Executive Summary

ES.1 Background to Botany Groundwater Cleanup (BGC) Project

From 1942 until 1998, ICI Australia Limited—then a subsidiary of ICI plc of the UK—manufactured a wide range of chemicals on the Botany site now known as Botany Industrial Park (BIP). As a result of historical manufacturing activities at that site, there is a legacy of groundwater contamination within the Botany Sands Aquifer. This contamination occurred during a time when environmental consciousness, and scientific knowledge about the potential impacts on the environment and standards, were less than they are today. The operations that caused the contamination have long since been discontinued on the BIP.

In 1997 ICI plc sold its holding in ICI Australia, which was renamed Orica. In 1998 the BIP was subdivided and is now occupied by various companies with manufacturing plants, including Orica. Orica retained responsibility for environmental legacies at the site.

Orica has stated that it regrets the groundwater contamination caused in the past and that it is committed to cleaning it up to prevent long-term environmental damage. Orica realises that many people are concerned, and it is doing everything possible to address the groundwater contamination with the best available technology.

Today, the groundwater contamination is present in several underground plumes, which have been identified and are moving with the groundwater in a southwesterly direction toward Botany Bay. The most concentrated of the plumes is centred beneath the Orica property known as Southlands, located on McPherson Street, Banksmeadow.

If no action is taken to contain, recover and treat the contaminants in the groundwater, they will increasingly pollute Penrhyn Estuary and possibly Botany Bay. Based on most recent monitoring, it is estimated that high concentrations of contaminants could reach the upper extent of Penrhyn Estuary in the first half of 2006. This would present potential risks to the recreational users in that area, the marine environment and protected migratory shorebirds in Penrhyn Estuary.

The Botany Groundwater Cleanup Project (BGC Project) is urgently needed to prevent this from happening. A key part of this project is the construction and operation of the Groundwater Treatment Plant (GTP). The GTP requires approvals from relevant government authorities before construction and operation can begin. These authorities will assess the proposal based on its merits and after considering the responses received from the community.

The current project follows some 15 years of investigation, research and passive remediation. ICI Australia, and later Orica, began investigating the contamination problem in 1989. Since that time, Orica has been investigating and trialing a number of different remediation strategies under a Voluntary Remediation Agreement (VRA) with the NSW Environment Protection Authority (EPA). These strategies have included bioremediation and reactive iron barriers.

In September 2003 the EPA issued Orica with a Notice of Clean Up Action (NCUA), which was amended and consolidated in February 2004. The NCUA sets a framework and timeframe for Orica to contain the contaminant plumes. Orica's Groundwater Cleanup Plan (GCP), prepared in response to the NCUA, resulted in the fast-tracking of a number of projects that focused on hydraulic containment. These include interim containment and treatment, which is currently in operation.

ES.2 Outline of the BGC Project

The broad objective of the BGC Project is to achieve hydraulic containment and reduction of the contaminants in the groundwater in and around the BIP, to meet the requirements of the NCUA and stop the plumes moving towards Penrhyn Estuary and Botany Bay. The Project Area is shown in **Figure ES.1**.

The key elements of the BGC Project are shown schematically in **Figure ES.2**, and involve:

- the extraction of groundwater from the wells installed in the three containment lines (primary, secondary and DNAPL);
- transfer of groundwater via pipelines to the Groundwater Treatment Plant (GTP);
- construction and operation of the GTP;
- transfer of treated water via pipelines for reuse by process plants in the BIP or discharge to Bunnerong Canal; and
- installation of a discharge point into Bunnerong Canal.

The construction and operation of the GTP is a key part of the BGC Project.

Some of the infrastructure for the BGC Project has already been constructed, under approvals granted earlier in 2004 by various government authorities as part of the interim containment works required to enable Orica to meet its obligations under the NCUA. Other infrastructure will be constructed under separate approvals.

ES.3 The Proponent

The proponent of the BGC Project is Orica Australia Pty Ltd (Orica). Orica is a major manufacturer of industrial specialty chemicals, fertilisers, explosives and mining chemicals, and paints and consumer products. Orica operates at several sites, including Botany, and employs some 1500 people in NSW.

ES.4 Planning Approvals Process

Under State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55), the BGC Project does not require development consent, because it is being undertaken to comply with the NCUA issued by EPA. Instead, various elements of the BGC Project must be assessed under Part 5 of the Environment Planning & Assessment Act (EP&A Act).

