete.

- Any transport activities to or from the BIP (as these are expected to be associated with construction / decommissioning only. There are no ongoing chemical deliveries / removal over the operational phase).

In accordance with standard PHA methodology, the PHA focuses on effects of potential accident or plant upset scenarios, i.e. acute exposure events.

The PHA does not cover ongoing environmental or health risks associated with long-term or continuous emissions. These are addressed during the project planning and design stage through other studies included in the EA, primarily the *Air Quality Impact Assessment for Remediation of the Car Park Waste Encapsulation at the Botany Industrial Park,* (prepared by Pacific Air and Environment Pty Ltd, PAE Ref 17) and the report prepared by URS Australia Pty Ltd (URS), *Proposed Car Park Waste Encapsulation Remediation, Human Health Impact Assessment* (HHIA, Ref 18). The PHA also does not address worker occupational, health and safety (OHS) risk (either during construction or operational phases).

During the operational phase these issues are covered via environmental licences (under the POEO Act and the EHC Act), and via OHS management and occupational hygiene monitoring requirements under the NSW OHS Act 2000 and Regulations.

2.5. Links to Other Studies

This report is intended as an attachment to the EA. However it has also been prepared to allow reading as a standalone report, hence duplicates some information from the EA.

Where noted in the Hazard Identification section of this PHA, some scenarios are assessed quantitatively in more detail in other studies within the EA, i.e. the Air Quality Impact Assessment and the HHIA.

This report is not anticipated to form a complete attachment to the application for the Technology Approval under the National Protocol Schedule X Waste guidance, however parts of it may be used for this purpose.

2.6. PHA Methodology

The PHA has been prepared based on the HIPAP No. 6 (Ref 3) guidelines and is also consistent with the DoP guideline *Multi-Level Risk Assessment* (Ref 4). The main steps are:

- Formal identification of hazards and description of representative incident scenarios.
- Evaluation of likelihood of the hazardous incidents occurring and the adequacy of the safeguards provided.

- Analysis of the consequences of these incidents on people, property and the biophysical environment.
- Estimation of the resulting risk levels.
- Comparison of the risk levels with risk criteria and identification of opportunities for risk reduction.

These steps are also consistent with the methodology required by Orica's internal risk management systems.

As suggested in the *Multi-Level Risk Assessment* guidelines, the frequency, consequence and risk analysis can be carried out either qualitatively or quantitatively, or using a combination of techniques. In this case the methodology is primarily qualitative with some supplementary quantitative information where this increases understanding of the risks. (This is known as a Level 2 assessment).

2.7. Project Status

As is commonly the case at the PHA stage, the project is at the preliminary design stage. As a consequence several options are still being investigated and detail design information, including Process Flow Diagrams, (PFDs), plant mass balances and Piping and Instrumentation Diagrams (P&IDs), are not available and these have not been provided with this report.

Therefore the strategy in the EA (and hence PHA) is to assess the option with the highest potential impact. Conservative assumptions have been made in developing the potential hazardous incident scenarios, and preparing the PHA, hence estimated risk levels should be conservative. As detail design progresses risk levels will be re-assessed. For example, a risk assessment based on detail design will be required as part of the Technology Approval process.

2.8. Qualitative Risk Assessment Methodology

The Orica risk matrix was used to assess potential Safety, Health and Environment (SH&E) risks associated with identified scenarios. (Business liability and operational risks are not included in this report). The risk ranking scales were applied taking into account the controls in place.

The risk scales for relevant risk categories are shown in Table 2.1 to Table 2.4. The consequence rating was applied for the category with the most serious potential consequence. For example if the possible outcomes were operator injury (e.g. a Lost Workday Case, Cat 3.1) or Minor pollution (Cat 2), the higher (i.e. more serious) consequence was used to rank the risk. The likelihood rating was applied on the likelihood of the assessed consequence being realised, not the likelihood of the initiating event.

Also note that a risk rank of Level III is generally described within this PHA report as "low" and Level IV as "very low".

TABLE 2.1: ORICA CONSEQUENCE SCALE

CORPORATE ISSUE	**Notable Event** **Cat 1**	**Significant Event** **Cat 2**	**Highly Significant** **Cat 3.1**	**Serious Event** **Cat 3.2**	**Extremely Serious** **Cat 4.1**	**Catastrophic** **Cat 4.2**
SAFETY &HEALTH	1 Minor Injury or First Aid	Single MTC	Single LWC or Multiple MTC	Permanent Disability; Multiple LWC	Single Fatality	Multiple Fatalities
ENVIRONMENT	Very minor pollution	Minor local pollution	Evident pollution local concern	Significant local pollution	Major local pollution	Extremely severe pollution
SECURITY BREACH / VULNERABILITY IMPACT	Site problem or off-site< 1000 people alerted	Minor injuries plus off-site impact with < 10000 affected	Site non-fatal injuries 1 month offline or < 100000 people affected at ERPG2 or equivalent level		Site fatality(ies) & injuries plus off-site fatality(ies)> 100000 people affected at ERPG2 or equivalent level; severe disruption	

TABLE 2.2: ORICA FREQUENCY SCALE

Likelihood Descriptor	**Qualitative Description**	**Range (per annum)**
Almost Certain	Will occur at least once a year	> 1
Very Likely	Very likely to occur at least once during a 10 year period of operation of the facility/business	10^{-1} to 1
Likely (possible)	Has occurred at least once during the operating life of the facility/business	10^{-2} to 10^{-1}
Unlikely	Known to have happened within the industry: periodically in small industries and more often in large industries	10^{-4} to 10^{-2}
Very Unlikely	Has occurred somewhere in the world in all related industries	10^{-6} to 10^{-4}
Extremely Unlikely	Could theoretically occur but not aware of any instances	< 10^{-6} (around 10^{-7})

TABLE 2.3: ORICA RISK MATRIX

Likelihood	Consequence / Severity					
	Cat 1	Cat 2	Cat 3.1	Cat 3.2	Cat 4.1	Cat 4.2
Almost certain	Level II	Level II	Level I	Level I	Level I	Level I
Very likely	Level III	Level II	Level II	Level I	Level I	Level I
Likely (possible)	Level III	Level III	Level II	Level II	Level I	Level I
Unlikely	Level IV	Level IV	Level III	Level III	Level II	Level I
Very Unlikely	Level IV	Level IV	Level IV	Level IV	Level III	Level II
Extremely Unlikely	Level IV	Level IV	Level IV	Level IV	Level IV	Level III

TABLE 2.4: DEFINITION OF MATRIX RISK LEVELS AND RESPONSE REQUIREMENTS

Risk Level	Categories	Risk Response Required
Level I Cat 3 & 4	Unacceptable level of risk	Take action within 1 day to 1 month as per Risk Assessment Matrix. If unable to mitigate in required time, notify Chief Executive Officer (CEO) for Category 4 and Business Manager for category 3. {Response would generally require ceasing operations or making significant changes to facilities and procedures}
Level II Cat 3 & 4	Risk may be tolerable in some circumstances	**Existing** operations: Notify Business Manager Take action within 1 month to 1 year as per Risk Assessment Matrix Include hazard scenario and controls in SHE Risk Register Risk Reduction for existing operations would generally require: Developing an improvement plan and demonstrating improvement over 5 year Periodic Hazard Study (PHS) cycle; Use of "as low as reasonably practicable" (ALARP) concept and cost benefit analysis assessment to justify plans; Consideration of the number of other Category 3 & 4 Level II risks on the site; and Upgrades funded by normal sustenance capital program and improved procedural control systems and facilities. New operations Risk reduction for **new operations** would generally require: Improved design to reduce risk to Level III or lower; or If Level III is not achievable, justification by ALARP and specific approval by Sanction authority.
Level II Cat 1 & 2	Risk may be tolerable in some circumstances	Notify Site and/or Facility Manager Take action within 1 month (or specified period) to mitigate risk Response would generally require focus on minor improvements to facilities, administrative controls and behavioural training/awareness, consistent with the hierarchy of controls.

Risk Level	Categories	Risk Response Required
Level III Cat 3 & 4	Acceptable level of risk where further risk reduction is not practicable	For Category 3 & 4 risks, consider risk reduction opportunities in 5 year PHS cycle (refer to MP-ET-004); Include hazard scenario and controls in SHE Risk Register. *NOTE: Referred to as "LOW" risk in context of this report*
Level IV Cat 1 to 4.1	Generally trivial level of risk :	Further risk reduction may not be practicable; _Reduce wherever practicable *NOTE: Referred to as "VERY LOW" risk in context of this report*

2.9. Risk Criteria

Risk criteria can be expressed in a qualitative or quantitative form. For this study the risk level is compared to the DoP quantitative criteria in HIPAP No. 4 *Risk Criteria for Land Use Safety Planning* (Ref 5), as well as to Orica's qualitative internal risk acceptance levels described above.

The DoP quantitative risk criteria are summarised in Table 2.5. They are expressed in terms of individual fatality risk, or likelihood of exposure to threshold values of heat radiation, explosion overpressure or toxicity.

TABLE 2.5: NSW RISK CRITERIA

Description	Risk Criteria (per year)
Individual Fatality Risk	
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6}
Fatality risk to residential and hotels	1×10^{-6}
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6}
Fatality risk to sporting complexes and active open spaces	10×10^{-6}
Fatality risk to contained within the boundary of an industrial site	50×10^{-6}
Injury / Irritation	
Fire / Explosion Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6}
Toxic Injury - Toxic concentrations in residential areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year	10×10^{-6}
Toxic Irritation - Toxic concentrations in residential areas should not cause irritation to eyes, or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year	50×10^{-6}

For completeness the HIPAP No. 4 escalation criteria associated with fire and explosion events are shown below. There are no significant inventories of flammable or combustible materials at the remediation facility hence there is no significant risk of an incident in the remediation facility escalating to other surrounding facilities. The remediation facility will therefore comply with the escalation criteria.

