AshtonCoal

Section 5

South East Open Cut Project
&
Modification to the Existing ACP Consent

SECTION 5 – EXISTING ENVIRONMENT AND IMPACT ASSESSMENT

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5 EXISTING ENVIRONMENT AND IMPACT ASSESSMENT

5.1 Introduction

This section of the EA report provides an overview of the existing environment, an analysis of impacts (including cumulative impacts) and mitigation measures with respect to the proposed development.

For those persons seeking a greater understanding of particular aspects associated with the SEOC project and the environment, your attention is drawn to the various specialist studies contained in this volume and **Volumes 3, 4** and **5**.

5.2 The ACP Environmental Management and Monitoring Regime

ACOL has implemented appropriate management systems for continual improvement safety, health, environmental and community performance and requires these aspects be managed to a high degree.

ACOL will apply these management systems will to the construction and operation of the SEOC.

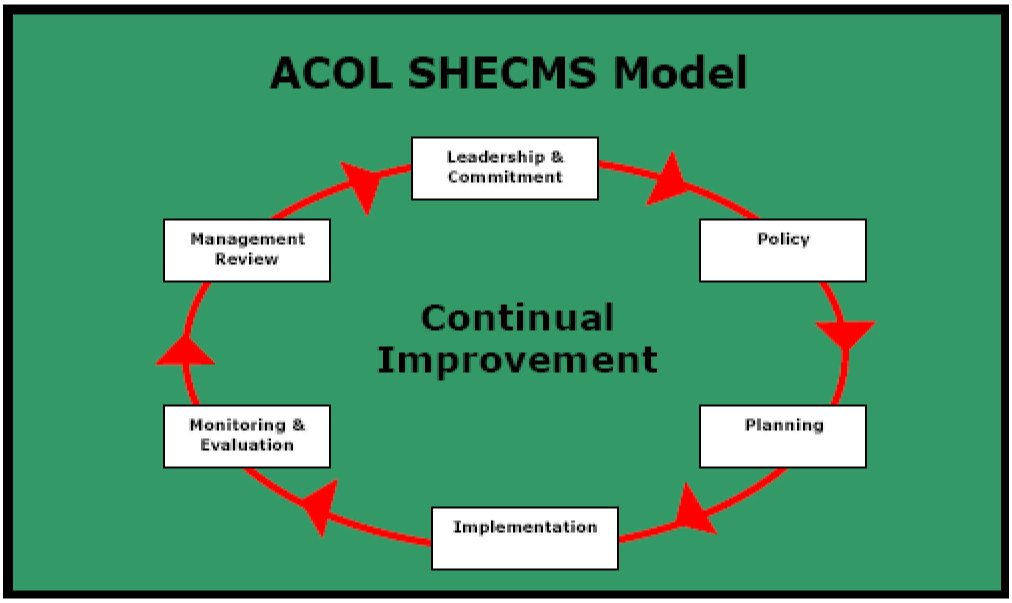
5.2.1 The Safety Health Environment and Community Management System

ACOL has adopted a structured and systematic approach to the management of safety, health, environment and community relations to specifically meet the needs of the operation. The safety and health of our employees and contractors, the protection of the environment and interaction with the community are paramount. Ongoing success in these areas is a fundamental requirement of our continued operation and growth.

The Safety, Health, Environmental and Community Policies and Procedures that have been developed by ACOL are to protect the health and safety of employees, contractors, sub- contractors, visitors and the general public, to protect the environment and to ensure compliance with all relevant Acts and Regulations. It is the policy of ACOL to ensure that all employees maintain a high standard of Occupational Health and Safety and Environmental management to achieve the operations objective of nil incidents. The Operations Team are committed to this objective and will, in so far as is practical, provide a safe hazard free workplace for all persons associated with the operation. The Safety, Health, Environmental and Community Management System (SHECMS) cover the following:

- Policies.
- Systems and Standards to be adopted to achieve these policies.
- Site Safety Procedures and Forms for the management of risks.
- Risk Assessments and Job Safety Analysis for specific tasks and jobs.

The ACOL Safety Health Environment and Community Management System (SHECMS) comprises six generic elements as depicted in the diagram below:



The elements of the system are detailed below, detailed information has been presented where applicable to the community and environment, while other aspects have only been noted. These sections detail ACOL's expectation and the *Operational* means by which it will be achieved.

5.2.1.1 Leadership and Commitment

The safety and health of ACOL personnel, the protection of the environment and interaction with the community is considered to be of the utmost importance. Resources to manage Safety, Health, Environment and the Community will be made available to ensure that activities on site comply with all relevant Legislation. The promotion and Continuance of the Safety, Health, Environment and Community Management System is primarily the responsibility of all personnel at the Ashton Coal Operation. Management are required to establish, implement and review the Safety, Health, Environmental and Community Management System for its effectiveness at the Ashton Coal Operation. The Management Team is responsible for the effective operation of the SHEC Management System and Procedures and the provision of adequate resources to ensure their effective implementation.

5.2.1.2 Policy

Current and relevant SHEC Policies authorised by the General Manager and Employee representatives are documented clearly stating overall SHEC objectives and demonstrating a commitment to improving SHEC performance. All employees are familiar with the objectives, requirements, and relevance to their duties of the SHEC Policies. The SHEC Policies are reviewed annually by the Occupational Health, Safety, Environment and Community Committee. The Policies are widely distributed and displayed prominently in main general public and workforce congregation areas. The ACOL SHEC Policies shall be the driver for the management of SHEC throughout the business. The Management Team shall ensure that all personnel receive training that reflects the contents, meaning, and implications of the SHEC Policy. Refer to *Section 5.2.2*.

5.2.1.3 Planning

The environmental management regime required under the existing Development Consent fits within the Planning component of the SHEC System, these management plans are detailed within *Section 5.2.3*.

Identification of Safety, Health Hazards & Environmental Aspects

ACOL shall establish, implement and maintain documented procedures for hazard identification, assessment and control of activities, products or services that may have an impact on Safety, Health, Environment and Community Relations over which we have control or influence, including those of our suppliers and contractors. Formal development of SHEC risk registers occurs before the commencement of site operations and these are reviewed at least every two years. Additional reviews are conducted when:

- Significant operational changes are to occur; or
- Community, legislative or other developments impact upon the operation; or
- Mine development, methods of mining, mining equipment has resulted in significant changes to the operation.

Legal and Other Requirements

ACOL are committed to complying with SHEC legislation, regulations, standards and codes of practice relevant to the operation as a minimum requirement. This information is kept up to date and relevant information is communicated to employees. ACOL maintains a Standard for the identification and understanding of legal and regulatory requirements for Safety, Health, and Environmental Performance, and Community Relations, that are directly applicable to the operation. The Standard stipulates requirements for periodic evaluation of compliance with relevant SHEC legislation.

Objectives and Targets

ACOL's goal is an Incident-free and healthy workplace through the application of a Zero Incident Culture. Personnel at ACOL have a personal responsibility for their own safety and that of their workmates and to protect the environment. Management objectives and targets for SHEC will be integrated into the overall planning process and deployed to all relevant functions activities and processes, and strive for continual improvement in performance. These objectives and targets are consistent with our SHEC policies, including our commitment to the prevention of pollution.

5.2.1.4 Implementation

A summary of the **Implementation** component is provided detailed below. Implementation applies to:

- **Structure and Responsibility,** is to define, document and communicate appropriately roles, responsibilities and authorities of all personnel associated with SHEC activities. Management shall identify and provide the resources to implement maintain and improve the SHEC management system.
- **Training and Competence**, ACOL in consultation with employees has developed a Standard for, training, and competence. The standard outlines the system required at site to ensure that the training needs of all personnel are identified, and that evidence is recorded demonstrating that personnel are competent to perform the tasks allocated to them.
- **Consultation, Communication and Reporting**, where ACOL has developed a process for effective consultation and communication with relevant internal and external stakeholders on SHEC matters affecting personnel and community. Stakeholders committed to, performance improvement initiatives and practices. The effectiveness of communication, consultation, and participation processes shall be regularly reviewed in collaboration with stakeholders.
- **Contractors and Suppliers**, ACOL maintains Standards for selection, evaluation and monitoring of the SHEC performance of contractors and suppliers. ACOL believes that the inherent risks of each contractor's use must be assessed and an appropriate amount of effort, planning and supervision be applied equally to the level of risk of the task being performed.
- **Controlling Documents and Data**, The ACOL SHEC management system to be effective is reliant upon the development, approval, and maintenance of relevant documents and data. All appropriate SHEC documents and data will be available via an electronic control system to personnel whose activities are dependent upon them.
- **Operational Risk and Aspects Control,** ACOL has established, implemented and maintains, a Standard for the Management of SHEC Risk. This Standard provides instruction and guidance on the identification, assessment and control of safety and health risk and environmental aspects throughout the operation. All risks must be managed through a preferred order of risk controls (commonly referred to as a hierarchy) namely Elimination, Substitution, Engineering Controls, Administrative Controls and Personal Protective Equipment.
- **Emergency Preparedness and Response**, ACOL has established, and maintains a Standard for emergency preparedness and response detailing the requirements for management of site emergencies. These plans shall be communicated to all relevant personnel and include links to external emergency services (e.g. fire, ambulance, police) with consideration of their response capability. Site plans shall include processes for preventing and mitigating illness and injury as well as environmental and community impacts.

5.2.1.5 Monitoring and Evaluation

A summary of the **Monitoring and Evaluation** is provided detailed below. Monitoring and Evaluation applies to:

- **Monitoring and Measurement,** ACOL has developed, and maintains Standards for monitoring and measurement of key characteristics of our operations SHEC performance to identify existing or emerging trends, and indicate progress towards the attainment of SHEC, objectives, and targets.
- **Incident, Investigation, Corrective and Preventative Action** Incidents and non-conformances are identified, reported, and investigated. Corrective and preventive actions are taken and a mechanism is provided for reporting non-conformances across the operation so that all areas of the business can benefit from the knowledge gained.
- **Records**, SHEC records are identified, maintained and reviewed to determine and ensure conformance to the Management System requirements.

- **Auditing and Review**, Auditi ng and review provide a systematic and structured method of verifying that activities conform to our Operational Plans, Systems, Standards and Procedures.

5.2.1.6 Management Review

ACOL has developed, and maintains, a Standard for Management review to ensure that all necessary information is collected to facilitate formal and effective evaluation and review of the SHEC Management System. Management Reviews shall be conducted yearly and examine the site management system, including the results of internal audits, the extent to which site objectives and targets have been met. The review shall be conducted under the direction of the General Manager, with the senior management team and in consultation with site personnel. Information and input shall be provided by the site Safety and Health Coordinator and Environmental Officer. All management reviews shall assess the need for changes in policy, objectives, and other elements of the SHECMS in the light of SHECMS audit results, changing circumstances and the commitment to continual improvement.

5.2.2 ACOL Safety, Health, Environment & Community Policy

The safety and health of our employees, contractors, sub-contractors, visitors and the general public, the protection of the environment and interaction with the community are paramount to the Ashton Coal Operations Team. Ongoing success in these areas and compliance with all relevant Acts and Regulations is a fundamental objective of our continued operation and growth as a commercial enterprise.

We are committed to:

- *Establishing, implementing and maintaining documented procedures for hazard identification, assessment and control of our activities, products or services that may have an impact on Safety, Health, Environment and Community (SHEC) relations over which we have control or influence, including those of our suppliers and contractors.*
- *Providing an Incident-free and healthy workplace through the application of a Zero Incident Culture. Personnel at Ashton Coal have a personal responsibility for their own safety and that of their workmates and to prevent environmental impacts. Management objectives and targets for SHEC will be integrated into the overall planning process and deployed to all relevant functions activities and processes, and strive for continual improvement in performance.*
- *In the event that an employee or contractor sustains a work related injury or illness, ACOL will provide an efficient workplace injury management program with the goal of restoring the injured person to pre-injury status*
- *Complying with the SHEC legislation, regulations, standards and codes of practice relevant to the operation as a minimum requirement. This information will be kept up to date and relevant information communicated to personnel.*
- *A process of consultation and communication with relevant internal and external stakeholders will be established and maintained on SHEC matters that may affect them. There will be regular review of the effectiveness of the communication in collaboration with stakeholders. The effectiveness of this process is reliant upon the development, approval, and maintenance of relevant documents and systems and the willing participation of employees and stakeholders. All appropriate SHEC documents and systems will be available to personnel whose activities are dependent upon them and where appropriate, to other stakeholders.*
- *Regularly reviewing and assessing the need for changes in policy, objectives and targets, and other elements of SHEC in the light of SHEC audit results, changing circumstances and our progression through continual improvement.*

5.2.3 Management Regime

As required by the original development consent DA 309-11-2001, ACOL have established a comprehensive environmental management and environmental monitoring regime which has been approved by relevant government agencies and implemented throughout the construction and operation of the ACP. All approved management plans are available on the Ashton Coal website (http://www.ashtoncoal.com.au/Documents.aspx?cat=Environmental+Plans). These management plans contain comprehensive environmental reporting procedures incorporating principles of operating the ACP in an efficient and environmentally responsible manner.

ACOL has established the following suite of management plans:

- Environmental Management Strategy.
- Air Quality Management Plan.
- Noise Management Plan.
- Blasting and Vibration Management Plan.
- Erosion and Sediment Control Management Plan.
- Site Water Management Plan
- Groundwater Management Plan.
- Aboriginal Heritage Management Plan.
- Archaeology and Cultural Heritage Management Plan.
- Flora and Fauna Management Plan.
- Weed Management Plan.
- Landscape and Revegetation Management Plan.
- Land Management Plan.
- Soil Stripping Management Plan.
- Rail and Road Closure Management Plan.
- Lighting Management Plan.
- Spontaneous Combustion Management Plan.
- Bushfire Management Plan.
- Waste Management Plan.
- Subsidence Management Plan

ACOL will where applicable integrate the SEOC with the above management and monitoring regime.

5.3 Climate

The prevailing climate in the area plays an important role in determining how the SEOC project may impact on the local community and environment. Rainfall, evaporation, temperature and prevailing winds all affect (amongst a multitude of other factors) the received levels of noise and dust and the impacts to groundwater and surface water.

Approximately 17km west of the ACP, the Bureau of Meteorology (BOM) station at the Jerry's Plains Post Office holds climate records since 1884, providing long term indications of weather in the area.

This section provides a summary of the area's climatic conditions based on these long term records, unless stated otherwise. Further information on the area's climate is contained within the air quality (e.g. prevailing winds, wind roses and climatic stability) and surface water (rainfall analysis for the Glennies Creek catchment) specialist reports.

5.3.1 Rainfall and Evaporation

Seasonal changes are a factor in the distribution of annual rainfall, with a greater proportion of rainfall occurring during the summer months. Over the remaining seasons, the rainfall is spread more evenly with minimum totals generally being recorded in winter. The wettest median monthly rainfall occurs in January where 65.1mm occurs over an average of 6.5 days, while the driest median monthly rainfall occurs in May with only 28.7mm of rain falling over 4.9 days. The median annual rainfall is 644.2mm.

The mean monthly evaporation rate for the period 1970 to 1979 was 154 mm with monthly variations between 78 mm in May and 245 mm in January.

Much of the year is characterised by a water deficit.

5.3.2 Temperature and Humidity

Summers are often characterised by extremely hot conditions with the highest temperatures exceeding 45 degrees Celsius (ºC). The average temperature during summer ranges from a maximum of more than 31ºC, to a minimum of 16ºC. During winter temperatures have been recorded below -4 ºC with the average temperature ranging from just over 4ºC to more than 18ºC. Frosts occur regularly during May to August, where on average more than 27 days per year record temperatures below 2ºC (temperatures less than 2ºC measured at 1.2m typically equate to a ground surface temperature of 0ºC, BOM 2008).

5.3.3 Winds

Measured from the ACOL meteorological stations the predominant winds on an annual basis are from the east-south-east (ESE) and west-north-west (WNW). These can be broken down seasonally as follows:

- Summer winds are predominantly from the coast in an east-south-east, south-east and easterly direction.
- Winter winds are from the inland in a west-north-west and north-westerly direction.
- The pattern in autumn and spring is a combination of these with winds from both the west-north-west and east-south-easterly directions.

Calm periods (that is, winds less than or equal to 0.5 metres per second [m/s]) occurred 6.2% of the time annually. The mean wind speed from the 2007/2008 data was 2.8 m/s.

Wind roses for the area are illustrated within the Air Quality report in Appendix 3.

Winds from the north and north-east are the worst case with respect to potential impacts for receptors to the south, while winds from the south and west-south-west are worst case with respect to potential impacts to receptors to the north of the SEOC, including the Camberwell village.

5.3.4 Inversions

Temperature inversions occur when relatively dense, cool air bodies are trapped below warmer, lighter air masses. Inversions typically represent calm air (no wind) conditions at the surface and the two bodies of air do not mix readily. An inversion, therefore, inhibits the dispersion of dust and gases, tending to cause higher concentrations at ground level. An inversion can also effectively “trap” sound energy near the ground leading to an increase noise levels.

Significant temperature inversions have been identified in the area during numerous studies, with approximately 60-70% of the year recording a temperature inversion of greater than 3^0C per 100 metres. It should be noted that a percentage of these days have only small inversions of 1 or 2^0C/100m for a very short period of time (less than 0.5 hours).

