Queensland Health

# Health Impact Assessment

Narangba Industrial Estate

May 2011

Tomorrow's Queensland: strong, green, smart, healthy and fair



## Acknowledgements

Queensland Health would like to acknowledge the support of the Community Reference Group comprising 16 members who met regularly for nearly 4 years. Their willingness to provide the benefit of their local knowledge and expertise, and commitment to attendance at meetings over the extended period, has helped ensure both the rigor and transparency of the process. The Chair, Ms Jan Taylor (JTAA) and the Independent Technical Advisor, Dr Neville Bofinger (Tooloona Consulting) worked with the Community Reference Group to provide overall guidance.

Queensland Health would also like to acknowledge the valuable assistance provided by representatives from the following agencies and businesses for their contribution to date:

- Accensi
- AWN Golder Pty Ltd
- All Treated Timber
- Atlantic Pools
- Austech Australasia
- BCD Technologies
- Boral Asphalt
- Custom Chemicals
- Department of Education, Training and the Arts
- Department of Emergency Services
- Department of Infrastructure and Planning
- Department of Environment and Resource Management
- Department of Justice and Attorney-General
- Frontline Fabrications
- Golder Associates
- Katestone Environmental
- Kingswood Cabinets
- Mann Waste
- Moreton Bay Regional Council Transfer Station
- Nationwide Oil
- Oil Technology Australia
- Packer Leather
- Permalog
- Queensland Organics
- Ridley Aquafeed
- Showerama
- Steritech
- Sunstate Coatings
- Tasman Tannery
- Wildcat Chemicals

## **Executive summary**

The Narangba Industrial Estate Health Impact Assessment was conducted in response to community concerns about the potential for health impacts from operations within the Narangba Industrial Estate (NIE).

A Community Reference Group (CRG) was established to provide oversight of the Health Impact Assessment and to develop recommendations for government consideration based on the outcomes of the study.

A number of issues were identified by the CRG for inclusion in the health impact assessment (HIA). These issues were associated with the emergency management framework that was applied in response to the Binary Industries fire, air quality, current health status, property sales and the impact of previous land use planning decisions to inform future planning decisions.

The aim of the HIA was to:

- assess the impact of the air emissions on ambient air
- · assess the potential risk to human health associated with emissions from the NIE
- assess whether the community has experienced adverse health effects and
- inform government decision-making processes.

The HIA commitment involved data collection and analysis by independent experts with support provided to the CRG by an independent technical adviser and independent facilitator.

## Air quality and health and odour impact assessment

A number of studies were conducted to enable a detailed air quality assessment for:

- hazardous air emissions and
- odour impacts.

More than 150 compounds were assessed by the air quality study and of these only eight were identified as requiring further assessment for human health impacts.

In regard to the community concerns about acute health impacts, formation of secondary air toxics and cumulative impacts, the data obtained through the project did not indicate health concerns.

In regard to chronic (i.e. long-term) health effects, the only issue that emerged was that of chromium. Chromium was only detected in one sample from one site, and an estimated exposure was derived from modelling based on that one sample, while assuming that the entire amount of chromium was only of the most hazardous form, which is improbable. An excess lifetime cancer risk for chromium VI was estimated to be equivalent to one additional cancer case per approximately fifteen thousand individuals exposed to the modelled level, continuously over 70 years. This finding does not necessarily reflect a significant risk, immediate or otherwise, due to the level of conservatism built into the risk assessment process generally and the conservative assumptions applied to the assessment.

While some confidence can be gained from the level of conservatism and assumptions applied as part of to the assessment, the assumptions should be further assessed by the relevant regulatory authority and the health risk re-evaluated.

Odours were assessed in accordance with air quality criteria and odour performance criteria. Air quality criteria for protection of the aesthetic environment were predicted to be exceeded for two compounds—styrene and methyl mercaptan. There were some limitations associated with both of these compounds with the predicted results yielding very conservative findings that did not reflect the conditions at the time of sampling. However, further investigation of these odour emissions is required. Given the nature of processes emitting odourous

pollutants, continued effort to manage these odour emissions will need to occur to ensure that the community can have confidence that the aesthetic environment is protected.

Overall, the NIE was found to meet the requirements of the odour guideline for the Department of Environment and Resource Management (DERM) at all receptor sites. Odour will be detectable within the wider community under certain meteorological conditions which may result in nuisance to residents.

## **Health status**

No evidence was found to indicate that the community had experienced adverse health effects as a result of its proximity to the NIE. The rates for mortality and cancer in Narangba/Deception Bay were found to be similar to the rest of Queensland.

Chronic disease information obtained through the hospital separation data did indicate some differences from the Queensland rates. Of particular note were chronic heart disease and respiratory diseases where the rates were higher in Narangba/Deception Bay than the rates for Queensland. However, the increased rates of respiratory diseases were not due to a disproportionate burden of asthma which would have been observed if air quality was an issue. This outcome is consistent with the findings of the air quality assessment.

## Post Binary Industries fire actions and land use planning

An independent post-event review was conducted to provide information to inform future decision making processes regarding the location and management of high impact and noxious and hazardous industry. While the emergency management framework for Queensland was adequate, a number of recommendations to inform future decision-making processes were made.

The Binary Industries fire presented a number of challenges particularly with respect to environmental contamination and subsequent management of the financial impact of associated with the incident. Designing future high impact industry estates in a way that accommodates potential firewater to limit contamination of the wider community has been identified as an important requirement in the establishment and management of noxious and hazardous industrial estates. Similarly, profiling the area prior to development of these estates/sites may assist in providing a bench mark against which to monitor for, and to enable identification of environmental contamination sources.

Local industry offers a lot to the surrounding community through employment and the contributions it makes to the local economy. However, the co-location of industry and community needs to be considered further in land use planning.

Concerns were raised by the CRG regarding previous land use planning decisions and the resultant nuisance impacts. While there is no evidence to suggest adverse impacts on the health of the community, adverse impacts have been reported by community, necessitating a response by industry and individual government agencies.

The CRG identified that to address the concerns regarding land use incompatibility issues identified with the NIE, consideration will need to be given to appropriate planning frameworks, particularly in regard to the proximity to residential property in order to protect the interests of the community and industry.

## Other issues

Community concerns were raised regarding devaluation of properties located within the study area. However, based on the evidence available, a positive growth in property values was recorded.

Management of community perceptions and expectations becomes particularly complicated when there is a divergence in opinion with regarding the management of environmental or

amenity criteria. Different perspectives are held across the community, business and government regarding the level of acceptability of an impact on amenity or environmental values. Strengthened communication between regulators and the community may assist in managing these perceptions and concerns.

This study has considered the findings of the data collected to inform the HIA in terms of three dimensions of health: physical health, psychological health and social health and well-being. While the data indicates that, considering the population as a whole, no health risks exist, it is recognised that some individuals who may be particularly susceptible to some impacts may have experienced adverse impacts prior to the HIA.

## **Community Reference Group recommendations**

- Department of Environment and Resource Management (DERM) assess the presence of chromium VI from Sunstate Coatings quenching process and, if confirmed, Queensland Health to re-evaluate the excess lifetime cancer risk. Should an excess cancer risk estimate be confirmed, then appropriate emission management strategies need to be implemented (DERM) and workplace risks should be assessed and appropriately managed (WPH&S).
- 2. Department of Environment and Resource Management consider whether changes are required to the management of the chromium emission from the hot dip galvanising quenching process (subject to the confirmation of presence of chromium VI and reassessment of excess cancer risk).
- 3. Moreton Bay Regional Council ensure that fugitive emissions associated with the release of styrene from Atlantic Pools are contained on site and impacts on the community are managed.
- 4. Moreton Bay Regional Council review and amend if necessary, the licence conditions of Atlantic Pools to reflect any emission control actions for fugitive styrene emission management.
- 5. Moreton Bay Regional Council review the draft *Narangba Industrial Estate Emergency Plan* and adopt it as a functional sub-plan of the *Moreton Bay Regional Council Local Disaster Management Plan*.
- 6. Moreton Bay Regional Council finalise the development of the evacuation sub-plan as a matter of priority and once developed, the plan should be exercised regularly with relevant response agencies using different scenarios.
- Department of Justice and Attorney-General (JAG) and Department of Community Safety (DCS) encourage businesses to maintain an off-site electronic copy of their chemical manifest which can readily be accessed by Emergency Services via the designated business contact during an emergency event.
- 8. State and Local Government continue to implement the recommendations of the Narangba Industrial Estate: Inter-Agency Fire and Firewater Risk Minimisation Inspection Program, in particular: a) annual joint agency inspections, b) changes to government policy and legislation in relation to hazardous materials management and c) advocate for changes to Building Code of Australia, and relevant National Standards and Australian Standards.
- Department of Environment and Resource Management continue to monitor the ground water movement of Binary Industries site and publish results of water monitoring on their website. Should indications of potential leaching into Saltwater Creek be found, appropriate management strategies should be implemented.

- 10. Queensland Fire and Rescue Service and Moreton Bay Regional Council continue to foster information exchange relating to ownership and business applications to ensure the local area plans remain current.
- 11. Additional costs associated with increased monitoring and surveillance of the NIE be met by the Queensland Government.
- 12. Moreton Bay Regional Council independently evaluates options for an early warning and emergency evacuation system prior to adopting a system.
- 13. Department of Justice and Attorney-General give consideration to the amendment, development and implementation of industry specific fire detection and alarm system requirements for existing and prospective businesses.
- 14. Department of Employment, Economic Development and Innovation (DEEDI) and the Department of Local Government and Planning (DLGP) ensure that all future sites for noxious and hazardous industry and estates be set out and developed with inherent estate and individual site bunding, controlled drainage (including emergency water/contaminated water dams), separation distances from sensitive receptors and satisfactory levels of emergency services access.
- 15. Queensland Government considers that prior to development of noxious and hazardous industrial parks and sites, baseline data collection of ambient air, water and soil quality are undertaken.
- 16. Queensland Government continues to support the development of the State Planning Policy: Air Noise and Hazardous Materials that prescribes separation distances within which further investigative work is required should industry or sensitive land uses be proposed to be located closer than the default separation distance.1
- 17. Department of Environment and Resource Management establish a procedure to communicate any monitoring results that are of concern to relevant stakeholders and the community.

<sup>&</sup>lt;sup>1</sup> The State Planning Policy for Air Noise and Hazardous Materials was recently released on 27 October 2010 and will be in effect from 28 February 2011.

## Contents

1.0	Introduction	1
1.1	Background	. 1
1.2	NIE HIA	. 6
1.3	Scope of the Health Impact Assessment	. 7
2.0	Health and Social Profile	13
2.1	Community Demographic	13
2.2	Health Status of Narangba/Deception Bay	14
2.3	Chronic Disease	17
3.0	Air Quality Studies	23
3.1	Background	23
3.2	Ambient Air Monitoring	25
3.3	Odour Survey	26
3.4	Point (stack) Source and Area Source Emission Monitoring	27
3.5	Air Dispersion Modelling	27
4.0	Findings	29
4.1	Health Risk Assessment (HRA)	29
4.2	Odour Assessment	32
5.0	Emergency Management	37
5.1	Background	37
5.2	Emergency Response framework for Queensland	37
5.3	Other Policies/actions supporting emergency response framework	39
5.4	Findings	39
5.5	Post-Incident Activities	39
5.6	Community Safety and Protection	43
6.0	Land Use Planning Issues	46
6.1	Background	46
6.2	High impact and noxious and hazardous industry separation	46
6.3	Issues identified for future noxious and hazardous industry site selection	47
Quee	nsland Health—Narangba Industrial Estate Health Impact Assessment	vi -

7.0	Other Issues	49
7.1	Property Sales	49
7.2	Trust in Government	50
7.3	Sources of Information	50
8.0	Conclusions and Recommendations	51

## Tables

Table 1 Examples of key factors that determine health	4
Table 2 Scope of issues and activities conducted	8
Table 3 Summary of odour survey impacts	26
Table 4 Ambient air quality objectives for the protection of the aesthetic environment includ in the Environmental Protection (Air) Policy	ed 33
Table 5 House Price Index for Brisbane 2002–03 to 2009–10	50

## Figures

Figure 1 Aerial photograph of Narangba Industrial Estate2
Figure 2 Incidence rate for prostate cancer among males residents in Narangba/Deception Bay16
Figure 3 Age and gender standardised hospital separation rates for coronary heart disease in Narangba/Deception Bay and Queensland
Figure 4 Age and gender standardised hospital separation rates for respiratory diseases (including asthma) in Narangba/Deception Bay and Queensland19
Figure 5 Age and gender standardised hospital separation rates for asthma in Narangba/Deception Bay and Queensland19
Figure 6 Age and gender standardised hospital separation rates for respiratory diseases (excluding asthma) in Narangba/Deception Bay and Queensland20
Figure 7 Contour Plot of Annual ground level concentration for Chromium
Figure 8 Median Property Prices for Deception Bay49
Figure 9 Median Property Prices for Narangba49

## Abbreviations

ABS	Australian Bureau of Statistics	
ATSDR	Agency for Toxic Substances and Disease Registry	
CHD	Chronic Heart Disease	
COPD	Chronic Obstructive Pulmonary Disorder	
CRG	Community Reference Group—established for the Narangba Industrial Estate Health Impact Assessment	
DERM	Department of Environment and Resource Management	
DGSMA	Dangerous Goods Safety Management Act 2001	
EPA	Environment Protection Act 1994	
EPP (Air)	Environment Protection Policy (Air)	
ERAs	Environmentally relevant activities	
GLC	Ground level concentration	
HIA	Health impact assessment	
HRA	Health risk assessment	
ICD	International Classification of Diseases	
IPA	Integrated Planning Act 1997	
LAP	Local area plans	
LDGL	Large dangerous goods location	
LDMP	Local disaster management plan	
MBRC	Moreton Bay Regional Council	
NHS	National Health Survey	
NIE	Narangba Industrial Estate	
NIEEP	Narangba Industrial Estate Emergency Plan	
OESR	Office of Economic and Statistical Research	
РАН	Polycyclic Aromatic Hydrocarbons	
PCB	Polychlorinated Biphenyls	
PCDD/PCDF	Polychlorinated Dibenzo Dioxins and Polychlorinated Dibenzo Furans	

QCR	Queensland Cancer Registry
QFRS	Queensland Fire and Rescue Service
QHAPDC	Queensland Hospital Admitted Patient Data Collection
QRG	Queensland Registrar General
SEIFA	Socio-economic indexes for areas
SLA	Statistical local area
SPA	Sustainable Planning Act 2009
SPP	State Planning Policy: Air, Noise and Hazardous Materials
VOC	Volatile Organic Compound
WHO	World Health Organization

## 1.0 Introduction

In response to community concerns about the potential for health impacts from operations within the Narangba Industrial Estate (NIE), the then Premier the Honourable Peter Beattie committed to an independent health impact assessment (HIA) in June 2006.

The NIE had been the source of complaints for some years. However, on 25 August 2005 a major fire occurred at a chemical plant, Binary Industries. The fire burned for approximately six hours and was accompanied by a visible smoke plume which travelled over the community of Deception Bay. The level of pollutants would have caused respiratory distress for some residents exposed to the smoke plume. The fire increased existing community concern with the NIE. While a post analysis of air sample results taken during the fire did not indicate that any long term health effects would be expected, the community remained concerned over their immediate safety and long term health.

In response to these concerns, the Queensland Government commenced a Health Impact Assessment. The purpose of the assessment was to assess the potential for impacts likely to affect the health of the local community of the Narangba Industrial Estate operating under normal operating conditions and to consider what measures need to be undertaken to mitigate those impacts.

The HIA involved a comprehensive study of the environmental, social and economic impacts associated with the NIE. The study took place over a three and a half year period and the likely impacts of the NIE on the physical, psychological and social health and wellbeing aspects of the community were examined in terms of the relevant scientific and medical knowledge, the history of the industrial estate and the input of local people.

## 1.1 Background

## Narangba Industrial Estate

Narangba is approximately 35 kilometres north of Brisbane and is divided by the six lane Bruce Highway which is a national highway that stretches north to Cairns and south to Brisbane, Sydney and Melbourne.

The Narangba Industrial Estate (NIE) is located within the local government area of the newly established Moreton Bay Regional Council (MBRC). It was established in the late 1960s to accommodate industry with regional significance. At this time the area was sparsely populated and legislative integrated planning frameworks had not been developed. Prior to the establishment of the MBRC, the NIE was located within Caboolture Shire and bordering the shire of Pine Rivers Shire Council.

Figure 1, below, shows the location of the NIE with respect to the surrounding suburbs of Narangba, Deception Bay, North Lakes, Burpengary and Dakabin.

The industrial estate is approximately 180 hectares and provides for both regional industry (containing high impact industry) and local industry (refer to Appendix 1 for details on the industry zone precinct relevant planning definitions). There is no further capacity within the NIE to accommodate additional high impact industry. In 2008, State Government advised that all remaining parcels of land which were zoned for high impact industry were to be restricted to general industry purpose only.



## Figure 1 Aerial photograph of Narangba Industrial Estate (Katestone Environmental Pty Ltd 2010, 43)

The long section of the NIE identified in figure one to the left of the highway consists of general industry while the larger outlined section contains a mix of general and specialised industry.

The types industries located within the NIE include:

- chemical formulation/storage
- chemical timber treatment
- biodiesel manufacture
- organochlorine waste treatment

- asphalt manufacture<sup>2</sup>
- waste oil recycling and chemical waste treatment
- leather tanning
- galvanising
- printing
- glass cutting
- refrigerated storage
- heavy machinery storage
- timber processing (saw milling or wood chipping)
- wastewater treatment
- wooden product manufacturing
- pet, stock or aquaculture food manufacturing
- soil conditioning manufacture
- cabinet making
- crude oil storage
- concrete manufacture
- product warehouse and distribution
- product irradiation<sup>3</sup>
- boiler making and metal surface coating.

There are approximately 74 businesses within the NIE ranging from low impact industry to specialised industry. Under the regulatory frameworks established by Queensland Government industries are classified in accordance with the type and quantities of substances stored and used on site as well as the potential for activities to release contaminants into the environment.

Industry is subject to regulations outlined in the following legislation:

- Dangerous Goods Management Act 2001 administered by Department of Justice and Attorney-General (JAG)
- Environmental Protection Act 1994, administered by Department of Environment and Resource Management (DERM) and local government. Activities that will, or have the potential to release contaminants into the environment that may cause environmental harm are known as Environmentally Relevant Activities (ERAs). These activities and the role of regulatory body are outlined in the *Environment Protection Regulation*.
- Workplace Health and Safety Act 2005, administered by JAG
- Radiation Safety Act 1999, administered by Queensland Health.