Activities assessed under Part 5 that are likely to significantly affect the environment are required to be assessed in an environmental impact statement (EIS). Although only certain elements of the BGC Project comprise an 'Activity' for the purposes of Part 5, the environmental impact of the overall BGC project is assessed in this EIS. There are a number of determining authorities responsible for approving various aspects of the BGC Project, as discussed in **Chapter 6**.

In accordance with clause 73 of the *Environment Planning & Assessment Regulation* 2000 (EP&A Regulation), the requirements for this EIS were sought from relevant government agencies. These requirements, known as the Director-General's Requirements (DGRs), have been addressed in this EIS.

The EIS will be publicly exhibited for a minimum of 30 days. The public exhibition period allows stakeholders and the community to convey their views on the project to the determining authorities.

ES.5 Overview of the Project

The following is a high level overview of the key aspects of the BGC Project.

- The project will use the proven technique of hydraulic containment to prevent the plumes moving towards Penrhyn Estuary and Botany Bay.
- The selected treatment technologies will achieve the critical timeline in the NCUA required to stop the plumes.
- Selected treatment technologies to be used in the GTP are based on the use of best practice and proven equipment, to achieve safe and effective destruction of the contaminants, and to control and minimise emissions to air, including dioxins and furans.
- The technology conforms to the principles of inherent safety, by minimising the inventory of hazardous materials, and by operating at low pressures and low concentrations.
- A systematic human health risk assessment undertaken in consultation with NSW Health as part of the EIS indicates that the incremental risk from the operation of the GTP to the health of residents, recreational users of areas surrounding the BIP, and BIP workers is negligible, even under worst case scenarios. The analysis included an assessment of the potential impacts of long-term exposure to trace levels of chemicals, such as dioxins, and found the human health impact to be negligible.
- Groundwater will be treated to achieve a water quality suitable for reuse as process water for the BIP and nearby users, thereby reducing the demand on Sydney's townswater supply.
- Emissions to atmosphere from the GTP will meet best practice, stringent air quality emission guidelines.
- The preliminary hazard analysis undertaken as part of this EIS concluded that the potential project risks comply with the relevant DIPNR risk guidelines.
- Preventing contaminants moving towards Penrhyn Estuary and Botany Bay will lead to an improvement in the commercial, recreational and ecological activities in the foreshore area. Flora and fauna are unlikely to be significantly affected.
- The project incorporates an extensive monitoring program to assess the effectiveness of the hydraulic containment throughout the project lifetime.
- There is negligible land subsidence risk to residential or commercial structures as a result of the contaminated groundwater extraction.
- Energy efficiency measures have been taken into account to minimise greenhouse gas emissions.

- Even considering existing and proposed industrial and other developments in the area, no significant cumulative impacts from the project were identified.
- The project is consistent with the principles of Environmentally Sustainable Development (ESD), because it is designed to clean up past contamination legacies for the benefit of current and future generations in the local communities.
- The project will involve the implementation of a range of environmental management measures to monitor and minimise the impact on the environment throughout the life of the project.
- Measures will be put in place to minimise waste generation, and waste will be controlled via a comprehensive waste management program.
- The project will not generate unacceptable levels of noise or cause traffic congestion on local or arterial roads. Visual impact will be low.

ES.6 Need for the BGC Project

The BGC Project is necessary to address the potential impacts of groundwater contamination on the environment of Botany Bay and Penrhyn Estuary. Without the proposed containment and treatment, high levels of the contaminants are likely to eventually discharge into Botany Bay.

Using best practice techniques and processes, the BGC Project seeks to:

- achieve the required level of groundwater containment;
- achieve the required reduction of the concentration of contaminants in the groundwater;
- clean up the contaminant plumes;
- minimise air emissions and generation of waste, according to ‘best practice’ design standards; and
- undertake sufficient monitoring to identify changes in contaminant concentrations and spatial distribution of the contaminants and groundwater levels, to optimise the effectiveness of the hydraulic containment.

ES.7 Alternatives

In order to identify the best technical solution for handling the extracted groundwater, an extensive review of the locations, treatment techniques and performance requirements was carried out. The following key objectives were considered mandatory in assessing alternative technologies for treatment:

- The technology must be proven and safe.
- The technology must be able to handle a large volume of groundwater (up to 15 ML/day) with low concentrations of contaminants (0.02% w/w).
- The technology must be able to meet the air and water emission specifications.

- The technology must achieve a critical start-up timeline that stops the plumes in time.