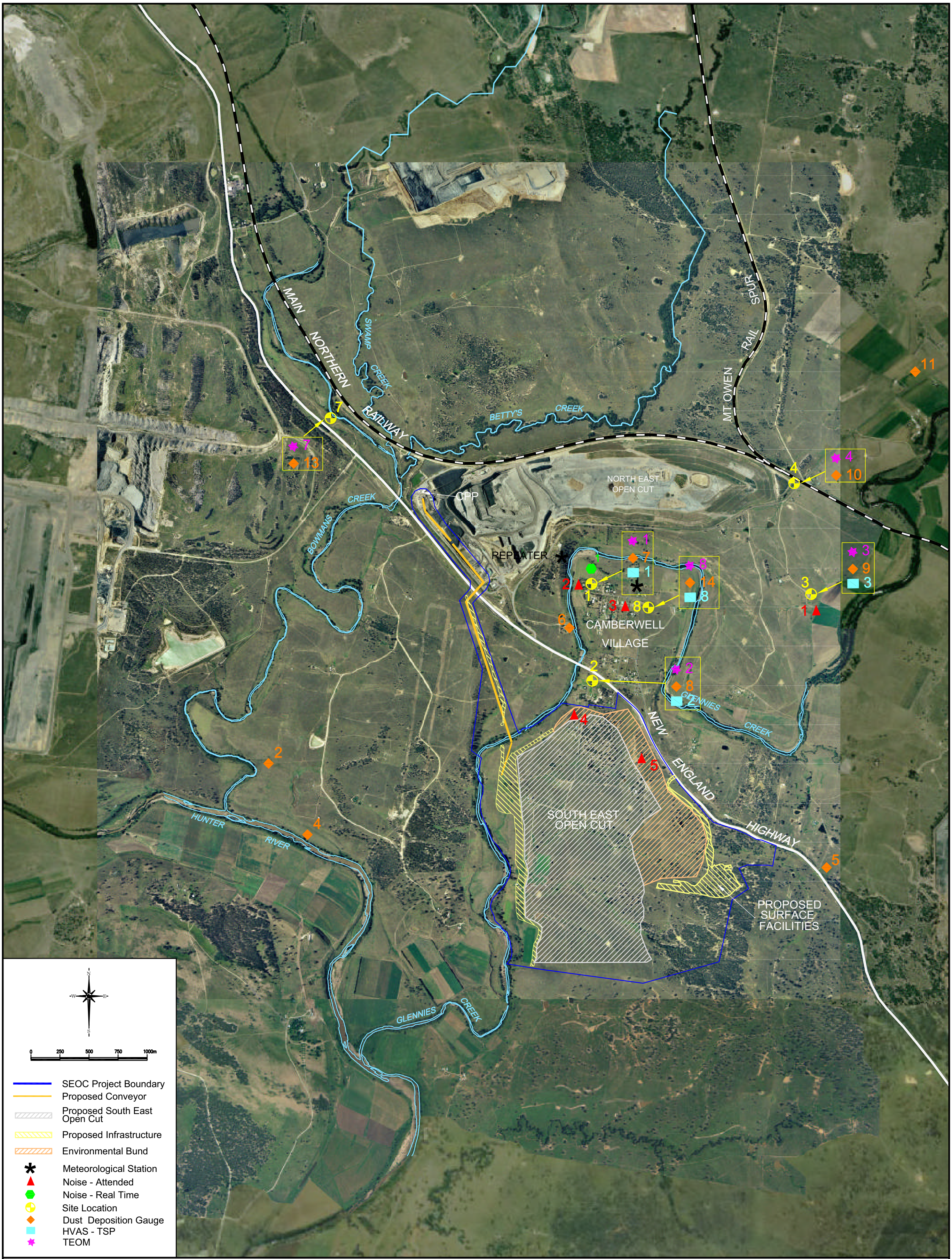
A temperature inversion study was conducted on the ACP site during August/September 2006, with five Gemini data loggers placed at various locations on the site and in Camberwell village to cover a total altitude separation of 79m.

The tenth percentile inversion strength recorded in the sound propagation path between mining activities and Camberwell village was 4.7^0C/100m. This inversion strength was adopted in noise modelling for the SEOC.

Typical calm daytime conditions of no wind, 70% RH and -1^oC/100m vertical temperature gradient (i.e., dry adiabatic lapse rate, DALR) was used in the noise modelled to represent daytime noise levels under calm conditions.

5.3.5 Weather Stations

ACOL has two established meteorological monitoring stations in the vicinity of the site with the potential to collaborate data from adjoining mines. The stations are located in the village of Camberwell and at the Repeater Station on the ridge above the village. The locations of the ACOL weather stations are shown in **Figure 5.1.**



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The existing ACOL monitoring network for meteorology, air and noise

Figure 5.1

Plan 25

Prepared by Pegasus Technical

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5.4 Land Uses of the SEOC Area and Nearby Lands

5.4.1 Dwellings and Land Zoning

Figure 5.2 illustrates the land use zoning under the Singleton Local Environmental Plan 1996 and dwellings in the vicinity of the ACP and SEOC project mapped by their respective landownership. Refer to *Section 2* for a description of the permissible land uses within the respective land zonings defined by the Singleton Local Environmental Plan 1996.

For the purpose of describing Camberwell village, the village has been assumed to include those lands zoned 1(d) Small Rural Holdings and extending some 500 metres from the zone boundary. Within this area there are:

- Thirty three (33) dwellings owned by ACOL.
- Seventeen (17) dwellings privately owned.
- St Clements Church.
- Camberwell Community Hall.

5.4.2 Past Land Use

An aerial photograph from 1958 was reviewed to determine past land uses of the SEOC area to ascertain what changes have occurred over the past 50 years.

Figure 5.3 illustrates the 1958 aerial photograph overlain with the SEOC project foot print whilst Figure 5.1 illustrates the same area using an aerial photograph from December 2008.

Comparison of the two aerial photographs reveals that over the last 50 years there has been some transition from dedicated rural properties deriving an income from the land (agriculture) to hobby type farms where income generated from the lands is ancillary to the resident's core income. Essentially the actual land use has not changed significantly but has probably reduced in intensity.

The number of dwellings within Camberwell and lands within the SEOC area has increased substantially over the last 50 years.

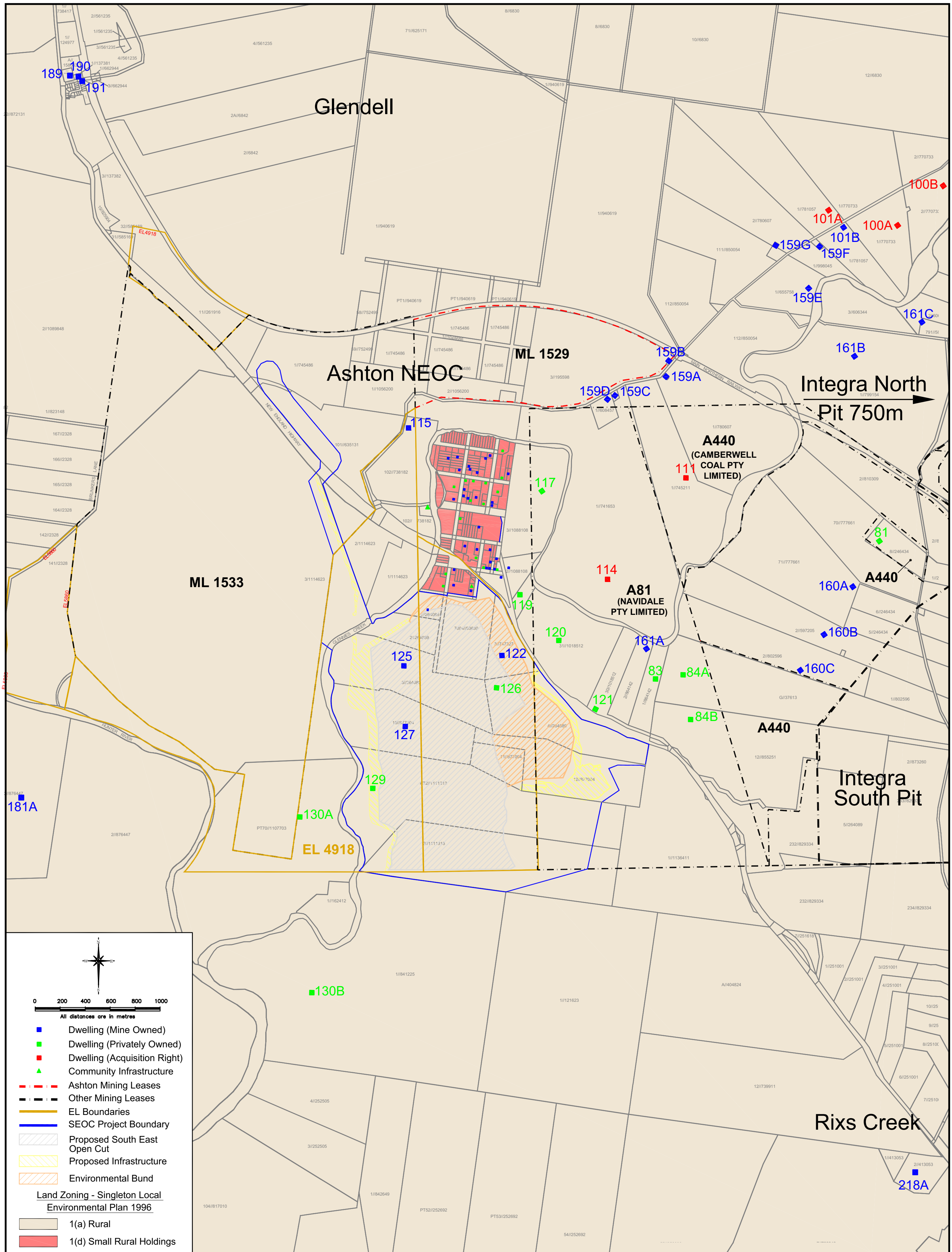
In 1958 the alluvial terraces of Glennies Creek appeared to be heavily used for agricultural crop production, both adjacent to the SEOC and immediately centre of Camberwell. The banks and terraces showed extensive clearing with substantially sparser tree cover then today.

Vegetation in the Camberwell Common and lands east of the SEOC in the location of the proposed office and workshop facilities were also substantially sparser than today, demonstrating potentially more intense use of the land and tendency for land clearing. It also demonstrates how the vegetation has recovered over 50 years.

5.4.3 Existing Land Use

To effectively understand the environment in the area of the SEOC project and its potential impacts on the receiving environment it is important to comprehend the existing land use within the project area and that of the surrounding lands.

The SEOC project area is currently used primarily for livestock grazing activities, alluvial soils along Glennies Creek are used for fodder cropping, while to the immediate south and south west of the area there is a dairy. Several rural dwellings and associated infrastructure (e.g. sheds, stock yards) are located within the project area. Vegetation is largely open pastures with isolated shade trees, there are pockets to the north and east of spotted gum - ironbark – grey box woodlands, and River Oak Forest along the riparian corridor of Glennies Creek.



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South East Open Cut Project

Landuse Zoning and Dwellings surrounding the SEOC Project

Figure 5.2

Plan 26

Prepared by Pegasus Technical

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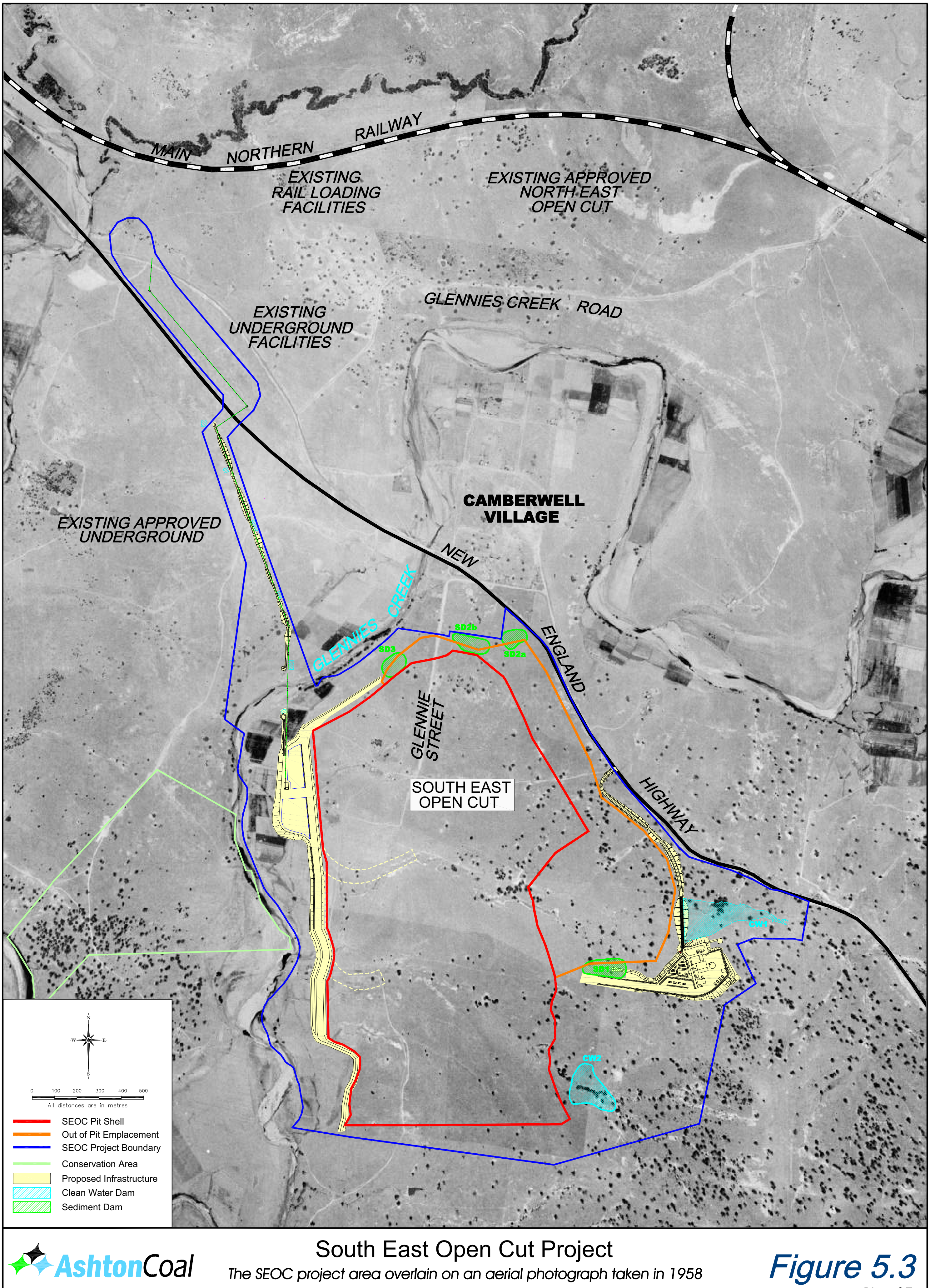

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South East Open Cut Project

The SEOC project area overlain on an aerial photograph taken in 1958

Figure 5.3

Plan 27

Prepared by Pegasus Technical

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Measured from the centre of the SEOC in a clockwise direction, **Table 5.1** provides the relative location of adjoining major land uses and key aspects of the nearby coal mines.

It should be noted that Table 5.1 only includes approved mining operations. The Integra Complex currently has a proposal for the expansion of the Camberwell (Integra South) pit that would extend open cut mining to the west toward Glennies Creek. At its closest this operation would be within 2km to the north east of the SEOC project and 2 km to the east of Camberwell.

Table 5.1: Relative locations of adjoining land uses.

Direction from SEOC	Land Use / Feature*	Approximate Distance from SEOC centre
North	**Camberwell Village** *"1(d) Rural small holdings zone" under the Singleton Local Environmental Plan 1996.*	1km #
	New England Highway	1km #
	Ashton North East Open Cut and CHPP *Refer to Section 4.*	3.0km
	Main Northern Railway line	3.5km
	Glendell Open Cut *Operated by:* Xstrata Mt Owen, part of Mt Owen Complex *Approved:* First approved 1983, commenced following modification approval in February 2008. *Tonnages:* 4.5Mtpa ROM coal. *Method:* Truck and Excavator *Mine Life:* 16 years to 2024. *Hours of Operation:* 24 hours 7 days. *Employees: Up to 150.* *Processing:* Uses Mt Owen CHPP and rail facilities *Note:* Closest to Camberwell Village in years 6 to 9 (approx 2014-2017), after Year 9 pit begins to move away from Village.	4km
	Ravensworth East Open Cut *Operated by:* Xstrata Mt Owen, part of Mt Owen Complex *Approved:* 2 March 2000, last modified 2005. *Tonnages:* 4.0Mtpa ROM coal. *Method:* Truck and Excavator *Mine Life:* 16 years to 2024. *Hours of Operation:* 24 hours 7 days. *Employees: Up to 150.* *Processing:* Uses Mt Owen CHPP and rail facilities	8km
North East	**Glennies Creek Underground (Integra Underground)** *Operated by:* Integra Coal Operations Pty Ltd, part of Integra Complex. *Approved:* First approved in 1991, extension approved on 16 June 2008, further extension under application. *Tonnages:* 4.5Mtpa ROM coal. *Method:* Longwall, 17 panels approved. *Mine Life:* 15 years to 2023. *Hours of Operation:* 24 hours 7 days. *Employees:* 170. *Processing:* Common use of Camberwell CHPP and rail facilities.	5km

Direction from SEOC	Land Use / Feature*	Approximate Distance from SEOC centre
North East	**Agriculture** Fodder crop production on the alluvial flats associated with Glennies Creek. Grazing on open country in the Glennies Creek catchment.	1.5 to 16km 1.5 to 20km
	Lake St Claire (or Glennies Creek Dam)	20km
East	**Camberwell Open Cut (Integra South Pit)** *Operated by:* Integra Coal Operations Pty Ltd, part of Integra Complex. *Approved:* March 1991 *Tonnages:* 4.5Mtpa ROM coal. *Method:* Truck and Excavator and highwall auger mining. *Mine Life:* Due to be completed in 2009 (application for extension, see Integra Open Cut. *Hours of Operation:* 24 hours, 7 days. *Employees:* 250. *Processing:* CHPP and rail facilities with processing rate of 4.5Mtpa, accepts coal from the Glennies Creek Open Cut and Underground.	4.5km
	Glennies Creek Open Cut (Integra North Pit) *Operated by:* Integra Coal Operations Pty Ltd, part of Integra Complex. *Approved:* December 2008 *Tonnages:* 1.5Mtpa ROM coal. *Method:* Truck and Excavator and highwall auger mining. *Mine Life:* 10 years to 2018 *Hours of Operation:* Truck and Excavator - 7am to 10pm 7 days. Highwall auger mining 24 hours 7 days. *Employees:* 178 (includes employees working in Camberwell Open Cut). *Processing:* Common use of Camberwell CHPP and rail facilities.	6.0km
	Proposed Integra Open Cut *Application by:* Integra Coal Operations Pty Ltd, part of Integra Complex. *Status:* Environmental Assessment Report on exhibition July/August 2009 *Tonnages:* 30Mt at 2.3 to 4.2Mtpa of ROM coal. *Method:* Truck and excavator/ shovel. *Mine Life:* 9 years *Hours of Operation:* 24hours 7 days. *Employees:* 250 (transferred from the Camberwell Open Cut). *Processing:* Common use of Camberwell CHPP and rail facilities.	2.5km
South East	**Rix's Creek Open Cut** *Operated by:* Bloomfield Collieries Pty Limited *Approved: 1990,* expansion in October 1995 *Tonnages:* Approximately 1.8Mtpa ROM coal. *Method:* Draglines, loaders and trucks. *Mine Life:* 2019 under current ML. *Hours of Operation:* 24 hours, 7 days. *Employees:* 100. *Processing:* CHPP and rail loading facilities, utilising the Camberwell balloon loop.	4.5km