At the time of this study 14 industries were classified as Large Dangerous Goods Locations (LDGL) and two as major hazard facilities (MHF) under the *Dangerous Goods Safety Management Act 2001 (DGSMA)*. Details regarding the classification criteria for these facilities are contained in Appendix 2.

## Topography of the area

There are approximately 180 hectares of green area directly north of the industrial estate with the remaining land surrounding the industrial estate zoned for residential purposes.

The topography is undulating, varying in heights from about 40 metres (m) above sea level to gullies in general at about 20m above sea level. The lowest point is at about 12m at the southeast corner near the corner of Boundary and Lipscombe Roads. The variation between wooded areas and the built environment will influence local winds and hence the local dispersion of emissions to air, particularly those released at or near ground level. At night, or under atmospheric inversion conditions where the air is colder near to the ground than higher up, there could be local drainage flow from the higher areas to the gullies, with limited mixing or dilution of the emissions.

<sup>&</sup>lt;sup>2</sup> This process no longer being conducted on site—ceased in 2009.

<sup>&</sup>lt;sup>3</sup> Refer to Appendix 3 for additional information on product irradiation

A number of tributaries within the industrial estate feed into Salt Water Creek and then to Moreton Bay.

## Health and factors affecting health

There are many factors and conditions that influence individual and population health outcomes and these are referred to as the determinants of health (enHealth Council 2006, p5). Some of these factors can be controlled by individuals, eg. smoking, while others are beyond the control of an individual or population, eg. air quality or genetics. Anything that alters a determinant of health may result in an impact on health (positive or negative).

Those factors that have the ability to produce a negative effect on health are known as hazards. When undertaking assessments of environmental risks, and undertaking health impact assessments it is often easier and more accurate to measure the hazard directly, rather than measure ill health due to the wide range of possible factors that have to be considered. The range of factors that impact on the health of a particular community are described in Table 1.

The factors that lead to someone developing disease are likely to have had their beginnings years earlier, through a complex chain of events fashioned by interactions of the individual, the environment, and broader social and economic factors.

Associations between environmental and social exposures and health status are bi-directional, with a stronger influence of social disadvantage on poor health. The underlying nature of these associations and interactions is not yet fully understood. Some hypotheses indicate that the duration and intensity of exposure to adverse social and environmental determinants and subsequent risk factors are important in selected health outcomes (Schmidt 1999, p26-31).

Health determinants, such as those listed below in Table 1, were considered during the design of the HIA and its appraisal. The community reference group (CRG) established for the HIA considered these determinants in the context of the possible influence of the NIE and decided that factors of employment, physical activity, air quality, risk of injury and water quality were of interest.

The HIA process ensures that human health impacts are carefully considered and balanced with the range of factors that determine health status. A problem that is overstated can potentially result in impacts that can compromise the sustainability of a region or present other health and social effects which can be the case if health risks are examined and considered in isolation of other broader factors.

Fixed	Social and economic	Lifestyle and behaviours	Access to services	Environment
Genes	Poverty	Diet	Education	Air quality
Sex	Employment	Physical activity	Health services	Noise
Ageing	Social exclusion	Alcohol	Social services	Housing
	Community structure and infrastructure	Sexual behaviour	Transport	Water quality
		Drugs	Leisure	Social environment

## Table 1 Examples of key factors that determine health

Fixed	Social and economic	Lifestyle and behaviours	Access to services	Environment
		Coping skills		Risk of injury
		Smoking		Sun exposure
				Disease vectors eg. mosquitoes

## Health impact assessment

Health impact assessment (HIA) is a process that provides a systematic yet flexible framework that can be used to consider the wider effects of local and national policies or initiatives and how they, in turn, may affect people's health. Some of the effects may be positive, whilst others could be more harmful. The aim is to assess and where relevant remove or mitigate any possible negative impacts on health and well-being and to maximise opportunities to improve the health of the population.

Many of the factors that contribute to poor health outcomes are beyond the control of the health system. HIA offers a way of assessing health dimensions such as physical, psychological and social health and well-being in the context of previous decisions and emphasises the need to:

- work towards sustainable development
- aim for equity and fairness
- target disadvantaged groups
- encourage the participation of those likely to be affected by the project and
- make use of different types of evidence eg. qualitative (observations, surveys) quantitative (evidence, data or information).

The assessment can be done through the use of procedures, methods and tools whose use depends on the nature of the proposal.

## **Elements of a Health Impact Assessment**

There are many models of the HIA process and these are well documented in literature on health impact assessment. While there are differences between them the main steps of the HIA process remain very similar.

The enHealth Council provides national leadership on environmental health issues, sets priorities, coordinates national policies and programs and provides a pivotal link between international fora and environmental health stakeholders in Australia. EnHealth has developed a set of national guidelines for health impact assessment titled enHealth, Health Impact Assessment Guidelines 2001 (enHealth Council 2006) and this HIA has been based on this nationally endorsed framework.

Elements of an HIA include:

- screening—acts as a selection process during which projects are quickly assessed for their potential to affect the health of the population
- scoping—identifying the issues to be addressed and the level of assessment
- profiling—identifying who is affected and their health status
- risk assessment—identifying what are the hazards, what is the likelihood of harm occurring and who might be exposed
- risk management—prevention or minimisation of risk of harm, managing any consequences and communication
- implementation and decision making and
- monitoring, environmental and health auditing and post project evaluation.

These elements are often depicted in a logical linear (step-by-step) fashion however, their practical application is non-linear—some elements generally occur throughout the process while some are revisited as new information or issues come to light.

Health impact assessments can be undertaken prior to projects proceeding, or retrospectively, after a project or development has occurred.

## 1.2 Narangba Industrial Estate Health Impact Assessment

The broad steps of an HIA were applied to this HIA. However, due to the magnitude and complexity associated with this retrospective HIA, the project process is summarised below.

The HIA commitment was for Queensland Health to project manage a team of independent experts engaged to collect and analyse data. This was done through the establishment of a community reference group (CRG) who were supported by an independent technical adviser and an independent facilitator.

The aim of the HIA was to:

- assess the impact of air emissions on the ambient air quality of the Narangba area
- assess the potential risks to human health associated with emissions from business operations conducted within the NIE
- assess whether the community has experienced adverse health outcomes as a result of those emissions
- identify whether any additional health surveillance or evaluation is required
- inform government agency decision making processes with respect to planning for high impact industry.

The HIA focussed predominantly on air quality and the impact of the air quality on the health dimensions, i.e. physical, psychological and social health and well-being.

The key components of the project included the:

- establishment of the CRG
- · engagement of an independent facilitator and an independent technical adviser
- identification of community concerns
- identification of the scope of work required to be conducted
- · commissioning of an Independent consultancy for air studies
- commissioning of independent environmental studies (ambient air and stack emission monitoring) for both winter and summer.
- commissioning of an independent consultancy to conduct an Ambient Odour Survey
- commissioning of an independent consultancy to conduct a post– event review of two chemical fires
- implementation of the Narangba Industrial Estate Health Risk Perception Survey
- commissioning of an independent consultancy to undertake health risk assessment
- · development of recommendations for the Queensland Government by the CRG
- Development of a HIA report integrating information from all the above components.

## Establishment of the Community Reference Group

A CRG was established to provide oversight to the HIA. CRG members were selected for their respected knowledge of a sector of the community with an interest in the operations of the industrial estate.

The CRG consisted of representatives from:

- local community
- local business
- Local Government
- State Government.

CRG members were not selected as representatives of particular sectors of the community and as such were not required to formally provide feedback to community groups although they were encouraged to promote the project if the opportunity arose. They were involved in decision making in respect of commissioning project briefs and were actively involved in evaluating impacts and formulating recommendations to the Queensland Government. Details regarding the Terms of Reference are contained in Appendix 4.

## Support to the CRG

To assist the CRG fulfil its role, an independent technical adviser was engaged to provide high level technical advice on all aspects of the project. A health advisory panel which consisted of Senior Medical Officer, Public Health Physicians and toxicologists from Queensland Health was established to provide health based advice to the CRG. An independent facilitator was engaged to facilitate the CRG meetings.

## 1.3 Scope of the Health Impact Assessment

Determining the scope of the HIA involved identifying the issues that the HIA would consider as well as establishing the area of interest.

## Consideration of issues

The community reference group raised a broad range of matters for consideration as part of the HIA. Appendix 5 contains a brief summary of these issues and relevant outcomes from CRG discussions.

While not an exhaustive list, the following demonstrates the wide variety of concerns/issues the CRG has had with respect to the operations, management, regulation of the NIE and future planning for the NIE and the local community. These concerns were grouped into common themes to enable a more targeted appraisal of issues for consideration, including (see Table 2 Scope of Issues included in the HIA);

- risks associated with smoke plume intrusion over populated areas of residential estates (including schools, etc.) downwind of the NIE during the Binary Industries fire
- the likelihood for another NIE major incident and the associated local community fear of whether or not they are 'living near a ticking time bomb' resulting in 'plummeting property values' as a consequence
- the perception that there is not a viable, integrated community emergency evacuation system or a linked disaster early warning system
- the extent to which health issues/complications, i.e. cancer and asthma rates present in the local community, might be linked to emissions emanating from the NIE
- ongoing issues with odours emanating from the NIE
- concerns about air quality
- the presence of dioxins in the environment believed to be associated with both the NIE and surrounding areas
- inability to sell properties because of the NIE
- expressed community uncertainty or lack of confidence in regulatory systems and planning processes
- the adequacy of existing buffer zones around the NIE, both in terms of concerns about safety and the uncertainty regarding future potential expansion of business or residential development
- the extent to which government planning and design of future industrial estates or current approval processes for the expansion of existing industrial estates, considers previously identified issues or concerns such as those identified by the community within and around NIE.

Scopes for each of the themes were established and specific data relevant to each issue was reviewed which included:

- compliance and regulatory information
- complaints data
- documentation and existing reports

Queensland Health—Narangba Industrial Estate Health Impact Assessment

- newspaper articles
- national data bases
- current activities and potential for duplication
- opportunities for community exposure
- review of population statistics, including demographic data.

Discussions were also conducted with regulatory authorities and business operators. This process enabled the identification of data that needed to be collected. A number of studies were then designed to provide the necessary information to inform health risk assessment and HIA.

Table 2 identifies the overarching themes, project scope and the associated data collection activities that were conducted. It should be noted that air quality was the main concern identified by the community.

Issue	Scope	Data gathering/analysis activities conducted
Binary Industries fire	To assess whether emergency/disaster planning processes are adequate to ensure community is protected from risks/hazards associated with emergency situations or incidents.	<ul> <li>Independent post-event review of two chemical fires for the Narangba Industrial Estate Health Impact Assessment.</li> </ul>
Air quality	To ascertain the air quality of the surrounding area taking into account particular processes being conducted in the NIE. This included assessment of hazardous emissions and odours.	<ul> <li>Air Studies:</li> <li>Ambient air monitoring</li> <li>Carbonyl air monitoring</li> <li>Polycyclic Aromatic Hydrocarbon (PAH) air monitoring</li> <li>Canister Air Sampling</li> <li>Stack Emission Monitoring</li> <li>Area Source Monitoring</li> <li>NIE Ambient Odour Survey</li> <li>Air quality impact assessment for the NIE.</li> <li>All of these studies were conducted to inform the assessment of health risks.</li> </ul>
Current health status	To assess whether data from existing registries and hospital records reveals any anomalies on morbidity and mortality that warrants further investigation.	<ul> <li>Data Analysis from existing data sets</li> <li>Narangba Industrial Estate Health Risk Perception Survey.</li> </ul>
Property sales	To consider whether property sale prices indicate any anomalies.	<ul> <li>Review of Property Data for Narangba and Deception Bay.</li> <li>Review of House Price Index Data for Brisbane.</li> </ul>
Land use planning	To consider the overall impact that historical land use planning decisions have had on the community to inform future planning decision making processes.	<ul> <li>Independent post-event review of two chemical fires for the Narangba Industrial Estate Health Impact Assessment.</li> </ul>

## Table 2 Scope of issues and activities conducted

## Consideration of geographical area

The NIE is immediately surrounded by the postcode areas of Narangba, Deception Bay and North Lakes which were considered within scope of the HIA due to their close proximity to NIE. Other suburbs beyond Narangba, Deception Bay and North Lakes include Burpengary, Dakabin and Mango Hill. These are located within a 6km radius from the centre of the NIE but were not considered within scope as no evidence was found to indicate that these communities had significant concerns regarding the NIE.

The area is well serviced with a number of local, state and private schools, hospitals and ancillary health services and with an established transport system including rail and bus services. Urban centres are provided with treated drinking water and sewage services.

While Deception Bay and Narangba are two well established postcode areas, North Lakes is a recently gazetted suburb with the most recent census data recording a population of 9068. This population size was too small to develop a community demographic profile and isolate health status data.

## Studies and assessment undertaken

An overview of the individual studies undertaken to provide data for the HIA are outlined below.

## Community demographic profile

The community demographic profile for the target area was developed and included key aspects of the general makeup of the community. This is important as factors contribute to overall health profile of the community and need to be taken into account in assessing any differenced between communities.

Data collected included population details for:

- size
- distribution
- age and sex
- ethnicity
- levels of employment/unemployment
- socio-economic status.

## Summary of data analysis from existing health data sets

Health status data provides a snap shot of the health of the general community. Indicator data is collected at both state and national levels to provide information on diseases and their risk factors. This data is important as it enables the identification and characterisation of the health of a community and conditions which may be of interest in assessing potential impacts of the NIE.

## Data examined included:

- mental health
- injury levels (external to estate, not workplace health and safety)
- respiratory health
- cardiovascular disease
- musculoskeletal health
- cancer.

## NIE Health Risk Perception Survey

The objective of the survey was to gain an understanding of how widely certain environmental health risks were perceived throughout the community.

Community members have their own perceptions of environmental health hazards and their own experience will affect these perceptions.

It has been found from previous studies that concerns about risk tend to be particularly heightened when those risks are:

- involuntary or imposed on the community
- man made rather than natural
- inescapable
- related to a distrusted source.

(Environmental Health Risk Perception in Australia, enHealth, 2000 p9-10)

The CRG identified a number of issues which were relevant for quantitative data collection such as concerns around quality of life, perception of the impact of odour and air quality, stress, impact on property values and respiratory disease (self reported). This work was conducted via a Computer Assisted Telephone Interview (CATI) survey of over 1000 households within the suburbs of Deception Bay, Burpengary, Dakabin, Narangba and Narangba Valley.

The information obtained via the survey was used to provide data on health status, community perceptions, behavioural risks, employment, trust in government, sources of information and property values.

## Independent post-event review of two chemical fires

The objective of the post event review of the fires (Binary Industries and Zelam Australasia) was to consider whether the emergency management framework was adequate to protect the greater community from risks/hazards associated with emergency situations/incidents.

The review also considered the following matters raised by the community in the context of its brief:

- appropriateness of the use of foam when responding to chemical fires
- availability of disaster plans for the area
- rationale for not evacuating the community
- limited environmental sampling after the fire
- potential for another NIE disaster or a multi-entity mass disaster
- ability to provide community assurance that a fire of this magnitude will not occur again
- perception that if businesses were doing the right thing then there would be no spills, odour, accidents and emissions
- assessment of need for mandating sprinkler systems
- need for a integrated community emergency evacuation system
- perception that communities living near a ticking time bomb as all business are fundamentally unsafe with inadequate emergency response planning capabilities
- lack of buffer zones.

A key purpose of the review was to provide information to inform future land use, regulatory and emergency planning decision making processes.

## Air quality studies

The air studies were conducted to provide objective data to inform the assessment of human health risks. A comprehensive list of more than 150 compounds was compiled based on their hazardous nature and their ability to evoke acute and chronic health effects over a broad range of health outcomes. These are listed in Appendix 6.

## Ambient air

Air quality was the main concern identified by the community. An ambient air monitoring program was established to gain an understanding of the types and levels of emissions to which the community were being exposed. This study employed a variety of different sampling methods, such as canister sampling and low volume sampling to screen for over 150 compounds including:

- Volatile Organic Compounds (VOC) including target aromatic compounds
- Carbonyls
- Polycyclic Aromatic Hydrocarbons (PAH)
- Pesticides including glyphosate
- Polychlorinated biphenyls (PCB).

## Ambient Odour Survey

Odour was identified by the CRG as a source of concern. Issues included the frequency, duration and the potential for adverse long term health effects from prolonged exposure to odour, and adequacy of response to community complaints. The CRG reported that community members would frequently complain about the odour but they did not feel that their issues were being addressed or taken seriously by regulators.

In response to these concerns, an odour survey was commissioned to:

- provide an independent professional assessment of odour within and around the surrounding community of the Narangba/Deception Bay area
- substantiate complaints data and odour diary contents relating to the NIE
- determine whether additional work was required (eg. modelling).

The findings from this survey also informed the scope and development of stack and area source monitoring.

## Stack emission (point source) monitoring

Point sources such as stacks were monitored for compounds of interest. The function of a stack is to remove pollution of high concentration and to discharge it into the atmosphere for dispersion and transport. Stacks release pollutants into the air and the space that they occupy is called a plume. As the plume travels it spreads and disperses reducing the pollutant concentrations. Emissions from stacks are important as they have the potential to settle upon areas of the community some distance from the source.

Stack emissions were analysed for the following compounds:

- heavy metals
- VOCs
- reduced sulfur compounds
- sulfur dioxide
- particulate matter total solid particulate matter and PM<sub>10</sub>
- Glyphosate
- Organochlorine compounds
- Organophosphate compounds
- PCB
- Polychlorinated Dibenzo Dioxins, Polychlorinated Dibenzo Furans (PCDD/PCDF)
- Oxides of Nitrogen
- PAH
- Ammonia/Ammonium Chloride/Hydrogen Chloride.

#### Area source monitoring

Air emissions can be released from sources other than stacks such as from doorways, stockpiles, roof vents, biofilters etc. Emissions from these sources can also contribute to the overall exposure of the community.

Queensland Health—Narangba Industrial Estate Health Impact Assessment

Samples were taken from these different sources and analysed to provide concentration, odour level and odour rate data. The compounds included those listed above.

The scope and design of the stack emissions and area source monitoring programs were developed in consultation with the independent technical adviser and a panel of experts consisting of independent consultants with experience and expertise in human toxicology, air emission monitoring and air dispersion modelling.

#### Air Quality Impact Assessment

An air quality assessment of the NIE was undertaken through the use of air dispersion modelling. Air dispersion modelling is a technique that uses monitoring results obtained at the industry site and information on local air movement patterns to predict ground level concentrations across a large area and at particular sites across the community (receptor sites). Receptor sites included areas where higher risk members of the community were present, such as schools and childcare centres.