For the BGC Project, best practice is required, particularly in relation to meeting strict air and marine discharge standards and a high destruction efficiency of contaminants.

Orica reviewed available technologies and identified air stripping with thermal oxidation or steam stripping as candidate technologies. These options were analysed by the international engineering consultants Aker Kvaerner, and were found to be technically feasible. Orica further refined these reviews and selected air stripping with thermal oxidation as its preferred option. The key reasons for this selection were:

- its proven performance in groundwater treatment;
- there is no intermediate storage of a hazardous, flammable liquid; and
- the thermal oxidiser represents 'Best Available Technology' as defined by the European Commission and the United Nations Environment Program for the destruction of CHCs in this type of application.

An independent review by an international remediation expert from URS, carried out as part of the EIS, identified three alternatives of equal ranking:

- air stripping with thermal oxidation;
- steam stripping with thermal oxidation; and
- steam stripping with thermal pyrolysis (e.g. plasma arc)

This validated Orica's choice of preferred technology.

The thermal oxidiser proposed will be designed to achieve greater than 99.99% contaminant destruction efficiency and to satisfy the best practice air emission standards. The selected technology will meet Australia's obligations for the minimisation of dioxin and furan emissions under the Stockholm Convention.

The most suitable site for establishing the GTP was found to be the former Silicates Plant site within the BIP. The logistics of transporting the huge quantities of groundwater (equivalent to 15 Olympic pools per day) precluded off-site treatment options for the GTP. In addition, off-site treatment was not feasible because there is no suitable existing plant that can treat the volume of groundwater required, and Orica considered that it was not feasible to identify an off-site location for a new plant, and gain the relevant approvals, in the required timeframe.

Similarly, it was not considered possible to send the extracted contaminants to an off-site facility, because there is inadequate capacity available. The Basel Convention precludes sending the contaminants for treatment and disposal overseas. Extended storage of the extracted contaminants would require significant storage with associated increased risk. The Basel Convention requires destruction at the place of generation where practical.

A number of options were considered for the management and disposal of the 15 ML/day of treated groundwater. Reinjection into the aquifer is not preferred, as there are significant challenges in performing this reliably without disturbing the aquifer and causing flooding. Discharge into the sewer system is not feasible, because the sewer does not have adequate spare capacity. Reuse of the treated water by users

on the BIP was identified as the preferred option, as it provides a sustainable outcome by reducing the demand from Sydney Water supply. The excess volume that cannot be taken up for reuse would be safely discharged to Botany Bay.

ES.7.1 'Do Nothing' Option

The 'do nothing' option would mean that groundwater could not be extracted at the rates required (some 15 ML/day) to contain the plumes and to provide treatment of this volume of groundwater. It may be possible to continue with the interim measure already in place, but this would be limited to 2 ML/day and would not provide adequate long-term protection.

The 'do nothing' option would result in high levels of contaminants reaching Penrhyn Estuary and Botany Bay, leading to:

- a potential increase in the impact on the terrestrial and marine flora and fauna in the Foreshore Beach and Penrhyn Estuary ecosystems, which could affect the migratory shorebirds;
- a potential increase in the risks to human health for recreational users on the foreshore and within Botany Bay, and potential diminished quality of life for residents and workers in the area; and
- failure to achieve the aims of the NCUA.

The 'do nothing' option would be socially, environmentally and legally unacceptable.

ES.8 Project Description

ES.8.1 Extraction Wells and Pipelines

Groundwater will be extracted by a submersible pump suspended inside each well, discharging into the transfer pipeline leading to the GTP. Extraction rates are designed to be adjustable, and responsive to changes in groundwater flow patterns and reducing contamination levels over time.

Monitoring wells will be installed along the containment lines for sampling and measurement, to assess and optimise the effectiveness of the hydraulic containment and extraction of the contaminant plumes.

The transfer pipelines are 150 mm in diameter and are designed to minimise potential points of leakage. All aboveground pipelines are within Orica owned land. Underground pipes (used when crossing non-Orica land) use dual-contained pipes for additional integrity and leak protection.

ES.8.2 Groundwater Treatment Process

A 3D visual simulation of the GTP is shown in **Figure ES.3**. The proposed process to treat the extracted groundwater is shown in **Figure ES.4.** The GTP has been designed for continuous operation to treat up to 15 ML/day for about 30 years. The process consists of four key stages.