Direction from SEOC	Land Use / Feature*	Approximate Distance from SEOC centre
South East	**New England Highway Motel**	7.7km
	Maison Dieu Industrial Estate	8.5km
	Service Station	9km
	Singleton Heights urban area	8.7km
South	**Agricultural land uses** Dairy farming, livestock grazing, fodder crop production on Glennies Creek and Hunter River alluvial flats.	0 – 8km
	Maison Dieu Road Access through to the Hunter River, Knodlers Lane, Shearers Lane, rural properties and dwellings.	4.5km
South West	**Hunter Valley Operations South (HVO South)** **(includes Cheshunt, Deep Cheshunt, North Lemington, South Lemington and Riverview open cut mines)** *Operated by:* Coal and Allied Operations Pty Limited *Approved:* Started in 1949, Project Approval for consent consolidation in March 2009. *Tonnages:* 16Mtpa ROM coal. *Method:* Draglines, shovels and trucks. *Mine Life:* 21 years (i.e. 2030). *Hours of Operation:* 24 hours, 7 days. *Employees:* 670 (829 including contractors). *Processing:* Lemington Coal Preparation Plant, with new rail facilities. *Note:* The North Lemington Pit is the closest pit to the SEOC Project.	5.5km
	Hunter River	2.5km
	Wollemi National Park	15km
West	**Glennies Creek**	1km #
North West	**Ashton Underground** *Refer to Section 4.*	2km
	Narama Open Cut *Operated by:* Ravensworth Operations Pty Limited, part of the Ravensworth Mining Complex (Narama and Ravensworth West) *Approved:* July 1991 *Tonnages:* 3.5Mtpa ROM coal. *Method:* Draglines, shovels and trucks. *Mine Life:* 21 years (2012). (Ravensworth West to 2027) *Hours of Operation:* 24 hours, 7 days. *Employees:* 119. *Processing:* Conveyor to Liddell and Bayswater Power stations	5km
	Macquarie Generation and Liddell Power Stations	16.5km

Direction from SEOC	Land Use / Feature*	Approximate Distance from SEOC centre
North West	**Ravensworth Underground (formerly Newpac No.1 and Nardell)** *Operated by:* Xstrata Coal NSW Pty Ltd. *Approved:* November 1996. *Tonnages:* 5Mtpa *Method:* Longwall mining. *Mine Life:* 21 years to 2017. *Hours of Operation:* 24 hours, 7 days. *Employees:* >150. *Processing:* CHPP and rail facilities.	5km
# The edges of the SEOC project are located immediately adjacent to these land uses. ** Information was sourced in the first instance, where possible, from Project Approvals and Development Consent, consultation, Environmental Assessments or the 2008 New South Wales Coal Industry Profile.*		

5.4.4 General Land Use Impacts

Most land use activities contribute to the quality of the existing environment. Typically the key issues associated with the main land uses are as follows:

- Open cut mines generate noise, dust and odour emissions, alter natural surface water flows and quality, clear remnant vegetation, alter/reduce topsoil and subsoil value, impact land capability and intercept groundwaters.
- Underground mining operations intercept groundwater, subside the surface, alter surface water flows, impact land capability and release fugitive emissions.
- CHPPs generate noise and dust emissions.
- Highways and railways are a source of noise and carbon emissions.
- Agriculture can generate dust emissions and alter natural surface water flows and quality clear remnant vegetation, alter/reduce topsoil value, impact land capability.

The consideration of adjoining land uses and their resulting impacts to the environment is fundamental to ensuring potential cumulative impacts are appropriately assessed.

5.4.5 Land Use Impacts from the SEOC

The predominant land use impact associated with the SEOC project will be the relocation of occupants of some dwellings and the loss of agricultural pursuits associated with those properties directly impacted by the initial construction of the SEOC, along with the relocation of service utilities and subsequent mining and rehabilitation.

The SEOC project will change, amongst other factors the acoustic, air quality, groundwater and surface water environment. These impacts in relation to the site and surrounding land uses have been assessed fully within this section.

Dwelling occupancy affected by the SEOC may require negotiated agreements between the proponent and land owner(s) or be subject to conditions of project approval.

The project also impacts upon agricultural lands associated with the alluvial flats and other rural lands that are within the foot print of the SEOC. ACOL propose to ameliorate these impacts through the establishment of a post mining landform of low intensity grazing and open woodlands. Other land uses which currently occur outside the SEOC footprint will generally be able to continue.

The future land use of the SEOC area is detailed within *Section 5.29 and 5.30*.

5.5 Air Quality

ACOL engaged Holmes Air Sciences (now PAE Holmes) to undertake an assessment of the SEOC project and its potential impacts on air quality. A copy of the report is contained in **Appendix 3**.

5.5.1 Air Quality Criteria

This section provides information on the air quality criteria used in coal mining developments in NSW. The assessment criteria are divided into impact assessment criteria (see **Table 5.2**) used for assessing environmental performance and land acquisition criteria (see **Table 5.3**) used to determine the criteria at which the landowner may request their property be acquired by ACOL.

Table 5.2: Air quality impact assessment criteria used in NSW.

Pollutant	Criteria	Averaging Period	Agency
Particulate Matter < 10µm (PM_{10})	50µg/m³	24 hour maximum from mine alone.	DECCW
	30µg/m³	Annual cumulative	DECCW
Total suspended particulate matter (TSP)	90µg/m³	Annual cumulative	NHMRC
Dust Deposition - Maximum <u>increase</u> in deposited dust	2g/m²/month	Month cumulative	DECCW
Dust Deposition - Maximum <u>total</u> deposited dust	4g/m²/month	Month cumulative	DECCW
µg/m³ – micrograms per cubic metre g/m²/month –grams per square metre per month			

Table 5.3: Department of Planning assessment criteria for particulate matter.

Pollutant	Criteria	Percentile[1]	Averaging Period	Basis
Particulate Matter < 10µm (PM_{10})	150µg/m³	99[2]	24 hours	Total[3]
	50µg/m³	98.6[2] 5 exceedances per annum	24 hours	Increment[4]
	30µg/m³	100	Annual	Total
Total suspended particulate matter (TSP)	90µg/m³	100	Annual	Total
Dust Deposition - Maximum <u>increase</u> in deposited dust	2g/m²/month	100	Month	Total
Dust Deposition - Maximum <u>total</u> deposited dust	4g/m²/month	100	Month	Total
µg/m³ – micrograms per cubic metre g/m²/month –grams per square metre per month				

Notes: [1] Based on the number of block 24 hour averages in an annual period.
[2] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed by the Director-General in consultation with the DECCW.
[3] Background PM_{10} concentrations due to all other sources plus the incremental increase in PM_{10} concentrations due to the mine alone.
[4] Incremental increase in PM_{10} concentrations due to the mine alone.

5.5.2 Existing Air Quality

With the long history of coal mining in the area, air quality in the vicinity of the SEOC has been monitored for more than 20 years by several different mining companies.

Monitoring for the ACP commenced in 1999. ACOL has an extensive air quality monitoring network in and surrounding the existing ACP which provides extensive baseline data for the purposes of assessing potential impacts on air quality. The locations of the monitoring sites are shown in Figure 5.1. The ACOL monitoring network comprises:

- 12 dust gauges collected and analysed on a 28 day cycle:
  - Dust gauge DG2 – Ravensworth property west of open cut.
  - Dust gauge DG3 – Ravensworth property near Hunter River.
  - Dust gauge DG4 – Ashton property near Hunter River.
  - Dust gauge DG5 – New England Highway south east of Camberwell Village.
  - Dust gauge DG6 – St Clements Church.
  - Dust gauge DG7 - TEOM site 1 – Camberwell Village.
  - Dust gauge DG8 – TEOM site 2 – Camberwell Village.
  - Dust gauge DG9 – TEOM site 3 – Property east of Camberwell.
  - Dust gauge DG10 – Onsite – TEOM site 4 (near east overburden dump).
  - Dust gauge DG11 – Northeast of emplacement area on Glennies Creek Road.
  - Dust gauge DG13 – Onsite – TEOM site 7 (western end of rail siding).
  - Dust gauge DG14 – TEOM site 8 – Camberwell Village.
- 4 high volume air samples (HVAS) for total suspended particulates (TSP) collected and analysed on a 6 day cycle:
  - Monitoring Station 1 – Camberwell Village (north).
  - Monitoring Station 2 – Camberwell Village (south).
  - Monitoring Station 3 – Property east of Camberwell Village.
  - Monitoring Station 8 – Camberwell Village (east).
- 6 real time TEOMs continuous analysis of PM_{10} concentration:
  - Monitoring Station 1 – Camberwell Village (north).
  - Monitoring Station 2 – Camberwell Village (south).
  - Monitoring Station 3 – Property east of Camberwell Village.
  - Monitoring Station 4 – Onsite north of Eastern Emplacement Area.
  - Monitoring Station 7 – On site at western end of rail siding.
  - Monitoring Station 8 – Camberwell Village (east).

Dust monitors have been installed and operated in accordance with AS 3580.10.1 and the PM_{10} monitor in accordance with AS 3580.9.6. These monitors measure the existing dust deposition, Total Suspended Particulates and PM_{10} concentration levels in the air due to emissions from all sources that contribute to air born dust. These sources include emissions from existing mining at the ACP operations, surrounding mining operations, power and other industry emissions, emissions from agriculture, and natural emission sources in the area.

5.5.2.1 Particulate Matter

Figure 3 of *Appendix F* in the original ACP EIS presented the historic PM10 monitoring results from the Ravensworth Mine HVAS – HV2 for the period 1996 to 2001 in Camberwell village. During this five year period there are several periods in time where the historic annual average is above the cumulative annual average criteria of 30μg/m$^{3.}$

All TEOMs are located within approximately 3km of the existing ACP with the closest being less than 1km from the site. The TEOMs record real-time PM_{10} concentrations that allow for operational changes where short-term averaging of PM_{10} concentrations indicate an increasing trend.

Annual average PM_{10} concentrations for 2007 to 2009 are shown in **Table 5.4**, all sites fall below the annual average assessment criterion of 30 μg/m^3. Generally, the monitoring results at these locations are influenced by existing ACP operations which would be expected as the monitoring network was specifically devised for that mine. It should also be noted that sites closer to the existing NEOC such as TEOM sites 1 and 8, show generally higher PM_{10} annual average concentrations than those sites further away such as sites 7 and 3. Sites 1 and 8 are also located within the north-west and south-east prevailing wind directions (see Figure 5.1)

Table 5.4: Summary of PM_{10} concentrations for the period June 2007 to July 2009.

Site number	Annual Average TEOM PM_{10} concentrations (µg/m³)			
	2007	2008	2009	Average (2007 – 2009)
1	27.5	25.9	26.3	26.6
2	23.4	18.2	18.4	20.0
3	24.1	22.5	24.6	23.7
4	23.9	23.1	27.1	24.7
7	23.7	21.5	23.0	22.7
8	24.5	25.1	24.6	24.7

5.5.2.2 Total Suspended Particulates (TSP)

Figure 2 of *Appendix F* in the original ACP EIS presented the historic TSP monitoring results from the Ravensworth Mine HVAS – HV2 for the period 1996 to 2001 in Camberwell village. During the five year period annual average TSP exceeded the 90µg/m^3 annual criteria on numerous occasions prior to the commencement of the existing ACP operations.

All HVAS's are located within approximately 3km of the mining site. The HVAS's record 24-hour average concentrations every sixth day and these results are presented **Table 5.5** for the 2007 to 2009 period. Exceedances of the annual average criteria of 90µg/m^3 have been measured, particularly at Site 1 that is the closest to the ACP operations. Site 3 is located east of the ACP approximately mid-way between the ACP and Integra coal mines, exceedances at are most likely a result of cumulative contributions between the two mines.

Table 5.5: Measured TSP concentrations for the 2007 to 2009 period.

Site number	Measured HVAS TSP concentrations (µg/m³)			
	2007	2008	2009	Average (2007 – 2009)
1	**103.4**	**99.9**	89.2	**97.5**
2	78.6	75.3	83.6	79.2
3	88.6	**92.3**	**94.2**	**91.7**
8	83.6	80.4	83.2	82.4

5.5.2.3 Depositional Dust

Table 5.6 shows the annual average dust deposition for the period from 2007 to 2008. The average across all sites for all measured years was 3.4g/m^2/month, below the DECCW criteria.

It is clear from the monitoring results presented in Table 5.6, that there are some sites that exceed the 4 g/m2/month DECCW criterion. Measurements at deposition gauges are heavily influenced by local dust producing activities, and this can be seen in the large variation in levels over small distances. For example, DG14 and DG7 are both located within Camberwell Village. DG14 has reported levels below 4 g/m2/month for the entire monitoring period while DG7, which is approximately 600 m south-east of DG7, is substantially higher. The annual average for all sites is 3.4 g/m^2/month which complies with the DECCW's criterion of 4 µg/m3.

Table 5.6: Annual average dust deposition for 2007 to 2008 (insoluble solids) (g/m^2/month).

Site	Annual average dust deposition for 2007 to 2009 (insoluble solids) (g/m^2/month).			
	2007	2008	2009	Average
DG2	3.8	**5.5**	**4.1***	4.7
DG4	3.7	**5.4**	4.6*	4.6
DG5	2.1	2.6	4.5*	2.4
DG6	3.1	2.9	3.5*	3.0
DG7	**4.4**	3.6	3.9*	4.0
DG8	3	3.1	3.0*	3.1
DG9	3.7	3.1	3.5*	3.4
DG10	3	**4.3**	2.3*	3.7
DG11	2.9	2.8	2.7*	2.9
DG13	3.7	4	**6.1***	3.9
DG14	2	2.5	2.3*	2.3
Average for all sites and for all years				**3.4**

** Less than 6 months of valid data available*
+ Contamination from bird dropping, grazing material, irrigation etc.

5.5.3 Assessment Methodology

5.5.3.1 Modelling

Modelling of the SEOC project was based on a modified version of the US EPA ISC model. For the study, the existing ACP and proposed SEOC operations were represented by a series of volume sources relative to the location of mining activities for the modelled scenario or year. Modelling also had regard to background air quality data, the progress of adjoining mines, dust emission rates for each activity, climate and location of receptors.

Air modelling was undertaken for the SEOC for years 1 (2010 – 2011), 3 (2012 to 2013), 5 (2014 to 2015) and 7 (2016 to 2017), providing an assessment for the full SEOC mining life. The model included the proposed increase to 5Mtpa for peak underground ROM coal extraction. The modelled years cover impacts arising for a range of product coal and overburden quantities for various mining activities in a range of locations. It should be noted that the SEOC final void will continue to be used to approximately 2023 as a tailings disposal area.

Given the tailings slurry is piped into the void, no dust modelling was considered necessary. Modelling included the proposed increase in peak production from the existing ACP underground.

The model assessed:

- Maximum 24-hour PM_{10} concentrations (mine only).
- Maximum 24-hour PM_{10} concentrations (cumulative).
- Annual average PM_{10} concentrations (mine only).
- Annual average PM_{10} concentrations (cumulative).
- Average TSP concentrations.
- Annual average dust (insoluble solids) deposition rates.

5.5.3.2 Estimated Emissions from Neighbouring Mines and other Sources

The SEOC model accounted for emissions from neighbouring mining operations, where possible utilising data from the respective EIS or EA, to create a set of emission sources that will change as the mines advance. The use of existing monitoring data for these estimates is not practical as existing concentrations will not change with the mining operations and are only relevant to the actual monitoring location. The model has included estimated emissions for the following approved mines:

- Integra North Open Cut (Year 1 and Year 3 only) (URS, 2009).
- Ravensworth East (Year 1, Year 3 and Year 5 only) (Holmes Air Sciences, 2003).
- Mt Owen (all years) (Holmes Air Sciences, 2006).
- Glendell (all years) (Holmes Air Sciences, 2007a).
- Narama (Year 1, Year 3 and Year 5 only) (Holmes Air Sciences, 2005).
- HVO South (Holmes Air Sciences, 2007b).
- Rixs Creek (Holmes Air Sciences, 1994).
- Ashton North East Open Cut (NOEC) (Year 1 - July to October only)(Holmes Air Sciences, 2003).
- Ravensworth West (Year 1 only) (Year 1 - July to October only).

Other land uses and activities such as agriculture and transport and more distant mining and power generation activities will contribute to the concentration of TSP, dust and PM_{10} in the area. The contribution of non-mining sources to the annual average quantity of particulate matter contributed by these more distant sources was calculated by comparing simulated model results without the SEOC (i.e. only existing ACP and neighbouring mines) against the measured PM_{10} data for the 2007 to 2008 year. This provided equivalent background that has been used in model to simulate other land uses. The background values are:

- 27 $\mu g/m^3$ for annual average TSP.
- 2 $\mu g/m^3$ for annual average PM_{10}.
- 0.5 g/m^2/month for annual average dust deposition.

This is a conservative approach that is likely to result in an over-prediction of annual average dust levels.

5.5.4 Air Quality Impacts

The predicted levels from the air quality model were assessed for each residential receptor by comparing the values to the air quality standards and goals contained in Table 5.2 and Table 5.3.

All residences located in areas where annual average concentration or deposition levels are predicted to exceed the DECCW assessment criteria have been assessed as being impacted by the SEOC and ACOL will seek to acquire the affected lands or enter into negotiated agreements with the landowner.

It should be noted that the following sensitive receptors would not exist in the stated year or subsequent years, as the sites are within the mining footprint and mining would occur at these locations:

- Year 1
  - One private residence (126).
  - Five residences owned by mining companies or other entities (122, 123, 125, 127 and 128).
- Year 5
  - One private residence (129).

The location of the following receptors should also be noted:

- Private properties 50 and 51 are located south of the New England Highway within 200m of the out of pit emplacement.
- Property 46 is the Camberwell Hall, that is currently in poor repair and unused, is also located south of the New England Highway within 200m of the out of pit emplacement.

- Private properties 2, 8, 11, 119, 120 and 121 are located north of the New England Highway and are within 500m of the out of pit emplacement.

5.5.4.1 Cumulative Annual Average

This section provides a summary of the predicted impacts for each year as a result of the SEOC inclusive of adjoining approved mining operations.

It should be noted the cumulative impact model predicted some receptors to be above criteria but not as a result of the SEOC, these receptors have been excluded from these summaries. For those receptors the relevant modelling undertaken by those mining operations is expected to be a more accurate representation of dust levels. **Figures 5.4, 5.5, 5.6** and **5.7** display the predicted PM_{10} annual average concentrations for years 1, 3, 5 and 7 respectively.

A detailed list of all assessed receptors (including those predicted to be below criteria) is included for each assessed mining year within Appendix 3.

Year 1

In Year 1 of the modelled operations the existing NEOC is still operating for part of the year before closing, the underground has maintained current production levels, and at the same time construction and mining has commenced at the SEOC, that includes the construction of the environmental bund and out of pit emplacement. This has resulted in air quality impacts above DECCW criteria within Camberwell village.