The predicted ground level concentrations at these receptor sites, generated by the model, were then compared with the air quality criteria for Queensland as contained in the *Environmental Protection (Air) Policy* (EPP (Air)) and the *National Environment Protection (Ambient Air Quality) Measure (NEPM (Air))* standards. These standards do not contain a comprehensive list of compounds so for substances that are not included in the EPP (Air) and NEPM (Air) standards, other national and international standards and guidelines were used in the assessment.

As ambient air quality guideline values are established for the purpose of protecting human health, only those compounds that were found to exceed guideline values were considered by the heath risk assessment.

#### Health Risk Assessment

The purpose of a health risk assessment (HRA) is to assess and characterise environmental health risks in relation to their nature and magnitude of their risk to human health.

Specifically this involved evaluating the short and long term health impacts of exposure to emissions from the NIE, including cumulative impacts and secondary formation of air toxics, in the context of the current and future residential populations.

The HRA was based upon the data gathered through the air quality monitoring and modelling studies and assessments.

## 2.0 Health and social profile

It is important to gain an understanding of the nature of the community, its pattern of disease and health risk factors, that is, its health and social profile. The health profile particularly focuses on those diseases and conditions that may be aggravated or caused by air pollutants. The purpose of examining the pattern of disease in the community is to identify whether or not there are any particular patterns of disease that may be related to exposure to air pollutants from the NIE. Potential risks to the community may be identified which would require further investigation.

## 2.1 Community demographic data

The most current set of demographic data for Australia is Australian Bureau of Statistics (ABS) 2006 Census data. Postcode data for Narangba (4504) and Deception Bay (4508) was extracted and analysed for the purposes of this study.

## Deception Bay community profile by postal area 4508

The 2006 Census data reveals that Deception Bay had a population of 17 907. Of the total population in Deception Bay 3.4 per cent were Aboriginal and Torres Strait Islander persons, compared with 2.3 per cent Aboriginal and Torres Strait Islander persons in Australia. The percentage of Aboriginal and Torres Strait Islander persons is important as this particular group tends to have poorer health outcomes than the general population. This should be considered when interpreting population based data.

Of this population 7278 people were aged over 15 years and in the labour force. This total figure includes both employed and unemployed persons. Labourers, technicians and trades were the most common occupations. Of the labour force, 7.9 per cent of the labour force was unemployed as compared to 5.2 per cent for Australia. The majority of people (71 per cent) of people 15 years and over completed Year 10-12 or equivalent as compared with 75 per cent for Australia.

The median weekly income for individuals was \$396 compared with \$466 in Australia. The median weekly household income was \$807 compared with \$1027 in Australia.

The median age of Deception Bay was 32 years as compared with 37 years for Australia. Of the population, 26.4 per cent of the population were children between 0-14 years compared to 19.8 per cent in Australia. The total percentage of people 65 years and over is 11.2 per cent compared with 13.1 percent for Australia.

There were a total of 4,836 families in Deception Bay. 42.2 per cent were couples with children, 32.9 per cent were couples without children while 23.7 per cent were single parent families. The percentage of single parent families in Australia is 15.8 per cent.

## Narangba community profile by postal area 4504

The 2006 Census data reveals that Narangba has a population of 12,736. Of the total population 1.3 per cent were Indigenous persons, compared with 2.3 per cent Indigenous persons in Australia.

Of the total population 6722 aged 15 years and over were in the labour force—of these 63.4 per cent were employed full time with 26.6 per cent employed part-time; 4.4 per cent were unemployed compared with 5.2 per cent for Queensland. Of the employed workforce, 17.8 per cent identified as Clerical and Administrative Workers, 17.6 percent identified as Technicians and Trades and 13.5 per cent as Professionals. A range of other professions were also recorded with much smaller percentages that are not shown here. Of those people aged 15 years and over 84.7 per cent completed Year 10-12 or equivalent as compared with 75 per cent for Australia.

The median individual income for persons aged 15 years and over was \$561 compared with

Queensland Health—Narangba Industrial Estate Health Impact Assessment

\$466 in Australia. The median weekly household income was \$1312 as compared with \$1027 in Australia.

The median age for Narangba was 31 years compared with 37 years for the median age for Australia. Of the population 28.2 per cent were children aged between 0-14 years. Only 8.9 per cent of the population was aged 55 years and over compared with 13.1 per cent for Queensland.

A total of 3,595 families reside in Narangba. Of those, 57.6 per cent were couples with children, 29.5 per cent are couples without children, while 12.4 are single parent families. The percentage of single parent families in Australia is 15.8 per cent.

## Socio-Economic Indexes for Areas (SEIFA)

The Australian Bureau of Statistics (ABS) released a series of measures called Socio-Economic Indexes for Areas (SEIFA), which compare the relative social and economic conditions of cities, towns and suburbs across Australia (ABS 2006). The index has been developed so that relatively disadvantaged areas (eg. areas with many low income earners) have low index values.

The SEIFA index value for Deception Bay from the 2006 Census data is 922.2, while the index value for Narangba is 1064.2. As indicated previously, the higher the index value the less disadvantaged an area is; Narangba is therefore considered to be less disadvantaged than Deception Bay (ABS 2006). In addition, Deception Bay was ranked as the ninth most disadvantaged Statistical Local Area (SLA) in Greater Brisbane (ABS 2006).

SEIFA is an index of an area and not of individual residents in the area. The indexes are derived from attributes such as educational attainment, unemployment levels, jobs in relatively unskilled occupations and variables that reflect disadvantage rather than measure specific aspects of disadvantage.

It is recognised that the socio-economic conditions of individual residents in any one area will vary and there may be relatively advantaged residents living in areas labelled as disadvantaged and vice versa.

## Local opportunities for employment

The NIE currently employs over 1000 people and is a major employment centre of the local area. Approximately one third of people randomly surveyed in the Narangba/Deception Bay area advised that they worked in the local area. Other employment opportunities have been identified in North Lakes, Caboolture and Redcliffe.

Deception Bay was one of fifteen Queensland communities who were identified in 1998 as experiencing social and economic stress. In response to this, a community renewal program was established to develop a community where people feel valued, safe and proud (Department of Housing, Community Renewal 2002-2003). The program was run over 10 years and included training and employment activities. Despite these activities, unemployment remains higher than the national average.

## 2.2 Health status of Narangba/Deception Bay

How people perceive their health is a powerful, independent predictor of their actual health and likelihood of survival. This association between 'self rated' health and actual health applies to many populations regardless of their age, sex, illnesses and disabilities, personality and social supports.

## Self reported health status

The people of Narangba/Deception Bay were surveyed on how they rate their health with the majority of people (82.2 per cent) rating their health as either excellent, very good or good which is comparable with that of the Queensland population (85.2 percent) (Health Surveillance and Epidemiology, Central Regional Services 2007).

Good health is partly about making healthy choices. The majority of people in Narangba/Deception Bay reported good health practices such as not smoking and walking or exercising outdoors in their neighbourhood.

## Queensland Health data on health status

To determine the actual health status of the community, data was extracted, analysed and compared with Queensland data to ascertain if there were any observed difference in rates for Narangba/Deception Bay and the rest of Queensland. Rates for Narangba and Deception Bay were combined in order to preserve the privacy and data confidentiality of the persons covered by the data (Queensland Health 2010, pp. 2-36)

Health related data from 2000-2006\* was obtained from a variety of sources including:

- Queensland Registrar General (QRG)-death rate data
- Queensland Cancer Registry (QCR)-records of cancer notifications at time of diagnosis
- Australian Bureau of Statistics (ABS)—census data by postcode
- Office of Economic and Statistical Research (OESR)-extracts of census data
- Queensland Hospital Admitted Patient Data Collection (QHAPDC)—hospital separation data.

The data has been standardised so that it can be compared with data for the rest of Queensland. Standardisation is a commonly used method to reduce the effect of differences in age or other factors in order to allow a comparison between two or more populations.

These data sources all use an international classification system which was developed to ensure that diseases and other health problems recorded on many types of health and other records including death certificates and health records are reported in a uniform manner. The classification system is known as the International Classification of Diseases (ICD) and provides a number of codes for a variety of conditions.

The following findings refer to data obtained from the 2000–06 period (latest available data).

## Mortality

No observed differences between the rates for mortality in Narangba/Deception Bay and Queensland as a whole were found. The annual mortality rate was 330 per 100 000. There were 714 deaths registered in Narangba/Deception Bay (due to all causes) between 2000–06; this was consistent with the state average.

## Cancer

'Cancer' is a broad term that describes hundreds of different diseases, where there is uncontrolled growth and possible spread of abnormal cells throughout the body. Different types of cancer generally have different known/suspected risk factors associated with them making it unlikely that they are caused by the same source trigger.

Most cancers are related to lifestyle, behavioural choices and family history. A relatively small proportion of cancers are associated with exposure to toxic substances in the environment or

<sup>\*</sup> Data prior to 2000 was unavailable for use due to previous collection methods making data extraction difficult and prone to significant error.

workplace. Where toxic substances are known to be associated with particular cancers, the risk of developing cancer depends on factors such as the level and duration of exposure and an individual's level of susceptibility to cancer. Current Australian data indicates that one in three males and one in four females can expect to be diagnosed with cancer in the first 75 years of their life. The rates for all cancers in Narangba/Deception Bay were similar to the Queensland rates.

## Breast cancer

Breast cancer is the most common cancer and most common cause of cancer deaths among females in Australia. This cancer mostly affects women after the age of 40 (HealthInsite 2010). Exact causes of breast cancer remain unknown however, a number of risk factors have been identified and include sex, age, diet, weight, hormonal related factors (menstrual life and childbirth history) and previous family history of breast cancer.

The rates of breast cancer in Narangba/Deception Bay were similar to the Queensland rate.

#### Colorectal cancer

Colorectal cancer is commonly known as bowel cancer and is the second leading cause of cancer deaths in Australia. It is very common with a large proportion of diagnoses with no known hereditary genetic association. Risk factors include diet, age, obesity, smoking and existing bowel disease. The rates for colorectal cancer in Narangba/Deception Bay were similar to the Queensland rate.

## Prostate cancer

Prostate cancer is the most common form of cancer in males and is a form of cancer that grows in the prostate gland which is part of the male reproductive system. Known risk factors include age, diet, lifestyle and family history of prostate, breast and ovarian cancer (Prostate Cancer Foundation of Australia 2010). The incidence rate fluctuates frequently, as shown in figure 2 but is generally consistent with expected incidence rate.

## Figure 2 Incidence rate for prostate cancer among male residents in Narangba/Deception Bay and Queensland



#### Trachea, bronchus and lung cancers

Lung cancer is the leading cause of cancer deaths in Queensland and affects both men and women. There are many different types of lung cancer depending on the type of cells affected

Queensland Health—Narangba Industrial Estate Health Impact Assessment

but the two main types are small cell carcinomas and non small cell carcinomas. The major cause of lung cancer is smoking with up to ninety percent of cases caused by tobacco smoking. Workers exposed to industrial substances such as asbestos, nickel, chromium compounds, arsenic, polycyclic hydrocarbons and chloromethyl ether are at higher risk of developing lung cancer. The rates for cancers of trachea, bronchus and lung in Narangba/Deception Bay were similar to the Queensland rates.

## Melanoma

Melanoma is the most dangerous type of skin cancer. A melanoma may appear as a new spot or as a change in an existing mole or freckle. Melanoma is usually diagnosed in older people; however young adults, teenagers and even children can be affected. The biggest risk factor for developing melanoma is overexposure to UV radiation from the sun (Queensland Health 2008 p32). The rates for melanoma in Narangba/Deception Bay were similar to the Queensland rate.

## Summary

Based on the available data, there is no observed difference in the rates of all causes of cancer in Narangba/Deception Bay as compared with the rest of Queensland.

## 2.3 Chronic disease

The CRG raised concerns regarding the rates of chronic diseases such as coronary heart disease, stroke and respiratory diseases including asthma. In 2006, chronic disease was the cause of 88.2 per cent of the health problems and early deaths in Queensland. Chronic diseases and their risk factors show significant variation across population groups in their incidence, prevalence and associated health outcomes. Hospital separation data is used to measure the rate of chronic disease in the community. Each time a person is admitted to hospital certain details are recorded such as the condition for which they were admitted. This information is collated for different conditions and is known as hospital separations. An examination of the hospital separation rates was conducted to ascertain whether there was significant variation in the total burden of disease between Narangba/Deception Bay and Queensland.

Hospital separation rates are dependent on a number of factors such as the admission practices of clinicians and hospitals which vary considerably throughout the state. Some doctors may prefer to admit someone to hospital for treatment while others may prefer the patient to remain at home.

Each time a person is admitted into hospital, it is recorded as a new separation event. So if an individual person has more than one hospital admission, it is counted as more than one hospital separation.

Other factors such as level of uptake of preventative health services by community members and size of the population will also influence the interpretation of health data. It is not possible to ascertain the level of uptake of preventative health services from this disease rate data. The size of a population is important when analysing data as fluctuations are common with smaller numbers.

## Coronary heart disease

Coronary heart disease (CHD) refers to the progressive reduction of blood supply to the heart muscle due to narrowing or blocking of the coronary arteries. The main underlying cause of CHD is the build up of fat, cholesterol and other substances in the inner lining of the arteries. It is associated with ageing and a number of other factors known to put people at risk irrespective of their age such as genetics, high blood cholesterol, high blood pressure, smoking, overweight and obesity, physical activity, diabetes and poor nutrition. Environmental health risk factors are not associated as underlying causes of this particular condition.

In Queensland for 2005–06 CHD, death rates were 29 per cent higher in socioeconomically disadvantaged areas as opposed to advantaged areas (Queensland Health 2008, p21). The hospitalisation rates for Narangba/Deception Bay were higher than the rates for Queensland with some fluctuations during this time without clear year to year trends. Figure 3 illustrates the standardised hospital separation rates for coronary heart disease for Narangba/Deception Bay and Queensland.



Figure 3 Age and gender standardised hospital separation rates for coronary heart disease in Narangba/Deception Bay and Queensland (Queensland Health 2010, p. 12)

#### Years

## Respiratory disease

Respiratory disease is the common term used for diseases of the respiratory system. There are 101 different diseases included under the term and these can be found in Appendix 5. Of particular interest to the HIA are the rates associated with chronic obstructive pulmonary disorder (COPD) and asthma.

COPD is a serious and progressive disease which involves the destruction of lung tissue and narrowing of the air passages, causing chronic shortness of breath. The main form of COPD is emphysema which is typically caused by tobacco smoking although other risk factors include exposure to passive tobacco smoke and exposure to occupational chemicals or dusts.

Asthma is a chronic disease causing wheezing, chest tightness and shortness of breath due to widespread narrowing of the airways and obstruction of airflow. The underlying problem is usually inflammation of the air passages which become sensitive to a wide range of triggers and is the leading cause of disease burden in children and young people.

The cause of asthma is not well understood however; known factors that may increase the risk include environmental exposure to tobacco smoke, allergens such as dust mites or mould spores, physical inactivity and stressful life events (Queensland Health 2008, p34).

Figure 4 below, indicates that from 2000/2001 to 2003/4, the rates for respiratory disease including asthma in Narangba/Deception Bay were similar to the Queensland rates. From 2005/2006 onwards the rates in Narangba/Deception Bay were higher than the Queensland rates.





Rates for asthma were reviewed separately (Figure 5) and a very slight excess was noted. In a community of 30 000 this represents an excess of 1-2 hospital separations per month and does not represent an unusual variation.



## Figure 5 Age and gender standardised hospital separation rates for asthma in Narangba/Deception Bay and Queensland (Queensland Health 2010, p16)

Hospital separations for respiratory diseases (excluding asthma) were further examined as per Figure 6. A comparison of the hospital separations for respiratory disease including asthma and excluding asthma indicate very little difference in analysis indicating that the increased incidence in respiratory disease is not due to an excessive burden of asthma.

# Figure 6 Age and gender standardised hospital separation rates for respiratory diseases (excluding asthma) in Narangba/Deception Bay and Queensland (Queensland Health 2010, p15)



## Summary of findings of respiratory diseases

Respiratory diseases in Narangba/Deception Bay are higher than the rates for Queensland. Figure 4 Separation rates for respiratory diseases (including asthma) and Figure 6 Separation rates for respiratory diseases (excluding asthma), indicate no obvious difference in the rates of respiratory disease. In addition, Figure 5 Hospital separation rates for asthma, also confirm this finding as the rates are similar to the rates for Queensland. The increase was most likely due to a wide range of acute respiratory infections and other chronic lung diseases.

These findings were further supported by Narangba Industrial Estate Risk Perception Survey where 23.3 per cent of respondents indicated that they had been diagnosed with asthma compared to 24.3 per cent of all Queenslanders. In addition, the survey also indicated that 2.1 per cent of respondents had been diagnosed with COPD. The prevalence for COPD in Queensland was estimated at 3.7 per cent in 2004/05, using self report (Queensland Health 2008, p32).

## Diabetes Mellitus

Diabetes mellitus is a disease marked by high blood glucose levels resulting from defective production and/or action of insulin, which is the hormone that regulates blood sugar. There are different types of diabetes and each has different causes: Type 1, Type 2 and gestational diabetes.

The factors that cause Type 1 and Type 2 diabetes are different. Type 1 diabetes is the result of genetic predisposition in combination with biological and environmental factors. Type 2 diabetes results from a combination of genetic factors and lifestyle behaviours (overweight and obesity and physical inactivity) and unlike Type 1, is highly preventable.

Gestational diabetes is diabetes that occurs during pregnancy but usually disappears after giving birth though it can be a predictor of future Type 2 diabetes in the affected person.

The hospitalisation rates for Narangba/Deception Bay were similar to the rates in Queensland except in the year 2003/2004 where the rate in Narangba/Deception Bay was lower.

### ental and behavioural disorders

Mental illness is widely recognised as a major health concern in Australia. It affects the perceptions, emotions, behaviour and resulting social wellbeing of individuals. There are numerous types of mental illnesses with varying degrees of severity. Examples include anxiety, depression, bipolar disorders and schizophrenia.

Mental health is associated with fewer deaths than other leading health problems but it is a significant contributor to the burden on disease in Queensland and a good indicator for the psychological health status of the community.

Genetic factors have been implicated in some types of mental illnesses, such as schizophrenia, bipolar disorder and depression while mental health problems and disorders can be due to an interaction between biological factors and adverse psychosocial experiences (Al-Yaman F, Bryant M, and Sargeant H 2002, p193).