Feed Pre-Treatment

The extracted groundwater will be dosed with hydrochloric acid to minimise the potential for fouling in the air strippers. The hydrochloric acid will be generated in the GTP off-gas treatment unit.

Air Stripping

The volatile contaminants will be removed from the groundwater by air stripping, where air is blown upwards through a falling column of groundwater in an enclosure. This produces an off-gas stream containing the volatiles from the groundwater.

Off-Gas Treatment

The contaminants in the off-gas will be destroyed using thermal oxidation, where they react with oxygen at high temperature to produce carbon dioxide, water and hydrogen chloride. The operating temperature will be 1000°C, with a residence time of two seconds to achieve greater than 99.99% contaminant destruction and to match world's best practice for dioxin control. Natural gas will be used in the oxidiser to maintain the required operating temperature.

The hot gases coming out of the thermal oxidiser will be cooled by generating steam in a waste heat boiler and pre-heating the off-gas from the air stripping units (achieving some energy recovery), followed by a rapid quench with weak acid to quickly reduce the temperature through the 'de novo' zone to minimise the chance of dioxin formation.

The cooled gas will then pass through an acid absorbing column to produce weak hydrochloric acid (for use in feed pre-treatment), then through a caustic scrubbing unit to remove any trace hydrogen chloride or chlorine, before discharge through a stack about 20 m tall.

Stripped Water Treatment

Stripped water from the air stripping process will undergo iron removal (by the addition of caustic soda and filtration) followed by removal of trace organic compounds (e.g. phenols) using activated carbon. About 10 ML/day of this water will undergo further treatment using reverse osmosis (RO) to remove salt, so that the water can be reused on the BIP and elsewhere. This will produce a salty wastewater stream of about 2.5 ML/day.

The 5 ML/day of excess treated water that does not pass through the RO unit will be combined with the 2.5 L/day of salty wastewater. This combined stream will undergo further treatment to remove organic acids (e.g. acetic acid) and ammonia. This water will then meet the ANZECC Marines Guidelines to allow discharge into Botany Bay, via Bunnerong Canal and Brotherson Dock using a refurbished underground pipeline and a newly constructed outlet.

In the event that the demand on the BIP is lower than predicted (e.g. during maintenance periods) the unused water would also be diverted to Brotherson Dock via the discharge pipeline.

Orica will continue to seek additional users of the treated water and will expand the RO treatment capacity as required.

ES.8.3 Process Control

Groundwater extraction, transfer, treatment in the GTP and discharge will be operated as an integrated process, with an automatic computer control system installed to ensure operation within design parameters. The control system will be located within a dedicated Control Room, with operators based permanently at the GTP to carry out regular inspections, and to respond to plant upsets.

A separate, high integrity safety shutdown system will be installed, so that in the event of an abnormal condition being detected, the GTP would be shut down, isolating all feeds and stopping all discharges.

ES.8.4 Construction

GTP

The target construction completion date for the GTP is August 2005. The key milestones required to meet this target, subject to approvals being obtained, are shown in **Table ES.1**.

Table ES.1 Construction timing

Timing	Activity
February– April 2005	Civil foundations and structural steel works
May–August 2005	Equipment, piping, instrumentation and electrical works
August–October 2005	Plant commissioning and operation

Before starting construction of the GTP, minor demolition to clear and level the GTP site will occur.

The estimated construction workforce for the GTP is likely to range from about 28 at the start of construction to a peak of around 115 over the nine month construction period.

ES.8.5 Decommissioning

Whilst the treatment of contaminated groundwater is expected to cease after approximately 30 years, Orica may continue to treat groundwater from other sources, if available, to provide clean water to industrial users. In the event that this activity is not pursued, the BGC Project and the GTP would be decommissioned in consultation with the EPA.

ES.9 Consultation

ES.9.1 Government Consultation

There has been extensive consultation with relevant authorities and agencies throughout the investigation and assessment of the groundwater contamination issue since the early 1990s.

Consultation during the environmental impact assessment process included a planning focus meeting with government agencies, and discussions with the following authorities:

- Department of Infrastructure, Planning and Natural Resources (DIPNR);
- Environment Protection Authority (EPA), part of Department of Environment and Conservation (DEC);
- NSW Health;
- South East Sydney Public Health Unit (SESPHU);
- Council of the City of Botany Bay (CCBB);
- Sydney Ports Corporation (SPC);
- NSW Waterways Authority (now NSW Maritime Authority);
- NSW Fisheries;
- NSW Roads and Traffic Authority;
- NSW Rail Corp; and
- Sydney Water Corporation (SWC).