For Year 1 the following receptors are predicted to experience dust levels above criteria:

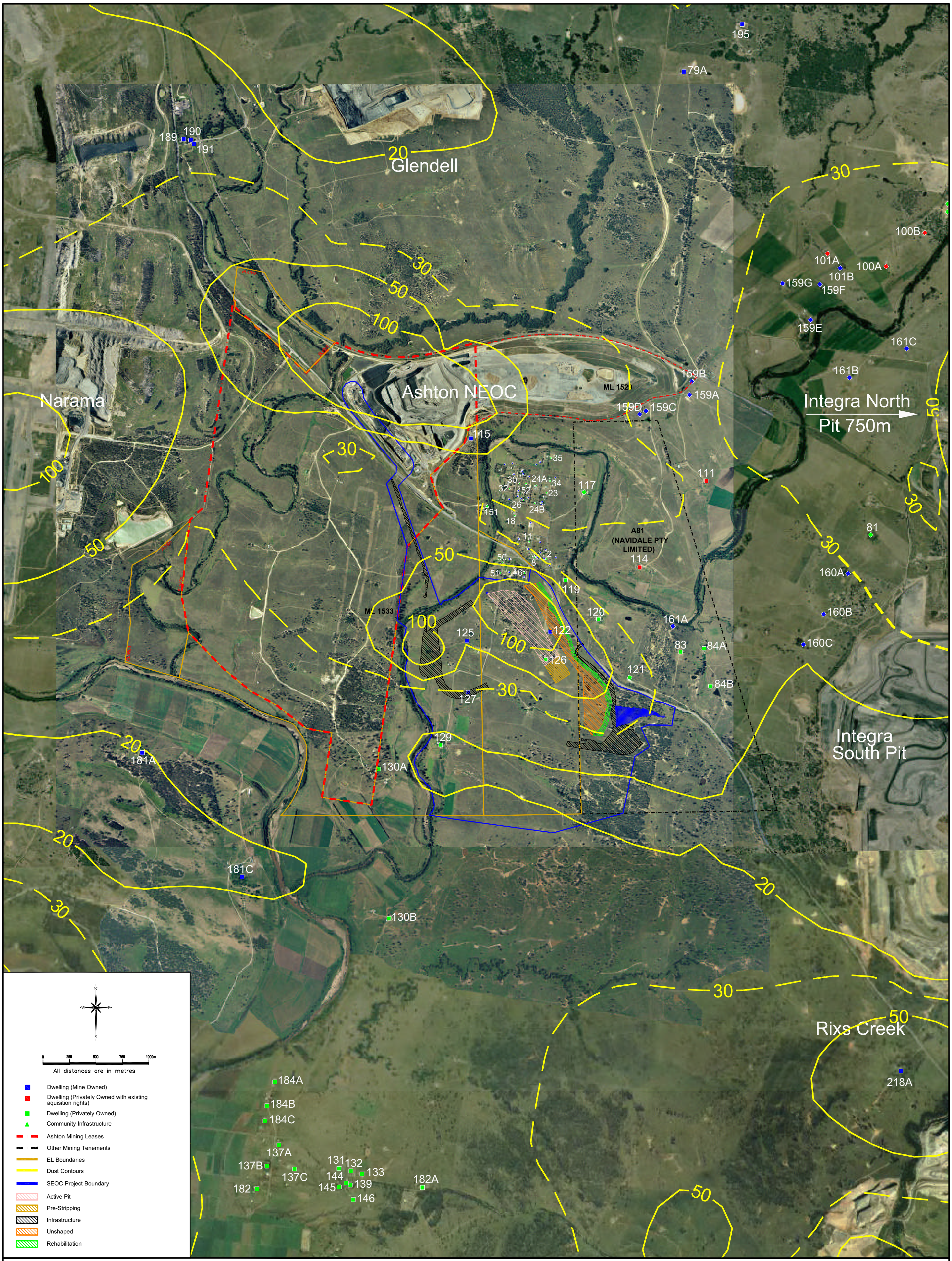
- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – One private residence (51).
- Annual average PM_{10} above 30 $\mu g/m^3$ due to the Project and other mines and other sources – Sixteen (16) private residences (23, 024A, 024B, 26, 30, 32, 34, 35, 46, 50, 51, 52, 117, 119, 120, 121) and nineteen residences owned by mining companies or other entities (21, 22, 25, 27, 28, 29, 33, 36, 36, 38, 39, 40, 41, 43, 44, 45, 47, 49 and 115). Refer to **Figure 5.4** for modelled contours.
- Annual average TSP above 90 $\mu g/m^3$ due to the Project and other mines and other sources – One private residences (51) and one residence owned by mining companies or other entities (115).
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – One private residence (35) and four residences owned by mining companies or other entities (36, 36, 43 and 115).

Year 3

In Year 3 of the modelled operations the NEOC has closed, peak extraction in the existing ACP underground is assumed to be 5Mtpa and mining within the SEOC has advanced to the south. This has resulted in reduced impacts to properties to the north of the SEOC.

For Year 3 the following receptors are predicted to experience dust levels above criteria:

- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – no residences affected.
- Annual average PM_{10} above 30 $\mu g/m^3$ due to the Project and other mines and other sources – Two private residences (121 – within 500m, and 129 within footprint). Refer to **Figure 5.5** for modelled contours.
- Annual average TSP above 90 $\mu g/m^3$ due to the Project and other mines and other sources – no residences affected.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – no residences affected.



AshtonCoal

South East Open Cut Project

Year 1 - Predicted Cumulative Annual Average PM_{10} Emissions

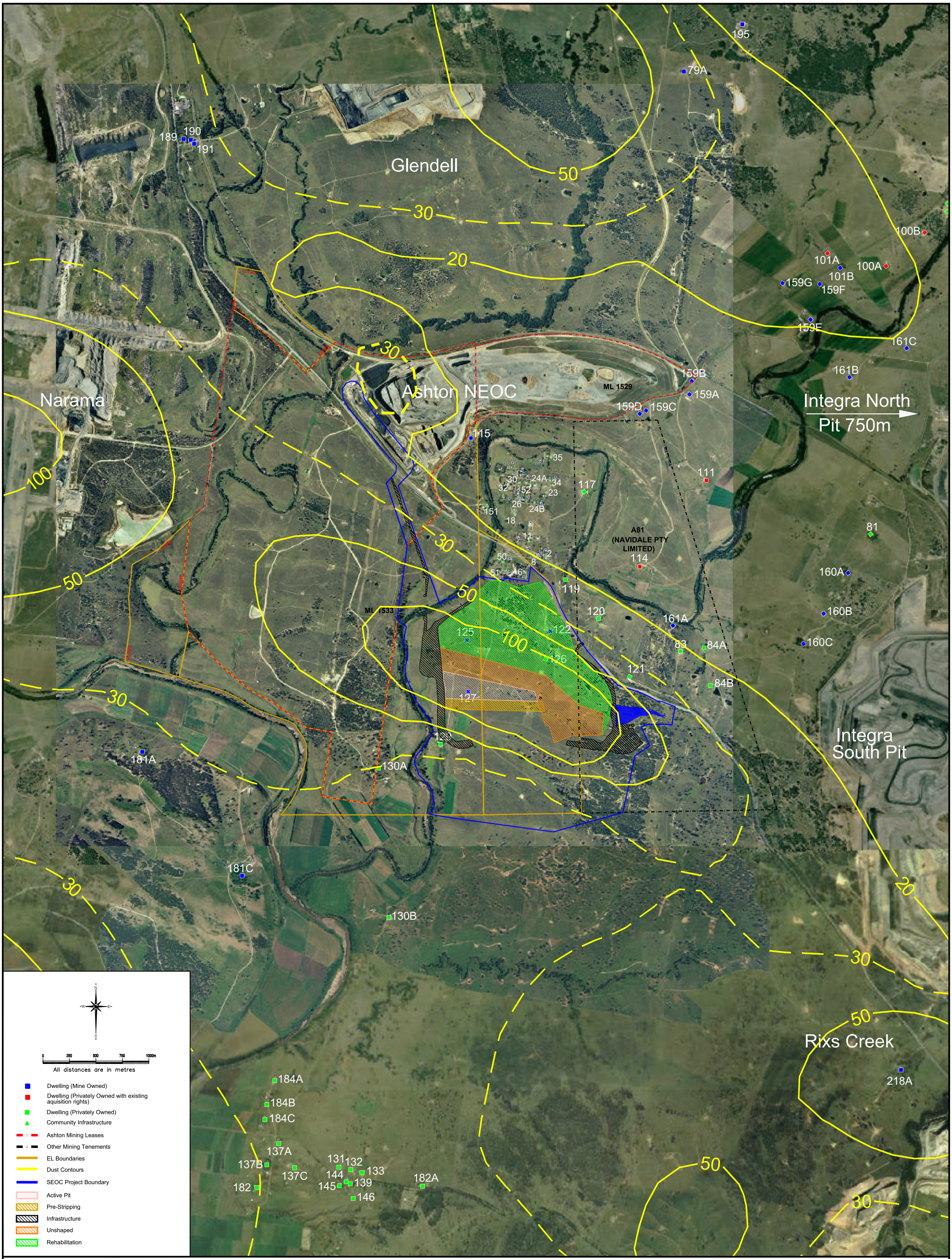
PAEHolmes

Figure 5.4

Plan 28

Prepared by Pegasus Technical

CAD FILE: 05025F.dwg



Prepared by Pegasus Technical

CAD FILE: 05026F.dwg

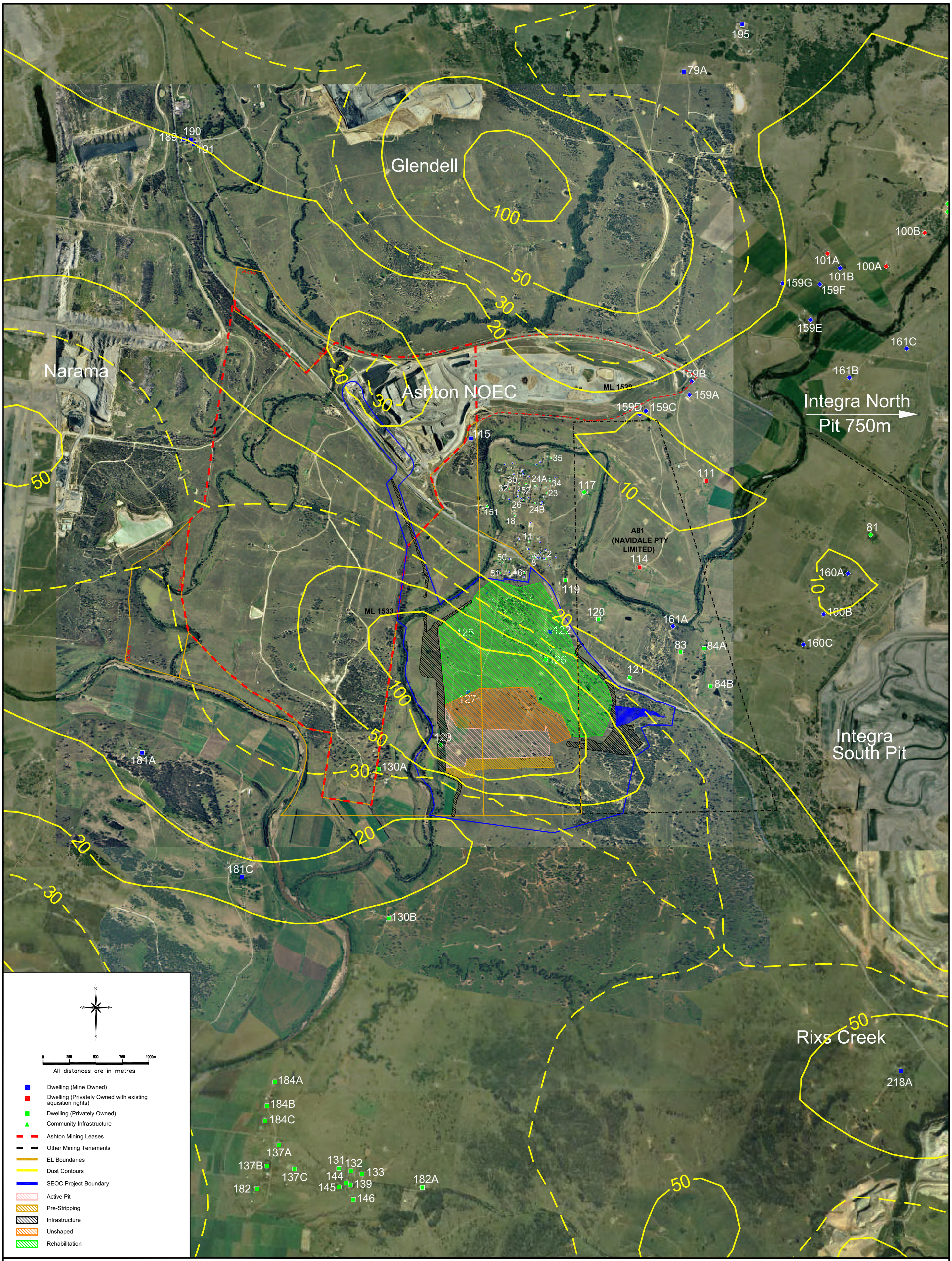
South East Open Cut Project

Year 3 - Predicted Cumulative Annual Average PM_{10} Emissions

PAEHolmes

Figure 5.5

Plan 29



AshtonCoal

South East Open Cut Project

Year 5 - Predicted Cumulative Annual Average PM_{10} Emissions

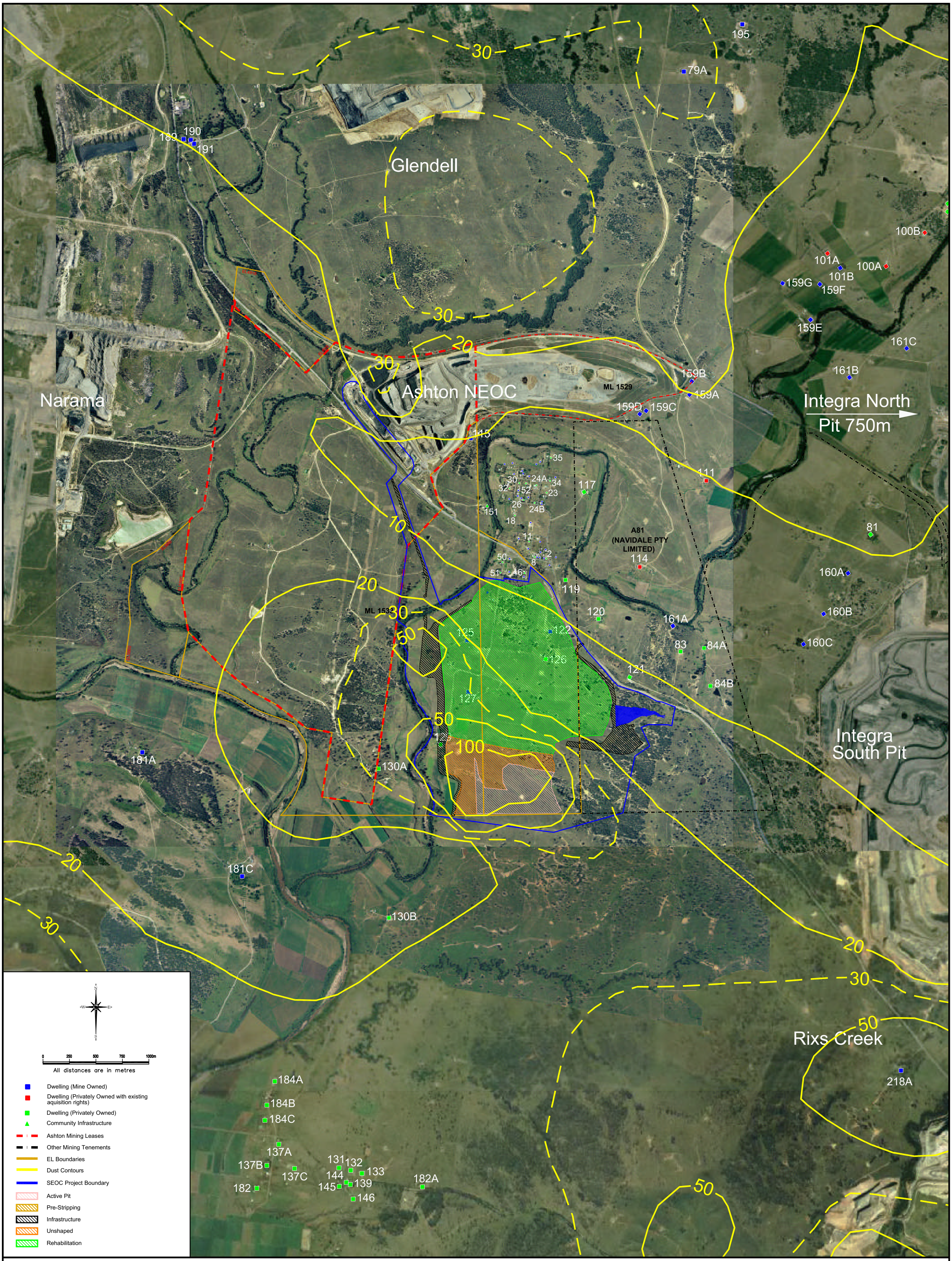
PAEHolmes

Figure 5.6

Plan 30

Prepared by Pegasus Technical

CAD FILE: 05027E.dwg



AshtonCoal

South East Open Cut Project

Year 7 - Predicted Cumulative Annual Average PM_{10} Emissions

PAEHolmes

Figure 5.7

Plan 31

Prepared by Pegasus Technical

CAD FILE: 05028F.dwg

Year 5

For Year 5 the following receptors are predicted to experience dust levels above criteria:

- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – no residences affected.
- Annual average PM_{10} above 30 μg/m^3 due to the Project and other mines and other sources – One private residences (130A – west of Glennies Creek). Refer to **Figure 5.6** for modelled contours.
- Annual average TSP above 90 μg/m^3 due to the Project and other mines and other sources – no residences affected.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – no residences affected.

Year 7

Year 7 is the final year of mining, with mining at the southern of the proposed pit limits, given the relative isolation of the mining the impacts to privately owned receptors (excluding 130A) are minimal.

For Year 7 the following receptors are predicted to experience dust levels above criteria:

- Annual average deposition above 2 g/m^2/month due to the Project considered in isolation – no residences affected
- Annual average PM_{10} above 30 μg/m^3 due to the Project and other mines and other sources – One private residence (130A – west of Glennies Creek). Refer to **Figure 5.7** for modelled contours.
- Annual average TSP above 90 μg/m^3 due to the Project and other mines and other sources – no residences affected.
- Annual average dust deposition above 4 g/m^2/month due to the Project and other mines and other sources – no residences affected.

5.5.4.2 24-hour PM_{10} Concentrations

Table 5.7 details receptors that are predicted to be impacted by PM_{10} 24-hour DECCW criteria of 50μg/m^3. Note that the DoP's criteria applies the same concentration value but allows 5 days of exceedance annually (i.e. applies a 98.6 percentile compliance level). Receptors in Table 5.7 predicted to experience PM_{10} 24-hour concentrations above 50 μg/m^3 for more than 5 days per year are shown in bold.