A number of risk factors have been associated with a higher likelihood of developing a mental disorder, but this does not mean that these factors cause mental illness, or that everyone who is exposed to them will develop a mental disorder. Risk factors can be individual (particular to the person), contextual (a product of the environment), or the result of the interaction between the person and the environment. Risk factors may include:

- individual factors such as prenatal brain damage, insecure attachment in infancy or childhood, low intelligence, difficult temperament, poor social skills, low self esteem
- family or social factors such as having only one resident parent, marital discord between parents, parental substance misuse, parental mental disorder, social isolation
- school context such as bullying, peer rejection, inadequate behaviour management, failure to achieve academically
- life events and situations such as physical, sexual and emotional abuse, divorce and family break-up, physical illness or impairment, poverty, homelessness

community and cultural factors such as socioeconomic disadvantage, social or cultural discrimination, neighbourhood violence and crime, population density and housing conditions. (Al-Yaman, F, Bryant, M and Sargeant H 2002, p193).

The rates for Narangba/Deception Bay were below or similar to the Queensland rates.

## Summary of the chronic disease status

Hospital separation rates for coronary heart disease and respiratory disease were found to be higher compared with those for Queensland as a whole. The increased rate of hospitalisations due to respiratory disease was not found to be caused by a disproportionate burden of asthma, which was a concern of the community. There was a very slight excess in asthma representing an additional 1-2 hospital separations per month which does not represent an unusual variation. This information was further supported by data from the health risk survey where rates of diagnosis for asthma, and COPD were both less than the hospital separation rates for Queensland.

The observed increase in disease rates are likely to be an artefact of the data caused by the following factors:

- interrogation of small quantities of data
- admission practises of clinicians
- bi-directional association between social disadvantage and health status.

## Injury and poisoning

Injury and poisoning have a major but preventable impact on health. They affect Australians of all ages with injury being the greatest cause of death in children. Injury and poisoning can also leave many with serious disability or long-term conditions. They can provide an indication of the psychological health status of the community. The rates for Narangba/Deception Bay were similar Queensland rates.

## Relevant reports for chapter 2: health and social profile

- Narangba Industrial Estate Health Impact assessment, Summary of data analysis from existing health datasets April 2010
- Narangba Industrial Estate Health Risk Perception Survey, 2007.

## 3.0 Air quality studies

## 3.1 Background

Clean air is considered a basic requirement for human health and well being. Significant levels of air pollution increase the risk of respiratory and heart disease in the population. Both short- and long-term exposure to air pollutants have been associated with health impacts particularly in susceptible groups such as children, the elderly and poor people (World Health Organization (WHO) 2010).

Air quality can be influenced by a number of emission sources such as motor vehicles, paints, solvents, lawn mowers, coal-fired power stations, pesticides, wood heaters, incinerators, bushfires, cigarette smoking, furnishings, and building products (DERM, 2010, p84). In relation to this study a wide range of activities conducted within the industrial estate were identified with the potential to generate air emissions. What was not well understood at the commencement of the HIA was the impact of these activities on the health of the broader community.

The presence of certain chemicals in a business process and subsequently in the ambient air, and the ability to detect them by smell, does not necessarily equate with human exposure to concentrations that may be of concern. For example, while a chemical may be involved in a particular process and released as an emission it may be at a level well below what would be required to elicit symptoms or disease in individuals.

Concentrations of chemicals at the source are higher than that occurring in the community, and therefore those in the workplace are exposed to a higher concentration than those in the wider community. The plume from an emission source undergoes dispersion into the atmosphere as it travels downwind and so the concentrations decrease with distance from the source. Dispersion is the process of dilution by mixing of the plume into the surrounding air as it is transported by the prevailing breeze. Dispersion is enhanced by turbulence in the atmosphere, resulting from differences between the temperature of the ground and the surrounding air (the atmospheric stability) and the roughness of ground over which the plume is transported.

## Data gathering considerations

A number of factors need to be considered when deciding to conduct air quality monitoring. These factors presented some challenges to the design of the sampling program which varied depending on the type of sampling to be conducted. In the case of ambient air monitoring, specific site and sampling requirements which needed to be considered, included:

- access to land including both ability to access the site and the permission to be on site
- access to a stable power source
- site security
- · location of objects that can shield the normal airflow such as buildings, trees and hills
- location of other air pollution sources
- wind direction
- site location is representative of community exposure.

For stack emission monitoring some of the site requirements included safe access to the stack and installation of a suitable sampling port.

For emission monitoring for odour, water solubility, other pollution sources and wind direction are some of the more important sampling requirements.

The design of a monitoring program largely depends on the objectives of the program and the type of compounds being sampled. Ideally the assessment of chronic exposure should include a full 12 months monitoring data. However, in most cases this method is cost prohibitive and sampling of at least two temporal extremes (with opposite weather patterns) is considered appropriate (U.S. Environmental Protection Agency (USEPA) 2007, p10-28).

Meteorological conditions for monitoring also impact on sampling. Rainy conditions are not conducive to sampling ambient air and area or odour sources. Some compounds are water soluble and may not be detected under these conditions.

In the case of this study, sampling for the project was postponed on a number of occasions due to unfavourable sampling conditions.

Other factors such as business operations also influence when and what samples are taken. Point sources such as stacks or vents were sampled during operation, while certain processes of interest were being conducted.

### Odour and people's perception

A great variety of gaseous compounds have an odour. Humans have an evolved sense of smell making it possible to detect changes in the environment. Detecting an odour may not necessarily cause discomfort, however when odorous compounds are present in sufficiently high concentrations they can trigger odour responses, such as gagging and nausea, in individuals who are exposed to them.

For many chemicals, humans will smell the chemical at lower concentrations than that which is known to cause harm to the individual. In addition, individuals vary in their sensitivity to odours and their response to them, making it difficult for consideration from a community wide perspective. Other harmful chemicals are odourless and the discussion regarding emissions generally is covered in subsequent sections. In this study, those odorous chemicals of concern that were present below health based guidelines were assessed in terms of their ability to cause a nuisance in the community.

Community responses to odour are complex and are strongly affected by factors that are not readily amenable to quantification. Within any community, there is a spectrum of individual sensitivities to odour and these inherent variations that exist within any group of people results in responses that are highly variable (Omerod, RJ and Best, PR 2000). Whether an odour is perceived as pleasant or unpleasant (i.e. its hedonic tone or offensiveness) depends on the nature of the substance(s) causing it and, importantly, it also depends on the individual's perception. Individual responses can also be, strongly influenced by memory, that is, if a person had a bad experience associated with an odour, detecting the odour on another occasion even at low levels, can trigger the same response.

Community dynamics can also play a part; attitudes towards an odour source can be modified by the views of influential members of the community or by outside influences such as media. All these factors are important in explaining why some people living near odour sources become annoyed and others do not. Odour sources differ widely in their characteristics and the main adverse effect of environmental odours is annoyance. People generally become annoyed by an odour they regard as unpleasant and from which they cannot readily escape. Repeated exposure to annoying levels of odour can result in nuisance.

Complaints are often associated with a strong emotional response and a high level of annoyance. Complaint rates may not necessarily reflect the true severity of a problem as annoyance may not lead to complaints or conversely, sensitised people may complain more frequently even though the odour may not be severe. Complaints are the only normal means of informing authorities about an odour problem and are often used as an indicator of the extent and severity of an odour problem.

In this study, logs of odour complaints were analysed but it was not clear at the commencement of the project whether the complaint data was a true reflection of the impacts experienced by the wider community as repeated complaints were made by the same individuals. It was also not known the rate at which the communities around the NIE experienced odours and ignored them or complained about them.

## Factors influencing odour response

Factors that are important in determining the potential for annoyance are known as the FIDOL factors. FIDOL factors stand for:

- frequency
- intensity
- duration
- offensiveness and
- location.

Generally, the greater the frequency, intensity and offensiveness of an odour in a sensitive location, the more likely it is to cause annoyance and lead to complaints.

## Odour units-odour detection threshold

Odour strengths are measured in odour units (ou). The strength of one ou means that the odour would be just detectable by half a panel of trained odour assessors in ideal circumstances. A strength of ten ou means that the sample needs to be diluted tenfold to make it just discernible to half of the trained panel. In practice, in the open air, it is unlikely that the average person would detect an odour strength less than twenty ou.

It should be noted that odours are detected by the nose in a time period of a few seconds; such a time period is difficult to model, most models giving concentrations on a time basis of 1 hour. Accordingly, a predicted odour concentration of less than one ou in a one hour average could still be discernible at any number of times within that one hour time period, and so some guidelines may include odour strengths of less than 1ou.

## 3.2 Ambient air monitoring

The air we breathe contains many different compounds. While the HIA focussed on air quality it specifically concentrated on the chemical contaminants likely to be emitted from the industrial estate. Identifying chemicals of potential concern was based on their known hazard to health and the probability of exposure to these particular contaminants.

Standard air monitoring data on air quality was not available for the specific area of Narangba/Deception Bay. In order to identify possible risks to the community an ambient air study was conducted part of this project. The aim of the ambient air study was to obtain not only an indication of the air quality of the area but an indication of where the resources of the project needed to be targeted.

Ambient air monitoring was conducted over two sampling periods in July 2007 and November 2007 at a number of receptor sites located internal and external to the industrial estate. These sampling periods were considered to reflect winter and summer periods, seasons with different meteorological conditions which were more likely to lead to higher concentrations of components at ground level (due to greater turbulence with the latter and calm conditions with little dispersion with the former). The inclusion of sample variability is very important when estimating seasonal changes.

The sampling was conducted during different times of the day including during the evening. This was to provide an indication of the changes in air quality throughout the day as a number of complaints were recorded during the evening. The monitoring was programmed to occur when businesses were operating under normal conditions and as such was conducted without the knowledge of business operators. This was done as a precautionary measure due to concerns raised by members of the public that businesses by-passed emission controls particularly during the evening.

The limitations of this sampling strategy meant that information about what actual activity was occurring within the business at the time of sampling was not known. However, the CRG was willing to accept this limitation. Most of the compounds of potential concern were not detected. This indicated that background levels for community exposure were not a cause for

Queensland Health—Narangba Industrial Estate Health Impact Assessment
concern and further extensive background monitoring was not warranted.

### 3.3 Odour survey

Complaints data was reviewed and it was found that odour impacts were experienced in the north, north-east and easterly directions and up to as far as 1.5km away from the NIE.

The main odour descriptors included:

- fish emulsion
- diesel
- bitumen
- fecal/effluent
- fertiliser
- acid chemical
- leather/manure
- tar like
- chemical/solvent.

Between 2004–2009, 139 complaints were received by DERM and the local Council received complaints from 59 people. Many of these complainants registered multiple complaints over this timeframe and on occasions multiple complaints were registered on the one day. An independent odour survey was conducted to gain an understanding of the nature, severity and extent of the odour impact and to determine whether a more detailed assessment was warranted. Specially trained, independent odour panellists were recruited to conduct field monitoring of odours at a number of different sites, and at different times of the day. The monitoring was conducted during two temporal extremes (i.e. windy (summer) and calm (winter) conditions) and concurrently with the ambient air monitoring.

The survey recorded:

- duration of odour events
- intensity of odours
- relative offensiveness of odours
- locations where odours from the NIE could be detected.

The survey report concluded that while the data collected is a snapshot in time of odours around the NIE, it was considered to be indicative of typical odour levels in the area. Odour was clearly detected at survey locations, during the sampling period (ten minutes). The findings for six odour types considered to cause the greatest impact presented in Table 3.

#### Table 3 Summary of odour survey impacts

Odour source	Maximum approximate distance detected from edge of NIE (m)	Typical duration short medium long	Relative offensiveness at survey location
Fishy/cat food/fish oil	1400m	Long	Medium-high
Chemical	1400m	Short	Medium
Soapy/chemical	1400m	Short	Low
Rancid/rotten meat	100m	Short	High
Asphalt/tar	1400m	Long	Medium-high
Fertiliser	900m	Long	Medium-high

The odour survey report also identified that assessing odours from the NIE was made difficult as different odour types were experienced at the same time. This meant that although a single business could comply with the Queensland Odour Guidelines in terms of frequency and levels of impacts, cumulative impacts from other odour sources might result in the potential for nuisance. The data from the survey clearly supported the community's complaints regarding the odour from some operations within the NIE. It also reaffirmed the requirement for the health impact assessment to include point source and area source monitoring.

## 3.4 Point (stack) source and area source emission monitoring

Based on the findings of the ambient air monitoring and odour surveys, a targeted emissions monitoring program was developed to capture further data on compounds of interest from a health risk perspective. Of the estimated 74 businesses within the NIE, 11 were identified for further assessment of emission sources.

The monitoring program focussed on identifying the emissions released from all significant sources at the individual facilities with the potential to cause an impact off-site during normal operations. Monitoring was conducted while the business was operating to ensure that emissions were captured associated with the different processes occurring on the site. Monitors were located near/in specific sources emitting air pollutants such as stacks and vents (point sources) and near areas that generally released chemicals of concern such as, buildings and stock piles( area sources). Emissions released from buildings and stockpiles are referred to as 'fugitive emissions'.

### 3.5 Air dispersion modelling

The data from the point source and area source monitoring was put into a specially designed air dispersion model for the area around the NIE. The air dispersion model is created using data on local meteorological conditions and dispersion characteristics in the study area over a 12 month period. The model also took into account the variability that occurred because the business operations generating emissions do not run continuously.

#### Intentional conservative assumptions

The model was verified by comparing the predicted data with data provided by actually measuring the wind at a site near the Binary Industries property. The predictions by the model tend to be 'conservative', that is, it tended to predict higher ground level concentrations than would be expected in the field. In addition, the assessment used the higher value found when duplicate samples of emissions were taken. In the cases where substances were not detected in the source emissions (that is, the levels were below the limit of detection of the analytical method employed), the model still included data based at a level equal to that of the limit of detection.

#### Predicted ground level concentration and standards

The model used the source data to predict the ground level concentration (GLC) occurring at 2 metres off the ground that is the concentration that humans would most likely be exposed to in the assessment area.

The resultant GLC data was compared against the air quality objectives set for Queensland. The *Environmental Protection Act 1994* provides for the management of air environment in Queensland and the *Environmental Protection Policy (Air) (EPP (Air))* contains a number of ambient air quality objectives for the protection of health and wellbeing; and for protecting aesthetic environment. The EPP (Air) does not contain objectives for all compounds. For those compounds not included, the GLC was compared against relevant national and international ambient air quality guidelines and objectives.

All standards or guidelines selected for use in the study were had been developed through use of available scientific evidence regarding adverse health effects and tended to lower

targets than that indicated by the evidence as necessary for maintaining an acceptable air quality level.

It is considered that if the air concentrations are found to be below these state, national or international standard or guideline values then risks to health are not expected to be significant.

The process of predicting GLC data at specific receptor sites for a 12 month period from measured data formed the basis upon which the risk to health could be assessed, that is, the Health Risk Assessment component of the project. It allowed the assessment of potential hazards and exposures to prioritise which emissions needed to be assessed, that is, where modelling indicated that a guideline value may be exceeded.

#### Relevant reports for Chapter 3: air quality studies

- Narangba Industrial Estate Ambient Odour Survey, November 2008
- Narangba Industrial Estate—Ambient Air Quality Monitoring, July 2007
- Narangba Industrial Estate—Ambient Air Quality Monitoring, November 2007
- Narangba Industrial Estate—Stack Emissions Monitoring Programme, July 2007.

# 4.0 Findings

### 4.1 Health risk assessment

#### Background

The HRA for this project characterised the nature and magnitude of the risks to community health associated with acute and chronic exposure to hazardous air emissions. The assessment considered the short and long term health impacts of ground level concentrations of selected air toxics resulting from emissions from the NIE, including the potential for cumulative impacts and the secondary formation of air toxics.

Acute effects generally occur within a relatively short time after coming in contact with high levels of a substance for a short period. They can range from simple mild irritation of mucous membranes, eyes or skin through to serious organ damage and death at sufficiently high concentrations. Generally, airborne toxics are likely to have only minor, reversible, acute effects at elevated concentrations that might be found in ambient air. (Golder Associates 2010 p46-47)

Chronic health effects are characterized by prolonged or repeated exposures over many days, months or years. Symptoms may not be immediately apparent and the effects are often irreversible.

#### Conservatism (HRA report p59)

Generally, a conservative approach is taken in risk assessment to compensate for its limitations and this HRA is no exception.

It is done because there will always be some level of uncertainty around:

- the quality and quantity of information available
- extrapolation from animal studies to human environmental exposure
- extrapolation from studies where very high doses are given to animals to relatively low doses to which humans are usually exposed to in the environment and
- human heterogeneity (individual factors that might affect response to chemicals).

These uncertainties are addressed by the HRA process by including a significant margin of error. Consequently, overall risks to health are usually overestimated rather than underestimated. The factors of conservatism that are introduced into the various steps of the HRA are multiplicative, rather than additive, and can result in a large degree of conservatism.

The degree of conservatism applied to this HRA provides assurance that any identified risks are an over-estimation of the actual risks.

#### Results

Out of the 150 compounds identified of interest to the HRA and initially screened against the air quality objectives, only eight were identified for further consideration by the HRA:

- hydrogen chloride
- methyl mercaptan
- nickel
- styrene
- chromium
- polychlorinated biphenyls (PCB)
- polycyclic aromatic hydrocarbons (PAH) and
- polychlorinated dibenzodioxins/ polychlorinated dibenzo furans (PCDD/PCDF).

They were of interest because they satisfied one of the following criteria:

- the predicted GLC exceeded the nominated ambient air quality objective at the location of sensitive receptors or
- the maximum GLC beyond the NIE exceeded the nominated ambient air quality objective or
- no ambient air quality objective could be identified for the pollutant.

#### Acute or short-term health effects

The following compounds were evaluated for possible acute health effects:

- hydrogen chloride
- methyl mercaptan
- nickel
- styrene.

The assessment concluded that for these compounds, acute exposures were not considered a cause for concern.

Styrene had been predicted, using the air dispersion model, to be present at a level above the relevant standard/guideline. However, the assessment took into account all of the conservative factors built into the modelling and the basis of standard (odour effects), and assessed styrene as not being of concern.

The two main factors influencing the overall outcome of the styrene assessment related to air velocity and the reference value used in the assessment. More specifically:

- air velocity through the building at the time of sampling could not be detected (i.e. very low air movement in the building). As such, the ground-level fugitive emissions were estimated using a velocity of 0.3 metres per second (m/s) through the building which was the lowest level the anemometer could detect. The use of a higher emission rate than what was actually present at the time of sampling resulted in a GLC prediction that was not reflective of the actual GLC because air flow leaving the building was low. Thus the emission rate and the predicted GLC are considered to be very conservative i.e. an over estimate (Katestone Environmental Pty Ltd, 2010 Appendix D, p8).
- the reference value of 260 micrograms per metres cubed (ug/m<sup>3</sup>) used for the acute exposure assessment was drawn from a WHO source that is ten years old. The Agency for Toxic Substances and Disease Registry (ATSDR) derived a more recent reference value of 10,000 ug/m<sup>3</sup> in 2007 which was based on human studies. If the more recent ATSDR value had been used then there would be no indication of styrene potentially being considered as a cause for concern.

