3.1 Strategic Context

3.1.1 Introduction

As a result of historical manufacturing activities on part of the Project Area, there is a legacy of sub-surface contamination within the Botany Sands Aquifer. The extensive groundwater monitoring and investigation work that has been carried out since the late 1980s has shown that a number of contaminant plumes are moving with the groundwater flow toward Penrhyn Estuary and Botany Bay, and are discharging contaminated groundwater via surface water drains and terrestrial discharge into Penrhyn Estuary.

The continued movement of these contaminants has the potential to cause increased pollution of the waters of Penrhyn Estuary and Botany Bay.

3.1.2 Regulatory Actions

As the contamination findings from the environmental surveys carried out in the 1990s became evident, Orica entered into a Voluntary Investigation and Remediation Agreement (VRA) with the NSW EPA under the *Contaminated Land Management Act* 1997 to formalise the existing ongoing monitoring, investigation, remediation assessment and communication activities.

The EPA issued a Notice of Clean Up Action (NCUA) on 26 September 2003, to set a framework and timescale for action to contain the contaminant plumes.

3.2 Project Need

3.2.1 Introduction

Numerous investigations and monitoring of volatile CHC contamination within the Botany Sands Aquifer within and surrounding the Project Area have been conducted since the implementation of the Stage 1 Survey in 1989 (AGEE, 1990), and the Stage 2 Survey in 1996 (Woodward-Clyde, 1996).

Following ongoing monitoring, more recent investigations have been completed to more fully characterise conditions in Penrhyn Estuary and groundwater contamination down-gradient of the northern part of the plant site and DNAPL source areas (URS, 2004-2004c). These additional investigations are in turn supported by the quarterly groundwater and surface water monitoring (URS, March and June 2004) undertaken under the program outlined in the GCP.

3.2.2 Groundwater

The Botany Sands Aquifer consists of three distinct layers: shallow (Layer 1), deep (Layer 2) and bottom (Layer 3). Assessment of the groundwater flow conditions has indicated that the groundwater is flowing in a south-west direction in both the shallow and deep layers, and is discharging into the Penrhyn Estuary and Botany Bay.

The current groundwater flow directions for the shallow layer are shown in **Figure 3.1,** showing the effect of Floodvale and Springvale Drains. The shallow groundwater discharges into these drains, creating the potential for accelerated transport of contaminants to Penrhyn Estuary.

Figure 3.2 shows the current deep groundwater flow direction. The depth of the potentiometric surface of the deep aquifer relative to the water table depth indicates that the vertical gradient is downwards at the BIP, changing to upwards beyond Southlands as it approaches the discharge zone at Penrhyn Estuary/Botany Bay.

The hydraulic containment described in **Chapter 12** will modify the groundwater flows to prevent the ongoing migration of contaminants towards Penrhyn Estuary and Botany Bay.

3.2.3 Contaminant Sources

Sub-surface investigations and monitoring have revealed an extensive and complex distribution of contaminants derived from multiple source areas. These source areas (small underground pools of concentrated contaminant) are referred to as Dense Non-Aqueous Phase Liquid (DNAPL). As the groundwater flows past these pools, it becomes contaminated.

Up to nine discrete source areas have been inferred in the area between Anderson Street in the north and the southern boundary of Southlands in the south. The source areas relate to former manufacturing sites and waste disposal on part of the Project Area. The principal materials are carbon tetrachloride (CTC), tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC) and EDC. The location and characterisation of some sources is not yet complete, especially for sources for the Northern Plumes.

Figure 3.3 shows the inferred source areas for the identified plumes and the direction in which the contaminants from the source areas are moving.

3.2.4 Contaminant Plumes

The source areas described above have led to the creation of multiple overlapping plumes. In some instances these plumes are highly mobile, i.e. move at or near the same rate as the groundwater. The various plumes contain a number of mobile CHCs. The plumes are summarised below.