Thirteen (13) private residences are predicted to be impacted during the life of the mining operation for more than the DoP permitted 5 days per year. This is broken down as follows:

- Year 1 – 9 receptors.
- Year 3 – 11 receptors (8 of those were also impacted in Year 1).
- Year 5 – 11 receptors (1 additional receptor than Year 3).
- Year 7 – 1 receptor (accounted for in Year 5).

Table 5.7: Number of days 24-hour PM_{10} is predicted to exceed criteria due to the SEOC project alone at private residences.

Property No.	Owner and Location	Year 1	Year 3	Year 5	Year 7
		No. of days above criteria			
2	**Ninness – Camberwell village**	**13**	**9**	**8**	-
8	**Chisholm – Camberwell village**	**13**	**9**	**8**	-
11	**Richards – Camberwell village**	**7**	3	**7**	-
18	Turner – Camberwell village	1	1	5	-
23	Lopes – Camberwell village	-	-	3	-

Property No.	Owner and Location	Year 1	Year 3	Year 5	Year 7
		No. of days above criteria			
024A	Vollebreght & Clarke – Camberwell village	-	-	3	-
024B	Vollebreght & Clarke – Camberwell village	-	-	3	-
26	Schubert – Camberwell village	-	-	2	-
30	Bennett – Camberwell village	-	-	1	-
32	Stapleton – Camberwell village	-	-		-
34	Olofsson – Camberwell village	-	-	3	-
35	De Jong – Camberwell village	-	-	2	-
46	**Camberwell Community Hall – trustees (Nowland, Moore & Dunn)**	**54**	**13**	**10**	-
50	**Standing – Camberwell village – south of New England Hwy**	**57**	**9**	**7**	-
51	**Bailey – Camberwell village – south of New England Hwy**	**127**	**19**	**10**	-
52	Foord – Camberwell village	-	-	3	-
83	**Hall – Dulwich – Integra area.**	3	**14**	**9**	-
084A	**Tisdell – north east of SEOC**	-	**8**	4	-
084B	**Tisdell – north east of SEOC**	2	**13**	**9**	-
114[b]	Richards – north of SEOC and Glennies Creek	4	3	3	-
117	McInerney – east of Camberwell village	-	2	2	-
119	**Beasley – north of SEOC and New England Hwy**	**130**	**10**	**9**	-
120	**Ernst – north of SEOC and New England Hwy**	**29**	**15**	-	-
121	**Burgess – north-east of SEOC and New England Hwy**	**49**	**43**	**26**	-
129[c]	Bowman & Elder – Within the open cut footprint	-	-	-	-
130A	**Bowman – West of Glennies Creek**	-	3	**27**	**34**
151	St Clements Church - Trustees of Church Property-Diocese of Newcastle	2	2	2	-
187	Stapleton – south west of the SEOC, north of HVO South	-	-	1	-

Notes:
a. These residences have Acquisition Right agreements with Glendell Mine.
b. These residences have Acquisition Right agreements with Mt Owen Mine.
c. This residence would not exist by Year 5 due to mining.

5.5.4.3 Summary of Air Quality Impacts

Table 5.8 provides a summary of the cumulative air quality impacts during the SEOC mining life (represented by Years 1, 3 5 and 7) showing only those properties predicted to be exceeded the indicated project assessment criteria.

Table 5.8: Summary of predicted air quality concentrations for receptors predicted to experience an exceedance of DECCW impact assessment criteria.

Property Number	Landowner	PM_{10} (g/m³)		TSP (g/m³)	Dust deposition (g/m²/month)	
		24 hour	Annual	Annual	Annual	
		Project alone[a)]	Project & other sources	Project & other sources	Project alone	Project & other sources
		50	*30*	*90*	*2*	*4*
2	Ninness	Year 1, Year 3, Year 5	-	-	-	-
8	Chisholm	Year 1, Year 3, Year 5	-	-	-	-
11	Richards	Year 1, Year 5	-	-	-	-
18	Turner	-	-	-	-	-
23	Lopes	-	Year 1	-	-	-
024A	Vollebreght & Clarke	-	Year 1	-	-	-
024B	Vollebreght & Clarke	-	Year 1	-	-	-
26	Schubert	-	Year 1	-	-	-

Property Number	Landowner	PM10 (g/m³)		TSP (g/m³)	Dust deposition (g/m²/month)	
		24 hour	Annual	Annual	Annual	
		Project alone[a]	Project & other sources	Project & other sources	Project alone	Project & other sources
		50	30	90	2	4
30	Bennett	-	Year 1	-	-	-
32	Stapleton	-	Year 1	-	-	-
34	Olofsson	-	Year 1	-	-	-
35	De Jong	-	Year 1	-	-	Year 1
46	Camberwell Community Hall	Year 1, Year 3, Year 5	Year 1	-	-	-
50	Standing	Year 1, Year 3, Year 5	Year 1	-	-	-
51	Bailey	Year 1, Year 3, Year 5	Year 1	Year 1	Year 1	-
52	Foord	-	Year 1	-	-	-
83	Hall	Year 3, Year 5	-	-	-	-
084A	Tisdell	Year 3	-	-	-	-
084B[c]	Tisdell	Year 3, Year 5	-	-	-	-
117	McInerney	-	Year 1	-	-	-
119	Beasley	Year 1, Year 3, Year 5	Year 1	-	-	-
120	Ernst	Year 1, Year 3	Year 1	-	-	-
121	Burgess	Year 1, Year 3, Year 5	Year 1, Year 3	-	-	-
129	Bowman & Elder	-	Year 3	-	-	-
130A	Bowman	Year 5, Year 7	Year 5, Year 7	-	-	-

Note:

a. Only includes residences where the predicted concentrations exceed the 24-hour average PM_{10} impact assessment criteria on more than five days.

b. These residences have Acquisition Right agreement with Glendell Mine.

c. These residences have Acquisition Right agreements with Mt Owen Mine.

5.5.4.4 Findings of the Independent Review of Cumulative Impact (Air) on Camberwell Village

The DGR's sought an assessment of the findings of the Independent Review of Cumulative Impacts on the village of Camberwell with regard to noise and dust. At the time of preparing the EA report the findings of the Independent Review of Cumulative Impacts on Camberwell village have not been publicly released.

5.5.5 Management and Mitigation Measures

5.5.5.1 Existing Air Quality Management at the ACP

The ACP has developed and refined an Air Quality Management Plan (AQMP) for the existing operations. The AQMP is a reactive document that has been refined since the commencement of operations. The key aspects of the plan include:

- Sampling sites and procedures.
- Real time monitoring of air quality levels in Camberwell using TEOMs.
- Air quality response triggers to air quality measured in Camberwell that allow operational changes to prevent exceedances of DECCW criteria.
- Meteorological triggers to all that allow operational changes to prevent exceedances of DECCW criteria.
- Procedures for responding to complaints.
- Procedures for responding to measured exceedances.
- Reporting requirements.

5.5.5.2 Mine Design

The SEOC mine design has been undertaken with consideration to minimizing air quality impacts adopting best practice mine design. The following best practice design measures were incorporated:

- Largest practical truck size to minimise wheel generated dust from coal transport.
- Shortest route to minimise wheel generated dust.
- A coloured profiled steel cladding conveyor will be used to transport coal to the CHPP, thereby reducing dust that may have been otherwise generated by truck haulage.
- The undulating out of pit emplacement, while constricted to a south-east to north-west alignment, gullies and spurs minimise strong wind flows and smooth gradients to reduce surface turbulence and reduce consequential dust generation.
- Progressive rehabilitation as soon as practical after disturbance.

5.5.5.3 Dust Management

The following safeguards are those that have been incorporated into modelled dust controls proposed for the management of dust emissions from the SEOC project. The aim of these safeguards are to minimise the emission of dust and associated effects. Dust can be generated from two primary sources, these being:

- Windblown dust from exposed areas, refer to **Table 5.9** for control measures.
- Dust generated by mining activities, refer to **Table 5.10** for control measures.

Table 5.9: Best practice control procedures for wind-blown dust.

Source	Control Procedures
Areas disturbed by mining.	Disturb only the minimum area necessary for mining. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden tipping.
Coal handling areas / stockpiles.	Maintain coal handling areas / stockpiles in a moist condition using water carts to minimise wind-blown and traffic-generated dust.
ROM coal stockpiles.	Have available water sprays on ROM coal stockpiles and use sprays to reduce airborne dust, as required.

Table 5.10: Best practice control procedures for mine generated dust.

Source	Control procedures
Haul road dust.	All roads and trafficked areas will be watered as required using water trucks to minimise the generation of dust. All haul roads will have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large overburden emplacement areas. Obsolete roads will be ripped and re-vegetated.
Minor roads.	Development of minor roads will be limited and the locations of these will be clearly defined. Minor roads used regularly for access etc will be watered. Obsolete roads will be ripped and re-vegetated.
Topsoil stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil stockpiling.	Long term topsoil stockpiles, not used for over 3 months will be re-vegetated.
Drilling.	Dust aprons will be lowered during drilling. Drills will be equipped with dust extraction cyclones, or water injection systems. Water injection or dust suppression sprays will be used when high levels of dust are being generated.

Source	Control procedures
Blasting.	Meteorological conditions will be assessed prior to blasting. Adequate stemming will be used at all times.
Conveyors.	All conveyors will be covered and transfer points enclosed.
Real-time monitoring.	Real-time air quality monitoring will be used in locations predicted to be susceptible to exceedances of the 24-hour average PM_{10} goal. Remedial action will be taken should the 24-hour concentrations approach the cumulative assessment criteria of 150 µg/m^3.

5.6 Spontaneous Combustion

5.6.1 Spontaneous Combustion at the Existing ACP

Since the commencement of operations at the ACP there has been no recorded occurrence of spontaneous combustion.

In the initial investigations for the ACP an assessment of the propensity for coals seams encountered to spontaneous combust was undertaken and the following conclusions derived:

- An analysis of crossover temperatures from several samples recovered from (exploration bores) WML 26 and 35, revealed relative ignition temperatures in the range of 168 to 178 degrees Celsius.
- Where crossover temperatures are less than 130 degrees Celsius the coal is considered to be prone to self-heating.
- A “safe” coal is expected to have a crossover temperature in excess of 200 degrees.
- The results obtained from test-work imply that the coal has a moderate potential to spontaneously combust.”

Discussions with surrounding mines indicate that most of the coal seams nominated for mining do not exhibit a propensity for spontaneous combustion, but care needs to be taken with some of the splits of the Liddell seam when they are exposed or stockpiled for extended periods of time, such as 3 – 6 months.

ACOL have developed a Spontaneous Combustion Management Plan (SCMP) for the ACP that recognises that some coal seams have the propensity to spontaneous combust when exposed to air and have established measures to mitigate the potential for such an event to occur to ensure including effective management measures are in place should such an event actually occur.

5.6.2 Spontaneous Combustion at the SEOC

Mining within the SEOC will encounter the majority of the existing seams within the existing ACP, with the exception of the Hebden seam and its splits. Given the history of mining at the ACP with no occurrence of spontaneous combustion coal within the SEOC is expected to be of a similar nature.

The management of spontaneous combustion at the SEOC will be through the integration of the site with the existing ACOL SCMP. With these management measures in place spontaneous combustion is not expected to be a safety issue or adversely impact air qualities.

5.6.3 Management and Mitigation Measures

Management measures detailed within this section are from the existing ACP SCMP and will be applied at the SEOC.

5.6.3.1 General Requirements

All employees and production contractors are responsible for the detection of potential hazards on site, including the potential for incidents of heating associated with spontaneous combustion. All persons associated with production activities on site are to be given specific instruction during their induction training to be aware of issues relating to spontaneous combustion and are to be instructed to report any observations of smoke or heating to their supervisor.

ACOL will undertake daily inspections of the areas to ensure that incidents of heating are recognised at the earliest possible stage.

All reports of smoke or potential heating are to be immediately reported to the General Manager or designate.

5.6.3.2 Management of Oxidized Coal and other Coals within Overburden Dumps

ACOL will to inspect all sections of ROM coal before extraction to determine whether or not the coal is oxidized.

If coal is determined to be oxidized, ACOL will ensure that it is distributed within the overburden dump in such a manner as to prevent the outbreak of spontaneous combustion. As a minimum, the oxidized coal is to be track rolled and covered with inert material as soon as is reasonably practicable.

ACOL will ensure that any instances of uncovered oxidized coal are inspected during each working shift.

ACOL will manage spoil piles in order to prevent spontaneous combustion, as a failure to prevent or manage outbreaks in the early stage of development will lead to costly remediation having to be taken later. Factors that can help reduce the risk of self-heating include:

- Battering of spoil piles to reduce angles and increase compaction.
- Reducing dump and stockpile heights to reduce size segregation.
- Degree of surface compaction.
- Planning spoil dumps so that inert material is dumped over the top of carbonaceous materials.
- Increasing topsoil and hence soil organisms to increase oxygen uptake at the surface of spoil and thereby reduce oxygen ingress into the spoil.

5.6.3.3 Carbonaceous Materials Placed In Pit

Carbonaceous materials will only be placed against the high wall after the placement of an effective barrier of inert material against any exposed coal. Any carbonaceous materials placed in the in-pit dump are to be placed in accordance with the principles outlined above for oxidized coal.

5.6.3.4 4.5 Management of Coal in Stockpiles

ACOL will develop Stockpile Management Plans for both the ROM and product stockpiles that provides for the early reclamation of any coals with a propensity for spontaneous combustion.

ACOL will maintain records on the age of the coals stored in the stockpiles, including starting date, origin, type of coal, coal quality and reclaim date.

Coal identified as having a propensity for spontaneous combustion will be monitored during processing, and where stockpiled for a period exceeding six weeks, the General Manage (or his delegate) will be notified.

When a stockpile reaches the age of eight weeks, a program of monitoring will be undertaken. This monitoring will involve visual inspections of the aged coal stockpile on a daily basis, looking for heat haze, smoke emissions or an odour that could be associated with spontaneous combustion. If this monitoring detects indications of spontaneous combustion, the ACOL will insert thermocouples into the stockpile(s) to measure the internal temperature of the stockpile, with the following actions implemented depending on stockpile temperatures:

- < 50 deg C - continue observations, measure weekly.
- Between 50 & 70 deg C - continue daily observations, measure temperature daily.
- > 70 deg C Spontaneous combustion likely to be occurring. Take remedial action. Continue daily observations and temperature measurement if safe to do so.

5.6.3.5 Coarse Reject Material

Coarse reject material from the CHPP is to be disposed in the overburden dump in such a manner as to prevent large accumulations of reject material. Reject material will be covered with inert overburden as soon as reasonably practicable.

5.6.3.6 Outbreak of Spontaneous Combustion

Handling material that is self-heated can create dust levels that have the potential to create health, safety and environmental risks on the site. The following procedures will be adopted:

- Where possible, isolate the affected coal.
- If practical and safe to do so, dig out the affected coal, spread in layers 300mm thick, track roll and saturate with water to dissipate heat and dust.
- Watering of self-heated coals in stockpiles should be conducted with caution as water ingress increases segregation and heating, aids oxygen penetration and can increase the magnitude of the problem. As a general rule, water should only be used on flames and only in small amounts.
- When applying water it should be sprinkled rather than jetted on to the material.
- .All incidents of an outbreak of spontaneous combustion are to be reported to the General Manager or designate.

5.6.3.7 Emergency Response Plans

A Fire Control and Emergency System to control and manage any outbreak of fire that may occur within the SEOC or the CHPP will be developed.

5.7 Greenhouse Gas Emissions

ACOL engaged Holmes Air Sciences (now PAEHolmes) to undertake an assessment of the greenhouse gas (GHG) emissions generated by the SEOC. A copy of the report is contained in **Appendix 3**.

Under the Kyoto Protocol GHG emissions include the following:

- Carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous oxide (N_2O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulphur hexafluoride.

For the SEOC project only CO_2, CH_4 and N_2O are relevant. These emissions are generated from combustion of fuels and fugitive emissions released in the breakup of coal during the mining process.

The World Resource Institute and the World Business Council for Sustainable Development established the *Greenhouse Gas Protocol: a corporate accounting and reporting standard.* This sets operational boundaries for GHG emissions to ensure direct and indirect emissions are accounted for and are not "double" counted, especially within the framework of a trading system. The operational boundaries have been defined as:

- **Scope 1 direct GHG emissions** that occur from sources that are owned or controlled by the company, such as emissions generated company owned or controlled vehicles, or fugitive emissions from coal stockpiles.
- **Scope 2 electricity and indirect GHG emissions** account for the consumption of purchased electricity by the company, produced by another organisation. Scope 2 emissions result from the combustion of fuel to generate the electricity, and do not include emissions associated with the production of fuel.
- **Scope 3 other indirect GHG emissions** are from all other activities that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation. Scope 3 emissions include emissions generated by the production of materials or fuels purchased by the company or transportation of materials and fuels that are delivered by others, or use of products or services sold by the company to others.

5.7.1 Greenhouse Gas Assessment Method

CO_2-equivalent emissions from the Project would result from the following sources:

- The extraction and processing of the coal due to the combustion of diesel fuel (used in diesel-powered equipment, in blasting and to power the diesel generators).
- The transport of the product coal to The Port of Newcastle and the transport of the product coal overseas.
- The combustion of the product coal in power generating facilities.

To estimate CO_2-e (CO_2 equivalent) emissions from extraction of the coal, assumptions were made based on the Department of Climate Change (DCC) document *National Greenhouse Accounts (NGA) Factors 2008* for Scope 1, 2 and 3 emissions, these are:

- Each kWh of electrical energy used results in the release of 1.07 kg of CO_2.
- Each litre of diesel fuel burnt is assumed to result in the release of 2.9 kg of CO_2.
- Each tonne of explosive used is assumed to result in the release of 0.17 t of CO_2.
- Each tonne of open cut ROM coal mined results in the release of 2.17 kg of methane and that methane has a greenhouse warming potential of 21 (This means that each kilogram of methane, because of its lifetime in the atmosphere and its spectral absorption characteristics, is equivalent

to 21 kg of CO_2). Therefore, the CO_2-e emissions released for each tonne of ROM coal mined is equal to 45.0 kg.

5.7.2 Greenhouse Gas Emissions Estimates

The most significant gases for the SEOC are carbon dioxide (CO_2) and nitrous oxide (N_2O), which will be liberated when fuels are burnt in diesel powered equipment, and in the generation of electrical energy that will be used by the project. The SEOC project will also give rise to emissions of methane (CH_4) and CO_2 that are currently held or trapped in the coal in the open cut mines. The gases are released as fugitive emissions as the coal is mined.

Approximately 35.13Mt of Scope 1, 2 and 3 greenhouse gas emissions are estimated to be generated by the SEOC project during the 7 years of mining. This is broken down in **Table 5.11,** with Scope 1 and 2 emissions accounting for only 1.35Mt of the total emissions.