These factors provide confidence that adverse health effects are not expected at the maximum predicted levels in the community. However, contrary to the assessment findings, members of the CRG remained concerned about the impending site relocation of the pool manufacturing business (the source of styrene emissions) to a site closer to residential properties. They were concerned that as it could result in short term adverse health effects, this is worthy of appropriate assessment and if necessary, management by the relevant regulatory agency.

#### **Chronic health effects**

The following substances were identified and evaluated for chronic effects:

- chromium (as chromium VI)
- total polychlorinated biphenyls (PCBs)
- total polychlorinated dibezo dioxins and polychlorinated dibenzo furans (PCDD/PCDF) (using upper bound estimates)
- total PAH (using upper bound estimates).

Chromium can be present in two forms—chromium III and (hexavalent form of) chromium VI. Chromium VI is a known carcinogen and considered to be the more hazardous. The laboratory analysis found chromium, but did not determine which form or species of chromium was present (speciation). So, for the purpose of analysis the HRA assumed that all of the chromium present was chromium VI even though it was most likely to be a mixture of the two forms.

The HRA was based on modelled data which produced an estimated excess cancer risk for chromium equivalent to one additional cancer case for approximately fifteen thousand individuals exposed over 70 years.

This finding does not reflect a true risk to the community due to:

- the levels of conservatism that are inherent to this risk assessment which were sufficient to account for different exposures such as at rest or during exercise when air volume intake is greater. The level of conservatism is further supported by the following assumptions that contributed to this outcome which include:
  - that all the chromium present was of the chromium VI form
  - the maximum ground level concentration for chromium was constant for 70 years, which would not be the case
  - the fifteen thousand individuals are exposed to that maximum concentration continuously for 70 years which would not be the case
- chromium was only detected in one sample taken from the site and was not predicted at a location where general population resides. The air dispersion modelling predicted the maximum GLC to be located at a point within the shaded yellow area of the Figure 7 below. This contour plot shows the annual maximum predicted average for chromium. Chromium was not predicted to extend beyond the NIE.

# Figure 7 Contour plot of annual average ground level concentration for chromium (Katestone Environmental Pty Ltd 2010)



While the independent health risk assessor concluded that there is no immediate cause for concern, they considered that this finding is worthy of closer examination by the regulatory authority.

This further work should include confirming the speciation of the chromium and ground level concentration and re-evaluating the excess lifetime cancer risk estimate based on the confirmation of the these results. This examination should then inform the need for any emission management and licence amendments, if required, and indicate whether there is a need for a review of state-wide management of this emission from similar business operations.

This health risk assessment did not consider occupational exposures generally, however it is recommended that consideration be also given to the occupational setting as outlined in the recommendations at the end of this report.

Exposures to PAH, total PCDD/PCDF and PCBs were not found to be cause for health concern.

#### **Cumulative Assessment**

Cumulative assessment refers to the consideration of health impacts of exposure to more than one chemical at the same time. The following were evaluated for potential cumulative impacts:

- Chromium
- total PCBs
- total PCDD/PCDF upper bound estimates
- total PAH upper bound estimates.

The air quality studies did not reveal a significant presence of these compounds to be of concern. The independent health risk assessor advised that chemicals present in concentrations well below the threshold for effects are unlikely to interact synergistically.

The assessment determined that cumulative impacts of mixtures are not a cause for concern.

#### Secondary formation of air toxics

Generally, the air human beings breathe contains a wide variety of substances, some of which are considered reactive substances that can be transformed by chemical reaction in the atmosphere. The products of these reactions may be more toxic than the original substances, and are referred to as secondary air toxics. For example, ozone and the hydroxyl radical which can react with volatile organic compounds (VOCs). The reactions occur only in daylight and tend to occur slowly. The reaction rate is further slowed as the VOCs are diluted during dispersion and transport. Consequently, products do not form for several hours after emission, by which time the air parcel would have been transported out of the local region and diluted to such an extent that concentrations would be so low as to be negligible.

Styrene is one VOC emitted from the NIE which could produce secondary air toxics. The products would most likely be a carbonyl such as formaldehyde or acetaldehyde. No carbonyls were detected in the ambient monitoring program. The HRA assessment concluded that they were a negligible health risk.

As there were no health risks associated with PAH, PCDD/PCDF and PCB compounds, secondary breakdown products were also not considered to present potential health risks.

### 4.2 Odour assessment

#### Background

Quantitative odour assessment is extremely useful for decision making and problem-solving. Obtaining information about the ground level concentrations at sensitive receptor sites and the duration and frequency of the odour can provide the community and government regulators with a greater understanding of odour movement in the area and support existing, or inform future management practices (Katestone Environmental Pty Ltd, 2010, Appendix A p1).

Odour emission sources were sampled at nine sites within the NIE where the following business activities are conducted:

- solid waste handling and green waste composting, storage and distribution
- swimming pool manufacturing
- wastewater recycling •
- treatment, recycling and management of waste oil and other chemicals in liguid and solid form
- kangaroo and cow hide tanning for leather production •
- manufacture of aquaculture feed and pet food •
- hot dip galvanising of steel fabrications •
- sheepskin tanning for the manufacture of sheepskin products.

A number of these sites had multiple sources of emissions and included stacks, vents, material stockpiles, ponds, biofilter and building emissions (via open doors).

The ground level concentrations resulting from the dispersion of emissions from these sources were then modelled and assessed against the air guality objectives as contained in the EPP (Air) and the Guideline—Odour Impact Assessment from Developments, July 2004 to provide a greater understanding of odour movement and potential impact in terms of the guidelines. Of particular note, the EPP (Air) also specified an analytical concentration as an odour-based air quality objective for styrene (a component of the resin used with fibreglass in the manufacture of products such as swimming pools) to protect the aesthetic environment.

Consideration was also given to the potential for cumulative impacts of all emission sources with similar odour characteristics.

#### Air quality assessment criteria for odour

The assessment criteria for odour is contained in two main documents:

Environmental Protection Policy (Air) EPP (Air) which contains a number of ambient air quality objectives for the protection of the aesthetic environment. Details of these objectives are contained in Table 4.

#### Table 4 Ambient Air Quality Objectives for the protection of the aesthetic environment included in the EPP (Air) (EPP (Air), 2008 Schedule 1)

Indicator	Averaging period	Air quality objective (ug/m <sup>3</sup> )
Styrene	30 min	75
Tetrachloroethylene	30 min	8600
Toluene	30 min	1100
Hydrogen Sulfide	30 min	7.5

Guideline— Odour Impact Assessment from Developments, July 2004. This guideline provides proponents, government agencies and the general public with a procedure for assessing the likelihood of odour nuisance from development proposals for new facilities. modifications of existing facilities and land developments (DERM 2004, p3).

It defines generic criteria for assessing odour annoyance as:

- 0.5 ou for a 1-hour average, 99.5<sup>th</sup> percentile concentration for tall stacks
  2.5 ou for a 1-hour average, 99.5<sup>th</sup> percentile concentration for ground-level sources and down-washed plumes from short stacks.

#### Results

The air quality assessment based on the air dispersion modelling found that the air quality objectives as per the *EPP (Air)* for the protection of the aesthetic environment (i.e. odour-based) were predicted to be exceeded at some sensitive receptor locations for styrene and methyl mercaptan. It should be noted that the predicted GLC for each substance was an over prediction attributed to the following:

- Styrene: air flow through the building was not able to be detected by the anemometer so it was assumed that the air flow existing the building was equal to the lowest flow rate the anemometer could detect. This means that the model based its GLC predictions for odour impact on a higher air flow rate than what was actually present at the time of sampling.
- Methyl mercaptan: this was not detected at time of sampling but it was modelled at the limit of reporting<sup>4</sup>. Methyl mercaptan is a colourless gas with a very distinctive smell like rotten cabbage at extremely low levels. The odour was not detected at the time of sampling.

The DERM odour guideline was not exceeded at any sensitive receptors around the NIE. The odour concentrations were not predicted to exceed the 2.5 odour units for the 99.5<sup>th</sup> percentile one-hour average. However, it should be noted that that ground level odour concentrations greater than 2.5 odour units can occur for few hours under specific meteorological conditions at sensitive receptor locations, while still meeting the DERM odour guideline.

While the odour impact assessment indicated that the NIE meets the odour guideline it does not mean that odour will not be detectable by the wider community. Throughout the lifespan of the project, a significant amount of effort by government and industry has been focussed on managing odorous emissions. These efforts, coupled with industry changes within the NIE, have resulted in a reduction of recorded odour-related complaints over time.

It is known that ongoing adverse odour impacts can lead to sensitisation of some individuals within a community. This means that short term low level odour events that in another context might not cause great offence, can cause immediate annoyance, thereby contributing to long term nuisance to some individuals (Starke,G, Galvin, G and Marawah, V 2008).

The unintended impact of odour upon the wider community has had significant consequences for community, business and government.

*Government*: resources required to manage public perception/expectations particularly with respect to odour related complaints; resources for compliance related activities, lost business opportunities due to land use planning decisions.

*Businesses*: significant negative media impacting on product sales, lost business expansion opportunities and anxiety over future business viability and job security, increased government presence on site and increased financial burden to cover cost of additional inspections by local government.

*Community*: lifestyle changes due to amenity related impacts, such as not hosting social gatherings such as BBQs outside because of odour.

<sup>&</sup>lt;sup>4</sup> Limit of reporting is the lowest concentration that can be reliably detected by equipment or analysis method. *Queensland Health—Narangba Industrial Estate Health Impact Assessment* 

#### Summary and recommendations

The assessment of acute/short term health effects did not indicate that there is cause for concern. This assessment was based upon:

- the concentration of pollutants present
- the predicted ground level concentrations at receptor sites and the maximum predicted beyond the boundary of the NIE
- the conservatism contained in the modelling and the HRA being multiplicative.

The health status data (hospital separation rates) did not indicate an excessive burden of asthma—a disease whose symptoms increase when irritant pollutants are present at sufficient concentrations.

The chronic health risk assessment of PCBs, PCDD/PCDF and PAH indicated no cause for concern.

An excess cancer risk for chromium was determined as equivalent to one additional cancer case for approximately fifteen thousand individuals exposed over 70 years. This risk was calculated assuming that the chromium present was in the more hazardous form (chromium VI), maximum ground level concentration was constant for 70 years and that the community were constantly exposed to the maximum concentration continuously for 70 years. It was also noted that the maximum ground level concentration, when calculated, was not present in areas where the general population reside. While this finding is not considered to pose a risk to the community, it does warrant further examination by the regulatory authority.

No potential health risks associated with cumulative impacts or secondary formation of air toxics were identified.

Odour has been a long standing issue for the community. The assessment found that the compounds of concern are not present in concentrations that would be expected to elicit an adverse health response. Therefore odour was assessed as to whether it was a nuisance.

The air quality objectives as per EPP (Air) relating to odour were predicted to be exceeded at two sites under certain conditions. However, these exceedences did not impact on the NIE performance against the generic DERM odour guideline which was met at all sensitive receptors.

#### Community reference group recommendations

- 1. DERM assess the presence of chromium VI from Sunstate Coatings quenching process and, if confirmed, Queensland Health to re-evaluate the excess lifetime cancer risk. Should an excess cancer risk estimate be confirmed, then appropriate emission management strategies need to be implemented (DERM) and workplace risks should be assessed and appropriately managed (WPH&S).
- 2. DERM consider whether changes are required to the management of the chromium emission from the hot dip galvanising quenching process (subject to the confirmation of presence of chromium VI and reassessment of excess cancer risk).
- *3.* Moreton Bay Regional Council ensures that fugitive emissions associated with the release of styrene from Atlantic Pools are contained on site and impacts to the community are managed.
- 4. Moreton Bay Regional Council review and amend if necessary, the licence conditions of Atlantic Pools to reflect any emission control actions for fugitive styrene emission management.

#### Relevant reports for chapter 4: assessment of risk

- Environmental Health Risk Assessment Narangba Industrial Estate, August 2010
- Air Quality Impact Assessment for the Narangba Industrial Estate May 2010
- Narangba Industrial Estate Ambient Odour Survey, November 2008
- Narangba Industrial Estate—Ambient Air Quality Monitoring, July 2007
- Narangba Industrial Estate—Ambient Air Quality Monitoring, November 2007
- Narangba Industrial Estate—Stack Emissions Monitoring Programme, July 2007
- Air sampling at Narangba for Polyaromatic Hydrocarbons (PAHs), June 2008
- Addendum to Air Sampling at Narangba for Polyaromatic Hydrocarbons (PAHs), September 2008.

# 5.0 Emergency management

A post-event review of two chemical fires (Binary Industries and Zelam Australasia) was conducted to consider whether the greater community is adequately protected from risks/hazards arising directly from emergency situations or incidents associated with or arising from business activities conducted within the NIE by the emergency management framework.

## 5.1 Background

The Binary Industries fire was the first of its magnitude to occur within the NIE. It presented challenges with respect to emergency and environmental management and communication with industry and the community which contributed to heightened community concern.

Considerable work was done to quantify the environmental impact and to contain and manage the resulting environmental contamination to limit, as much as possible, further impact on the surrounding community and environment.

An analysis of the air quality data obtained during and after the fire indicated that no long term adverse health effects were expected. However, the community remained concerned that they could be harmed should a similar event occur in the future.

While efforts are made to minimise the occurrence of incidents, risks arise due to factors as human error, operational/process failure, non industry-related accidents, inadvertent physical damage, lightning strike and other natural disaster. It is this wide range of variables and the level of uncertainty around them that makes a risk-free environment unachievable.

An effective emergency response framework enables response agencies to coordinate their efforts when an incident occurs. This sets out mechanisms for co-ordination at all levels - on site, at local level and regional level. The framework provides a common language or terminology to make inter-agency working simpler and a mechanism to immediately determine a lead agency in every emergency situation.

The magnitude of an incident is dependent on a number of factors such as:

- types and quantities of bulk materials involved
- · quantities of hazardous or toxic materials released in the course of the incident
- surrounding topographical environment
- weather conditions
- preparedness/response of the facility
- preparedness/response and support of emergency services.

The process of preparing for an emergency is called preparedness. Preparedness is a variety of measures designed to ensure that, should an emergency occur, agencies and communities, have a clear plan of what action they will take, and can access the necessary resources and support services to respond to the incident and cope with the effects.

### 5.2 Emergency response framework for Queensland

The *Disaster Management Act 2003 (the Act)* provides the framework for disaster management within Queensland and contains provisions around the following:

- establishing disaster management groups for the State, disaster districts and Local Government areas
- preparation of disaster management plans and guidelines
- ensuring communities receive appropriate information about preparing for, responding to and recovering from a disaster
- declaring a disaster situation
- establishing the State Emergency Service (SES) and emergency service units
- ensuring the SES and emergency service units can effectively perform their functions.

The Act is supported by the State Disaster Management Plan and a strategic policy framework that covers the four phases of disaster management:

- prevention and mitigation
- preparedness
- response
- recovery.

The management of a disaster event occurs at a local level first and where an incident exceeds the capacity of the local response it may be necessary to escalate support and assistance from the district or state-wide level. The *Disaster Management Act 2003* sets out obligations at a state, district and local level.

#### Local level

This is the first level of management where communities must be prepared and capable of managing local disasters. The Act requires local government to develop a local disaster management plan (LDMP) for their jurisdiction.

The LDMP must outline:

- the roles and responsibilities of the entities involved in the disaster operations and disaster management
- the coordination arrangements for disaster operations
- identification of the type of disaster events expected
- strategies and priorities for disaster management.

A number of sub-plans are required to be developed to complement the LDMP which may include community evacuation, events communication and/or public education plans.

Moreton Bay Regional Council released their current Local Disaster Management Plan on 13 April 2010 and a number of sub-plans are currently under development.

Activities of local councils that contribute to the disaster management phase of prevention and mitigation include town planning measures, building and construction standards, and constructed works such as levees and firebreaks.

Disaster management functions go beyond natural disaster events and for chemical spills/gas release, fires etc. links to the state preparedness on these issues need to be made.

#### **District level**

The Disaster District is formed to cover an area of one or more local government areas and is the level where state government departments collectively plan for and are coordinated to provide assistance to the community within that geographical district.

A District Disaster Management Group is required to be established and develop a Disaster Management Plan for the district that incorporates state government resources which can be utilised in emergencies where capacity exceeds the local level.

#### State level

The Act requires the establishment of a State Disaster Management Group who are charged with responsibility for ensuring effective disaster management is developed and implemented for the State and includes the development of State Disaster Management Plan and State Disaster Recovery Plan.

## 5.3 Other policies/actions supporting emergency response framework

The *Dangerous Goods Safety Management Act 2001* (DGSMA) deals with the safe management of the storage and handling of hazardous materials, particularly dangerous goods and combustible liquids, and the management of major hazard facilities and emergencies involving hazardous materials within Queensland.

A key component of the DGSMA is the requirement for individual premises to develop emergency plans. These premises specific emergency plans contain information such as the dangerous goods and combustible liquids, the types of potential emergencies, emergency procedures, resources and equipment etc.

The Queensland Fire and Rescue Service (QFRS) also play a role in supporting preparedness of the local area through the development and maintenance of Local Area Plans (LAPs). These plans contain premises specific emergency response information such as emergency contact details of owner, location of manifest etc, to support the timeliness of the response actions.

There is no requirement for an industrial estate site specific plan to be developed. However, it was noted that a draft Narangba Industrial Estate Emergency Plan (NIEEP) had been developed with input from community and Moreton Bay Regional Council. The purpose of the draft NIEEP is to provide a link between the premises emergency plans and the LDMP; link key issues between premises' emergency plans and local area plans; and be a repository for information relevant to the NIE in estate wide emergency response resources. The NIEEP is yet to be adopted by the Moreton Bay Regional Council but its benefits are noteworthy.

### 5.4 Findings

The emergency management framework was independently assessed as reasonable and considered adequate to protect the community from risks/hazards arising directly from emergency situations. It outlines roles and responsibilities for all government levels and provides key direction for planning by these levels. Some areas for improvement identified.

These areas included:

- increasing the opportunity for QFRS access to chemical manifest during emergencies. Binary Industries had a chemical manifest but it was unable to be accessed during the event due to the intensity of the fire. The maintenance of an electronic manifest in addition to the copy required to be contained on site, offers a simple solution to this issue.
- strengthening the roles and responsibilities of government in the incident handover and recovery phase. Some role clarification of state agencies has occurred increasing emergency preparedness and greater community protection.
- expanding the current arrangements for exercising emergency management plans
- finalising the MBRC evacuation sub plan and adoption of the NIE emergency plan.