TABLE 2.6: NSW FIRE / EXPLOSION ESCALATION CRITERIA

Description	**Risk Criteria (per year)**
Escalation	
Incident heat flux radiation at neighbouring potentially hazardous installations or land zoned to accommodate such use should not exceed a risk of 50 per million per year for the 23 kW/m^2 heat flux contour	50 x 10^{-6}
Overpressure at neighbouring potentially hazardous installations or the nearest public building should not exceed a risk of 50 per million per year for the 14kPa overpressure contour	50 x 10^{-6}

3. SITE DESCRIPTION

3.1. Site Location

The BIP was formerly a single site (operated and owned by ICI Australia Operations Pty Ltd, ICI), however has been subdivided into a number of areas corresponding to the main chemical complexes on the site. These areas are owned by or leased to the various operators including Orica, Qenos and Huntsman Corporation Australia Pty Ltd (Huntsman), as well as other non-manufacturing companies. The remediation works will take place in two main locations on the BIP:

- The CPWE area (owned by Orica). This is an L-shaped area in the north east of the BIP site. It is mostly covered in bitumen with some landscaped areas around the perimeter. In the past it was used as a car park, mainly during the construction of the Qenos Olefines facility and by Olefines facility employees. However, for security reasons (vandalism of employees cars) the car park is no longer used. An Excavation Soil Building (ESB) will be constructed in this area. All excavation activities will take place within the ESB.
- The former Propathene Plant area (owned by Orica). This is located south west of the CPWE, within the BIP, between 11th Street and 9th Street close to the Qenos Olefines facility. Access is via Gate 4. The soil pre-treatment and remediation (DTD) process will be located within this area. The Propathene Plant has been previously demolished and the area is effectively clear. (Some minor surface works are required). A Feed Soil Building (FSB) will be constructed where all soil preparation activities will take place. The DTD Plant will also be constructed in this area. The prepared soil from the FSB will be fed directly to the DTD Plant by conveyor. Treated soil will be stockpiled in this area. Any excess treated soil will be stockpiled to the east of the former Propathene Plant area.

Transport of excavated material from the ESB to the FSB would be undertaken by covered truck on internal BIP roads. For further details, refer to the layout drawings in APPENDIX 1.

3.2. Surrounding Land Uses

The CPWE area is on the perimeter of the BIP, bounded by Corish Circle to the east and neighbouring industrial land to the north and west. Access is via internal roads on the BIP or via a gate (Gate 8) in Corish Circle.

The BIP (more specifically, the Qenos Olefines facility) is to the south. Hensley Athletics Field is to the east across Corish Circle and is used for various recreational and sporting activities.

Relevant neighbouring land uses are summarised in Table 3.1.

TABLE 3.1: SUMMARY OF NEARBY LAND USES

Land Use	Occupants	Distance from CPWE/ DTD plant area	Direction from CPWE / DTD plant
HIPAP 4 land use categories for individual fatality risk criteria			
Residential	General residential	Denison Street ~ 160m Eastlakes / Pagewood ~ 400m	east / south east north west
"Sensitive "	Banksmeadow Public School Matraville Public School Pagewood Public School Childcare facility at Eastgardens	Brighton Street ~ 1000m Beauchamp Road ~ 800m Page Street ~ 600m Wentworth Avenue ~ 250m	south west south east north west north
Recreational	Hensley Athletics Field	Corish Circle ~ 40m	east / north east
Commercial	Eastgardens	Wentworth Avenue ~ 250m	North
Industrial – external to BIP	Corish Circle industrial units	Immediate neighbours in Corish Circle	north
BIP neighbours			
BIP occupants	Qenos Olefines facility	Immediate neighbours in BIP	south / north
Food related industries (as per DOP requirements for EA, Ref 2)			
Food manufacturers	Kellogg Australia Pty Ltd (Kelloggs)	Between Stephen Rd, Swinbourne St and the Botany Goods railway ~ 800m	West
	Nudie Juice	Corish Circle ~150m / 300m	North
	Bakery / food repackaging	Immediately north of CPWE	North
	Soy products	Baker St ~400m	west / north west
	Bakery / patisserie	Baker St ~500m	west / north west

External Neighbours:

The nearest residential areas are in Denison Street around 160 m to the east / south east of the CPWE and in Eastlakes / Pagewood around 400 m away to the north west of the CPWE.

As per the HIPAP 4 definition used for individual fatality risk criteria, "sensitive" land uses usually include schools, hospitals, aged care facilities (e.g. elderly and children, or other locations difficult to evacuate). Banksmeadow Primary School is located approximately 1000 m south west, Matraville Primary School is located approximately

800 m south east and Pagewood Primary school is located approximately 600 m north west of the site. A childcare centre is located at the Eastgardens shopping centre.

In terms of other receptors, food manufacturers are also likely to be concerned about potential impacts (e.g. contamination of ingredients, plant etc in the event of an incident), hence these are included as potentially sensitive land uses in addition to the usual categories defined in HIPAP 4 (i.e. schools, hospitals etc). Identified food related industries are:

- Kelloggs (snack foods, cereals etc) is a food manufacturing facility located approximately 800 m west of the proposed remediation facility (DTD Plant) and 1 km west of the CPWE.
- A juice factory (Nudie Juice) has reopened on Corish Circle, approximately 300 m north of the proposed remediation facility and approximately 150 m north of the CPWE.
- There was also a food distribution company (Gazelle Foods Pty Ltd) in Denison Street, near the corner of Smith Street which is opposite Hensley Athletics Field. The facility no longer exists and the site has been cleared awaiting development.
- A food manufacturing facility (soy products are produced and distributed) exists within 19A Baker Street, located approximately 400 m to the west of the CPWE and approximately 400 m north west of the proposed remediation facility. A bakery/patisserie is also located approximately 500 m north west of the CPWE and approximately 600 m north west of the remediation facility.
- Immediately north of the CPWE is an industrial building leased out to various industrial users, including a bakery and food repackaging company. The remaining businesses are of a general industrial non-hazardous nature.

Eastgardens shopping centre across Wentworth Avenue also has typical food hall outlets. None of these are food manufacturing or repackaging facilities.

Neighbours within BIP:

The nearest BIP neighbour to the CPWE is the Qenos Olefines facility Administration Building immediately to the south and the Olefines car park is located adjacent to the western boundary of the CPWE. The Gate 4 gatehouse, the Olefines canteen and former Propathene Plant Administration Building (currently unoccupied) are also fairly close to the southern boundary of the CPWE.

The closest process operations to the former Propathene Plant area are the Qenos Olefines propane (C3/C4) storage bullets immediately south of 9th Street. ABB Ltd

(ABB) maintenance sheds and workshops are located on the north eastern corner of the former Propathene Plant area.

3.3. Prevailing Wind Direction

As noted in the PAE Air Quality Impact Assessment report (Ref 17), the prevailing wind directions at the BIP site are from the west, north east and southerly directions.

3.4. Security and Access

The existing CPWE area is fenced and accessed via a gate (Gate 8) from Corish Circle. Access from Corish Circle to the CPWE will be blocked for the duration of the remediation works. The primary access to the remediation site is proposed to be via Denison Street (Gate 3) and then by internal (BIP) roads. The secondary access to the site is proposed to be via a gate from Wight Street.

The ESB will be staffed approximately 12 hours per day. The existing fencing will be maintained and a security alarm system installed in the ESB, primarily for protection of equipment. Work procedures will include lock up of building and access gates at the end of the day and security patrols overnight.

The BIP is a secure site with controlled access for vehicles via a security gatehouse at Gate 3 and turnstile access for inducted personnel with swipe cards at other points. The nearest turnstile to the proposed works area is at Gate 4. Access for visitors must be pre-arranged with security and visitors escorted from the security gate into the site by a BIP-inducted person with a current access pass. The former Propathene Plant area is within the secure area of the BIP and the FSB will be manned 24 hours per day.

3.5. BIP Site Systems

The BIP is a well-established chemical manufacturing site. The proposed remediation facility will draw on existing BIP site and Orica infrastructure and services to help minimise potential safety or environmental impacts associated with the proposal. Relevant systems are briefly described in the following section.

3.5.1. Emergency Response

Each operating plant on the BIP has an emergency response plan linked to the overall BIP integrated Emergency Response Plan (ERP). The basic philosophy is that local incidents are handled at the plant level by staff trained to implement measures such as spill containment and first aid firefighting (e.g. use of extinguishers or monitors). Incidents more severe than this will involve response by the Botany Emergency Response Team (BERT) via alert to Gate 3 security, and by the emergency services, initiated by alarms to the Fire Brigade.

A dedicated ERP for remediation facility covering ESB, FSB and DTD Plant operations will be developed prior to operations commencing. Other operators within the BIP whose operations could impact the proposed remediation area (specifically the Qenos Olefines facility) will update their ERPs as required. The ABB ERP and the integrated BIP ERP will also require updating.

It is noted that the recently enacted NSW OHS (Dangerous Goods Amendment) Regulations require that emergency services be consulted about emergency plans. Consultation with the Fire Brigade will be undertaken as part of preparing the remediation facility ERP and updated BIP ERPs. The CPWE remediation facility ERP would be based on the ERP in place at the former Allied Feeds site (Rhodes).

3.5.2. Fire Protection

Firewater piping, hydrants and monitors supplied by firewater from the existing BIP firewater supply system (storage tanks, ring main and pumps, with top up from towns water) already exist in the former Propathene Plant area proposed for the processing areas of the remediation facility.

As a minimum, fire detection and protection required by the Building Code of Australia (BCA) and relevant Australian Standards (AS) will be provided. The Fire Brigade are normally able to attend the site within 10 minutes of an alarm. (Nearest station is Banksmeadow). As the detail design phase of the project progresses, a detailed Fire Safety Study (FSS) that satisfies the DoP’s guideline *HIPAP No. 2 Fire Safety Studies* will be prepared (as is usually required by project conditions of consent).

3.5.3. Effluent Collection and Treatment

There is potential for contaminated effluent (chlorinated hydrocarbons, CHC, and sediment contamination) to be generated from DTD Plant process pads area, truck wheel washes and water accumulation in the synthetic liner. Additional effluent handling facilities will be provided for this project to ensure that all effluents comply with relevant EPL conditions.

Treated effluent from the CPWE remediation facility may be discharged to the BIP effluent system. In this case, the quality of the water from the CPWE treatment plant would be monitored before discharge to the BIP system to ensure BIP effluent quality remains in accordance with licence conditions.

There is also scope for re-use of treated CPWE effluent within the remediation process and this option will be taken if detailed review shows that it is practicable.