ES.9.2 Community Consultation

Orica has been engaged in community consultation regarding the groundwater contamination since it was discovered, through an extensive program designed to inform all stakeholders of actions and activities being undertaken and to provide the opportunity for effective comment and participation throughout the process. The process utilises various communications channels including:

- the Community Liaison Committee (CLC);
- the Orica Botany Groundwater website, at http://www.oricabotanygroundwater.com;
- quarterly newsletters distributed throughout the suburbs neighbouring the Orica site;
- a regular Orica column in the *Southern Courier* newspaper presenting information on progress with the project; and

- an on-site communications team contactable by telephone or email (with details regularly advertised).

Four EIS workshops were organised during the preparation of the EIS. Invitations to the workshops were extended to all interested stakeholders, including members of the CLC, members of the local communities, representatives of community groups, local industries and non-governmental organisations.

Aside from the EIS workshops, a number of meetings and teleconferences were conducted with specific organisations (National Toxics Network, Greenpeace and the Council of the City of Botany Bay) to understand the particular issues and concerns that they and their associated members may have about the BGC Project, and to ensure that these issues were addressed in the EIS.

Under the Community Relations Plan developed for the BGC Project, consultation and communication with the local communities will be maintained throughout the life of the project.

ES.10 Environmental Impact Assessment

Detailed scientific and environmental studies were undertaken by technical experts as part of this EIS to enable the potential impacts of the BGC Project to be understood and assessed These studies are included in the EIS as appendices. The findings of studies, assessment of impacts and the identification of safeguards are presented in this EIS and are summarised below.

ES.10.1 Land Use

The BGC Project will be compatible with industrial development already existing in the Banksmeadow industrial area and will not affect existing land uses within the Project Area. In addition, the successful completion of the project could eventually lead to lifting of DIPNR's current restrictions on use of the groundwater in the area, and to an alleviation of concerns relating to recreational activities in and around Foreshore Beach, which would have a positive impact on surrounding land uses and improved amenity.

ES.10.2 Geology, Soils and Geotechnical

Geotechnical studies indicate that the GTP site would provide suitable support for shallow foundations and pavements. Assessment of soil at the GTP site found that concentrations of metals, hydrocarbons and chlorinated hydrocarbons (CHCs) are very low and that potential risks to human health and the environment during or after construction are therefore considered to be negligible.

The potential for erosion and sedimentation during construction of the GTP and off-site infrastructure would be minimised by employing a Soil & Water Management Plan before and during construction. Due to the potential for acid sulphate soils (ASS) to be present within the BGC Project area, an ASS Management Plan will be developed for implementation, should ASS be encountered during construction.

ES.10.3 Hydrogeology

The operation of the BGC Project is designed to alter the existing groundwater flow regime so that contaminated groundwater is contained before it enters Penrhyn Estuary and Botany Bay.

Computer modelling has been used to determine the optimal layout and operation of groundwater extraction wells for the cleanup of the groundwater. The results of the modelling have illustrated that the proposed groundwater extraction well network would be successful in satisfying the requirements for hydraulic containment of the plumes as described in the NCUA.

One consequence of the groundwater extraction will be a 15% reduction of the total groundwater discharge into Botany Bay. The rate of groundwater discharge to Penrhyn Estuary will reduce, and the contaminant levels in that discharge will eventually decline. It is likely that there will be no dry weather flow in Springvale and Floodvale Drains.

Groundwater extraction and transfer via pipelines to the GTP will be managed and optimised through a monitoring regime to minimise any potential impacts and to maintain the effectiveness of the hydraulic containment and groundwater treatment.

Potential subsidence impacts have been assessed and are concluded to be negligible. Orica proposes to monitor subsidence at relevant locations.

ES.10.4 Water Quality and Wastewater

Construction works will generate small quantities of wastewater from the commissioning of wells. This contaminated groundwater will be collected by a licensed waste contractor and transferred to existing bunded tanks prior to treatment at the BIP.

The GTP has been designed to achieve the water quality standards to enable reuse of the treated water on both the BIP and by other users, and to ensure that there is no negative impact from the discharges of excess water to Brotherson Dock.