The estimated annual average Scope 1 and 2 emissions from the SEOC are 0.19Mt of CO_2 – e, with the total Scope 1, 2 and 3 greenhouse gas emissions estimated to be 5.02Mtpa of CO_2 – e.

Table 5.11: Summary of total estimated CO_2-e emissions all sources (Mt/y).

Year	Product coal (Mt)	CO_2-e Mining and extraction (Mt)		CO_2-e Transport of product coal (rail & sea) (Mt)	CO_2-e Usage of product coal (Mt)	CO_2-e Total (Mt)	
		Scope 1 & 2	Scope 3	Scope 3	Scope 3	Scope 1 & 2	Scope 3
1	1.83	0.19	0.006	0.28	4.84	0.19	5.13
2	2.15	0.22	0.006	0.33	5.67	0.22	6.01
3	1.78	0.20	0.006	0.28	4.70	0.20	4.99
4	1.89	0.21	0.006	0.29	4.98	0.21	5.28
5	1.85	0.22	0.006	0.29	4.88	0.22	5.18
6	1.85	0.21	0.006	0.29	4.88	0.21	5.17
7	0.72	0.11	0.005	0.11	1.90	0.11	2.02
Total	**12.06**	**1.35**	**0.04**	**1.87**	**31.86**	**1.35**	**33.77**
						TOTAL (Scope 1, 2 & 3) (Mt)	**35.13**
						Annual average (Mt/y)	**5.02**

5.7.3 Impacts and Conclusion on Greenhouse Gas Emissions

The annual average Scope 1 and Scope 2 emissions from the Project are 0.19 Mt per year. When compared with 2007 Scope 1 and Scope 2 emissions in Australia and NSW, this represents approximately:

- 0.3% of the annual greenhouse emissions of 69.5 Mt from mining in Australia (DCC, 2009b).
- 0.9% of the annual greenhouse emissions of 21.6 Mt from mining in NSW (DCC, 2009b).
- 0.03% of the total annual greenhouse emissions of 597.2 Mt in Australia (DCC, 2009c).
- 0.12% of the total annual greenhouse emissions of 162.7 Mt in NSW (DCC, 2009c).

Because the relationship between global warming and greenhouse gas concentrations is not linear (i.e. the warming effect of a given quantity of greenhouse gases to the atmosphere is less and less as the concentration become higher and higher), there is no accepted method to determine the contribution that a given emission of greenhouse gases might make to global warming, however an estimation can be made as follows (refer to Appendix 3 for further background on the science of Climate Change).

At any point in time, it would be reasonable simply to compare the estimated emission of CO_2-equivalent from the various activities with the estimated equivalent global emission from fuel burning of 29,195.42 Mtpa (IEA, 2009). On this basis, average annual emissions over the lifetime of the Project from the mining and burning of coal (including transportation) are estimated to be 0.02% of global CO_2-equivalent annual emissions from fuel burning. Thus, the Project could be considered to contribute 0.02% to the increase in global temperatures caused by the increase in greenhouse gas emissions as they are currently. This invites the question as to what temperature rise might be attributed to the GHG emissions from the Project.

Based on the Intergovernmental Panel on Climate Change (IPCC), which estimates that a doubling of the CO_2-equivalent concentration in the atmosphere would lead to a 2.5°C increase in global average temperature, and that the current global CO_2 load is approximately 3,000 Gt, we can estimate that the annual average emissions during the life of the SEOC Project (including mining, transporting the coal to the Port of Newcastle and overseas, and usage of the coal) would lead to an increase in global temperature of 0.000004 °C [(5.02 x 10^6/3,000 x 10^9) x 2.5°C]. Given this, it is clear that the project would comply with the principles of ESD.

In light of the principles of ecologically sustainable development it should be noted that if coal is not produced at the SEOC project, given the international and domestic demand for coal and the burning of coal on greenhouse gas emissions, should the SEOC not proceed, coal would be extracted at some place else (including other existing New South Wales or Australian mines) and have a similar potential impact. Accordingly, there is no substantial benefit, in respect of climate change in limiting or preventing coal production at SEOC.

Ultimately, the control of greenhouse gas emissions is likely to occur via economic instruments such as the Carbon Pollution Reduction Scheme, as outlined in the Australian Government green paper released in July 2008 (DCC, 2008a), and subsequent white Paper released in December 2008 (DCC, 2008b), which detail the design of a national emissions trading scheme.

The scheme will require businesses and industry to buy a 'pollution permit' for each tonne of carbon they contribute to the atmosphere, giving them a strong incentive to reduce pollution, encourage the development of carbon capture and sequestration, encourage the development of renewable forms of energy generation and improve the efficiency with which electricity is used. At the time of writing the emissions trading scheme had been delayed to July 2011, and the legislation has yet to be passed through Parliament.

5.7.4 Management and Mitigation Measures

Energy consumption is a significant cost in mining operations. Projects such as the SEOC can gain significant benefits through the incorporation of energy efficiency design that in turn result in less GHG emissions.

The SEOC has been designed to minimise greenhouse gas emissions and achieve minimum fuel consumption compatible with efficient operation of the mine and efficient use of capital. This has included:

- Avoidance of vegetation through the limiting of the open cut and positioning of facilities and clearing the minimum vegetation at anyone time increases available living vegetation for carbon sequestration.
- Preference for the mulching and reuse of vegetation in preference to burning, reduces GHG emissions that might be generated from burning timber.
- Utilisation of conveyors where possible in preference to truck haulage, conveyors operate on electricity with lower friction and wasted energy then truck haulage.
- Selection of the shortest possible route for truck haulage and conveyors.
- Matching equipment to the task to improve efficiencies.
- Progressive revegetation to a combination of pasture and woodland to improve carbon sequestration.
- Enhancement of other vegetation and additional plantings to improve carbon sequestration.
- Orientation and design of facilities to achieve maximum natural light in work areas.

The assessment of efficiency has also been undertaken in the selection of the design of the SEOC with numerous alternatives considered as detailed in *Section 7.2*.

While the SEOC project will utilise relocated machinery and some infrastructure from the existing ACP, opportunities to further minimise and mitigate greenhouse as emissions (above that gained from reusing existing equipment) may be reasonably and practicably achieved during construction of new facilities and upgrade of existing machinery or facilities through:

- Investigating the potential use of hybrid diesel/LNG engines for future replacement of mining fleet.
- Investigating of the potential use of biodiesel blends as an alternate fuel.
- Installing, using and monitoring payload information to ensure that maximum efficiency of the haulage trucks is consistently achieved.
- Ensuring operators are trained to understand the importance of energy efficiency and the use of specific equipment.
- Implementing a fuel monitoring and database management system to track diesel use for major equipment.
- Investigating the efficiencies of the specified transformers and look at cost/benefits of upgraded equipment.
- Specifying the use of energy efficiency equipment and ensuring that pumps are sized correctly in operational facilities.
- Where upgrading facilities, investigating the installation of heat pump hot water systems instead of standard electric hot water systems.
- Investigating the installation of heat pump air conditioning systems boosted by gas heaters instead of standard electric heaters and incorporating timers and/or control systems.
- Installing high efficiency lights with photo-sensors and timers.

5.8 Acoustic Environment

ACOL engaged Spectrum Acoustics to undertake an assessment of the impacts to the acoustic environment from the SEOC. A copy of the report is contained in **Appendix 4**.

Spectrum Acoustics (or its principals) have worked on the ACP since 1999, including the management, refinement and calibration of the acoustic model and attended monitoring. Modelling for the SEOC Project has utilised this experience.

5.8.1 Existing Acoustical Environment

ACOL currently have one real time noise monitor (a Sentinex monitor) installed within Camberwell village. The monitor has the functionality that allows some separation of mine noise from typical village sounds to help ACOL identify machinery that may be contributing to high noise levels. The monitor also continuously records noise.

In addition to the real time monitor ACOL monitor potentially impacted residential receptors on a quarterly basis in accordance with the ACP conditions of consent. Typically this equates to five (5) regular attended monitoring sites that are monitored by Spectrum Acoustics. Figure 5.1 shows the location of the noise monitoring sites.

5.8.1.1 Inversions

Significant temperature inversions have been identified in the area during numerous studies, with approximately 60-70% of the year recording a temperature inversion of greater than 3^0C per 100 metres. It should be noted that a percentage of these days have only small inversions of 1 or 2^0C/100m for a very short period of time (less than 0.5 hours).

A temperature inversion study was conducted on the ACP site during August/September 2006, with five Gemini data loggers placed at various locations on the site and in Camberwell village to cover a total altitude separation of 79m.

The tenth percentile inversion strength recorded in the sound propagation path between mining activities and Camberwell village was 4.7^0C/100m. This inversion strength was adopted in noise modelling for the SEOC.

Typical calm daytime conditions of no wind, 70% RH and -1^oC/100m vertical temperature gradient (ie, dry adiabatic lapse rate, DALR) was also modelled to represent daytime noise levels under calm conditions.

5.8.1.2 Ambient Noise Levels

Ambient noise levels within the village of Camberwell are influenced by the New England Highway to the south, the railway line to the northeast and mining operations to the north. To establish ambient noise levels and therefore establish criteria for the SEOC project, ambient noise monitoring was conducted at four receivers close to the project site during the period 12 to 18 August 2008.

The attended noise monitoring during August 2008 confirmed that the major contributing noise source at R120, R83 and R114 was the New England Highway. Noise from ACP was evident in Camberwell village at R24 (Clarke), suggesting that noise criteria cannot be uniformly established for all receptors in accordance with the Industrial Noise Policy (INP).

The results of the noise monitoring are expressed as L_{Aeq} (equivalent continuous noise level) and L_{A90} (the noise level which is exceeded for 90% of a given monitoring period). The L_{A90} percentile is called the background noise level. A summary of the noise levels used to establish noise criteria for the SEOC is shown in **Table 5.12**.

Table 5.12: Existing L_{Aeq} and L_{A90} (Rating Background levels, RBL) levels.

Location		L_{Aeq}, period			L_{A90}, period (RBL)		
		Day	Eve.	Night	Day	Eve.	Night
Camberwell (north)[1]	Traffic	41	37	38	38	38	36
	Other mines	31	31	38			
Camberwell (south)[2]	Traffic	44	44	39	40	39	36
	Other mines	34	34	40			
R83 – Hall[3]	Traffic	55	44	44	40	39	36
	Other mines	46	46	50			
R111 – Richards[3]	Traffic	N/A	N/A	N/A	38	38	36
	Other mines	40	41	45			
R114 – Richards[3]	Traffic	52	49	46	38	38	36
	Other mines	39	40	44			
R120 – Ernst[4]	Traffic	48	46	42	41	43	39
	Other mines	38	39	43			
South of SEOC	Traffic	N/A	N/A	N/A	32	32	32
	Other mines	37	37	37			

1. *Residences in Camberwell (north) are R35, R117, R34, R22, R23, R24 and R52.*
2. *Camberwell (south) residences are R32, R18, R11, R12, R8, R2 and R50. Acoustically Similar to R83 in terms of RBL and traffic L_{Aeq}.*
3. These properties are subject to acquisition in the Glendell Coal Mine consent.

5.8.2 Noise Criteria

The INP specifies two noise criteria: an *intrusiveness criterion* which limits Leq noise levels from the industrial source to a value of 'background plus 5dB' and an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed. DECCW recommended industrial noise levels (ANL's and maxima, as presented in Table 2.1 of the INP). These values, and the measured existing traffic and industrial noise levels, are used to establish the amenity criteria by applying corrections to the recommended levels. Full details of this are available in Appendix 4.

Intrusiveness and amenity criteria established in accordance with the INP are detailed within **Table 5.13** below for both the construction and operational phases of the project.

Table 5.13: Intrusiveness and amenity criteria for the SEOC project at private residences.

Receiver	Intrusiveness criteria dB(A),$L_{eq(15minute)}$			Amenity criteria dB(A),$L_{eq(period)}$		
	Day	Evening	Night	Day	Evening	Night
R35 De Jong	43	43	41	55	50	45
R117 McInerney	43	43	41	55	50	45
R34 Olofsson	43	43	41	55	50	45
R23 Lopes	43	43	41	55	50	45
R24 Clarke	43	43	41	55	50	45
R52 Foord	43	43	41	55	50	45
R30 Bennett	43	43	41	50	45	40
R32 Stapleton	45	44	41	55	50	43
R22 Robertson	43	43	41	55	50	45
R18 Turner	45	44	41	55	50	43
R11 Richards	45	44	41	55	50	43
R8 Chisholm	45	44	41	55	50	43
R2 Ninness	45	44	41	55	50	43
R50 Standing	45	44	41	55	50	43

Receiver	Intrusiveness criteria dB(A),$L_{eq(15minute)}$			Amenity criteria dB(A),$L_{eq(period)}$		
	Day	Evening	Night	Day	Evening	Night
R119 Beasley	46	48	44	55	50	41
R120 Ernst	46	48	44	55	50	41
R121 Burgess	46	48	44	55	50	41
R83 Hall	45	44	41	55	48	40
R84 Tisdell	45	44	41	55	48	40
R114 Richards	43	43	41	55	50	39
R111 Richards	43	43	41	55	50	37
R129 Bowman	37	37	37	50	45	37
R130A Bowman	37	37	37	50	45	37
R130B Bowman	37	37	37	50	45	37
R184A Moxey	37	37	37	50	45	37

5.8.3 Noise Assessment Method

Spectrum Acoustics created a noise model for the project using RTA Technology's Environmental Noise Model (ENM) v3.06. All major noise producing items and plant were modelled at their known or most exposed positions for Year 1, Year 3, Year 5 and Year 7. Using sound levels and source heights for different plant items, noise contours and / or point calculations were generated for the area surrounding the SEOC project.

Adopted noise levels for the key pieces of infrastructure are shown in **Table 5.14**. Equipment will be assessed during operations to ensure that sound power levels are similar to those shown to ensure the model remains representative of actual noise levels produced.

Table 5.14: Sound power levels of key pieces of equipment.

Operational noise source	Sound power level, dB(A)		Source Height, m
	Leq(15 min)	Lmax	
Loading empty coal wagons	101	116	3
3 x loco's idling on loop	105	111	3
Trucks at ROM hopper	115	125	3
Primary crusher	114	118	5
Dozer on dump	115	130	2
Overburden drill	114	116	1
O/B excavator (e.g. 996)	116	125	5
Coal excavator (e.g. R9350)	115	122	5
Overburden dump (per pit)*	115	125	3
Overburden haul (on slope)*	115	123	3
Overburden haul (on flat)*	113	121	3
Coal haul (from pit to processing area)*	111	120	3
Transfer station	115	118	15
Coal washery	116	118	15
Conveyors (per 100m)	96	N/A	2-10
Ventilation fan (enclosed)	102	102	5
Personnel carrier	110	115	1
Stacker/reclaimers (each)	105	N/A	10

Modelling was conducted for the following atmospheric conditions:

- Daytime calm "Neutral" – Air temperature 20°C, 70% relative humidity (RH), no wind, -1°/100m vertical temperature gradient (dry adiabatic lapse rate).

- Inversion – Air temperature 5°C, 70% RH + 4.7°C/100m vertical temperature gradient.
- Prevailing summer/ autumn and spring winds including:
  - "NE wind" – Air temperature 20°, 70% RH, 3m/s wind from the north east.
  - "ESE wind" – Air temperature 20°, 70% RH, 3m/s wind from the east south-east.
  - "S wind" – Air temperature 20°, 70% RH, 3m/s wind from the south.
- Prevailing winter winds including:
  - "WSW wind" – Air temperature 20°, 70% RH, 3m/s wind from the west-south-west.
  - "N wind" – Air temperature 20°, 70% RH, 3m/s wind from the north.

Noise models were generated for operational scenarios in Year 1, 3, 5 and 7 for each of the seven (7) atmospheric conditions outlined above.

The following scenarios are considered to be the worst cases in terms of noise generation and potential impacts for each year of operations:

- Year 1 with a "WSW wind"
- Year 3 with a "WSW wind"
- Year 5 with an inversion.
- Year 7 with an inversion.

Accordingly model contours for these scenarios are included as **Figure 5.8**, **Figure 5.9, Figure 5.10,** and **Figure 5.11**, modelled contours for all other scenarios are included in Appendix 4.

5.8.4 Noise Impacts

5.8.4.1 Modification to Existing ACP

The proposed modifications to the existing ACP are not expected to result in a significant change in acoustic levels from the extraction or processing of the material given the existing infrastructure is in place and requires little modification. Additional trains required for the transportation of product coal are considered in *Section 5.8.6.3*.

5.8.4.2 SEOC Construction

The impact to privately owned receptors from the construction of the SEOC will be similar to that predicted for year 1 of operations as detailed below. No specific construction criteria are proposed, as such all construction activities will be assessed under the adopted operational criteria.