3.5.4. Stormwater Management

Only uncontaminated rainwater from building roof areas will be permitted to flow to stormwater drains. All other runoff is considered potentially contaminated hence is treated as effluent.

Again, there is potential to capture stormwater for use for activities such as treated soil re-wetting and this option will be taken if detailed review shows that it is practicable.

4. PROJECT DESCRIPTION

As noted previously the design is preliminary and a number of options are still being reviewed. The information below has been summarised from Thiess' Scope of Works document for the project (Ref 6).

4.1. Overview

The remediation project involves:

- Construction of a ventilated excavation building (ESB) fitted with an Emission Control System (i.e an ECS comprising dust filters, carbon beds, ventilation fan and stack) in the CPWE area and excavation of contaminated material within the ESB.
- Construction of the FSB fitted with an ECS (similar to the one for the ESB) in the former Propathene Plant area. All excavated material will be transferred from the ESB to the FSB for sampling and pre-blending to achieve a consistent feed to the DTD Plant.
- Construction of the DTD Plant adjacent to the FSB in the former Propathene Plant area. Contaminated material will be fed by conveyor from the FSB to the DTD Plant for destruction of contaminants.

Some activities within the ESB and FSB will operate 12 hours per day (7 am to 7 pm) six days per week, and others, e.g. the ECS, will operate 24 hours per day. The DTD Plant will operate continuously, i.e. 24 hours per day.

All buildings and plant will be removed on completion of soil remediation. An overview of the remediation process is shown in the flow diagram in APPENDIX 1.

4.2. Timing

Overall, the remediation project is expected to take 18 months. Of this, approximately half the project duration will involve excavation and processing the excavated material in the DTD Plant. The remainder of the project duration is construction, and decommissioning and removal of the facility. Restoration of the CPWE area will also take place after clean soil is reinstated and the ESB is removed.

4.2.1. Excavation Soil Building

The ESB may be a single large building or a smaller building that is relocated in up to five stages depending on the outcome of detailed design studies and costings. The maximum impact in terms of noise and contaminant emissions will be for the five stage scenario hence this has been selected for the EA assessment.

Activities in the ESB involve excavation of the bitumen layer, sand and encapsulated material, exposing contaminants and creating an emission from the exposed surface. The face will be covered with the CPWE synthetic liner and sealed as best as possible to minimise these emissions. If the liner cannot be reused, then alternatives such as covering the face with High Density Polyethylene (HDPE) or by some other appropriate means would be used to control the emissions. This will be addressed during the detailed design. The CPWE synthetic (Hypalon) liner will also be removed and either processed in the DTD Plant, or landfilled if validation shows that it is suitable for off-site disposal.

The plant in the ESB will include an excavator, loader and grizzly screen operating for 12 hours per day. Personnel will include one operator for each plant item (excluding the grizzly), plus a manager and general hand. Three tip trucks (each with dedicated operator) will transport the soil to the FSB. Self Contained Breathing Apparatus (SCBA) will likely be required in the ESB to ensure that personnel are not exposed to any contaminants exceeding Occupational Exposure Levels (OELs).

As previously stated, the ESB will be vented through an ECS comprising dust filters and two stage carbon beds. Air will continuously be drawn into the ESB, with the ESB ECS nominally sized at 90,000 m^3/hr, determined principally by OHS considerations for various oxides of nitrogen (NO_x) and carbon monoxide (CO) emissions from machinery in the building. The ESB ECS will be located in the Qenos Olefines facility car park and cleaned air will be exhausted via an elevated stack.

The building will have an IN / OUT airlock(s) plus an automated wheel wash on the exit to prevent contaminants being transferred outside the building. Some water may be removed from under or above the synthetic liner. The ESB will be serviced by a Water Treatment Plant (WTP) to process CPWE seepage and truck wheel wash water. The water will be treated to a standard to enable reuse in the wheel wash, on treated soil for rehydration, or alternatively for disposal to the BIP effluent system or direct to sewer.

4.2.2. Transport to Feed Soil Building

Transport from the ESB to FSB will be by truck, which will be covered and decontaminated prior to exiting either the ESB or FSB.

There will be six truck loads per hour assuming 12 tonne payload, operating 12 hours per day (864 tonnes per day) with a 20 to 30 minute turnaround. All truck transport will occur within the BIP and all loads of contaminated material will be covered. There will be no use of external roads (e.g. Corish Circle).

4.2.3. Feed Soil Building

The FSB will be located in the former Propathene Plant area. The plant in the FSB will include an excavator, and power screen operating for 12 hours per day and a loader operating 24 hours per day. A loader will also operate outside the FSB in the DTD plant area moving stockpiles 12 hours per day. Personnel will include one operator for each plant item (excluding the screen), plus a manager and general hand. SCBA will likely be required in the FSB to ensure that personnel are not exposed to any contaminants exceeding OELs.

Excavated material will be stockpiled in the FSB for sampling. It will then be blended to achieve a relatively consistent feed (calorific value and contaminant load) to the DTD plant. Blended material will be loaded into a feed hopper to the covered conveyor in the FSB and fed to the DTD Plant at a rate of up to 35 tonnes per hour. The plant operating in the building will include trucks delivering soil, loaders for soil stockpiling / blending and a conveyor.

There is potential for excavation to uncover oversize materials such as concrete, steel, corroded drums and timber impregnated with volatile CHCs (e.g. ethylene dichloride from the former Vinyls Plant). This material will be segregated in the FSB. All oversize materials will be screened, segregated, washed (steel only), tested and recycled, or if appropriate, disposed to an appropriate off-site waste facility. If treatment is required, the material will be shredded (drums and timber) or crushed (concrete) and blended with the CPWE feed soil.

As for the ESB, it is anticipated that SCBA will be required in the FSB to ensure that personnel are not exposed to any contaminants exceeding OELs.

The FSB will include an IN / OUT air lock(s), wheel wash, decontamination sheds for the FSB and DTD Plant operators, and an ECS for the building (nominal ventilation rate up to 60,000 m^3/h). The FSB ECS will continuously draw air into the FSB via louvres. The air flows via the FSB ECS dust filters and carbon beds, and the cleaned air is exhausted through the FSB ECS elevated stack.

4.2.4. DTD Plant

The DTD Plant will have an instantaneous throughput of up to 35 tonnes per hour or approximately 25 tonnes per hour on average (600 tonnes per day) allowing for maintenance based on 24 hours per day operation. The process includes:

- a rotary dryer to volatilise contaminants
- a Thermal Oxidiser (TO) to destroy the contaminants
- a quench and acid gas scrubbing system to control dioxin formation and acidic gases respectively to below EPL limits

- a cyclone and baghouse to control dust emissions.

An overview of the DTD process is shown in the block diagram in APPENDIX 1.

Rotary Dryer

A natural gas directly-heated rotary dryer operating at a soil treatment temperature of between 350 - 450^{o}C (depending on results of commissioning trials) heats the CPWE soil. An air blower supplies combustion air. The air is normally drawn from inside the FSB. The blower FSB air inlet is equipped with a hydrocarbon gas detector and will automatically alarm and divert to the atmospheric air intake if high hydrocarbon levels are detected.

The dryer will be around 12 m long and operate at a speed giving a residence time of 10 to 20 minutes. Contaminants desorb and volatilise as they pass along the dryer. Soil is heated in the first third of the dryer length and most desorption and volatilisation occurs in the next third of the dryer as contaminants reach their boiling points. Water is also vaporised resulting in a hot wet combustion gas flow.

Soil Handling

Hot soil from the rotary dryer passes to a pugmill where it is sprayed with water for cooling and rewetting. Treated soil is then transferred to stockpiles, which are then validated. Once validated, material can be reused.

Cyclone and Thermal Oxidiser

Hot exhaust gases flow from the rotary dryer through a cyclone to the TO. Dust from the cyclone goes to the pugmill where it is combined with the soil from the dryer.

The TO is a natural gas-fired forced-draught appliance operating at around 1,000 ^{o}C. At this high temperature, the contaminants oxidise or decompose forming carbon dioxide (CO_2), water vapour, hydrogen chloride (HCl) and small amounts of chlorine (Cl_2). The TO will have a best practice destruction efficiency for CHCs. It will be equipped with a sophisticated temperature control system to ensure that operating conditions remain within the range required to maximise destruction efficiency and minimise by-product formation.

Very small quantities of uncombusted contaminants and by-products of combustion (such as dioxins) will remain in the combustion gases from the TO.

Quench

The hot gases from the TO are drawn into the quench by the Induced draught (ID) fan (at a nominal flow rate of around 20,000 m^3/hr). Water is injected at about 10 m^3/hr to rapidly cool the hot combustion gases to temperatures suitable for downstream equipment. Rapid cooling also minimises the potential for dioxin formation due to recombination of combustion products or products of incomplete combustion.

The *Hexachlorobenzene Waste Management Plan November 1996* (ANZECC, 1996 Ref 7) requires that emissions of dioxins to atmosphere from the destruction of scheduled HCB wastes shall not exceed 0.1 ng TEQ/m^3. This is the design performance standard for dioxin emission from the DTD Plant.

Baghouse

The cooled exhaust gas is combined with steam from the pugmill and is drawn by the ID fan through the baghouse. The baghouse contains a series of fabric filters which remove most particulates. If required, activated carbon may also be blown into the baghouse to coat the fabric filters and assist with removal of mercury which is present in the feed soil. The need for this control technology will not be known with certainty until commissioning trials have been completed, but provision will be made for the necessary hardware.

Acid Gas Scrubber

The exhaust gas passes through the ID fan into the acid gas scrubber. The scrubber will be a packed tower with a re-circulating caustic soda (sodium hydroxide, NaOH) solution that reacts with the HCl vapour and Cl_2 in the exhaust gas forming a salt solution. The clean gas is then vented to atmosphere via the acid gas scrubber stack.

A saline bleed stream from the scrubber solution will be taken off and used to rewet the treated soil in the pugmill (assuming soil quality is not compromised) or sent to effluent. A clean water makeup stream is fed to the scrubber to replace the bleed.