Orica has identified demand for about two-thirds of the available treated water. Treatment capacity will be installed to meet current reuse demand, with room for expansion to meet future requirements. Orica has in-principle approval from the NSW Government to recycle and make the treated water available for sale to other industrial users. Orica will continue to work with relevant authorities and other potential users of the treated groundwater to maximise the level of reuse, thus reducing the demand on Sydney's water supply.

ES.10.5 Hydrology

Assessment of potential surface hydrology impacts determined that the GTP would have negligible effect on current flood levels along Springvale Drain, both upstream and downstream of the site, up to the 1 in 100 year Average Return Interval (flood) event.

The treated water discharges to Bunnerong Canal will not result in any significant effects on flood levels. There will be no detrimental effects on sediment transport and erosion in the canal.

A Soil and Water Management Plan (SWMP) will be developed for the construction and operational phases to minimise contaminated runoff from the site.

Potentially contaminated stormwater from the GTP site will be retained within either containment bunds or the first-flush pit system, to prevent discharge during stormwater events. The retained stormwater (equal to the volume from the first 15 mm of rain) will be analysed and treated before discharge into either the GTP feed or the sewer.

All underground sections of the groundwater collection pipes have dual-containment and leak detection. Regular inspection of the aboveground sections of the transfer pipes will ensure no uncontrolled discharge of contaminated groundwater to the environment.

ES.10.6 Waste

A Waste Management Plan (WMP) will be developed prior to the construction and operation of the GTP to optimise the reduction, recycling and reuse of waste materials during the project. The amount of waste generated during the construction of the GTP will be small. Soil generated during construction of wells will be collected, dewatered and analysed before disposal.

The principal solid wastes generated by operation of the GTP comprise the spent activated carbon (if it cannot be regenerated) and dewatered solid waste (from the iron removal and organic acid and ammonia removal units). Analyses will be undertaken to confirm whether these wastes are suitable for safe disposal to landfill. Ongoing monitoring of the waste streams will be undertaken according to a program developed in the WMP to ensure ongoing suitability for landfill disposal.

ES.10.7 Traffic and Transportation

The traffic associated with the construction and operation of the BGC Project will lead to very minor increases on arterial and sub-arterial road traffic volumes, which are not considered significant. Local roads will not be used. Therefore, any increases in traffic as a result of the project will not affect local traffic or the availability of parking on local streets. Transport of the recovered waste EDC liquid, temporarily stored at Terminals Pty Ltd's facility at Port Botany, to the BIP will be undertaken using designated access routes, in accordance with the Botany Local Environment Plan 1995.

ES.10.8 Energy and Greenhouse Gases

The overall design of the BGC Project incorporates energy efficiency design criteria while still achieving best practice destruction efficiencies of the extracted contaminants. Energy use during the construction phase, mainly of fuel, is not expected to be significant. The electrical energy use has been estimated to be equivalent to about 22,500 tonnes of carbon dioxide (CO_2) a year. The operation of the thermal oxidiser is estimated to be equivalent to about 33,000 tonnes of CO_2 annually.

ES.10.9 Visual Impact Assessment

The BGC Project is located within an existing industrial development with large manufacturing plants that include highly visible industrial features such as storage tanks, cooling towers, boiler stacks and distillation columns.

Within this context, the GTP and associated off-site infrastructure will have a low level of visibility across all elements of the BGC Project, during both construction and operation.

ES.10.10 Flora and Fauna

The project infrastructure is on developed areas with little native vegetation. Only the heavily disturbed and contaminated Southlands site contains potential fauna habitats. Wells and an aboveground pipeline will be located on Southlands. The site may become less boggy due to groundwater interception. The threatened green and golden bell frog has been recorded on this site in the past, but no permanent population is present.

Hydraulic containment will reduce groundwater entering Penrhyn Estuary and the eastern end of Foreshore Beach. In addition, the existing dry weather flows in Floodvale and Springvale Drains, which discharge into Penrhyn Estuary, are likely to stop. Little is known of the effects of interception of groundwater on marine communities; however, it is predicted to lead to changes in the species of benthic invertebrates that occur in the intertidal and subtidal areas close to shore. The single, sparse intertidal seagrass bed may be at risk due to drying at low tide.

Penrhyn Estuary is the only feeding and roosting area for threatened and migratory shorebirds remaining in northern Botany Bay. While the species of invertebrate prey are expected to change, the overall abundance of invertebrates, and therefore potential food, is expected to be maintained. Shorebirds are expected to adapt to the change in invertebrate prey species, as they are known to readily switch prey due to their migratory habit.