#### 5.5 Post-incident activities

In response to the Binary Industries fire, significant work has been undertaken which has greatly enhanced the operations of the NIE and communication between government agencies, business and community. These are detailed below.

#### **Environmental Monitoring**

In order to make informed environmental management decisions with respect to the site remediation of the Binary Industries site and the adjacent land, DERM implemented a range of environmental sampling programs. These included a water sampling program which was conducted immediately after the fire to determine quality of the water and potential impact to health and environment. Ground water monitoring was also conducted to monitor the movement of the contaminated water below the site.

Other types of environmental monitoring included soil and sediment sampling for dioxins and

Queensland Health—Narangba Industrial Estate Health Impact Assessment

chemicals after the fire. Dioxins are a by-product of fire with different toxicities and were a large concern for the community. Concentrations were expected to be higher at sites closest to the fire. They have a long half life so immediate sampling was not imperative. It was concluded that the dioxin levels present in the areas sampled were unremarkable.

Ambient air quality was also monitored during the contaminated soil removal phase of the adjacent site remediation.

The Binary Industries site and its immediate environs have been the subject of a coordinated, comprehensive remediation and monitoring program with oversight provided by DERM.

Copies of the results of the monitoring programs associated with the Binary Industries incident were made available on the DERM website for the information of the broader community.

#### Accelerated planning initiatives

In 2007, the Queensland Government initiated a series of cross agency policy projects, collectively named the Accelerated Planning Initiatives (API), to provide a robust and holisitic regulatory management regime for the management of existing high impact industries and to establish best practice standards for new operations.

The API consisted of eight (8) projects and included:

- Multi-agency Fire and FireWater Risk Minimisation Inspection Program
- Chemical Incident Recovery Management Policy Framework
- Statewide Inspection Program of Large Dangerous Goods Locations
- Review of Queensland Industrial Estates
- Improved Land Use Planning for Industrial Land Uses
- Acquisition, Planning and Development of Industrial Land
- Review of Regimes for Dangerous Goods and High Impact Industries Interim Solutions and
- Consultation Processes for Industry/Community/Government interface on Industrial Estates.

All of these projects have been progressed by state government.

# Narangba Industrial Estate Multi-Agency Fire and Firewater Risk Minimisation Inspection Program

After the Binary Industries fire, the Queensland Government initiated a multi-agency inspection program of industrial premises storing hazardous materials within the NIE. Joint inspections were undertaken of all premises within the NIE that store large quantities of dangerous goods to assess immediate risks and level of statutory compliance associated with the operations of these facilities, especially with respect to the possible consequences of fire and firewater.

The inspection focussed on fire and firewater minimisation and legislative compliance. While non-compliance issues were identified, none were of such seriousness as to warrant immediate closure/stoppage of business activities and were considered to be of the same order as that seen generally in industry.

A report was released known as the Narangba Industrial Estate Fire and Firewater Risk Minimisation Inspection Report April 2007 contained a number of recommendations. These included that:

1. the regulation of dangerous goods storage and handling in the estate place greater priority on fire risk management, commensurate with the requirements of the *Dangerous Goods Safety Management Act*, the *Fire and Rescue Service Act*, the *Building Act* and other relevant legislation.

- 2. the State Government work with occupiers to establish an ongoing risk assessment program within the estate, including cumulative effects, with the aim of identifying options for minimising the risk from or involving hazardous materials, in particular, the risk from fire. This should be done by an appropriately qualified consultant with experience and expertise in areas such as fire engineering, hazardous materials management and emergency management.
- 3. a whole-of-government strategy be developed for the management hazardous industry in the estate that addresses:
  - a. the promotion of best practice by industry within the estate for the management of dangerous goods and combustible liquids
  - b. fire prevention, early fire detections, early fire suppression, accessibility for fire fighting activities and the management of firewater
  - c. development of an emergency management plan for the estate as a threat specific functional plan of the local disaster management plan.

In the longer term, it should reflect developments in government policy and legislation that emerge in relation to hazardous materials management such as the management of post-incident recovery, the management of buffer zones around hazardous industry, and the development of a more rigorous regulatory regime for LDGLs approaching MHF status.

- 4. an ongoing multi-agency program of monitoring, inspection and enforcement at MHF and LDGL in the estate be established—including annual joint inspections of hazardous materials premises by EPA, QFRS, WHSQ, MBRC, Department of Infrastructure and CHEM Services.
- 5. existing and new businesses within the estate be required to develop an Emergency Plan appropriate to their level of risk that interfaces with the estate-wide emergency management strategy.
- 6. mechanisms be developed to ensure that all relevant aspects of hazardous materials risk management are addressed both at the Development Application stage for a proposed new industry in the estate and whenever a material change of use of proposed for an existing industry.
- 7. the learnings from the Binary fire and the Narangba Industrial Estate be applied to the management of hazardous materials storage at other industrial locations across the State.
- 8. the Queensland Government advocate for change in the Building Code of Australia and relevant National Standards and Australian Standards to provide specific guidance on fire risk management for dangerous goods storage, particularly in high risk facilities, which can be reinforced by appropriate legislation.

#### Chemical Incident Recovery Management Policy Framework

The objectives of the Chemical Incident Recovery Management Policy Framework were to:

- ensure that the state is able to respond quickly and effectively to dangerous situations
- identify clear roles and responsibilities for government agencies
- · ensure appropriate legislative mechanisms are available to achieve cost recovery
- inform amendments to land use planning mechanisms.

The policy framework was developed and has now been incorporated into planning frameworks for government agencies.

#### Statewide Inspection Program of Large Dangerous Goods Locations

Approximately 130 LDGL were inspected to identify those premises where offsite consequences might occur as the result of a major chemical fire or other incident and assess the level of compliance with relevant legislation as an indicator of the level of safety control that occupiers maintain over their dangerous goods.

The inspection program revealed that there is a level of risk that could be further reduced. This level of risk could be better accomplished through reform at the national level. The national standard for the control of Major Hazardous Facilities has been subject to a wider review known as the national review into Model OHS laws which commenced in 2008 and is due for completion in 2011.

#### Review of Queensland industrial estates

The objective of the review was to identify any non-compliance with environmental legislation and immediate risks associated with the operation of licenced industries within estates.

#### Improved Land Use Planning for Industrial Uses

This initiative originally related to the development of a planning guideline for noxious and hazardous industry for use when developing planning schemes. However, this has evolved into the development of a State Planning Policy: Air Noise and Hazardous Materials (SPP) by DERM.

The SPP applies to the preparation of new local planning schemes, as well as master plans and structure plans under the *Sustainable Planning Act 2009*. The primary focus of the SPP is on the strategic location and management of the interface between zones for industrial land uses and zones for sensitive land uses. This may include the need to separate industry zones from zones for sensitive land uses. This SPP specifically seeks to provide direction about how and where industrial growth can be managed sustainably. The SPP was recently supported by government and will be enacted in 2011.

#### Acquisition, planning and development of industrial land

The objective of this project is to identify and secure appropriate sites for the location of high impact industries. This project has been pending the progression of the SPP.

#### Consultation process for industry/community/government interface on industrial estates

The objective of this initiative was to explore the potential for the establishment of a Neighbourhood Environmental Improvement Planning process similar what occurs in Victoria. Community, business and local government input into resolving amenity conflicts between industrial and residential land uses occurs through two different models that involve the community. Exploration of the Victorian model revealed that application is incompatible with the Queensland framework.

#### Review of Regimes for Dangerous Goods and High Impact Industry—Interim Solutions

This initiative involved the participation of the national standard for dangerous goods and hazardous materials and the national standard for control of major hazardous facilities, for the purpose of implementing appropriate regulatory and management regimes in respect of dangerous goods locations and major hazard facilities. This review incorporated within reforms of national Occupational Health and Safety legislation.

#### Increased surveillance of the Narangba Industrial Estate

Moreton Bay Regional Council has introduced a compliance inspection program that results in the NIE being inspected more frequently than the annual inspections required by legislation. An environmental health officer position was created specifically for this purpose and provides oversight, guidance and support to businesses.

While the position and its achievements to date have been a positive influence on the NIE, concerns were raised by businesses regarding inequitable conditions as compared to the rest of Queensland. Businesses are currently required to pay an additional levy to council to support the cost of these inspections thereby in their opinion, placing them at unfair disadvantage to the rest of Queensland.

#### Local area plans

Local area plans (LAP) are compiled by the QFRS and contain specific emergency response information. The scope of information captured by the LAP has been extended for NIE businesses to include the following:

- site name and address
- latitude and longitude
- basic directions to site
- identification of closet fire hydrant and hose reels
- individual site map
- building descriptions
- evacuation system details
- manifest location
- HAZchem rating
- ventilation features
- mitigation options
- contact person details
- alarm information/details.

These plans are reviewed annually and businesses are encouraged to update their details whenever the need arises. The LAP are not currently linked to development approvals or licensing requirements. This means that should a business exchange hands or a new business establish the LAP is not automatically updated with these changes.

## 5.6 Community safety and protection

Three key community concerns associated with emergency management were considered by the independent post event review. These included the potential for a disaster to involve multiple businesses, increasing the risk rating of the NIE; the need for a community early warning system; and adequacy of fire and safety requirements on NIE.

# Potential for a multi-entity disaster and the relationship between incident frequency and perceived increased risk rating of the Narangba Industrial Estate

The independent review found no evidence to support common community concerns expressed in the local media as reportedly 'living next door to a ticking time bomb', alluding to the close proximity of housing to the NIE.

A situation where there is no risk does not exist as there will always be an uncertainty of outcome regardless of the situation. The Emergency Management Framework for Queensland is appropriate to manage population health in the event of an incident.

In addition, situations where industrial fires spread to other neighbouring sites are uncommon. Many factors need to be at play for a fire to escalate to multiple sites. Risks associated with fire communication are generally managed through a number of methods including business and site design and management. Many of these requirements are linked to regulated legislative provisions that are satisfactory and administered by the appropriate authorities.

#### **Community Early Warning System**

Strong community support exists for integrated early warning telephone paging systems for the surrounding areas of the NIE. However, such systems inherently suffer from significant practical limitations and do not offer any certainty or reliability of early warning of the target population group. The independent review identified a number of significant limitations such as:

- such systems are absolutely reliant upon every member of the community having access to the selected telecommunications system
- every member of the target community must be within range (i.e. at home and be able to hear the subject page alarm)

- every member of the target community must react in accordance with the directions of the subject page alarm
- the system must be technically fail-safe
- such systems are only effective under circumstances where the incident/disaster progresses/develops relatively slowly (in particular, the hazardous consequences for the subject community), thus allowing evacuation to occur before the hazardous effects impinge upon that community. Should this circumstance not be achievable, the community may well be placed at greater risk than had it remained in place (RBA Materials Pty Ltd, 2009, p32).

The independent assessor concluded that the success of such a system rests almost wholly upon the ability of emergency services to be able to evacuate the subject community, before the hazardous effects of the disaster impinge upon that (exposed) community. Based on this information, an early warning system may not be the most appropriate emergency response tool for the communities located around NIE.

#### Fire/hazard safety requirements

Generally industrial premises routinely have on site varying quantities of flammable and combustible materials. The escalation of a fire can therefore be extremely rapid. There are a number of mandated fire/hazard safety requirements for businesses as contained in Australian Standards and state legislation. One such requirement relates to the installation of a site specific fire detection and alarm system.

These requirements are often linked to the size of the facility and the activities undertaken. This is because these mandated fire/hazard safety requirements are generally applied to larger business entities where the consequences of an out of control fire or chemical incident are considered to present an unacceptable risk to the greater community. The size of the businesses within the NIE are insufficient to trigger the requirement for the installation of such systems.

#### Community reference group recommendations

- 5. Moreton Bay Regional Council review the draft *Narangba Industrial Estate Emergency Plan* and adopt it as a functional sub-plan of the *Moreton Bay Regional Council Local Disaster Management Plan*.
- 6. Moreton Bay Regional Council finalise the development of the Evacuation Sub-Plan as a matter of priority and once developed, the plan be exercised regularly with relevant response agencies using different scenarios
- 7. JAG and Department of Community Safety (DCS) encourage businesses to maintain an off-site electronic copy of their manifest which can readily be accessed by Emergency Services via the designated business contact during an emergency event
- 8. State and Local Government continue to implement the recommendations of the Narangba Industrial Estate: Inter-Agency Fire and Firewater Risk Minimisation Inspection Program, in particular: a) annual joint agency inspections, b) changes to government policy and legislation in relation to hazardous materials management and c) advocate for changes to Building Code of Australia, and relevant National Standards and Australian Standards.
- 9. DERM continue to monitor the ground water movement of Binary Industries site and publish results of water monitoring on their website. Should indications of potential leaching into Saltwater Creek be found, appropriate management strategies should be implemented.
- 10. QFRS and Moreton Bay Regional Council continue to foster information exchange relating to ownership and business applications to ensure the local area plans remain current.
- 11. Additional costs associated with increased monitoring and surveillance of the NIE be met by the Queensland Government.
- 12. Moreton Bay Regional Council independently evaluate options for an early warning and emergency evacuation system prior to adopting a system.
- 13. JAG give consideration to the amendment, development and implementation of industry specific fire detection and alarm system requirements for existing and prospective businesses.

#### Relevant report for chapter 5: emergency management

• An independent post-event review of two chemical fires for the Narangba Industrial Estate Health Impact Assessment, April 2009

# 6.0 Land use planning issues

### 6.1 Background

When first established, the NIE was located within the Caboolture Shire and on the boundary of Pine Rivers Shire. The land surrounding the NIE was sparsely populated consisting of either farms or green field sites and this arrangement initially worked well for the former Caboolture Shire Council as the vacant neighbouring land was used to provide a separation distance to dilute or mitigate residual impacts. However, because of changing land use patterns in the area, the NIE is now more closely located to residential development.

Land use conflicts associated with the NIE have occurred when residual impacts from activities have infringed on nearby land users threatening amenity, and perceived community health and safety issues. Community members have reported that they feared "living next to a ticking time tomb".

It is now widely accepted that the development of sensitive uses (eg. residential development) near industry, and visa versa, can impact on the health and wellbeing of communities and individuals. It is the role of planning to ensure that the needs of industry and community are balanced. However, in the case of the NIE, both groups have indicated that they do not consider their interests are adequately protected.

### 6.2 High impact and noxious and hazardous industry separation

One of the many issues raised by the community related to the lack of prescribed physical distance of industry and residential properties. The role of separation distances is to ensure that the amenity of existing land uses can be maintained; it does not include the amelioration of impacts. The term 'separation distance' refers to the separation of land zoned for industrial purposes and land zoned for sensitive uses such as residential development.

Off site impacts are generally managed to a level that is acceptable. However, there is a difference between what regulators and community may perceive as acceptable presenting a challenge in terms of management and levels of mitigation. This was particularly evident where odour was concerned. Businesses and DERM have been working together to achieve best business practice which may not result in nil release whereas sectors of the community expect a situation of nil impact.

The Queensland Government has considered the information provided by the community (i.e. business and residents) of Narangba/Deception Bay with respect to land use planning in the drafting of the *State Planning Policy: Air, Noise and Hazardous Materials (SPP) (SPP, 2010).* 

The SPP seeks to complement the existing management framework by providing a more strategic focus on the location and protection of industrial land uses.

The policy seeks to ensure that planning instruments provide strategic direction about:

- where industrial land uses should be located to protect communities and individuals from the impacts of air, noise and odour emissions, and the impacts from hazardous materials, and
- how land for industrial land uses will be protected from unreasonable encroachment by incompatible land uses.

Planning frameworks have become further refined through the release of the *Sustainable Planning Act 2009* (which supersedes the *Integrated Planning Act 2009*) to bring together planning, Local Government and infrastructure responsibilities to deliver integrated solutions that consider the population and economic challenges to ensure a sustainable future for Queensland.

The SPP considers the potential for off site impacts from medium impact, high impact, and noxious and hazardous industry, and specifies separation distances. Where medium impact, high impact and noxious and hazardous industry zones and zones for sensitive land uses are

Queensland Health—Narangba Industrial Estate Health Impact Assessment

proposed to be located closer than the separation distances, one or more planning investigations must be used to demonstrate that the expected impacts from these industry zones have been adequately considered in the local context.

These changes should see an improvement in future land use planning matters. However, it is important to note that these changes will only apply to new developments with all previously approved planning decisions remaining effective.

To further facilitate community concern management over the proximity of the NIE to sensitive land uses, communication to the wider community on issues of concern such as monitoring results or information regarding incidents is encouraged.

# 6.3 Issues identified for future noxious and hazardous industry site selection

Runoff is generally a problem in established industrial estates as large scale water containment systems were not considered as design requirements as was the case with Binary Industries fire. It was necessary for DERM to undertake significant remedial action to address the environmental consequences of the fire. The issue of firewater runoff at NIE was addressed by Department of Infrastructure and Planning (DIP) as part of the accelerated planning initiatives where a range of mitigation strategies to reduce potential chemical runoff in the event of a future incident within the Narangba Industrial Estate were examined.

The actions undertaken by DIP to improve the emergency management infrastructure of the NIE include:

- a. development of an options assessment for emergency infrastructure assessment (GHD Report May 2009)
- b. Narangba Industrial Estate Temporary Bund Modelling (GHD Report May 2009)
- c. confirmation of Fire and Fire Water Management Strategy for Narangba Industrial Estate.
- d. fire fighting access to enhancement infrastructure which includes a series of gate access locations for emergency services, as per Appendix 7.

Noxious and hazardous industrial estate planning and design including controlled drainage features could assist in reducing environmental contamination that may be experienced as a result of firewater runoff. Experience from the Binary Industries fire highlighted the difficulty associated with introducing emergency management infrastructure to an established industrial estate.

A common risk with vacant land or bushland involves the dumping of unwanted products. The NIE is no exception, with evidence of dumped material found. The main problem with this is that the contents are largely unknown increasing the risk of environmental contamination. The limited knowledge surrounding the extent of possible contamination can make it difficult when trying to prove point of origin after an event. It is recognised that areas have been subsequently fenced to reduce unauthorised access to sites within the NIE.

#### Community reference group recommendations

- 14. DEEDI and DLGP ensure that all future sites for noxious and hazardous industry and estates be set out and developed with inherent estate and individual site bunding, controlled drainage (including emergency water/contaminated water dams), separation distances from sensitive receptors and satisfactory levels of emergency services access
- 15. Queensland Government considers that prior to development of noxious and hazardous industrial parks and sites, baseline data collection of ambient air, water and soil quality be undertaken.
- 16. Queensland Government continues to support the development of the *State Planning Policy: Air Noise and Hazardous Materials* that prescribes separation distances within which further investigative work is required should industry or sensitive land uses be proposed to be located closer than the separation distance.
- 17. DERM establish a procedure to communicate any monitoring results that are of concern to relevant stakeholders and the community.