Caustic soda for the scrubber will most likely be supplied as a 46% solution from the Orica ChlorAlkali Plant at the southern end of the BIP. Storage of caustic will be dependent on the volume and usage required (i.e in a bulk vessel such as an Isotainer or in smaller 1,000 L packages such as IBCs). Appropriate bunding will be provided for any storage facility.

4.2.5. Clean Soil

Treated soil will be stockpiled at the southern end of the former Propathene Plant area. There will also be an additional stockpile area to the east of the former Propathene Plant area, adjacent to the Gate 4 car park area.

Perimeter drains and bunds will be provided to manage runoff, and stockpiles will be grassed or covered to manage dust and sediment. Clean soil will be used to reinstate the CPWE area and may also be used for beneficial re-use elsewhere on the BIP. Transport of clean soil will be by truck within the BIP.

4.3. Plant Control

The ESB and FSB building ventilation systems will have instrumentation and stand-alone Motor Control Centers (MCC) for the fans. A number of interlocks and alarms will be provided. Any ventilation system alarms will activate flashing lights and audible alarms in the relevant building. Failure of a ventilation system will mean that work and processes within the affected building will stop, and the building will be evacuated as these ventilation systems are a key OHS control for workers in the buildings.

The DTD Plant will be controlled via a Programmable Logic Controller (PLC) with operator panel interfaces. Burner Management Systems (BMS) will be provided for the gas fired equipment.

4.4. Plant Shutdown

There will be many alarm and information trending functions on the plant. Some critical alarms result in a condition known as the Automatic Soil Feed Shut Off (ASFSO). This means stoppage of the feed conveyor to the rotary dryer, minimising the quantity of contaminated soil in the rotary dryer / DTD Plant, hence minimising the quantity of any emissions in the event of a plant failure or upset condition.

Conditions which result in an ASFSO are:

- failure of the soil conveying device
- high pressure in the rotary dryer
- high soil feed rate to the rotary dryer
- low treated soil temperature
- low TO temperature
- flame failure of any of the burners (rotary dryer, TO)
- high baghouse inlet temperature
- low acid gas scrubber water flow
- ID fan failure
- process water supply failure
- any utilities failure such as power, natural gas or water outage.

4.5. Utilities

Natural Gas

Natural gas for the rotary dryer and TO will be supplied to the DTD Plant by underground pipe from the existing reticulation system on the BIP. An isolation valve will be provided at the remediation facility battery limit.

All gas piping and BMS will be designed and installed in accordance with relevant Australian Standards for industrial gas-fired appliances, and be approved as required by the relevant regulatory authority. No alternative or back-up fuels will be used.

A loss of gas supply would automatically initiate a shutdown of the DTD Plant.

Power

During normal operations all power for the plant will be supplied from the BIP grid. A power failure results in all equipment stopping.

A backup diesel generator will be provided to enable restart of critical equipment and a controlled shutdown. The generator will be sized to run critical equipment such as the ID fan, quench water and acid gas scrubber pumps. Switchover to the backup power will be initiated by the operator, which will initiate the restart sequence required for a safe shutdown. The ID fan, water quench and acid gas scrubber circuit and the soil conveying equipment comprising the dryer and the equipment downstream of the dryer are started. Note that the soil supply conveyor to the rotary dryer cannot be restarted on diesel power supply. The plant then undergoes a controlled shut down.

A battery operated Uninterrupted Power Supply (UPS) will be provided for the control system.

Diesel

Diesel will be required for plant equipment such as excavators and loaders, as well as the backup generator. As per current practice for the BIP, all re-fuelling will be by mini-tanker in a dedicated area. No diesel storage will be provided.

Potable Water

Water will be supplied from the existing BIP towns supply to a break tank at the DTD Plant. It will be then be pumped from the break tank to the quench and acid gas scrubber. The quench will be provided with a backup water tank pressurised by air cylinders to cater for loss of main water flow.

5. HAZARD IDENTIFICATION

5.1. Hazardous Materials

5.1.1. CPWE Soil

The CPWE soil is a sandy soil contaminated with various semi-volatile and volatile CHCs. Boiler ash containing low levels of heavy metals such as mercury is also mixed in with the CPWE. An MSDS for the CPWE soil is contained in APPENDIX 2. Table 5.1 gives a typical composition (Ref 8).

Due to the presence of HCB, the CPWE material is classified as Schedule X Waste under Australia's national approach to regulating "intractable waste" (Ref 1), and is a scheduled waste under the 2004 Chemical Control Order issued under the EHC Act. As per the MSDS, the CPWE soil is not a Dangerous Good (DG) under the Australian Dangerous Goods Code (ADG). The main contaminants in the CPWE are listed in Table 5.1.

TABLE 5.1: TYPICAL CPWE SOIL COMPOSITION

Material	**Typical Concentration (MSDS,** APPENDIX 2.**)**
Hexachlorobutadiene (HCBD)	< 1 %
Total chlorinated hydrocarbons including: Hexachlorobenzene (HCB) Hexachloroethane (HCE) Tetrachloroethene (PCE) Octachlorostyrene (OCS)	< 0.1 %
Heavy metals	< 1%

The most significant characteristics common to the chlorinated materials in the CPWE material are:

- all (except OCS) are considered to be carcinogens or suspected carcinogens by most health authorities.
- the occupational exposure standards of the all materials are extremely low.
- the majority of the substances can be absorbed via skin contact.
- these chemicals do not have significant acute physiological effects (i.e. are not immediately irritating or toxic due to a one-off exposure in the sense that substances such as chlorine and ammonia are).

Also, some of the chlorinated chemicals and heavy metals are bio-accumulative (i.e. persistent pollutants).

5.1.2. Combustion Products

Hydrogen Chloride

Hydrogen chloride (HCl) is a severely irritating toxic gas with a pungent odour. It has the potential to cause acute toxic effects (e.g. severe irritation, burns to eyes, mucous membranes, pulmonary oedema and other respiratory damage resulting in fatality). It is classified as Class 2.3 under the ADG. Cl_2 has similar properties but will be formed in much smaller quantities than HCl so is not considered in isolation.

Dioxins

As noted previously dioxins can be formed in very small quantities as a by-product of combustion processes such as will occur in the TO. The term “dioxins” describes a group of compounds that belong to the larger family of persistent organic pollutants. These compounds share similar chemical structures, properties and biological characteristics including toxicity. These compounds can accumulate in the body fat of animals and humans and tend to remain unchanged for long periods (Ref 9).

The World Health Organization (WHO) has advised that short-term exposure of humans to high levels of dioxins may result in skin lesions and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions. Chronic exposure of animals to dioxins has resulted in several types of cancer. Based on human epidemiology data, (for a specific dioxin compound, 2,3,7,8-tetrachlorodibenzop-dioxin or TCDD) dioxin was categorised by International Agency for Research on Cancer (IARC) as a "known human carcinogen". However, it does not affect genetic material and there is a level of exposure below which cancer risk would be negligible. (Ref 10).

5.1.3. Natural Gas

Natural gas is a non-toxic flammable lighter than air gas, primarily methane. It has a flammable range in air of approximately 5-15 vol%.

5.1.4. Caustic Soda

Caustic soda (NaOH) is a corrosive material and will be handled as an aqueous solution. It is a Class 8 PGII material under the ADG. The main hazards are its potential to cause human tissue corrosive or chemical burns, and to alter the pH in the environment if a spill occurs. It has no potential to cause significant impact to people or the environment outside the immediate area of a spill. Controls such as bunding and safety showers will be in place. It is not considered further in the PHA as the effects of any incidents will be confined to the immediate area.

5.1.5. Occupational Exposure Limits

For reference, a summary of worker OELs is given in Table 5.2 (Ref 11). The OELs are aimed at ongoing worker exposure over a working life rather than an acute one-off exposure due to an incident, however they do provide an indicator of material toxicity. The values are for pure components, not mixtures of chemicals as they occur in the CPWE material.

TABLE 5.2: SUMMARY OF WORKPLACE EXPOSURE STANDARDS (REF 11)

Chemical	TWA	STEL	Poisons Schedule	Carcinogen Category
HCB	0.002 mg/m^3 Sk	-	S7	Cat 2, A3
HCBD	0.02 ppm Sk	-	NS	Cat 3, A3
HCE	1 ppm	-	NS	Cat 3, A3
PCE	50 ppm	150 ppm	S6	Cat 3, A3
OCS	-	-	NS	-
HCl	-	2 ppm Peak	NS	-
Dioxin (as TCDD)	OELs not defined.	Various	Various	

TWA =	8 hr Timed Weighted Average exposure limit
STEL =	Short Term Exposure Limit for 15 Min exposure
Peak Limitation	Maximum or peak concentration to which workers may be exposed.
Sk =	Skin notation to indicate that toxic quantities absorbed through intact skin.
NS =	Not a scheduled poison
-	not applicable

5.1.6. Acute Toxic Effects

Acute toxic effects (i.e. immediate irritation, serious injury or fatality due to short duration one-off exposures) are not associated with one-off exposures to the low levels of CHCs as they occur in the waste.

The possible toxic combustion products of CHCs (primarily HCl) do have the potential to cause acute effects. The values used to assess the impact associated with events involving a release of HCl are summarised in Table 5.3.

Fatality

Probability of fatality is usually estimated using probit equations of the form shown below. Probits can be converted to probability of fatality using the error function transform. Refer to Table 5.3 for the probit constants for HCl.

$$Pr = A + b \ln(c^n t)$$

$$\text{Probability} = 0.5(1 + \text{erf}(\frac{Pr - 5}{\sqrt{2}}))$$

Injury / Irritation

HIPAP No 4 injury and irritation risk criteria for toxic exposure were given in Table 2.5. The PHA makes the interpretation that "injury" and "irritation" threshold concentrations can be represented by Emergency Response Planning Guidelines (ERPG), and, if these have not been defined for a particular material, by Temporary Emergency Exposure Levels (TEEL) based on limited information.

- *Serious Injury:* occurs due to toxic exposure to the ERPG-2 concentration. ERPG-2 is defined as the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.
- *Irritation:* occurs due to toxic exposure to ERPG-1 concentration. ERPG-1 is defined as the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odour.

This is considered a very conservative approach as ERPGs are defined for 1 hour exposure durations and the plant upset events are generally of a shorter duration.