Removal of groundwater may create conditions more favourable to saltmarsh than mangrove habitat. Species composition of the existing saltmarsh is predicted to shift towards the more salt-tolerant species such as *Sarcornia*, which provides a preferred roosting habitat for shorebirds. Monitoring will be undertaken to assess impacts and the need for management.

ES.10.11 Heritage

The Project Area has been significantly previously disturbed, with no current or past evidence of any Aboriginal relics or Aboriginal places. No known non-Indigenous heritage items will be affected.

ES.10.12 Air Quality

There is a significant buffer distance between the GTP site and nearby residential areas. This factor, combined with dust control by limited water spraying during construction, will mean that dust emissions from construction will not be expected to result in off-site nuisance impacts.

The GTP will be designed to meet strict air quality emission limits matching the best performance from around the world. In particular, the dioxin emission limits will equal the world's strictest values.

To assess the impact of the GTP operation on ambient air quality, a detailed atmospheric dispersion modelling study was undertaken. This indicated that, even if the GTP was operating at the maximum allowable emission limits (worst case), the GTP would not be expected to have a significant impact on air quality in the surrounding area. The maximum ground level concentration of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), particulates, chlorine (Cl_2), hydrogen chloride (HCl) and organics (including ethylene dichloride (EDC), vinyl chloride (VC) and benzene) are below the accepted level for no impact.

Two abnormal (worst case) operating scenarios were considered, which involve the simultaneous failure of numerous measurements, controls and trips This is estimated to occur once in 50,000 years. For both these scenarios, there are no exceedances leading to health concerns.

The GTP will be continuously monitored for a range of process parameters to ensure optimum performance, including air stripper flows and temperatures and thermal oxidiser temperature, quench and scrubbing performance. Air emissions will be continuously monitored for key measurements including HCl and EDC. Periodic laboratory analysis will validate the performance. The human health impacts of air emissions from the GTP are assessed in the human health risk assessment chapter (**Chapter 24**).

ES.10.13Preliminary Hazard Analysis

The risk associated with the GTP has been assessed and compared against the DIPNR risk criteria through the process of a Preliminary Hazard Analysis (PHA). This analysis shows that the risk complies with DIPNR guidelines for tolerable fatality, injury, irritation and societal risk. The impact on the cumulative risk in the Botany/Randwick Industrial Area from releases is also acceptable. These conclusions apply to risks both on-site (neighbouring industrial facilities) and off-site (residential areas and other sensitive receivers).

The primary reasons for the low risk levels are the low inventory of hazardous material, low pressures and concentrations, and the distance to nearby facilities and residences.

The risk associated with the wells and pipelines is negligible because the materials are non-hazardous. The system is designed to minimise the chance of leaks.

The PHA will be reviewed throughout the project design stage via the HAZOP methodology and updated in the Final Hazard Analysis.

ES.10.14Human Health Risk Assessment

Risks to human health associated with the construction and operation of the GTP have been evaluated using a systematic, standardised approach as outlined in guidance provided by enHealth (2002). This includes the identification of key issues, evaluation and quantification of exposure, evaluation and quantification of hazards or chemical toxicity, and the characterisation of risk.

The calculation of risks was based on highly conservative assumptions developed in consultation with DEC and NSW Health.

The prescribed human health risk assessment is very detailed, providing a systematic review of many aspects of the BGC Project, the surrounding areas and key aspects associated with chemicals that require evaluation. The health risk assessment provided an evaluation of incremental risk to human health associated with the BGC Project, including the long-term impact of trace levels of dioxins emitted from the GTP. While the study shows the impact of this project on community health, it cannot effectively review the wider community health status, since this is dependent on many individual factors, including age, family history (genetic make-up) and lifestyle choices such as sports, diet and consumption of drugs (particularly tobacco and alcohol).

The exposure routes considered a range of scenarios, such as residents living near the BIP, school children, workers on- and off-site, and users of the nearby athletics field. Emissions from the BGP Project were conservatively evaluated under worst case (abnormal) operating conditions.

The assessment indicates that incremental risk to the health of residents, recreational users of areas surrounding the BIP, and workers from the operation of the GTP is negligible for both short- and long-term exposure to all emissions.

Operational conditions (assessed for normal and worst case scenario releases) have been based on estimated emissions from the GTP. These emissions are expected to be conservative, and once the GTP is operational, should be monitored and re-evaluated against the assumptions used in the health risk assessment.