- The Southern Plumes consist of up to three separate discernible areas based on composition; the CHCs are derived mainly from the former Solvents (CTC and PCE) and TCE Plants. The separate plumes are considered representative of groundwater as follows:
  - plume S1 is representative of groundwater in the northern part of Southlands Block 1;
  - plume S2 is representative of groundwater in the middle part of Southlands Block 1; and
  - plume S3 is representative of groundwater in the southern part of Southlands Block 1.

  The front of the Southern plumes has already reached Penrhyn Estuary, in low concentrations.

- The Central Plume consists of a single plume (plume C1) made up predominantly of EDC, which is believed to have originated from the former Vinyls manufacturing plant and storage tanks (which have been removed). This plume has been monitored very frequently since it was first detected in March 1998. It has revealed a mobile high concentration core, which is migrating in a south-westerly direction towards Botany Bay. The plume is presently located on Southlands Block 2 and is inferred to have crossed McPherson Street.
- The Northern Plumes consist of up to five separate dissolved phase plumes. The location and characterisation of the source areas of these plumes are currently being investigated. Most of the plumes are thought to have derived from the storage of CHC wastes in open air, unpaved drum storage areas. The separate plumes are considered representative of groundwater as follows:
  - plume N1 is representative of groundwater in the very northern portion of the BIP;
  - plume N2 is representative of groundwater in the northern portion of the BIP;
  - plume N3 is representative of groundwater from an as yet unidentified source;
  - plume N4 is representative of groundwater from the former CTC/PCE Storage Tanks; and
  - plume N5 is representative of groundwater from the former storage of drums of CHC wastes on the western boundary of BIP.

The inferred source areas for the identified plumes are shown on **Figure 3.3**, together with the inferred direction of plume movement. It should be noted that the extent of the zones shown on **Figure 3.3** is indicative and is largely based on the width and location of the contaminant plumes.

The principal contaminants are CTC, PCE, TCE, VC and EDC. The distribution of these contaminants, inferred from quarterly monitoring conducted in June 2004, is illustrated in the following figures:

- **Figure 3.4**: inferred distribution of CTC in deep groundwater in June 2004;
- **Figure 3.5**: inferred distribution of PCE in deep groundwater in June 2004;
- **Figure 3.6**: inferred distribution of TCE in deep groundwater in June 2004;
- **Figure 3.7**: inferred distribution of VC in deep groundwater in June 2004; and
- **Figure 3.8**: inferred distribution of EDC in deep groundwater in June 2004.

These figures illustrate the current position of the contaminated groundwater as it progresses toward Penrhyn Estuary and Botany Bay. They show that, without the proposed containment and treatment, high level contaminants are likely to eventually discharge into Botany Bay.

3.2.5 Notice of Clean Up Action

The EPA issued the Notice of Clean Up Action (NCUA) in September 2003 (and a subsequent Variation in February 2004). The NCUA requires very specific actions from Orica, which has created the need for the BGC Project.

3.2.6 Potential Impacts

In general terms, the BGC Project is necessary to prevent or reduce the potential impacts of groundwater contamination on the environment of Botany Bay and Penrhyn Estuary. The consequences of not containing the contamination are discussed in this EIS.

3.3 Objectives

In response to the identified need, the specific objectives of the BGC Project, as presented in this EIS, are to use best practice techniques and processes to:

- achieve the required level of groundwater containment in both the Primary Containment Area and the Secondary Containment Area and prevent the discharge of contaminants at levels greater than the ANZECC (2000) trigger values into Penrhyn Estuary and Botany Bay;
- achieve a reduction of the concentration of contaminants in the groundwater at the Primary Containment Area to the maximum extent practicable, with a target of an 80 per cent reduction in levels, as set out in the Orica 2002 Annual Report to the EPA (Orica, 2003) by 31 October 2005;
- clean up the contaminant plumes by:
  - preventing further contaminant migration through containment lines, allowing gradual cleanup of down-gradient areas; and
  - assisting DNAPL removal projects by containing potentially increased concentrations of mobilised contaminants;
- minimise air emissions and generation of waste, according to ‘best practice’ design standards; and
- undertake sufficient monitoring, under the monitoring framework presented in the GCP, to identify changes in concentrations and spatial distribution of the contaminants and groundwater levels, to assess the effectiveness of the hydraulic containment.