ERPG levels have been set for the potential toxic combustion products as well as HCBD. TEELs have also been published for HCB and HCE and are included in Table 5.3. Note that ERPGs are not defined for mixtures.

TABLE 5.3: IMPACT LEVELS FOR TOXIC IMPACTS

Material	**Concentration**			
	1% Fatality at 15mins exposure		**Serious Injury**	**Irritation**
	Probit (Ref 12) (ppm^n min)	ppm	ppm (ERPG2 Ref 13)	ppm (ERPG1 Ref 13)
Hydrogen Chloride (HCl)	-35.76+3.69ln(ct)	2,223	20	3
Hexachlorobenzene (HCB) (Notes 1,2)	Not applicable	-	1 mg/m^3	0.006 mg/m^3
Hexachlorobutadiene (HCBD)	Not applicable	-	3	1
Hexachloroethane (HCE) (Note 1)	Not applicable		5	3
Tetrachloroethene (PCE) (Note 3)	Not applicable	-	230	35

Notes:
1. TEELs
2. Units for HCB are mg/m^3 as it is a solid (dust), TEEL1 = 0.006 mg/m3, TEEL2 = 1 mg/m^3
3. Interim ERPGs

5.2. Potential Hazardous Incidents

The hazardous incidents associated with proposed facility were primarily identified during the Orica HS 1 and 2 workshops for the project. The HS 1 and 2 workshops (held in July 2006) were attended by experienced Orica and Thiess personnel, including the design engineer, engineering manager, technical manager and operations personnel, the project manager, an occupational hygienist and site environmental representative and were chaired by a Sherpa facilitator.

It should be noted that facilities of this nature have been operating for about 20 years and have undergone a number of refinements and improvements through the application of techniques such as Hazard and Operability reviews (HAZOP) and these are now incorporated into the design of modern plants. Thiess personnel attending the HS workshops had significant design and operational experience with modern DTD plants, such as the DTD Plant currently operating at the former Allied Feeds site (Rhodes).

The hazard studies were supplemented by a review of previous studies associated with the HCB wastes on the BIP site (which includes other types of HCB waste apart from the CPWE). Included in the review were the PHA prepared for a previously proposed HCB waste destruction facility (Geomelt, Ref 14) and the report from the Independent Review Panel (IRP) for HCB Waste Destruction (Ref 15).

The information has been compiled into Hazard Identification and Risk Assessment Control (HIRAC) tables showing the risk event, causes, consequences, likelihood and controls in place. The compiled information is contained in APPENDIX 3.

Note that safeguards and controls agreed as part of the hazard study process have been included as “in-place” for the proposed design, hence a list of separate recommendations is not included in this PHA report. It is also noted that once the detail design process is well advanced, a HAZOP will be conducted which may result in additional controls being included in the design.

5.3. Representative Incidents

The scenarios were grouped into representative incidents as summarised in Table 5.4. This table does not cover all identified scenarios. Those rated as very low risk (Level IV in the Orica risk matrix), or not related to the nature of the waste (for example general industrial OHS issues such as interaction between pedestrians and heavy vehicles) are not discussed in the PHA (refer to APPENDIX 3 for all scenarios).

In some cases potential consequences of a scenario have been quantitatively assessed within the PHA. If off-site effects were predicted to occur, a frequency estimate is also given to enable a quantitative risk estimate to be made and compared to the risk criteria. If no off-site effects are predicted for a scenario (i.e the consequence is effectively zero in the context of the risk criteria used for a PHA), the risk is considered minimal and the event frequency is not quantified.

Other scenarios have been noted as included in the URS HHIA or PAE Air Quality Impact Assessment for further review (though not necessarily quantification). This is because the effects were chronic or long term, rather than acute which is the focus of the PHA.

The scenarios are discussed in more detail in the text following the table.

5.4. Dispersion Model

It is noted that all quantitative dispersion calculation results discussed in the PHA have been reproduced from the PAE air quality impact report which were produced using an advanced three dimensional dispersion model, CALPUFF.

Refer to the PAE Air Quality Impact Assessment (Ref 17) for full details of the CALPUFF model.

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TABLE 5.4: SUMMARY OF REPRESENTATIVE INCIDENTS

Event	Scenario Description	Controls (reducing magnitude, duration, frequency)	Qualitative Risk Rank	ID HAZID Tables (APPENDIX 3)	Discussed in PAE Air Quality study?	Discussed in URS HHIA?	PHA report Section
1.Ventilation failure in ESB or FSB leading to emissions from buildings.	Fan failure leads to loss of airflow into buildings. Emission of volatile components from exposed soil surfaces via any building apertures.	ESB and FSB ECS fan failure alarmed (lights and sound). Operator will manually shut down louvres (procedure). Building doors will automatically close.	III (low)	3,6	No	Yes	5.5
2. Ventilation exhaust carbon bed failure in the ECS for the ESB and FSB leading to emissions of contaminants from the ECS stack(s).	Breakthrough of carbon beds (e.g. wrong material, bed saturated, failure of sampling regime) resulting in emissions of contaminants (diluted by ventilation airflow) from ECS stack(s).	Air is preheated to prevent condensation. Capture efficiency is high for HCBD (most volatile and highest concentration contaminant). Carbon beds sized to take full load in one bed. Two stage bed (in series).	IV (very low)	4,7	No	Yes	5.5
3. Failure of natural gas supply or spurious BMS trip leading to shutdown of DTD Plant and continued volatilisation of contaminants, release of partially treated emissions.	Continued volatilisation of hydrocarbons in rotary dryer until cooled below relevant boiling points, carried over to TO and not fully combusted. Dioxin formation due to falling temperature in TO. Uncombusted CHCs and dioxin exhausted via acid gas scrubber stack.	Automatic shutdown of feed conveyor to DTD Plant on natural gas failure, limiting inventory of contaminants. Stop rotary dryer. Quench, baghouse and acid gas scrubber continue to operate providing at least partial treatment of HCl & organic compounds.	III (low)	15	Yes	Yes	5.7

Event	Scenario Description	Controls (reducing magnitude, duration, frequency)	Qualitative Risk Rank	ID HAZID Tables (APPENDIX 3)	Discussed in PAE Air Quality study?	Discussed in URS HHIA?	PHA report Section
4. Operating malfunction in TO leading to poor destruction efficiency and/or dioxin formation.	Loss of quench water, poor temperature control resulting in poor TO efficiency, e.g. CHC breakthrough, dioxin formation.	Temperature monitoring in TO / quench. Low water flow alarm and auxiliary water supply tank with pressurised air cylinder to provide driving force if power failure occurs. High temperature alarm and trip will stop soil feed conveyor and initiate controlled DTD Plant shutdown.	III (low)	16, 17	Yes	Yes	5.7
5. Power failure leading to DTD Plant shutdown.	ID fan stops. Emission of hot untreated contaminant gases from the rotary dryer. Potential for operator injury and untreated contaminant gases outside remediation area.	Backup diesel power generator for critical emission controls (ID fan, quench water, acid gas scrubber). Allows restart of ECS and at least partial treatment of emissions and controlled plant shutdown. Control system UPS.	III (low)	22	No	No	5.7
6. Failure of acid gas scrubber leading to HCl emissions from scrubber stack.	Failure of caustic supply / strength / circulation flow leading to loss of scrubbing capability and HCl breakthrough from the acid gas scrubber stack.	Alarms on loss of flow, high HCl concentration from the scrubber stack. Auto stop soil feed conveyor and initiate controlled DTD Plant shutdown if scrubber pH limits exceeded or loss of circulation flow.	III (low)	18	Yes	No	5.7

Event	Scenario Description	Controls (reducing magnitude, duration, frequency)	Qualitative Risk Rank	ID HAZID Tables (APPENDIX 3)	Discussed in PAE Air Quality study?	Discussed in URS HHIA?	PHA report Section
7. Failure of piping / ductwork from the rotary dryer.	Mechanical failure of piping from the rotary dryer leading to release of hot gas containing CHCs to atmosphere.	Appropriate materials and installation quality assurance (QA). No corrosion, highly visible, daily inspection.	III (low)	13	No	No	5.7
8. Mechanical failure of equipment downstream of quench.	Mechanical failure of piping, baghouse, scrubber ex quench leading to release of HCl to atmosphere.	Weekly inspection on planned shutdown, daily check of scrubber water quality. Appropriate materials of construction	III (low)	13	No	No	5.7
9. Natural gas leak and subsequent fire.	Mechanical failure or impact on gas piping causes leak, subsequent ignition and torch fire.	Low pressure alarm at gas users. Auto shutdown on low pressure via BMS. Battery limit isolation valve. All gas piping outside, confinement and explosion unlikely.	III (low)	9	No	No	5.7
10. Internal explosion in gas fired equipment.	Build-up of flammable gas in rotary dryer or TO due to natural gas leak, or high calorific value feed to dryer, internal explosion, asset damage, operator injury.	BMS for gas fired appliances. Segregation of any non-standard excavated material. Extensive soil sampling and blending to maintain consistent feed calorific value and stay below Lower Explosive Limits (LEL) in dryer. Explosion vent hatches on dryer.	II (due to operator injury potential – no off-site impact)	10,11,14	No	No	5.7

Event	Scenario Description	Controls (reducing magnitude, duration, frequency)	Qualitative Risk Rank	ID HAZID Tables (APPENDIX 3)	Discussed in PAE Air Quality study?	Discussed in URS HHIA?	PHA report Section
11. Spill of contaminated soil during transport within BIP.	Vehicle accident.	Site speed limited. Covered trucks. Spill cleanup procedure.	III (low)	5	No	No	5.6
12. External event impacts FSB / DTD Plant	Incident such as a large flammable gas leak or propane storage/ tanker loading explosion / BLEVE at Olefines causes damage to FSB / DTD Plant.	Mechanical integrity of equipment (materials of construction and preventative maintenance), gas detection and Emergency Shutdown (ESD) at the Qenos Olefines facility. Integrated ERP for remediation facility and Olefines.	II (due to operator injury potential)	26	No	No	5.8

5.5. Failures of the ECS for Buildings

The ESB and FSB will each be provided with an ECS comprising a building ventilation fan, dust filter and two-stage carbon beds (in series) exhausting via an elevated stack. Failure of the ECS in either the ESB or the FSB could be one of two types of event:

1. Failure of building ventilation fan
2. Saturation / breakthrough of ECS carbon beds

5.5.1. Failure of building ventilation fan

Causes include power failure or catastrophic mechanical failure resulting in loss of air inflow, hence loss of capability to exhaust contaminants via carbon beds and building stack. Low velocity diffuse release of volatile contaminants from exposed soil surfaces (within the buildings) could occur via building apertures. (Power failure would also shutdown most operations in the buildings).