5.8.4.3 SEOC Operations

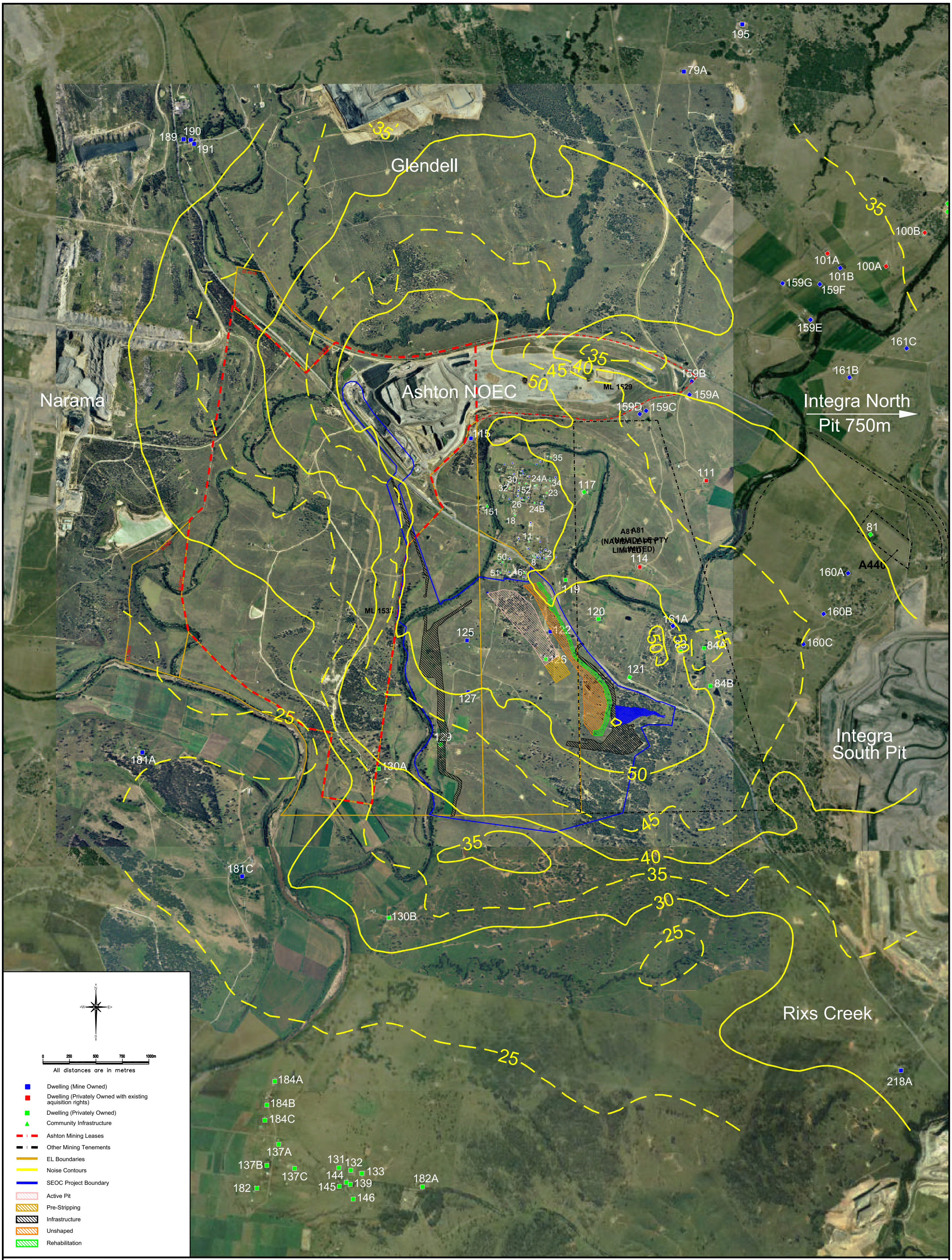
The predicted operational noise levels using the ENM point calculation mode are presented below for each year and all modelled operational and meteorological scenarios.

Items shown in **bold** represent receivers that may experience exceedances above the most sensitive night time criterion, whilst those shaded in grey and bold represent a substantial exceedance (>5dB or more). Those receivers denoted with by hash "#" have acquisition rights under existing development consents/ project approvals.

Year 1

For the majority of receivers the inversion and west-south-west winds are the worst conditions in Year 1 as the environmental emplacement is constructed and mining commences. In summary, in the first year of the SEOC the following modelling predictions were formed:

- Major (5dB or more) exceedances of the noise criteria have been predicted at all receivers except, R84 (Tisdell), R111 (Richards) and R184A (Moxey). Hence all receivers except these three (3) are within a noise acquisition zone. Given the magnitude of exceedances (generally



AshtonCoal

South East Open Cut Project

Year 1 - Predicted Noise Contours - LAeq(15 minute) - West-South-West Wind

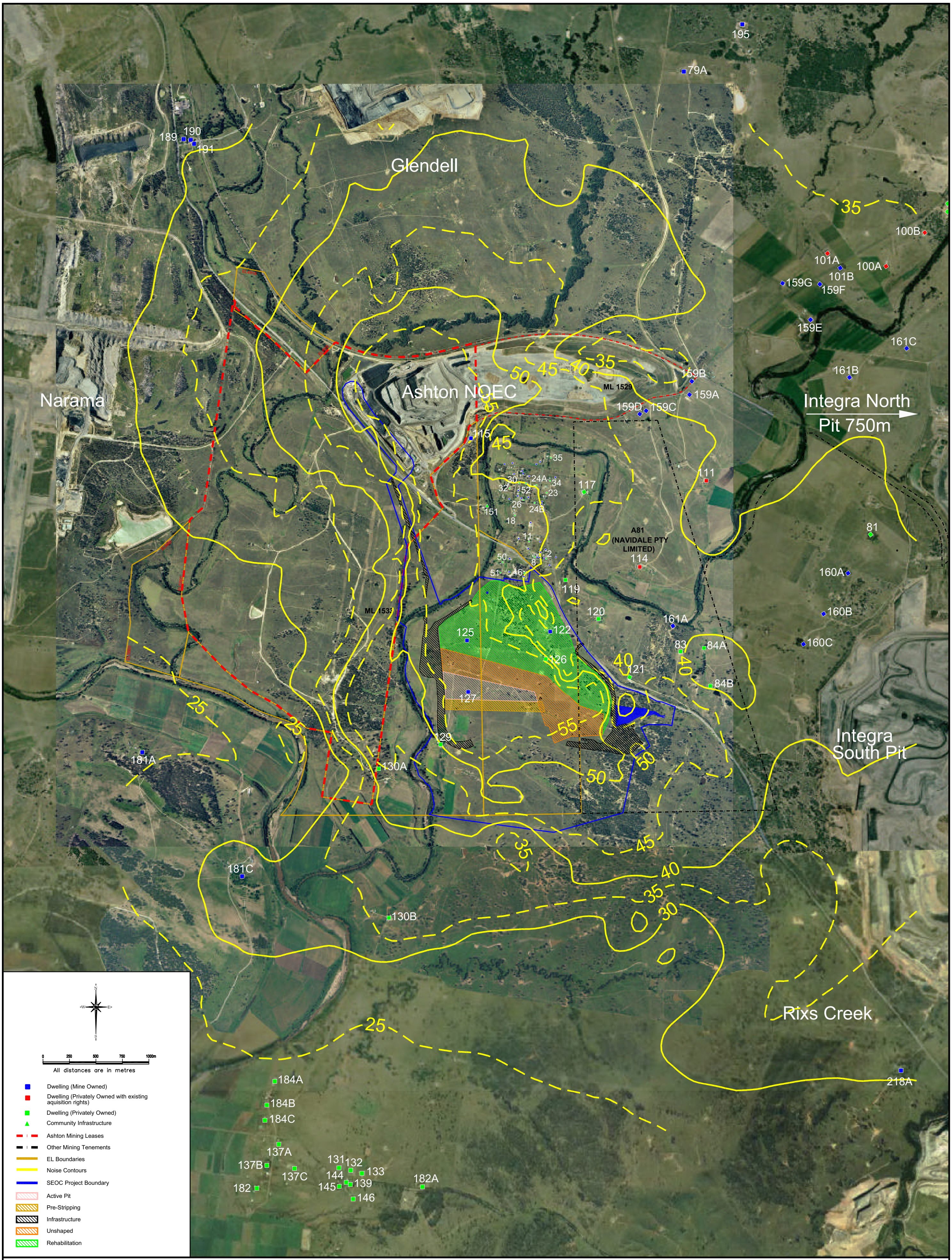
Spectrum Acoustics

Figure 5.8

Plan 32

Prepared by Pegasus Technical

CAD FILE: 05029E.dwg



AshtonCoal

South East Open Cut Project

Year 3 - Predicted Noise Contours - LAeq(15 minute) - West-South-West Wind

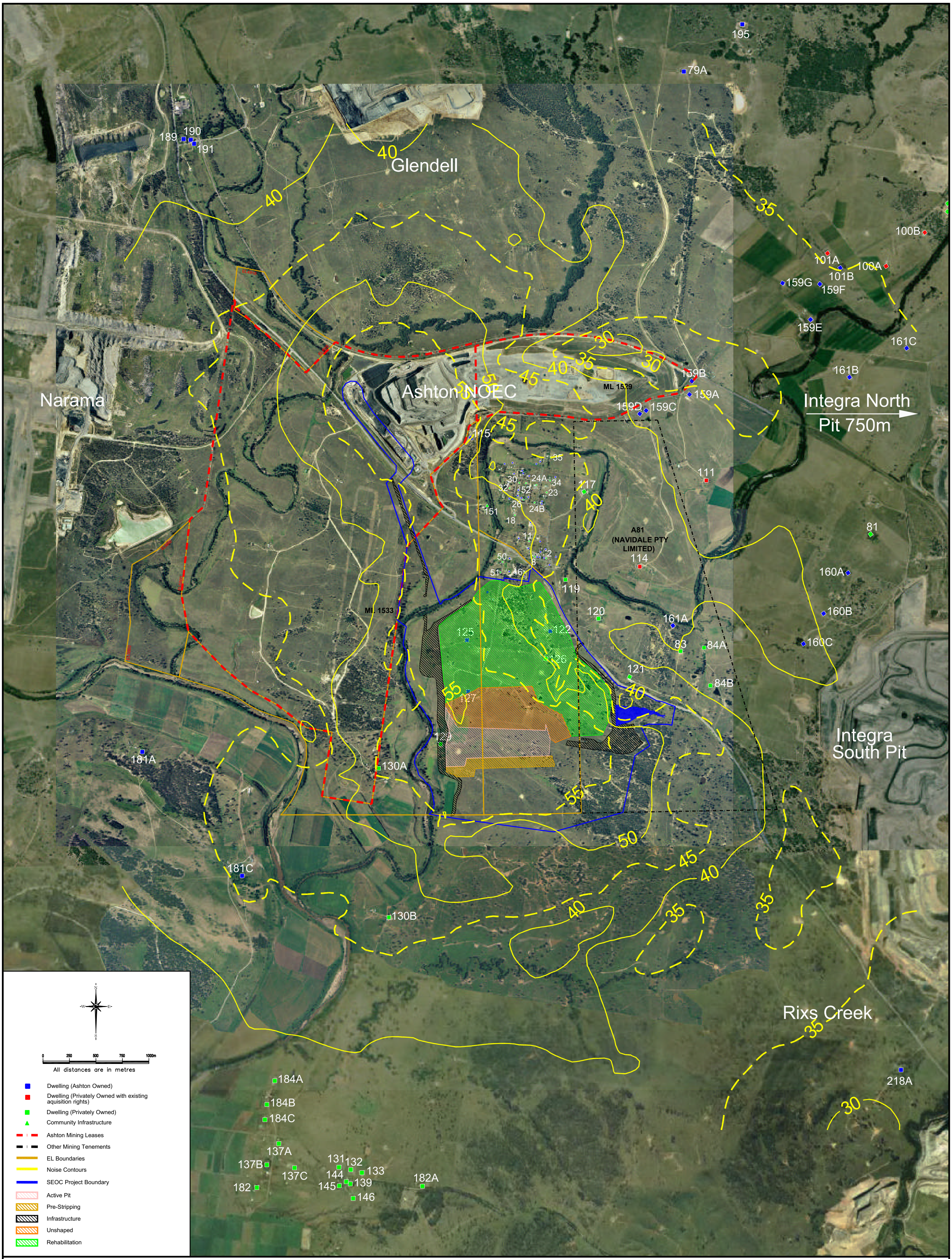
Spectrum Acoustics

Figure 5.9

Plan 33

Prepared by Pegasus Technical

CAD FILE: 05030E.dwg



AshtonCoal

South East Open Cut Project

Year 5 - Predicted Noise Contours - LAeq(15 minute) - Inversion Wind

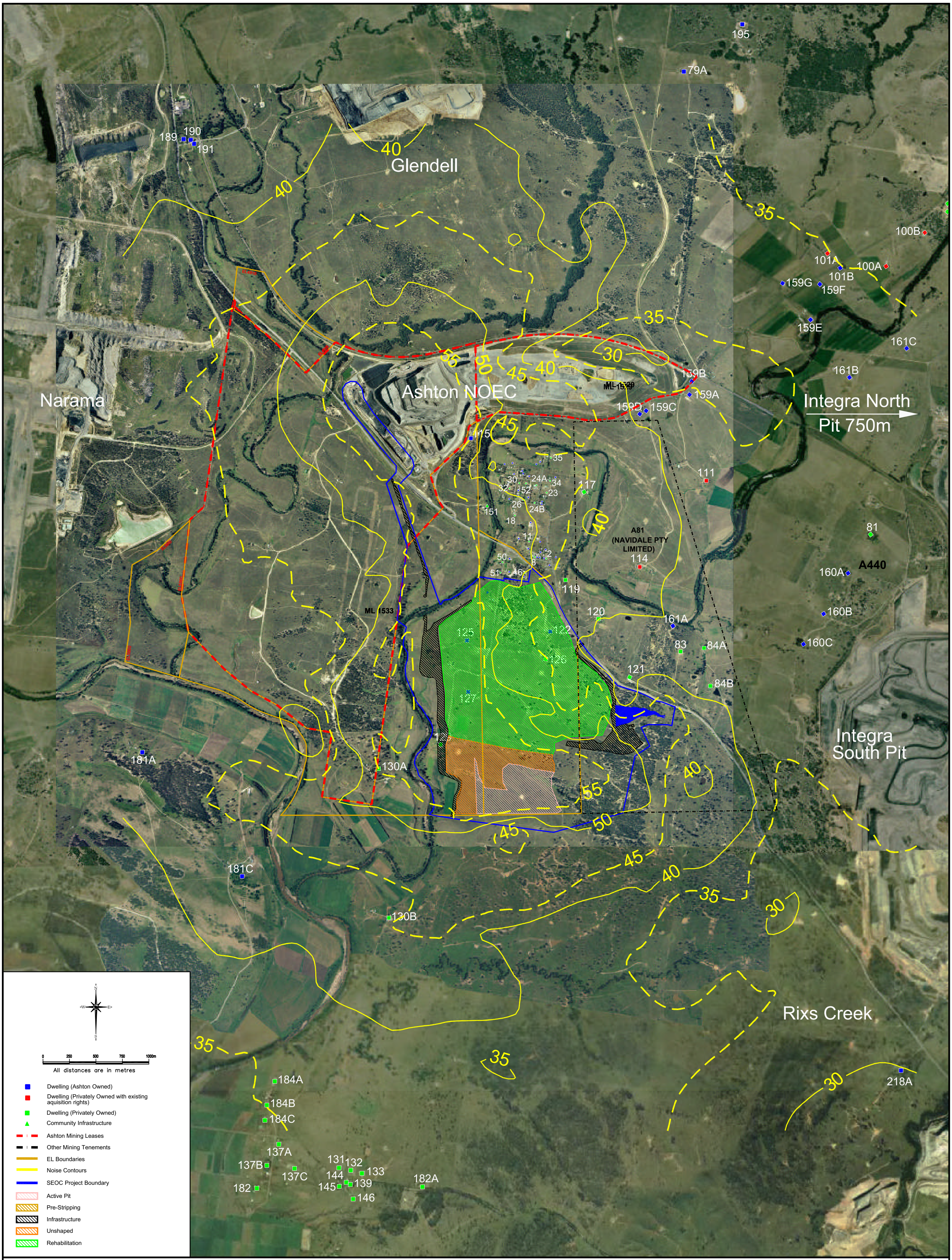
Spectrum Acoustics

Figure 5.10

Plan 34

Prepared by Pegasus Technical

CAD FILE: 05031E.dwg



AshtonCoal

South East Open Cut Project

Year 7 - Predicted Noise Contours - LAeq(15 minute) - Inversion Wind

Spectrum Acoustics

Figure 5.11

Plan 35

Prepared by Pegasus Technical

CAD FILE: 05032E.dwg

- 10dB or more), options for effective noise control of mobile plant to lower than achievable with current best practice technology cannot be recommended.
- Predicted exceedances from 1dB to 4dB at R84 (Tisdell) and R111 (Richards) place these receivers in a management zone.
- No exceedances are predicted at R184A (Moxey).
- Predicted 1-4 dB exceedances at St Clement's Church

Table 5.15 details the results of the acoustic modelling for Year 1 under all conditions.

Table 5.15: Predicted Year 1 noise levels.

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
35	37	**47**	37	35	40	**46**	**48**	41
117	38	**47**	37	35	40	**45**	**48**	41
34	38	**48**	38	35	40	**46**	**49**	41
23	39	**49**	40	36	**42**	**47**	**50**	41
24	40	**50**	40	36	**42**	**49**	**50**	41
52	**41**	**50**	41	38	**44**	**50**	**51**	41
30	**45**	**52**	**45**	41	**47**	**52**	**52**	41
32	**45**	**52**	**45**	41	**47**	**52**	**52**	41
26	41	**50**	42	39	**47**	**49**	**51**	41
151	49	**53**	50	46	**51**	**54**	**54**	50
18	**45**	**52**	**48**	**44**	**48**	**52**	**50**	41
11	**45**	**52**	**47**	**44**	**48**	**50**	**50**	41
8	**45**	**52**	**47**	**44**	**48**	**50**	**50**	41
2	**45**	**52**	**46**	**44**	**48**	**50**	**50**	41
50	**51**	**53**	**51**	**51**	**51**	**53**	**52**	41
51	**51**	**53**	**51**	**51**	**51**	**53**	**52**	41
119	**45**	**51**	**45**	44	**50**	**51**	**50**	44
120	**48**	**52**	**47**	**45**	**50**	**52**	**53**	44
121	**50**	**51**	**50**	**45**	**50**	**50**	**53**	44
83#	39	**45**	40	35	35	40	**50**	41
84#	34	40	35	29	29	35	**45**	41
114#	**43**	**50**	41	39	**45**	**50**	**49**	41
111#	30	**42**	29	25	30	40	**43**	41
129	**45**	**51**	**52**	**52**	**46**	**42**	**44**	37
130A	**40**	**50**	**50**	**50**	**45**	**40**	**40**	37
130B	33	**44**	**45**	**43**	35	30	31	37
184A	24	36	36	33	28	20	23	37
# Acquisition rights under existing development consents/ Project Approvals								

Year 3

For the majority of receivers the inversion and west-south-west winds represent the worst meteorological conditions for Year 3. Impacts to the majority of receivers north of the SEOC have reduced as the SEOC progresses south. The following modelling predictions were formed:

- Major (5dB or more) exceedances of the noise criteria have been predicted at all receivers within Camberwell village and at R129 (Bowman), R130A (Bowman) and R130B (Bowman).
- Predicted exceedances from 1dB to 4dB at R117 (McInerney), R114 (Richards), and R121 (Burgess) place these receivers in a management zone for Year 3, although these three receivers are included within the Year 1 acquisition zone. place these receivers in a management zone.

- A minor 1dB exceedance is predicted at R184A (Moxey).

Table 5.16 details the results of the acoustic modelling for Year 3 under all conditions.

Table 5.16: Predicted Year 3 noise levels.