ES.10.15Socio-Economics

The construction phase of the BGC Project is expected to have short-term direct positive impacts on the local economy, through the injection of capital investment of $86 million and the creation of 53 full-time equivalent jobs (with a peak of 115 jobs for two months) over the construction period. A team of 10 skilled process operators will be employed on the GTP. There is also an associated increase in potential household spending and demand for goods and services in the local area. Construction activities will also generate indirect jobs, which in turn have induced effects that will filter through the economy.

The BGC Project will have the significant positive benefit of avoiding the discharge of the contaminant plumes into Penrhyn Estuary, in turn avoiding the significant potential impacts on the commercial, recreational and ecological activities within the area. As an additional benefit, the quality of the treated groundwater will be such that it can be reused by BIP and nearby users, thereby reducing the demand on the Sydney's water supply, a particular benefit in the current drought conditions.

ES.10.16Noise

A noise study has been carried out by an independent acoustic noise consultant to ensure that the BGC Project will comply with statutory and BIP noise requirements. The GTP will be located within the BIP and will comply with the stringent noise emission criteria set down in the Environmental Protection Licence issued by the EPA to Orica. The GTP will be subject to further noise evaluation during the detailed design stages, and noise testing will be undertaken during commissioning to verify that all noise criteria are met.

The statutory requirements for occupational noise exposure level will also be complied with. The GTP will be designed in accordance with BIP engineering requirements for cumulative effects of additional plant on

the BIP. While no specific operational noise criteria apply to the associated off-site infrastructure, such as extraction wells and pipelines, these will also to be covered by the GTP noise design goals.

Construction activities for the BGC Project are not anticipated to result in any significant noise impact at sensitive receptors. Similarly, noise impacts are not anticipated as a result of traffic arising from either the construction or the operation of the BGC Project, given the relatively small amount of additional traffic that will be generated when compared with the existing traffic levels on Denison Street and the surrounding road network.

ES.10.17 Cumulative Impacts

The potential cumulative impacts of the BGC Project with existing and proposed major developments in the Botany area have been considered. No significant cumulative impacts have been identified. Therefore, the potential cumulative effect of the BGC Project with other existing or proposed developments in the area is considered to be low.

ES.11 Environmental Management

An Environmental Management Plan (EMP) will be developed and implemented for the BGC Project, in accordance with the management and monitoring measures set out in this EIS, statutory requirements and the conditions of approval for the BGC Project. The EMP will incorporate the mitigation measures discussed in the EIS.

Environmental monitoring will be a fundamental component of both the construction and operation EMPs for the BGC Project. Orica has committed to undertake regular environmental performance reporting, and will investigate the establishment of an independent monitoring process with community representation to provide stakeholders with assurance of the performance of the project.

Implementation of the environmental management and monitoring requirements identified in the EIS will ensure that the impact on the physical, social and economic environments of the BGC Project will be acceptable.

ES.12 Ecologically Sustainable Development

The BGC Project is focused on the principles of ESD, because it is designed to clean up the legacy groundwater contamination for the benefit of current and future generations in the local communities.

ES.13 Project Justification

The BGC Project is designed to meet the requirements of the NCUA, by achieving hydraulic containment of the plumes to prevent discharge from the groundwater into Penrhyn Estuary and Botany Bay, and to remove and destroy the contaminants safely and effectively.

Hydraulic containment is a proven technique for groundwater cleanup. The selected treatment technologies to be used in the GTP are based on best practice and proven equipment to achieve effective

destruction of the contaminants, and to control and minimise emissions to air, including dioxins and furans.

The treatment technologies have also been selected to ensure that the groundwater treatment achieves a water quality that meets a combination of relevant standards for reuse as process water, thereby reducing demand on Sydney's townswater supply.

The BGC Project also incorporates an extensive monitoring program, to continually assess the effectiveness of the containment and treatment throughout the project lifetime.

While the BGC Project will have significant environmental benefits, it is recognised that it will also have some unavoidable environmental impacts. These are relatively minor, and have to be balanced against the impacts that would occur if the containment and treatment were not implemented and uncontrolled groundwater contaminant discharge occurred. A range of mitigation measures has been identified to minimise the impact on the environment. The environmental performance of the BGC Project will be monitored to ensure that the adopted environmental standards are met and maintained.

Based on the assessment in this EIS, undertaking the BGC Project in the manner proposed is justifiable, taking into consideration potential environmental, health, economic and social impacts and the principles of ESD.