Preventative Controls

- Periodic inspection and maintenance of fans.

Mitigation Controls

- Audible and visible alarms on loss of ventilation fan and automatic closure of building doors.
- Attended operation. Building closed at the end of the day shift.
- Operator would shutdown equipment and manually close building louvres within a few minutes. Note that work cannot continue with the ventilation out of action as the fans are required to ensure worker OELs are achieved within buildings. The duration of any emission from the building would be limited to less than 10 minutes. Should ventilation fans not be able to be restarted within a short time, exposed soil surfaces within the buildings could also be covered to further reduce potential emissions.

Residual Risk

Estimates of the total contaminant (i.e total of all volatile CHC compounds) emission rates from exposed soil faces (in the ESB) and stockpiles (in the FSB) range from $6x10^{-5}$ kg/s to $1.5x10^{-4}$ kg/s (calculated from PAE Air Quality Impact Assessment, Tables 6.2 and 6.5, Ref 17).

Assuming these total flows were emitted via unclosed building apertures for a maximum period of 10 minutes gives a total contaminant mass range of around 0.04 kg to 0.09 kg that could be released from all apertures in the ESB and FSB respectively. These are small quantities and given the diffuse, low velocity nature of this type of release, any effects would be local to the building apertures.

Given the small mass that could be released, and the short duration of the event, the risk of acute effects to third parties is regarded as very low and further quantification is not undertaken in the PHA.

5.5.2. Saturation / breakthrough of ECS carbon beds

Building fan is operating normally, but the carbon beds are not adsorbing the contaminants in the exhaust air. If this event did occur, it would result in a point source emission from the ESB ECS stack or the FSB ECS stack. The duration of this event would also be very short because the carbon beds are continuously monitored for breakthrough. Note that this is regarded as a very unlikely scenario, as it would mean that:

- the first carbon bed is saturated (either with hydrocarbons or water); and
- that there is also incorrect, saturated or no carbon material in the second carbon bed.

Preventative Controls

- The carbon beds are sized such that first bed should be sufficient to capture all fumes generated over the facility operating duration.
- No bypasses will be provided around the carbon beds.

Mitigation Controls

- Continuous monitoring of the exhaust gas quality (measuring volatile organics, temperature, pressure and humidity with the sample point cycling between inlet, interstage and downstream sample points from the carbon beds) and an alarm if high levels of contaminants are detected ex the first bed. (Note that an alarm is provided rather than a shutdown function as the capacity of the second bed will continue to absorb contaminants preventing a breakthrough to the environment).
- Weekly check of volatile gas levels before and after the carbon beds (i.e stack) to confirm adsorption effectiveness.
- Dilution from fan air flow and elevated stack effects (even in carbon beds not performing to design).

Residual Risk

As noted previously, estimates of the total volatile contaminant (i.e total of all volatile CHC compounds) emission rates from exposed soil faces (in the ESB) and stockpiles (in the FSB) range from $6x10^{-5}$ kg/s to $1.5x10^{-4}$ kg/s (PAE Air Quality Impact

Assessment, Tables 6.2 and 6.5, Ref 17). Assuming complete breakthrough (i.e zero removal in carbon beds) the total volatile CHC concentration ex the ECS stack is around 0.002mg/m^3 total CHC for the ESB (assuming the nominal fan design rate of 90,000 m^3/hr) and around 0.009 mg/m^3 total CHC for the FSB ECS stack (assuming fan operating at a nominal 60,000 m^3/hr).

Based on the total CHC concentrations, the stack emission concentrations are well below all individual volatile compound acute exposure guidelines given in Table 5.3 which range from a low of 1 ppm (10.8 mg/m^3) for HCBD irritation (HCBD ERPG-1) level, to highest of 230 ppm (1,586 mg/m^3) for HCE injury level (HCE ERPG-2). Hence acute injury or irritation effects for the carbon bed failure scenario are not credible.

Due to the low likelihood of this event, the low concentrations of contaminants and the high rate of dilution by the ventilation air, the risk of acute effects to third parties associated with failure of ESB or FSB building ECS carbon beds is regarded as very low (Level IV) and further quantification is not undertaken in the PHA.

5.6. Transport Incidents (within BIP)

A loss of material from a truck could occur during transport from the ESB to the FSB, for example due to a vehicle accident or loss of the load cover.

As the solid wastes are not dusty, a spill of soil will be contained in the immediate area, and can be readily cleaned up. All transport will be on sealed roads. This is rated as a very minor pollution incident.

Preventative Controls

The following controls reduce the likelihood of an accident resulting in a spill:

- Decontamination and inspection of trucks prior to leaving buildings
- Site speed limit
- Transport during dayshift only

Mitigation Controls

The following controls minimise the consequence of the event:

- Spill response kits, driver trained in their use.

Residual Risk

The risk associated with this incident is considered low to very low (Level III-IV on the Orica scale) and able to be adequately controlled by the proposed safeguards. There would be no effects outside the BIP from this type of incident.

5.7. DTD Plant Incidents

5.7.1. Incomplete Treatment of Contaminants due to DTD Plant Malfunction

The potential causes of higher than design emissions from the DTD Plant stack are:

1. Thermal oxidiser (TO) or quench temperature control failure
2. Quench water flow failure
3. Loss of natural gas supply to the TO

Temperature control failure or quench water failure could result in inefficient destruction and emission control, and elevated contaminant levels (uncombusted chlorinated material and dioxins) being emitted from the DTD Plant stack. Therefore control of the TO temperature to within the optimum range is very important in maximising contaminant destruction, and rapid quenching is very important to prevent recombination of combustion products to form dioxins.

Loss of natural gas supply would result in continued volatilisation of hydrocarbons in the rotary dryer until soil has cooled down below relevant boiling points. Hydrocarbons would continue to be carried over to the TO and not fully combusted. Dioxins would be formed due to falling temperature in TO, leading to uncombusted CHCs and dioxin being exhausted via the stack.

Quantitative Consequence Assessment

Of these causes, Thiess advised that the worst (i.e. largest contaminant mass flow) emission case would result from the loss of natural gas supply (or loss of power resulting in automatic cutoff of the gas supply) and emission of partially treated contaminants from the DTD Plant stack. Hence this case was assessed in the PHA as an upper limit for determining whether acute off-site consequences are possible.

The soil feed is automatically isolated on natural gas failure, limiting the contaminant inventory to what is available in the rotary dryer inventory (i.e. a release duration of about 15 minutes). The ID fan, quench and acid gas scrubber continue to operate as normal. An estimate of contaminant stack emission rates of untreated contaminants has been made (Ref 16). Note the there are no significant HCl emissions in this scenario as the acid gas scrubber continues to operate.

During a loss of gas / power outage to the TO, the quench continues to condense some CHC contaminants. These are retained in the acid gas scrubber, and the scrubber solution tested. Depending on the results, the scrubber solution is either sent to the WTP or put back onto the untreated soil for treatment in the DTD Plant.

Dispersion of this release has been modeled by PAE (Table 9.4 Ref 17) and the resulting concentrations at various receptors compared against the ERPG / TEEL values (mg/m^3 basis, indicating irritation or injury), as shown in Table 5.5.

Results shown are at ground level for a 15 minute averaging time corresponding to the event duration. It can be seen that all estimated concentrations are well below the irritation / injury risk criteria (i.e below the ERPG threshold values).

TABLE 5.5: DTD PLANT UPSET (GAS SUPPLY FAILURE) DISPERSION RESULTS

Contaminant		**HCBD**	**HCB**	**HCE**	**PCE**
ERPG1	mg/m^3	10.8	0.006	29.5	241
ERPG2	mg/m^3	32.5	1	49.2	1586
Following data all from PAE report (Ref 17):					
Contaminant mass flow rate ex stack (Ref: PAE report Table 6.8)	g/s	2.33	0.012	0.012	0.32
Total flow ex stack (0°C, 1 atm, wet) (Ref: PAE report Table 6.7)	m^3/s	4.3	4.3	4.3	4.3
Ground level concentrations (Ref: PAE report Table F.17)					
Maximum conc at any location	mg/m^3	0.169	$9x10^{-4}$	0.014	0.45
Maximum conc at any off-site location	mg/m^3	0.094	$5x10^{-4}$	0.006	0.21
Residential / Sensitive Receptors:					
Denison St North	mg/m^3	0.059	$4x10^{-4}$	0.004	0.045
Denison St South	mg/m^3	0.035	$3x10^{-4}$	0.004	0.045
Hensley Field (Grandstand)	mg/m^3	0.068	$1x10^{-4}$	0.003	0.046
Banksmeadow Primary	mg/m^3	0.014	$1x10^{-4}$	0.001	0.030
Pagewood Primary	mg/m^3	0.031	$2x10^{-4}$	0.001	0.029
Matraville Primary	mg/m^3	0.039	$3x10^{-4}$	0.003	0.04
Food Industries					
Kellogg	mg/m^3	0.027	$1x10^{-4}$	0.002	0.05

Prevention Controls

- Maintenance / calibration of all DTD Plant temperature control equipment.
- Australian Standard design, i.e. gas trains and BMS supplying dryer and TO designed to minimise spurious trips.

Mitigation Controls

- On loss of quench water, high temperature alarm and trip will stop soil feed conveyor and natural gas feed and initiate controlled DTD Plant shutdown. Water supply break tank has some capacity if the event involved total water supply failure. Backup water supply from auxiliary tank on low quench water flow.

- Loss of natural gas flow / low temperature ex rotary dryer will stop soil feed and slow down dryer rotation, limiting quantity of contaminants.

Residual Risk (People)

Table 5.5 shows that ERPG-1 levels (the lowest level of interest) are not exceeded at any ground level point on the BIP site or off-site, including the nearest residential (Denison Street) or sensitive receptors (primary schools). Ground level concentrations (GLCs) as are at least a factor of 10 lower that the ERPG-1 levels. Hence it can be concluded that there are no significant acute off-site injury or irritation effects.