#### Relevant report for chapter 6: land use planning

• An independent post-event review of two chemical fires for the Narangba Industrial Estate Health Impact Assessment, April 2009

# 7.0 Other issues

### 7.1 Property sales

Some community concern was expressed that the NIE was affecting the value their properties. An examination of real estate data for Deception Bay (figure 8) and Narangba (figure 9) indicates that over the past ten years median house prices have tripled for both suburbs.





Figure 9 Median property prices for Narangba



The house price index figures recorded for Brisbane from 2002–2010 by ABS indicates a similar growth pattern to Deception Bay and Narangba (presented in Table 5).

These findings were further supported by information from the health risk perception survey where 85.7 per cent of people indicated that they did not agree that property values within the Narangba/Deception Bay area had decreased. Based on the available data, there is no evidence to support the claim that housing prices are adversely impacted by the NIE.

#### Table 5 House Price Index for Brisbane 200–03 to 2009–10 (ABS, Cat. No. 6416.0)

Financial year (c)	Brisbane			
		Annual %		
	Index	change		
2002–03	75.5	n.a.		
2003–04	100	32.5		
2004–05	104.2	4.2		
2005–06	108.2	3.8		
2006–07	119.2	10.2		
2007–08	141.8	19		
2008–09	139.8	-1.4		
2009–10	151.7	8.5		
n.a. = not available				
(a) Established houses				
(b) Base of each index: 2003–04 = 100				
(c) Average four quarters				

### 7.2 Trust in government

Trust is commonly viewed as a proxy indicator of social capital, and a high level of trust is considered a factor that can enhance economic growth and social well-being. Indicators of trust inform about the quality of people's interactions with others. The local community was surveyed and results indicated that the community believed that it is government's role to protect the public from environmental health risks. While a very small sector of the community indicated it thought that the fulfillment of this responsibility was excellent, the majority indicated it considered it adequate. In addition, people indicated they do not worry until government has alerted them to specific environmental health problems.

#### Relevant report for trust in government

• Narangba Industrial Estate Health Risk Perception Survey, 2007

## 7.3 Sources of information

Media plays a significant factor in shaping public perception. The local community indicated that it obtains information regarding environmental health risks from newspapers, television and State and Local Government agencies. To a lesser extent information was also obtained through friends and relatives and the internet. Confidence in the information about health risks from state government agencies, environmental groups, internet and medical doctors is higher than for information contained in newspapers and television. The community perception of environmental risk was found to differ from the actual risk which is consistent with the portrayal of the NIE by the media. In addition, it was found that the community had reasonable confidence in the information provided by friends and relatives.

#### Relevant report for sources of information

• Narangba Industrial Estate Health Risk Perception Survey, 2007

# 8.0 Conclusions and recommendations

Air quality was the main issue of concern for the community. Over 150 compounds were identified for consideration and a screening level assessment was undertaken involving monitoring of point and area source emissions for an air quality assessment conducted via air dispersion modelling. The air quality assessment identified only eight compounds for further assessment for human health impacts. No concerns for acute health impacts were identified. Similarly, concerns regarding the formation of secondary air toxics and cumulative impacts were not identified.

Chromium was only detected in one sample taken from the site. The air dispersion model predicted that the location of maximum ground level concentration would be a point beyond the boundary of the source site, but not within an area of residential development.

Nevertheless, assuming that ground level concentration was present in the area of residential development, the excess lifetime cancer risk for chromium VI was identified that is equivalent to one additional cancer case for approximately fifteen thousand individuals exposed over 70 years. It was considered that this estimate did not reflect a significant risk to the community due to the levels of conservatism that were inherent to the assumptions that were used in the calculation of risk.

The estimate assumed that:

- all the chromium present was in the form of chromium VI
- the maximum ground level concentration for chromium remained constant for 70 years which would not be the case
- the fifteen thousand individuals would be exposed to that maximum concentration continuously for 70 years, again which would not be the case.

For completeness, it was considered that this finding required further examination by the regulatory authority to confirm the presence of chromium VI and if confirmed, re-evaluate the excess lifetime cancer risk. Should the cancer risk estimate be confirmed, then appropriate emission management strategies need to be implemented.

Aside from the chromium finding there was no indication that compounds of potential concern were present in concentrations that would be expected to elicit an adverse health response.

Odours were therefore assessed in accordance with air quality criteria and odour performance criteria. Overall, the NIE was found to meet the requirements of the DERM odour guideline at all receptor sites. Based on the requirements of the guideline, odour will be detectable within the wider community under certain meteorological conditions but would not be in concentrations that would be expected to elicit an adverse health response.

Air quality amenity criteria was predicted to be exceeded for the compounds styrene and methyl mercaptan. There were some limitations associated with these results as styrene ground level concentration was predicted using an assumed air flow rate through the building as the air flow rate was too low to detect at the time of sampling. Methyl mercaptan was not detected at the time of sampling but was modelled at the limit of reporting which then led to a predicted GLC that exceeded guideline values.

Management of these potential odour emissions would need to occur to ensure that the aesthetic environment is protected.

No evidence was found to indicate that the community had experienced adverse health effects as a result of its close proximity to the NIE. The rates of mortality and cancer for Narangba/Deception Bay were found to be similar to the rest of Queensland.

Chronic disease information obtained through the hospital separation data did indicate some differences from the Queensland rates. Of particular note were chronic heart disease and respiratory diseases where the rates were higher in Narangba/Deception Bay than the rates for Queensland. However, the increased rates of respiratory diseases were not caused by a

disproportionate burden of asthma in Narangba/Deception Bay which would be expected if air quality was an ongoing issue. This finding is further supported by the air quality data where concentrations were below guideline values. The Emergency Management Framework for Queensland was found to be adequate with some areas identified for strengthening.

The assessment confirmed that a difference exists between community perception of risks and the actual risk as determined through objective data. These perceptions were most likely exacerbated by the negative media most likely contributing to undue stress to both the community and industry.

Business owners have faced uncertainty regarding their future within the NIE as a result of the media reports. This uncertainty has impacted on ability/opportunities to expand operations limiting long term sustainability and future job creation.

Local industry contributes to the local community through local employment and the contributions it makes to the local economy. However, the co-location of industry and community needs to be considered further by government. Two main areas have been identified relating to planning:

- land use allocation for high impact industry and compatibility with other land uses
- land design of high impact industrial estates.

The issues surrounding the NIE are remnants relating to previous land use planning decisions and subsequent nuisance level impacts on the community. While they are not likely to cause disease or ill health, they are still important considerations for government. Adverse impacts were experienced by community, industry and individual government agency as a result of previous land use planning decisions.

Community trust of government was considered reasonable although distrust of private industry was reported in the risk perception survey. The positive level of trust and confidence in government is an indication of the social well being of the community. The level of distrust expressed towards industry will limit the ability of industry and sectors of the community to work together effectively in the future.

The management of community perceptions and expectations becomes complex when there is a divergence in views of levels of acceptability as is the case with the management of environmental or amenity criteria. Business and government operate under principles of best practice controls while community will often seek an environment of nil risk/impact which in some cases may not be achievable.

Land use incompatibility issues identified with the NIE, have been considered by the Queensland Government in the establishment of the Accelerated Planning Initiatives and the State Planning Policy: Air, Noise and Hazardous Materials.

In addition, the Binary Industries fire presented a number of challenges to the state government with respect to environmental contamination containment and the costs associated with the cleanup. It is now recognised that future high impact industry estates need to be designed in a way that accommodates potential firewater volumes and limits contamination of the wider community has been identified. Similarly, profiling the area prior to development may assist in providing baseline data against which subsequent industry impacts or environmental contamination may be assessed.

The HIA has considered a broad range of information to determine the impact of the NIE on the community. This information has been considered in the context of the three dimensions of health:

• *Physical health*—there were no indications that the physical health of the community was compromised. Self reported health was similar to Queensland. Morbidity rates were below or similar to the rates for Queensland except for respiratory diseases and coronary heart disease which were higher. The increase in respiratory disease was not due to a disproportionate burden of asthma but a variety of acute respiratory infections and other chronic lung diseases. The rates for asthma represented 1-2 additional hospital separations per month which does not represent an unusual variation. The higher rate for

Queensland Health—Narangba Industrial Estate Health Impact Assessment

chronic heart disease is not associated with air quality and was not entirely unexpected due to the bi-directional association between social disadvantage and health status.

- *Psychological health*—there was no indication that the psychological health of the Narangba/Deception Bay community was stressed. Mental and behavioural disorders were below or similar to Queensland rates. These figures did not indicate any anomalies within the community. However, this is not to underestimate the impact on some community members associated with uncertainty about the potential for emissions to be impacting on their health prior to the HRA.
- Social health and well-being—some social health and well-being impacts were identified. Impact on some community sectors from environmental odour nuisance was reported at the commencement of the study. Efforts by business and government have reduced the impact of odour with CRG reporting that odour impacts had decreased. This was also reflected in the decreased number of odour related complaints throughout the progress of the study.

Employment opportunities for the local community are limited even though the NIE is a major workplace provider.

Trust issues associated with government were not identified through the community survey indicating generally positive relations within the community.

#### Community reference group recommendations

Based on the findings of the objective data collection and analysis the CRG developed the following recommendations for Queensland Government and Local Government consideration.

- 1. DERM assess the presence of chromium VI from Sunstate Coatings quenching process and, if confirmed, Queensland Health to re-evaluate the excess lifetime cancer risk. Should an excess cancer risk estimate be confirmed, then appropriate emission management strategies need to be implemented (DERM) and workplace risks should be assessed and appropriately managed (WPH&S).
- 2. DERM consider whether changes are required to the management of the chromium emission from the hot dip galvanising quenching process (subject to the confirmation of presence of chromium VI and reassessment of excess cancer risk)
- 3. Moreton Bay Regional Council ensure that fugitive emissions associated with the release of styrene from Atlantic Pools are contained on site and impacts on the community are managed.
- 4. Moreton Bay Regional Council review and amend if necessary, the licence conditions of Atlantic Pools to reflect any emission control actions for fugitive styrene emission management.
- 5. Moreton Bay Regional Council review the draft Narangba Industrial Estate Emergency Plan and adopt it as a functional sub plan of the Moreton Bay Regional Council Local Disaster Management Plan.
- 6. Moreton Bay Regional Council finalise the development of the Evacuation Sub-Plan as a matter of priority and once developed, the plan be exercised regularly with relevant response agencies using different scenarios.
- 7. JAG and DCS encourage businesses to maintain an off-site electronic copy of their chemical manifest which can readily be accessed by Emergency Services via the designated business contact during an emergency event.
- 8. State and Local Government continue to implement the recommendations of the Narangba Industrial Estate: Inter-Agency Fire and Firewater Risk Minimisation Inspection Program, in particular: a) annual joint agency inspections, b) changes to government policy and legislation in relation to hazardous materials management and c) advocate for

Queensland Health—Narangba Industrial Estate Health Impact Assessment

changes to Building Code of Australia, and relevant National Standards and Australian Standards

- 9. DERM continue to monitor the ground water movement of Binary Industries site and publish results of water monitoring on their website. Should indications of potential leaching into Saltwater Creek be found, appropriate management strategies should be implemented.
- 10. QFRS and Moreton Bay Regional Council continue to foster information exchange relating to ownership and business applications to ensure the local area plans remain current
- 11. Additional costs associated with increased monitoring and surveillance of the NIE be met by the Queensland Government
- 12. Moreton Bay Regional Council independently evaluate options for an early warning and emergency evacuation system prior to adopting a system.
- JAG give consideration to the amendment, development and implementation of industry specific fire detection and alarm system requirements for existing and prospective businesses
- 14. DEEDI and DLGP ensure that all future sites for noxious and hazardous industry and estates be set out and developed with inherent estate and individual site bunding, controlled drainage (including emergency water/contaminated water dams), separation distances from sensitive receptors and satisfactory levels of emergency services access.
- 15. Queensland Government considers that prior to development of noxious and hazardous industrial parks and sites, baseline data collection of ambient air, water and soil quality be undertaken
- 16. Queensland Government continues to support the development of the State Planning Policy: Air Noise and Hazardous Materials that prescribes separation distances within which further investigative work is required should industry or sensitive land uses be proposed to be located closer than the default separation distance.5
- 17. DERM establish a procedure to communicate any monitoring results that are of concern to relevant stakeholders and the community.

<sup>&</sup>lt;sup>5</sup> The State Planning Policy for Air Noise and Hazardous Materials was recently released on 27 October 2010 and will be in effect from 28 February 2011.

# **NIE precinct information**

Regional industry relates to those industrial uses that are inappropriate to locate close to sensitive receiving environments because of the size and nature of the operations while local industry are those operations which are generally small scale and compatible with the function of Councils preferred hierarchy for industrial areas. The types of activities include a range of industrial uses with a strong service and commercial orientation to service the needs of the local community (Caboolture Shire Council 2005, Part 5, Division 10, 5.24).

In accordance with the former Caboolture Shire Plan, the Regional Industry area consists of 2 precincts, each having a distinct function.

- a. Precinct 1 (General Industry)—consists of a total land size of 52 hectares which provides for larger scale manufacturing industries and other general industries such as heavy industries with limited impact.
- b. Precinct 2—this precinct is considered to be of regional significance for difficult to locate businesses and industries in South East Queensland. It is zoned to cover a mix of special industry/general industry. Building design, buffers and setbacks respond to minimise impacts on environmental features, residential areas and other sensitive receiving environments.

The Caboolture Shire Plan defines Special Industry as "the use of premises for any industrial activity that requires separation from sensitive land uses due to the detrimental effects that may result from the processes or materials involved in its operation. The term includes, but is not limited to those activities classified as an environmentally relevant activity by the *Environmental Protection Act 1994* and not devolved to local government".

Figure 9, below, illustrates the regional industry portion of the industrial estate which is split into precincts 1 and 2. Precinct 1 is located west of the Bruce highway while Precinct 2 is located on the eastern side of the Bruce highway and is zoned to cover a mix of special industry/ general industry.



Figure 9 Narangba Industrial Estate Regional Industry Zone Precincts, Caboolture Shire Plan 2005

## **Dangerous goods**

In Queensland, requirements surrounding the storage and handling of hazardous materials, particularly dangerous goods and combustible liquids, the management of major hazard facilities and emergencies involving hazardous materials are contained in the *Dangerous Goods Safety Management Act 2001* (Office of the Queensland Parliamentary Counsel 2009, p. 14

Goods are *dangerous goods* if they are defined under the Australian Dangerous Goods Code as:

- (a) dangerous goods or
- (b) goods too dangerous to be transported.

A location is determined to be a LDGL if, the quantity stored or handled at the location, or likely to be stored or handled at the location, of the stated dangerous goods or combustible liquids equals or exceeds the quantities identified in the *Dangerous Goods Safety Management Regulation 2001*.

Facilities that are identified as LDGL are subject to a number of requirements including the development and implementation of an emergency plan and procedures; and safety management system.

These facilities are regulated by Workplace Health and Safety, JAG and local authority who have responsibilities to help regulate the storage, handling and transportation of dangerous goods, licence certain activities, and deal with emergencies.

# **Product irradiation**

Product irradiation is the treatment of products by a certain type of energy i.e. gamma rays. The process involves exposing the product, to carefully controlled amounts of ionizing radiation for a specific time to achieve certain desirable objectives, such as sterilization or decontamination. The process cannot increase the normal radioactivity level of the product, regardless of how long it is exposed to the radiation, or how much of an energy 'dose' is absorbed. Also the product itself does not come into direct contact with the radiation source (International Consultative Group for Food Irradiation (ICGFI) 1999).

Gamma rays have high energy, short wavelengths and form part of the electromagnetic spectrum like radio waves, microwaves, ultraviolet and visible light rays.



The source of gamma rays associated with gamma irradiation comes from a radionuclide cobalt-60. Cobalt-60 emits gamma rays all the time and because of this very heavy radiation shielding is required in accordance with national and international specifications. This shielding prevents the release of ionising radiation and when not in use, the gamma ray "source" is stored in a pool of water which absorbs the radiation harmlessly and completely. The water does not become radioactive and neither do any objects that are exposed to the rays such as the walls of the containment chamber or the products themselves, because the source does not produce neutrons which are required to make materials radioactive and a subsequent nuclear chain reaction. Radioactive waste is not generated and it is not possible for the source to have a meltdown or for it to explode.

Any industrial activity includes certain risks to human beings and the environment. Irradiators are designed with several levels of protection to detect equipment mal- function and to protect personnel from accidental radiation exposure. Under normal operating conditions, all exposures of workers to radiation are prevented because the radiation source is shielded. Potentially hazardous areas are monitored and a system of interlocks prevents unauthorized entry into the radiation room while products are being irradiated. Worker safety further rests upon strict operating procedures and proper training.

Radiation sources are tracked throughout Australia and all sites using these sources are subject to specific licence requirements. Queensland's regulations require periodic inspection of the facility to ensure compliance with the terms of operating licences.

# Narangba Industrial Estate Community Reference Group: draft terms of reference

#### Introduction

The Narangba Industrial Estate Health Impact Assessment (NIE HIA) is an initiative developed by Queensland Health as part of the Narangba Health Action Plan to address the health-related concerns of the surrounding community regarding the Binary fire on the Narangba Industrial Estate (NIE). The focus of the NHIA is broader than an investigation of the impact of the Binary Industries fire, and will investigate potential future impacts of the industrial estate on the surrounding community.

The HIA will commission a number of independent technical studies to inform the assessment of health impacts.

The Community Reference Group will be established for the life of the community HIA project, expected to operate from October–April 2007 and will meet regularly throughout the project (fortnightly to monthly as required). It will be convened and resourced by Queensland Health, and facilitated by an impartial, professional facilitator (Jan Taylor).

#### Role of the community reference group

The role of the CRG will be to oversee the preparation of the Health Impact Assessment, and to make recommendations to the Queensland Government in response to its findings.

The CRG will be responsible for decision making in respect of commissioning project briefs, evaluating impacts and formulating recommendations to the Queensland Government.

It is expected that recommendations will address what health impacts exist and need to be addressed.

The CRG will aim to research negotiated agreement on matters before it; however, if agreement cannot be reached, decisions will be made on a majority basis.

#### Membership

The CRG will comprise representatives of a diversity of local communities of interest affected by the Narangba Industrial Estate and leading experts in health impact assessment.

#### Specific tasks

The CRG will have the following tasks:

- 1. To make recommendations to the Queensland Government about the health risks associated with the operation of the NIE that are currently present, or expected to be present in the future, that need to be addressed.
- 2. To confirm the Terms of Reference.
- 3. To confirm the scope of the HIA.
- 4. To confirm individual briefs for technical studies, approve the selection of tenders, monitor their progress and review their findings.
- 5. To oversee the peer review of technical studies.