It can also be concluded that potential for a process upset to impact on BIP neighbours such as Qenos personnel is very low.

The likelihood of this event is also low, hence from a PHA perspective (off-site irritation / injury) the risk associated with this scenario is considered to be low to very low (Level III to IV).

It is also considered that the likelihood of continuing to attempt to process new material if a loss of utilities occurs is remote. Loss of utilities will automatically stop the feed conveyor to the DTD Plant. The feed conveyor is not connected to the backup power supply hence plant feed cannot be restored until “normal” DTD Plant operating parameters are re-established, including restoration of power.

Acute impacts due to other identified process upset causes would be lower than the limiting case upset scenario defined above, hence no further quantification is undertaken in the PHA. However longer term human health risks associated with process upsets are assessed as part of the HHIA.

Residual Risk (Food Industries)

There are a number of food manufacturing facilities located within the areas surrounding the BIP, with a bakery located directly north of the CPWE in the existing commercial/industrial area. Therefore potential contamination of food products may be a concern.

The manufacturing businesses in the area do not involve growing crops where there is the potential for chemicals to accumulate within the edible portions of the plants. Hence any exposure associated with the production of food products in the area will only be associated with direct deposition to the surface of the products or ingredients. Any food manufacturing is expected to occur within a building where there is a lower potential for dusts to settle (compared with direct deposition to outdoor plants and soils).

Plant Upsets

Table 5.5 shows that the levels of volatile contaminants in the event of a process upset are low (around 0.094 mg/m^3 for the highest mass rate contaminant HCBD at any off-site location, 0.17 mg/m^3 within the CPWE area). The PAE report also reports deposition rates for the DTD Plant upset event. For a 15 minute averaging time, a maximum off-site deposition quantity of 0.62 mg/m^2 for the 15 minute event duration. This is a total for all chemicals including HCB, HCBD, PM_{10} etc. Refer to Table F96 PAE Air Quality Impact (Ref 17). Even for a large exposed surface area (e.g. 1,000 m^2) this is less than 1 gram of material.

Given the short duration of the event (15 minutes) and the low predicted atmospheric contaminant concentrations, the quantity of contaminants that could potentially affect outdoor material / ingredient stockpiles (which are not known to be present at any of the identified food industries) or be drawn into factory air intakes is small.

It is therefore difficult to envisage any significant potential for contamination in the manufacturing process given the small quantities of emissions that could occur in a plant upset condition, and the short duration of any such event.

Ongoing Exposures

The HHIA (URS, Ref 18 Section 7.7) considers the effect of the upset scenario as well as the total exposure over longer periods to normal operating case maximum emissions on human health risks. The HHIA takes a conservative approach as it is based on the maximum off-site concentration and maximum off-site deposition rates. The HHIA concludes that "*exposures by workers and consumers of any food products that may be manufactured in areas located adjacent to or within the areas surrounding the CPWE are expected to be lower than presented in the worst-case (maximum off-site) scenario. Risks to human health are considered low and acceptable for these businesses and products".*

5.7.2. Power Failure

A loss of mains power to the DTD Plant would result in shutdown of all equipment except the control system which is powered by a UPS. The ID fan draught would eventually be lost as the fan wound down, causing untreated hot gas containing volatalised CHCs to leak out of most equipment, primarily the rotary dryer seals at ground level. This could cause potentially serious OHS issues for any operators in the vicinity due to both the high temperature and contaminant concentrations exceeding OELs.

A backup diesel generator is therefore provided to allow restart of emission control equipment (ID fan, quench, acid gas scrubber etc) to minimise impacts on operations personnel. Assuming the backup power operates, loss of power will have the same consequences in terms of emissions as the failure of natural gas supply described earlier (because loss of power also results in loss of natural gas), i.e. continued draught of contaminants through ECS and some emission from DTD Plant stack.

Prevention Controls

Primarily design of electrical supply. Power supply in the Botany area is reasonably reliable however periodic dips and outages do occur.

Mitigation Controls

- Shutdown of feed to DTD Plant (conveyor would stop). The conveyor cannot be restarted on backup power.
- Control system UPS.
- Back up diesel generator for critical equipment including ID fan, quench and acid gas scrubber to allow controlled restart of equipment.
- Fully attended operation 24 hours per day

Residual Risk

The duration of this event would be short (less than 15 minutes). The maximum emission quantity is limited by the inventory in the rotary dryer. The gas leaking from the seals would be flowing at a low rate as there is no pressure or velocity driving force, and it would tend to disperse upwards due to temperature buoyancy effects (initially at around 400 - 500 ^oC).

Based on a typical soil feed rate and ID fan flow (approximately 20 m^3/s and around 140 kg/hr of contaminants being fed to the rotary dryer) the initial CHC concentration in the hot gas in the dryer would be around 170 ppm which would be diluted as the hot gas stream rose. (Refer to APPENDIX 4 for calculation assumptions and a basic hot plume dispersion model known as the Briggs Plume Rise model indicating that dilution to very low levels would occur before plume finished rising).

Any injury or irritation effect outside the immediate area of the rotary dryer is therefore considered of very low likelihood, due both to the conditions of the release and the short event duration. The risk level outside the remediation area is regarded as low.

Note that the time taken to restart the ECS system powered by the diesel generator, will determine whether most contaminants leak out from DTD equipment, or partial emission control is achieved and contaminants are exhausted via the DTD Plant stack as per the failure of natural gas supply scenario described previously.

5.7.3. Acid Gas Scrubber Failure

Failure of the acid gas scrubber, for example due to loss of recirculation or saturation of the caustic soda solution (NaOH), would result in HCl breakthrough and emissions from the stack.

Prevention Controls

- Duty/standby circulation pumps with regular changeovers scheduled as part of operations.
- pH measurement of scrubber solution and deviation alarm, backed up by periodic sampling.

Mitigation Controls

- Alarms on loss of flow and high HCl concentration in the scrubber. Periodic sampling of scrubber solution.
- Auto stop of soil feed conveyor and initiation of controlled DTD Plant shutdown if scrubber pH limits exceeded or loss of circulation flow occurs.
- Backup power supply covers scrubber pumps and ID fan.

Quantitative Consequence Assessment

Assuming that shutdown of the soil feed occurs, the maximum quantity of HCl formed can be estimated by assuming that the TO and ID fan are still functioning, and that all chlorine in the feed stream is converted to HCl. It is also assumed that the quench does not remove any HCl.

Based on the maximum feed rate of 35 tonnes soil per hour with a chlorine content of 3,335 mg Cl/kg soil, a maximum HCl formation rate equivalent to 40 kg/hr is estimated. This corresponds to approximately 1,040 ppm HCl in the total exhaust flow ex the stack of approximately 20 m^3/s.

Dispersion of this release has been modelled by PAE (Ref 17) and the results for a 15 minute averaging time are summarised in Table 5.6. Refer to APPENDIX 4 for HCl formation rate calculation assumptions and inputs to the dispersion model.

TABLE 5.6: DTD PLANT UPSET (HCL BREAKTHROUGH) DISPERSION

Contaminant		**HCl**
ERPG-1	mg/m^3	3.3
ERPG-2	mg/m^3	22
Dispersion Results (Ref: Tables 6.7 and F.19 PAE Report 17)		
Contaminant mass flow rate ex stack	g/s	11.1
Total gas flow ex stack (0°C, 1 atm, wet)	m^3/hr	19.7

Contaminant		HCl
Maximum concentration at any location	mg/m^3	0.808
Maximum concentration at any off-site location	mg/m^3	0.447
Denison Street North	mg/m^3	0.284
Denison Street South	mg/m^3	0.167
Hensley Athletics Field (Grandstand)	mg/m^3	0.327
Banksmeadow Primary	mg/m^3	0.069
Pagewood Primary	mg/m^3	0.147
Matraville Primary	mg/m^3	0.188
Kellogg	mg/m^3	0.128

Residual Risk

The maximum HCl concentration ex the stack (approximately 1,000 ppm) is well below levels capable of causing fatality (above 2,000 ppm as per Table 5.3), hence there is minimal potential for this type of event to cause a fatality either onsite or off-site.

The predicted ground level concentrations at any ground level location onsite or off-site are well below the ERPG-1 and 2 levels, hence it can be concluded that there are no significant acute off-site injury or irritation effects. It can also be concluded that potential for an HCl breakthrough event to impact on BIP neighbours such as Qenos personnel is very low.

As there are no predicted injury or irritation effects, primarily due to the stack height and relatively large dilution from the ID gas flow, the risk associated with this scenario is rated as low (Level III).

Note that HCl does not accumulate or have the potential to contaminate ingredients, process equipment etc hence this upset scenario does not have any significant impacts on food manufacturing processes such as Kellogg's.

Short duration scenarios such as this also would have minimal environmental impact, e.g. no significant potential for ongoing pollution such as acid rain formation.

5.7.4. Mechanical Equipment Failures

Mechanical failure of ducting, pipes or equipment carrying gases from the rotary dryer or TO would result in release of hot relatively dilute gases. Possible causes include impact, installation defects or corrosion. This is a similar scenario to leaks from the rotary dryer (Section 5.3). The effect would be relatively limited and the residual risk level is regarded as low.

Controls

The main controls include:

- Appropriate materials of construction and appropriate inspection and testing before and after initial installation.
- Heavy vehicle movement paths located away from DTD process to minimise potential for impact.
- Highly visible and inspected daily.

5.7.5. Natural Gas Leaks

Natural gas will be supplied at around 500 kPag. A leak and subsequent ignition could result in a torch fire. Previous modeling (Ref 14) indicates that a 50 mm hole could result in an ignited torch fire of up to 10 m flame length, i.e. effects in immediate area only.

All natural gas piping will be located outside the ESB and FSB, so confinement of a gas leak within a buliding / enclosed space and delayed ignition and explosion is regarded as unlikely.

The risks associated with natural gas use are well known, controlled by appropriate choice of equipment, correct installation and inspection, provision of isolation valves and location to avoid confinement or impact / penetration of underground piping.