- 6. With the support of an independent technical advisor, to review the Health Risk Assessment and formulate a Risk Management Profile in consultation with the QH Advisory Group.
- 7. To make recommendations regarding the project findings.
- 8. To provide general advice to the Queensland Government in relation to the Health Impact Assessment.

#### Responsibilities

The CRG will have the following responsibilities:

- 1. Each member of the CRG is present as an individual with a respected knowledge of a sector of the community with an interest in the operations of the Narangba Industrial Estate. Members are not expected to act as formal representatives of a wider group or organisation.
- 2. Members should not speak to the media about the technical content of the HIA until relevant documentation is publicly available. We should point out that this information will only be publicly available at the end, or at least when the HRA is complete. It is the HRA document which will be able to place the technical documents into a paper which explains the human health impacts. The Risk Management Profile is the next logical step after the HRA.
- 3. Respect for the agreed rules of conduct of the CRG.

#### **Operational details**

- 1. Meetings will be held at times convenient to the entire group, with meeting dates and times to be agreed at the first meeting.
- 2. Meetings will generally be two hours, unless otherwise negotiated, and will start on time.
- 3. The meetings will be held at a central venue near the study area.
- 4. Participation is voluntary; however, all out of pocket expenses (eg. taxi, child care) will be met by Queensland Health.
- 5. Meals/refreshments will be provided.

# Issues scoping for HIA

Theme	Issue	Advice/decision
Binary Industries fire	What was the community exposed to at the time of the fire?	Extreme heat can breakdown toxic compounds into less toxic forms. A review of the RACE report data and comparison with health based guidelines did not indicate that long term health effects would be expected. No further action for the HIA
	Why wasn't foam used to put out the fire?	All issues associated with the management of the incident rests with the incident controller and will not be considered for the HIA. The limitations associated with the use of foam will be are to be included in the HIA.
	Why were there no disaster plans for the area?	Local governments are required to have local disaster management plans (LDMP). The Caboolture Shire Council had a LDMP. There was an expectation by the community that there should have been an emergency plan for the NIE. There is no requirement for such a plan. Individual businesses are required to have their own evacuation plan while the local authority is required to have a community evacuation plan as a sub plan of the LDMP.
	Why wasn't the community evacuated?	The decision for community evacuation is the responsibility of the incident controller who considered all available data.
	What was in the Binary Industries inventory?	A manifest was contained of site at the time of the fire but issues were raised regarding the currency and contents. These issues were being addressed through other processes – no further action for the HIA
	Why weren't environmental samples of leaves and soil taken after the fire?	Chemical composition during a fire is different than those found after a fire. Sampling after an event does not always yield fruitful information. Post combustion products are unable to indicate what might have been released during a fire. Post event monitoring responsibility to be considered by the HIA.
	How will the site be remediated?	Responsibility of DERM—no further action for the HIA
	Will the community be at risk while the site is being remediated?	Responsibility of DERM—no further action for the HIA
Theme	Issue	Advice/decision
----------------	---	---
	Some health allegations were made after the Binary Industries fire that people were attributing to exposure to the smoke plume.	A review of the environmental air quality sampling during the fire were reviewed and assessed against health based guidelines. It was determined that long-term health effects are not expected based on the measured levels during the event. No further action for the HIA.
General issues	Why doesn't the study consider off site consequence analysis?	Off site consequence analysis was not identified as an area for consideration at the commencement of the HIA. This is usually considered during the development application process by relevant government agencies. No further action for the HIA
	Property values have decreased because of the NIE	Property sales data to be considered in the HIA
	What is the air quality— exposure to hazardous emissions, cumulative impacts?	Air quality to be assessed by HIA
	Is odour noxious?	Odour to be assessed by HIA
	Residential encroachment on industrial estate and buffer zones	HIA not able to reverse previous land use decisions but is able to inform future decision making processes by government.
	Concerns about where businesses are located with respect to each other and potential for increased risk from fire spreading	HIA to consider whether changes to the Australian Building Code are required.
	Disaster planning for the area	To be considered by the HIA
	Possible ground water leaching	Existing monitoring bores already established and monitored for movement and concentrations by DERM. No further consideration by the HIA
	Why weren't sampling for dioxins taken immediately after the fire?	Roles and responsibilities post event - To be considered by the HIA. Dioxins are ubiquitous in the environment; stable with significant longetivity; expect concentration to be greatest closest to the fire.
	Soil surface contamination from activities from industrial estate activity	Falls within jurisdiction of DERM but should air monitoring indicate the potential for widespread contamination matter level of involvement will be reviewed.

Theme	Issue	Advice/decision
	Worker exposure	Falls within the jurisdiction of DEIR who assess against relevant workplace exposure guidelines which vary from those used to assess population exposure and risk. No further action for the HIA
	Upset conditions/incidents	There are mandated roles and responsibilities in the event of an incident. Queensland Health committed to providing an assessment of any data that may be generated form an emergency response should a health interpretation be warranted. No further action for the HIA.
	Exposure via food	The target area is well resourced with food supply shops. Some residents may grow and consume their own food. There is limited impact of air quality impacting on food quality as it is dependent on many things such as deposition by rain, rates of deposition, the amount of runoff compared to absorption into the soil, biological degradation and root uptake. This exposure pathway was reserved for further consideration should air quality concentrations indicate a potential issue. Air concentrations were largely unremarkable and exposure assessment via this pathway was not warranted. No further assessment for the HIA.
	Exposure via water	Moreton Bay Regional Council provides a reticulated treated drinking water supply. Some residents may consume water from a rain water tank. There is limited impact of ambient air quality concentrations on water quality as it is dependent on many things such as water solubility factor, deposition by rain and rates of deposition. This exposure pathway was reserved for further consideration should air quality concentrations indicate a potential issue. Air concentrations were largely unremarkable and exposure assessment via this pathway was not warranted. No further action for the HIA.

Theme	Issue	Advice/decision
	Exposure to radiation	The source used in product irradiation cannot increase the radioactivity level of a product. The design requirements and operations of the facility provide negligible opportunity for individual/community exposure under normal operating conditions. Appendix 5 contains some additional information on irradiation plant processes. No further action for the HIA.

# Appendix 6

### List of compounds screened by HIA

### Organochlorine (OC) and organophosphate (OP) pesticides

НСВ	Heptachlor	Heptachlor epoxide
Aldrin	gamma-BHC (Lindane)	alpha-BHC
beta-BHC	trans-Chlordane	cis-Chlordane
Oxychlordane	Dieldrin	pp-DDE
pp-DDD	pp-DDT	Endrin aldehyde
Endrin ketone	alpha-Endosulfan	beta-Endosulfan
Endosulfan sulfate	Methoxychlor	Dichlorvos
delta-BHC	Dimethoate	Diazinon
Chlorpyrifos	Chlorpyrifos methyl	Endrin
Malathion (maldison)	Fenthion	Ethion
Fenitrothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)
Parathion ethyl	Parathion methyl	Pirimiphos methyl
Pirimiphos ethyl	Azinphos methyl	Azinphos ethyl
Demeton-S-methyl		

#### Volatile organic carbons (VOCs)

Freon 12	Freon 114	Chloromethane
Vinyl chloride	1,3-Butadiene	Bromomethane
Chloroethane	Freon 11	Ethanol
Freon 113	1,1-Dichloroethene	Acetone
2-Propanol	Carbon disulfide	3-Chloropropene
Methylene chloride	Methyl tert-butyl ether	trans- 1,2-Dichloroethene
Hexane	1,1-Dichloroethane	2-Butanone
		(methyl ethyl ketone)
cis- 1,2-Dichloroethene	Tetrahydrofuran	Chloroform
1,1,1-Trichloroethane	Cyclohexane	Carbon tetrachloride
2,2,4-Trimethylpentane	Benzene	1,2-Dichloroethane
Heptane	Trichloroethene	1,2-Dichloropropane
1,4-Dioxane	Bromodichloromethane	cis-1,3-Dichloropropene
4-Methyl-2-pentanone	Toluene	trans-1,3-Dichloropropene
1,1,2-Trichloroethane	Tetrachloroethene	2-Hexanone
Dibromochloromethane	1,2-Dibromoethane	Chlorobenzene
Ethyl benzene	m,p-Xylene	o-Xylene
Styrene	Bromoform	Cumene
1,1,2,2-Tetrachloroethane	Propylbenzene	4-Ethyltoluene
1,3,5-Trimethylbenzene	1,2,4-Trimethylbenzene	1,3-Dichlorobenzene
1,4-Dichlorobenzene	alpha-Chlorotoluene	1,2-Dichlorobenzene
1,2,4-Trichlorobenzene	Hexachlorobutadiene	

#### Glyphosate;

### Polychorinated Biphenyls (PCBs)

Aroclor 1016	Aroclor 1221	Aroclor 1232
Aroclor 1242	Aroclor 1248	Aroclor 1254
Aroclor 1260		

#### Heavy metals

Aluminium	Antimony	Arsenic
Barium	Beryllium	Boron
Cadmium	Chromium	Cobalt
Copper	Iron	Lead
Manganese	Mercury	Molybdenum
Nickel	Selenium	Silver
Strontium	Thallium	Tin
Titanium	Vanadium	Zinc

#### **Reduced Sulphur Compounds**

Hydrogen Sulphide Carbonyl Sulphide Methyl mercaptan			
	Hydrogen Sulphide	Carbonyl Sulphide	Methyl mercaptan

#### Sulphur dioxide

#### Polycyclic Aromatic Hydrocarbons (PAHs)

Benzo[ghi]perylene	Dibenz[a,h]anthracene	Indeno[1,2,3-cd]pyrene
Benzo[a]pyrene	Benzo[b+k]fluoranthene	Chrysene
Benz[a]anthracene	Pyrene	Fluoranthene
Anthracene	Phenanthrene	Fluorene
Acenaphthene	Acenaphthylene	

#### Carbonyls

Formaldehyde	Acetaldehyde	Acrolein
Acetone	Proprionaldehyde	Crotonaldehyde
Methacrolein	2-Butanone	Buturaldehyde
Benzaldehyde	Valeraldehyde	p-Tolualdehyde
Hexaldehyde		

# Appendix 7



# Glossary

Air toxics	Diverse range of air pollutants usually present in the ambient air in low concentrations with characteristics such as toxicity or persistence that makes them hazardous to human health.
Ambient air	The outdoor air that humans and other organisms breathe.
Area source	A two-dimensional source of diffuse air pollutants eg. emissions from a stockpile.
Bi-directional	Associations between different entities moving in two different directions.
Compounds of potential concern (COPC)	The contaminants of interest identified on the basis of their hazardous nature and ability to evoke acute or chronic health effects over a range of health outcomes.
Covenant	Contractual agreement (which is legally binding) limiting the land use for particular purposes.
Cumulative impacts	The overall impact on the environment resulting from the combination of incremental impacts.
Dangerous goods	As defined under the Australian Dangerous Goods Code.
Determinants of health	Factors that influence individual and population health outcomes.
Emergency Management	Is a process by which hazards are managed in an effort to avoid the impact resulting from the hazard.
Emissions	Releases into the ambient environment.
EnHealth Council	Provides national leadership on environmental health issues and drives the implementation of the National Environmental Health Strategy
Environmental Relevant Activity (ERA)	Industrial activities as prescribed by the Environmental Protection Act 1994 that have the potential to release contaminants into the environment.
Fugitive emission	Emission releases not confined to a stack, duct or vent. These emissions generally include equipment leaks, emissions from the bulk handling or processing of raw materials, windblown dust and a number of other specific industrial processes.
Ground level concentration (GLC)	The concentration in the air of a pollutant to which a human being is normally exposed i.e. between the ground and a height of 2m.
Hazard	The capacity of an agent to produce a particular adverse health or environmental effect.
Health impact assessment	Process that provides a systematic framework to allow consideration of wider effects of local and national policies and programs and how they may affect health.

Hedonic Tone	Is a subjective or qualitative aspect of odour, relating to its pleasantness or unpleasantness.
High Impact Industry	As per Queensland Planning Provisions. Premises used for industrial activities that have significant off-site impacts on non-industrial uses including air, noise or odour emissions that are not easily controlled or contained. These uses may operate indoor, but do not involve the manufacture of agricultural chemicals, pharmaceutical products, explosives or fertilisers.
Hospital separation rate	The total number of separations in all hospitals (public and private) providing acute care services per 100,000 estimated residential population.
Large Dangerous Goods Location	Location that stores or handles dangerous goods or combustible liquids equal or exceeding amounts in <i>Dangerous</i> <i>Goods Safety Management Regulation 2001.</i>
Limit of reporting	The lowest concentration that can be reliably detected by equipment or analysis method.
Mortality rate	Measure of the number of deaths per 100,000 in a population.
Normal operating conditions	Typical conditions of operations.
Noxious and hazardous industries	As per Queensland Planning Provisions. Premises industrial activities that have the potential for extreme, adverse impacts on other land uses. This includes the potential for fire, explosion or toxic release. These uses may involve the production of organic chemicals, and the storage and production of explosives.
Plume	A space in air that contains contaminants released from a point source.
Point source	A single identifiable source of air pollutants eg the emissions from a stack.
Reference value	Quantity value, generally accepted as having a suitably small measurement uncertainty to be used as a basis for comparison with values of quantities of the same kind.
Regional Industry	Industry that is inappropriate to locate close to sensitive land uses due to size and nature of operations.
Risk	The probability that, in a certain timeframe, an adverse outcome will occur in a person, group of people, plants, animals and/or ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent, i.e. it depends on both the level of toxicity of the agent and the level of exposure.
SEIFA index	A measure developed by Australian Bureau of Statistics that compares the relative social and economic conditions of cities, towns and suburbs across Australia.

Sensitive land use	Land use considered to be sensitive to emissions from industry, including hospitals, aged care facilities, child care facilities, schools, residential dwellings.
Sensitive receptors	Sites identified by health risk assessor and include sampling sites, child care centres, nursing homes, schools.
Separation distance	Distance between source of emission and receiving environment.
Source emission	A source of air pollutant emissions.
Standardisation	Commonly used method to reduce the effect of differences between age or other factors in order to allow a comparison between two or more populations.
Upper bound estimate	Upper bound estimate - estimated value based on assigning the limit of detection to results that are reported as being less than the limit of detection.

## **Bibliography**

Al-Yaman, F, Bryant, M & Sargeant, H (2002, p. 193), Australia's children: their health and wellbeing 2002, p. 193, AIHW Cat.No. PHE 36, AIHW, Canberra 35

Australian Bureau of Statistics (2006), Socio-economic Indexes for Areas (SEIFA), Data only, 2006, Statistical Local Areas, Cat. No. 2033.0.55.001, Australian Bureau of Statistics, Available at:

Barnes, RC (2009), An Independent Post Event review of Two Chemical Fires for the Narangba Industrial Estate Health Impact Assessment, RBA Materials, Victoria......passim

Caboolture Shire Council (2005, Part 5, Division 7, 5.15), Caboolture ShirePlan, Part 5, Division 7, 5.15, [Online], Available at: www.pdonline.caboolture.gld.gov.au/masterplan/enquirer/publishR.aspx?page=eplan>,

DERM (2010), Draft State Planning Policy, Air, Noise and Hazardous Materials 2009, [Online], DERM, Brisbane, Available at:

www.derm.qld.gov.au/environmental\_management/planning\_and\_guidelines/policies\_and\_strat egies/pdf/draft\_state\_planning\_policy.pdf>, Accessed 2010 ......61

DERM (2010, p. 84), State of the Environment Queensland 2007, p. 84, [Online], DERM, Brisbane, Available at:

www.derm.qld.gov.au/environmental\_management/state\_of\_the\_environment/state\_of\_the\_environment\_queensland\_2007/index.html> Accessed 2010......37

enHealth Council (2006), Health Impact Assessment Guidelines September 2001, [Online], Department of Health and Aged Care, Canberra, Available at: www.dhs.vic.gov.au/nphp/enhealth/council/pubs/ecpub.htm>, Accessed 11 May 2010passim
Golder Associates Pty Ltd (2010), Narangba Industrial Estate Environmental Health Risk Assessment August 2010, Brisbanepassim
Health Surveillance and Epidemiology, Central Regional Services (2007), Narangba Industrial Estate Health Perception Survey 2007, Queensland Health, Brisbane
HealthInsite (2010), www.healthinsite.gov.au/topics/Breast_Cancer>, Accessed 15 January 2010
International Consultative Group for Food Irradiation (ICGFI) (1999), Facts about food irradiation, [Online], ICGFI, Vienna, Available at: www.iaea.org/nafa/d5/public/foodirradiation.pdf>, Accessed 2010
Katestone Environmental Pty Ltd (2010, 43), Air Auality Impact Assessment for the Narangba Industrial Estate, Katestone Environmental Pty Ltd, Brisbanepassim
Real Property Data Deception Bay (2010), www.myrp.com.au/ Accessed 15 June 2010
Real Property Data Narangba (2010), www.myrp.com.au/ Accessed 15 June 201064
Office of the Queensland Parliamentary Counsel (2009), Dangerous Goods Safety Management Act 2001, Reprint No. 3, p. 14, [Online], Office of the Queensland Parliamentary Counsel, Brisbane, Available at: www.legislation.qld.gov.au/LEGISLTN/CURRENT/D/DanGoSaManA01.pdf, Accessed 2009.74
Omerod, RJ & Best, PR (2000), Review of Odour Assessment Principles: A perspective on Apparently Conflicting approaches, In: Proc. Enviro 2000 Odour Conference, 9-13 April 2000, Sydney, [Online], Sydney, Available at: < >, Accessed
Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19 June - 22 July 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948. The definition has not been amended since 1948 17
Prostate Cancer Foundation of Australia (2010), www.prostate.org.au/articleLive/pages/What- is-Prostate-Cancer.html, Accessed 15 January 2010
Queensland Health (2008), www.access.health.qld.gov.au/hid/Cancer/SkinCancers/melanoma_ap.asp, Accessed 15 January 2010
Queensland Health (2008, p. 21), The Health of Queenslanders 2008: Prevention of Chronic Disease, Second Report of the Chief Health Officer Queensland, p. 21, [Online], Queensland Health, Brisbane, Available at: www.health.qld.gov.au/cho_report/documents/2008choreport.pdf, Accessed 2009
Queensland Health (2008, p. 32), The Health of Queenslanders 2008: Prevention of Chronic Disease, Second Report of the Chief Health Officer Queensland, p. 32, [Online], Queensland Health, Brisbane, Available at:
www.neaitn.qid.gov.au/cno_report/documents/2008choreport.pdf, Accessed 2009

Health, Brisbane, Available at: www.health.qld.gov.au/cho\_report/documents/2008choreport.pdf>, Accessed 2009......32

## NOTES

- 74 -