5.7.6. Internal Explosions in Gas-fired Equipment

With any gas-fired appliance, the potential for buildup of an explosive atmosphere within the appliance exists, followed by an ignition and explosion. For the DTD facility a failure of the BMS could allow natural gas to leak into either the rotary dryer or TO while offline. Another mechanism is that a high calorific value material is fed to the rotary dryer, leading to hydrocarbon levels above the LEL concentration in the gas stream from the rotary dryer.

Internal explosions have the potential to cause damage due to overpressure effects and possibly projectiles. They can pose a significant potential hazard to operators in the vicinity. Previous calculations using the well accepted TNO method (Ref 19) for equipment volumes of up to 200 m^3 (much greater than the TO or dryer) indicate that overpressure levels of 7 kPa (i.e. the injurious level as per HIPAP No. 4) do not occur past about 40 m from the explosion. Hence any effects outside the remediation facility area are unlikely.

Controls

- BMS complying with relevant AS. This would typically include a startup and shutdown purge sequence, and shutdown on failures like low or high gas pressure, flameout etc.

- Extensive soil feed segregation, sampling and blending to ensure feed soil calorific value is appropriate.
- The rotary dryer will also be provided with explosion hatches to minimise the potential for missiles.

Residual Risk

Given the controls in place and relatively small impact area, off-site effects are considered unlikely and the residual risk from a PHA / surrounding land use perspective is low.

However as with any gas-fired appliance, the potential for operator injury / fatality cannot be entirely eliminated, hence from this perspective, a Level II risk rating has been assigned.

5.8. External Events

The proposed location of the DTD Plant / FSB is about 70 m away from the Olefines (Qenos) propane (C3/C4) storage bullet area. A serious flammable gas incident in the Qenos area, for example a gas leak and explosion, or a BLEVE involving the C3 storage has the potential to damage the remediation facility, resulting in loss of contaminants to atmosphere, either from exposed soil surfaces or damaged plant.

Another possibility is an unignited gas cloud drifting from Qenos to the CPWE and being ignited by a vehicle or other remediation plant ignition source, again causing significant asset damage, operator injury and potential contaminant release.

However as noted in previous scenarios, the quantity of contaminants that can be released from the DTD Plant and FSB area is relatively small and in itself does not result in a significant risk to surrounding land uses. The main concern is potential injury / fatality to operators in the remediation area if a serious incident occurs at Olefines (Qenos).

Controls:

Olefines (Qenos) have a number of controls in place around the propane (C3/C4) storage bullet area reducing the likelihood and severity of a gas release and subsequent fire or explosion including:

- Mechanical integrity of equipment
- Gas detection around pumps.
- ESD with isolation valves and excess flow valves (XSFV) at storages and tanker unloading to minimise the quantity from a leak.

- Clean soil stockpiles will be located along the boundary with Olefines (Qenos) to provide some baffling / mitigation against explosion pressure waves.
- Co-ordinated emergency response.

Residual Risk

The incremental risk to surrounding land use due to the positioning the remediation facility relatively close to the Olefines (Qenos) propane C3/C4 storage bullet area is small. However the potential for remediation facility operator injuries / fatalities due to an event in Olefines cannot be eliminated, hence from this perspective, a Level II risk rating has been assigned.

Similarly to other scenarios with the potential to cause operator injury, it is recommended that a more detailed risk assessment be carried out to ensure that the employer can demonstrate that duty of care obligations under the NSW OHS Act are met.

5.9. Worst Case Scenarios from HCB Independent Review Panel

The HCB IRP report focused primarily on risks associated with the destruction of high level HCB (i.e. liquid and / or concentrated) waste stored on the BIP using the Geomelt waste destruction process. Neither the type of waste nor process technology considered by the IRP are relevant to the proposed CPWE soil remediation project (Ref 15).

Several "extreme scenarios" were also raised including:

- The possibility of an incident involving an explosion and / or major fire at a neighbouring plant. This was discussed in relation to the CPWE remediation with respect to incidents at the Qenos Olefines facility in the previous section. The conclusion was that the main risk from Qenos is to operators within the remediation facility (rather than additional off-site risks associated with a knock-on event at the CPWE resulting in contaminant release).
- A major mishap such as an aircraft or laden fuel tanker crashing and burning on the site. This is always a possibility, albeit very unlikely for the proposed location of the remediation facility. This type of event would damage the assets and could cause release of contaminants from exposed soil or damaged plant. However compared to other potential impacts, for example the consequences of a plane impact on the propane (C3/C4) storage bullets adjacent to the proposed FSB area, additional consequential effects from damage to the CPWE remediation facility would be small.

5.10. Controls Required By Codes and Standards

The proposed facility will comply with all relevant AS requirements. As well as generally applicable building and electrical, industrial machinery standards, specific standards that apply to either the chemicals handled or the process equipment include:

- AS 3814-2005: *Industrial and commercial gas-fired appliances*
- AS 3780-1994: *The storage and handling of corrosive substances*

Any fire protection provided will meet the requirements of *AS2419.1-2005: Fire hydrant installations - System design, installation and commissioning* and *AS 2118.1: Automatic fire sprinkler systems - General requirements* (details will be covered in more depth when the Fire Safety Study is prepared). These standards are incorporated into the recently issued NSW WorkCover Code of Practice for the NSW OHS Regulations (DG).

6. RISK ASSESSMENT CONCLUSIONS

6.1. Fatality and Injury / Irritation Risk Levels

The potentially hazardous incidents identified did not have the potential to have a significant effect (safety, health or environmental) outside the immediate incident area. No incidents were identified with an off-site (i.e. outside the Orica property) fatality risk, or an injury or irritation effect in residential areas.

Potential impacts at the nearest BIP receptors (i.e. Qenos Olefines facility) were also below the toxic impact criteria used for the study, hence any acute impacts to other BIP operators are also regarded as very unlikely.

The quantitative individual fatality, injury and irritation risk criteria suggested by the DoP are therefore satisfied. The risk level in the land use planning context associated with the proposed facility is therefore considered very low. The risk level is also in the "acceptable" band for identified issues with potential off-site impacts when assessed against the internal Orica risk matrix criteria.

6.2. Risk to Sensitive Receptors and Food Industries

Air dispersion modelling predicts that plant upset scenarios will not cause levels of contaminants at sensitive areas (e.g. residential areas, primary schools etc) sufficient to cause irritation or injury.

There are a number of food manufacturing facilities located in the areas surrounding the BIP, with a bakery located directly north of the CPWE. Therefore potential contamination of food products may be a concern. Based on dispersion model results, the quantity of contaminants that could potentially affect outdoor material / ingredient stockpiles (which are not known to be present at any of the identified food industries) or be drawn into factory air intakes is small (a total of less than 1 g for exposed surfaces up to 1,000 m^2).

It is therefore difficult to envisage any significant contamination in food manufacturing processes given the small quantities of emissions that could occur in a plant upset condition, and the short duration of any such event.

The HHIA also draws the conclusion that the human health risk associated with potential contamination in food manufacturing processes is very low (URS report, Ref 18 Section 7).

6.3. Risk to Biophysical Environment

Whilst any impact on the environment is obviously undesirable, the main concern for risks to the biophysical environment from accident events is the potential effect on whole systems or populations. The potential environmental hazards associated with the project are due to the bio-accumulative properties of the chlorinated compounds in the waste or due to the small quantities of toxic by-products such as dioxins that could be produced in the TO.

The incident scenarios identified involving either a gas emission or an effluent / liquid spill had very limited impact area due to the relatively small quantities of contaminants and short incident durations. The risk to environment from accident or process upset scenarios occurring at the proposed remediation facility is therefore regarded as low.

6.4. Adequacy and Relevance of Safeguards

For all the identified scenarios, as shown in the hazard identification table in APPENDIX 3, hardware and procedural safeguards are in place which are aimed at reducing the likelihood and/or consequence of an incident. Key controls include:

- Sophisticated temperature control of TO and rapid quench to maximise contaminant destruction efficiency and minimise unwanted by-product formation.
- Redundant systems to maintain function of key emission control equipment (cyclone, quench, baghouse and acid gas scrubber) in the event of a utility failure (gas, water and power). This includes a backup power source (diesel generator) and backup water tank.
- Automatic isolation of contaminated soil feed to DTD Plant in the event of a plant upset and controlled shutdown sequence.

These controls will be supported by a management system which covers maintenance and periodic review of the controls to maintain their effectiveness.

6.5. Effect on Cumulative Risk from BIP

No events were identified with an impact on areas outside the BIP boundary. Therefore the project will not increase fatality risk (hence societal risk) from the BIP site.

6.6. Further Hazard Studies and Recommendations

The PHA indicates that the risks to surrounding land uses associated with the proposed remediation project will be low. As the design is still preliminary and a number of options are being investigated specific design recommendations have not been made. However to ensure that additional risk reduction opportunities are identified and implemented as the design progresses, the following activities should be completed:

1. Conduct a Construction Safety Study (which has been included in Conditions of Consent by the DoP for previous development applications).

2. Develop a Fire Safety Study (which has been included in Conditions of Consent by the DoP for previous development applications).
3. Complete a HAZOP study once detail design is close to complete.
4. Ensure that the ERP for the facility is prepared, integrated with Qenos Olefines facility and BIP ERPs, and that the Fire Brigade has the opportunity to provide input as required by the NSW DG regulations.
5. The PHA and hazard study process also highlighted a number of areas where potential risk levels to personnel working at the remediation plant may be relatively high. While this does not alter the PHA conclusions with respect to off-site land use planning risks, it is recommended that a more detailed risk assessment be completed to ensure that the operator's duty of care obligations to employees under the NSW OHS Regulations are met.

APPENDIX 1. REFERENCE DRAWINGS

This Appendix contains copies of the following drawings :

Title
1. BIP Map showing location of proposed works on BIP and surrounding land use
2. Layout of Proposed Remediation Works
3. Block Diagram of Overall Remediation Process
4. Block Diagram DTD Process

0 75m

- Botany industrial park site boundary
- Lot boundary
- CPWE boundary
- Land affected by project

HLA

Figure 1

Land Subject of the Proposal "The Site"

Orica Australia Pty Ltd

Remediation of Car Park Waste Encapsulation

Botany Industrial Park

Preliminary Hazard Analysis

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