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
35	35	**45**	35	30	32	40	**47**	41
117	30	**43**	35	28	28	35	**45**	41
34	35	**45**	36	31	31	40	**46**	41
23	35	**45**	39	31	31	40	**46**	41
24	37	**47**	39	33	34	**43**	**48**	41
52	39	**47**	40	35	36	**45**	**49**	41
30	**42**	**49**	**43**	39	40	**47**	**51**	41
32	**42**	**49**	**43**	39	40	**47**	**51**	41
26	35	**45**	40	32	32	40	**47**	41
151	45	**52**	48	46	47	49	**53**	50
18	40	**50**	**46**	39	39	**45**	**51**	41
11	40	**48**	**46**	40	37	**42**	**50**	41
8	40	**47**	**45**	40	36	41	**49**	41
2	38	**46**	**45**	38	35	40	**45**	41
50	**47**	**52**	**50**	**45**	**47**	**47**	**52**	41
51	**47**	**52**	**50**	**45**	**47**	**47**	**52**	41
119	31	44	40	30	29	34	41	44
120	32	43	40	30	29	34	42	44
121	33	42	38	32	30	35	**45**	44
83	28	39	35	27	25	30	41	41
84	27	37	35	25	24	29	39	41
114	28	**42**	38	28	28	33	**43**	41
111	25	37	27	22	23	33	40	41
129	**55**	**56**	**56**	**57**	**55**	**54**	**53**	37
130A	**45**	**53**	**51**	**50**	**50**	**40**	**44**	37
130B	36	**45**	**47**	**45**	37	33	38	37
184A	24	37	**38**	35	27	20	23	37

Year 5

In summary at Year 5 of the SEOC the following modelling predictions were formed:

- Major (5dB or more) exceedances of the noise criteria have been predicted at all receivers within Camberwell village and at R129 (Bowman), R130A (Bowman) and R130B (Bowman).
- Predicted exceedances from 1dB to 4dB at R114 (Richards), and R121 (Burgess) place these receivers in a management zone for Year 5, although both receivers are in the acquisition zone for previous years.
- A minor 1dB exceedance is predicted at R184A (Moxey).

Table 5.17 details the results of the acoustic modelling for Year 5 under all conditions.

Table 5.17: Predicted Year 5 noise levels.

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
35	35	**45**	35	30	32	41	**47**	41
117	30	**43**	34	28	28	37	**46**	41
34	35	**45**	35	31	31	40	**47**	41

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
23	35	**45**	36	31	31	40	**46**	41
24	37	**46**	38	34	34	**43**	**48**	41
52	39	**47**	40	35	35	**45**	**49**	41
30	**42**	**49**	**42**	39	40	**47**	**51**	41
32	**42**	**49**	**42**	39	40	**47**	**51**	41
26	35	**45**	40	32	32	40	**47**	41
151	45	**52**	46	42	43	50	**53**	50
18	40	**50**	**45**	40	39	**45**	**51**	41
11	40	**47**	**45**	40	37	**42**	**50**	41
8	40	**46**	**45**	40	36	41	**49**	41
2	36	**45**	**42**	36	35	40	**46**	41
50	**47**	**52**	**49**	**45**	**44**	**48**	**52**	41
51	**47**	**52**	**49**	**45**	**44**	**48**	**52**	41
119	30	43	40	30	29	33	41	44
120	30	43	39	30	29	33	40	44
121	33	41	35	31	30	36	**45**	44
83	28	40	35	27	25	32	41	41
84	27	38	34	25	24	29	40	41
114	29	**42**	36	28	27	34	**45**	41
111	25	38	25	24	24	33	40	41
129	**54**	**>55**	**55**	**>55**	**>55**	**>55**	**55**	37
130A	**46**	**55**	**50**	**55**	**55**	**46**	**45**	37
130B	37	**48**	**47**	**49**	**41**	35	**41**	37
184A	25	**38**	36	37	30	23	24	37

Year 7

In summary at Year 7 of the SEOC the following modelling predictions were formed:

- Major (5dB or more) exceedances of the noise criteria have been predicted at all receivers within Camberwell village and at R129 (Bowman), R130A (Bowman) and R130B (Bowman).
- Predicted exceedances of 3dB at R114 (Richards) places this receiver in a management zone, although this receiver is included in the acquisition zone for previous years.
- No exceedances are predicted at R184A (Moxey).

Table 5.18 details the results of the acoustic modelling for Year 7 under all conditions.

Table 5.18: Predicted Year 7 noise levels.

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
35	35	**45**	35	30	32	40	**47**	41
117	30	**42**	34	29	28	36	**46**	41
34	35	**45**	36	31	31	40	**47**	41
23	35	**45**	37	31	31	40	**47**	41
24	37	**47**	39	34	34	**43**	**48**	41
52	39	**48**	40	35	36	**45**	**50**	41
30	**42**	**49**	**43**	39	40	**47**	**51**	41
32	**42**	**49**	**43**	39	40	**47**	**51**	41
22	35	**45**	40	32	31	40	**47**	41
18	40	**50**	**46**	40	39	**45**	**51**	41
11	40	**48**	**46**	40	37	**42**	**50**	41

Receiver	Predicted intrusive noise level dB(A),$L_{eq(15min)}$							Criteria
	Neut	Inv	Winds					
			N	NE	ESE	S	WSW	
8	40	**47**	**46**	39	36	41	**48**	41
2	36	**45**	**45**	36	34	39	**46**	41
50	**46**	**52**	**50**	**45**	**43**	**48**	**52**	41
119	30	43	40	30	29	34	41	44
120	30	40	40	30	29	33	39	44
121	32	40	37	30	29	35	40	44
83	29	38	35	26	25	30	40	41
84	27	36	34	25	24	28	38	41
114	29	42	38	28	27	34	**44**	41
111	25	37	32	23	23	33	39	41
129	**>55**	**>55**	**>55**	**>55**	**>55**	**>55**	**55**	37
130A	**46**	**55**	**50**	**55**	**55**	**47**	**45**	37
130B	36	**45**	**47**	**45**	38	32	35	37
184A	23	35	37	34	25	<20	22	37

5.8.4.4 Summary of Noise Impacts from Mining

Noise levels above the project specific criteria are summarised in **Table 5.19.**

Table 5.19: Summary of the predicted noise levels from the SEOC project.

Receiver	Management zone		Acquisition zone 5 dB or more (major)
	1 or 2dB (minor)	3 or 4dB (moderate)	
R35 De Jong			Years 1, 3, 5 and 7
R117 McInerney		Year 3	Years 1, 5 and 7
R34 Olofsson			Years 1, 3, 5 and 7
R23 Lopes			Years 1, 3, 5 and 7
R24 Clarke			Years 1, 3, 5 and 7
R52 Foord			Years 1, 3, 5 and 7
R30 Bennett			Years 1, 3, 5 and 7
R32 Stapleton			Years 1, 3, 5 and 7
R26 Schubert			Years 1, 3, 5 and 7
R18 Turner			Years 1, 3, 5 and 7
R11 Richards			Years 1, 3, 5 and 7
R8 Chisholm			Years 1, 3, 5 and 7
R2 Ninness			Years 1, 3, 5 and 7
R50 Standing			Years 1, 3, 5 and 7
R51 Bailey			Years 1, 3, 5 and 7
R119 Beasley			Year 1
R120 Ernst			Year 1
R121 Burgess	Years 3 and 5		Year 1
R83 Hall			Year 1
R84 Tisdell		Year 1	
R114 Richards	Year 3	Year 5	Year 1
R111 Richards	Year 1		
R129 Bowman			Years 1, 3, 5 and 7
R130A Bowman			Years 1, 3, 5 and 7
R130B Bowman			Years 1, 3, 5 and 7
R184A Moxey	Years 3 and 5		

5.8.5 Sleep Disturbance

Potential for sleep disturbance will be considered at receivers not included in the operational noise acquisition zone. Sleep disturbance criteria for receivers identified within management zones are:

- R111 (Richards) 51 dB(A),Lmax
- R84 (Tisdell) 51 dB(A),Lmax
- R184 (Moxey) 47 dB(A),Lmax

5.8.5.1 Sleep Disturbance Assessment Methodology

An assessment of L_{max} levels has been conducted as follows:

- Determine the worst case noise impacts at the three receivers for Year 1 (worst case at R84 and R111) and Year 5 (worst case at R184);
- Review the source ranking files and note down the five largest individual LAeq contributions; and
- Add the difference between LAeq and LAmax sound power level (Lw) from Table 5.13 to each of the ranked LAeq levels at the receivers.

5.8.5.2 Predicted Maximum Noise Levels

Estimated L_{Amax} noise levels for assessment of potential sleep disturbance impacts are summarised in **Table 5.20**.

Table 5.20: Estimated L_{max} noise levels for assessment of potential sleep disturbance impacts.

Receiver	Top 5 sources (dB(A),L_{eq})	Source L_w (L_{max} - L_{Aeq})	Est. L_{max} at receiver	L_{max} Criterion
R111 Richards Year 1 WSW wind	Dozer on dump (36.8)	13	50	51
	Dump on bund (36.7)	6	43	
	O/B Truck 1 (36.5)	5	42	
	O/B Truck 2 (35.9)	5	41	
	Conveyor (33.4)	N/A	33	
Received L_{Aeq}	43			
R84 Tisdell Year 1 WSW wind	O/B Truck 1 (38.4)	5	43	51
	Dump on bund (38.0)	6	44	
	Dozer on dump (37.8)	13	51	
	O/B Truck 2 (35.9)	5	41	
	Conveyor (34.5)	N/A	35	
Received L_{Aeq}	45			
R184A Moxey Year 5 Inversion	Dozer clearing (30.8)	3	34	47
	Loader clearing (30.7)	3	34	
	O/B Dump 1 (27.6)	6	34	
	Dozer on dump 1 (27.2)	13	40	
	Dozer on dump 1 (26.6)	13	40	
Received L_{Aeq}	38			

Results in Table 5.20 suggest that maximum noise levels from dozers operating at high level on overburden dumping areas may approach or equal the sleep disturbance criterion at R84 and R111. Since the sleep disturbance criteria are recommended by DECCW as the first step in assessing potential sleep disturbance and, as they are not exceeded, no further assessment is required.

5.8.6 Cumulative Mining Noise Levels

As with the assessment of potential sleep disturbance, cumulative mining noise impacts will only be considered at receivers R84, R111 and R184A. All other receivers have predicted noise levels from the SEOC of 10 dB or more above the intrusive noise criteria and additional noise from existing approved mining operations is unlikely to raise these levels significantly. This is confirmed by predicted SEOC noise levels in the order of 46-52 dB(A) in Camberwell village and existing non-ACP mining noise levels of 31-34 dB(A).

5.8.6.1 Receivers north of the SEOC

Receivers R84 and R111 are generally northeast of the SEOC, southwest of the Integra mine and southeast of the Glendell mine. These receivers would therefore receive maximum noise levels from each mine under different wind conditions.

The assessment of cumulative noise impacts at R84 and R111 has considered available predicted levels for approved operations at the Glendell and Integra mines. **Table 5.21** summarises these levels.

Table 5.21: Estimated cumulative mining noise levels at receivers north of the SEOC.

Receiver	Mine	Year of operation (approximate)			
		2010	2012	2014	2016
R111 Richards	SEOC	42	37	38	37
	Glendell	34	29	36	39
	Integra	39	39	39	39
	TOTAL	**44**	**41**	**43**	**43**
R84 Tisdell	SEOC	40	37	38	36
	Glendell	33	26	31	33
	Subtotal	**41**	**37**	**39**	**38**
	Integra	44	44	44	44
	TOTAL	**46**	**45**	**45**	**45**

The recommended acceptable and maximum amenity (ie, cumulative) mining noise level at the rural receivers in Table 5.21 are 40 dB(A) and 45 dB(A), respectively. Given the high level of mining development in the area, a level in the range 40-45 dB(A) may be considered a reasonable limit on cumulative mining noise. Existing and approved levels, when combined with predicted levels from the SEOC, lie within this range at R111.

Receiver R84 is within the Camberwell Zone of Affectation and additional noise from Glendell mine and the SEOC is predicted to further increase noise levels at this receiver by 1-2 dB. Since 2 dB is widely accepted as the minimum noise level increase perceptible by the human ear, the additional noise from Glendell and the SEOC does not constitute a significant increase over existing levels at R84.

5.8.6.2 Receivers south of the SEOC

Receiver R184A is the northern-most residence off Maison Dieu Road and would receive noise from the SEOC and/or Hunter Valley Operations (HVO) under various meteorological conditions.

The worst case predicted level of 36 dB(A) from the SEOC (with land clearing not occurring under inversion) when combined with the typical worst case level of 37 dB(A) from HVO gives a cumulative worst case level of 40 dB(A). This is equal to the acceptable night time amenity level for rural receivers.

5.8.6.3 Transportation Noise

Road

The proposal will not increase the number of employee vehicles on Glennies Creek Road, associated with the current surface facilities and underground mine access. Rather, employee traffic on this road would decrease considerably when the open cut activities relocate to the SEOC.

The majority of existing access to the ACP is derived from the New England Highway, with no additional employees proposed there will be no change to the existing traffic noise levels as a result of the SEOC.

A short term increase in traffic will be experienced during construction.

Rail

The SEOC project seeks to increase the total product coal output of the ACP by 2.3Mtpa. This equates to approximately 1.2 additional trains per day, or a maximum of 2 trains per day, from ACP.

A review of the ARTC's *"Standard working Timetable – freight and Country Passenger Services from 5th August 2007 – Book 5 North and North West",* effective 8 January 2008, suggests that there are over 160 timetabled coal train slots (100+ during the day and 60+ during the night) on the Main Northern Line. This capacity is not filled by the current coal train numbers. Data presented by GHD in the Minimbah Third Track EA (July 2008) suggest an actual maximum volume of 63 coal trains during the day and 35 coal trains at night.

The addition of a maximum of two additional trains per 24-hour period from the SEOC will not increase existing noise levels by a measurable or audible amount, nor would any current train noise set-back distances be affected, and further assessment of train noise impacts from the proposal is not required.

5.8.6.4 Findings of the Independent Review of Cumulative Impact (Noise) Camberwell Village

The DGR's sought an assessment of the findings of the Independent Review of Cumulative Impacts on the village of Camberwell with regard to noise and dust. At the time of preparing the EA report the findings of the Independent Review of Cumulative Impacts on Camberwell village have not been publicly released.

5.8.7 Noise Monitoring

Acoustical monitoring for the ACP and SEOC will comprise a combination of continuous (near real-time) monitoring and logging of noise for operational analysis only and attended monitoring by an acoustical consultant for compliance assessment. The monitoring program will be integrated between the existing operations and the SEOC project.

The results collated from the real-time monitoring will be used as an operational tool to understand noise levels emanating from any one activity. The continuous units will provide an early warning tool to inform ACOL personnel that noise levels are approaching criteria. This will provide the opportunity for ACOL to review its activities and respond proactively.

Noise and meteorological triggers will be developed for the SEOC based on the existing knowledge gained at the ACP and will be continually reviewed and improved to minimise noise impacts during construction and operational activities.

5.8.8 Management and Mitigation

Acoustically sensitive design elements that were incorporated into the design of SEOC project include:

- The construction of environmental bund to shield operations.
- The enclosed conveyors.
- Conveyors rather than truck haulage of coal to the CHPP.

In addition to the mine design, **Table 5.22** outlines typical acoustical controls that will be applied to the SEOC Project.

Table 5.22: Noise control measures for the SEOC project.

Timing	Management / Control Actions
As required / specified by manufacturer.	Maintain equipment and machinery in good working order.
At all times.	Maintain haulage roads in good condition free of pot-holes or unnecessarily rough areas to reduce haulage related noise;
When people are entering site for first time.	Provide awareness and understanding of construction noise issues through site inductions for all staff, contractors and visitors to the SEOC. Including highlighting of noise reducing universal work practices including: • Avoiding shouting/yelling, unless required for safety; • Reducing or avoiding the use of stereos outdoors; • Avoiding of slamming vehicle doors; and • Avoiding dropping materials from height.
As required.	Use and operation of equipment such as: • Reduction of throttle settings and turning off equipment when not being used; • Avoid metal to metal contact on equipment; and • Where possible use quieter equipment (e.g. rubber wheeled tractors instead of steel tracked tractors), in situations where either piece of equipment will suit the purpose.
From Year 3 onward	Clearing activities not occur under inversion conditions as a management measure to achieve compliance with the noise criterion at 184A (Moxey).
Prior to operating onsite	• Install broadband reverse alarms to be fitted to all machinery.
Within 1 week of machinery being used on site.	Sound-power level measurement of plant and equipment.

Notwithstanding the measures incorporated above it should be noted that **all** modelled receivers except R84 (Tisdell), R111 (Richards) and R184A (Moxey) are predicted to be within the acquisition zone. Due to the high level of predicted noise impacts (10dB or more in most cases) recommendations to reduce levels to within the noise criteria at receivers in the acquisition zone have not been made.

5.8.9 Response to Monitoring and Exceedances

Those identified properties that will experience sound power levels between 1dBA to 5dBA above the criteria due to the SEOC operations, will have noise levels monitored. Where monitoring identifies an exceedance of the amenity criteria due to the SEOC, acoustical mitigation measures for the residence will be negotiated with the land owner. Acoustical mitigation measures could potentially include air conditioning of the dwelling, insulation and/or thicker glazing to windows.

Where noise monitoring identifies that privately owned receptors are experiencing sound power levels 5dBA above the noise criteria (i.e. above the land acquisition criteria), as a result of the SEOC operations alone, the land owners will have a right to request ACOL to acquire the affected property, enter into a negotiated agreement or receive acoustical mitigation measures.

Where an exceedance of noise criteria (impact assessment of land acquisition criteria) is recorded as results of the ACOL SEOC project alone, ACOL is obliged to report this to the Department of Planning, relevant government agencies, including a report on expected cause and measures to reduce or ameliorate the impact. Those affected by the exceedance will also be notified and where this exceeds the proposed land acquisition criteria will be entitled to request ACOL to purchase their property.

5.9 Blasting and Vibration

Spectrum Acoustics was engaged to undertake a blasting and vibration impact assessment of the SEOC project and to consider cumulative impacts and safeguards. A copy of the report is contained in Appendix 4.

5.9.1 Existing Blast and Vibration Environment

As detailed within Section 5.2 there are numerous coal mines in the vicinity of the SEOC. All mines in the area need to undertake blasting to remove the overburden and win the coal. Blasting at the ACP is currently undertaken between 9.00 am to 5.00 pm Monday to Saturday except public holidays.

Under the current ACP Blast and Vibration Management Plan (BVMP) ACOL liaise with neighbouring mines to ensure that cumulative impacts do not occur and that monitoring data is available. ACOL also advise residents of Camberwell village and occupiers of buildings who wish to be notified within two kilometres of blasting locations of future blasting events on at least a monthly basis, and of any changes to the proposed blast schedules. The program is also advertised on the internet.

The existing BVMP contains a set of functional procedures and guidelines that have allowed the open cut operations to operate within a confined area with minimal disturbance to the surrounding lands. The BVMP addresses dust management, road closures, fly rock management, monitoring practices and mechanisms to respond to criteria exceedances and complaints. This document provides a sound basis to develop blast practices for the SEOC.

5.9.2 Blasting and Vibration Criteria

Blasting overpressure and ground vibration criteria proposed for the SEOC are shown in **Table 5.23** and **Table 5.24**.

Blasting within the SEOC is proposed to be undertaken between 7.00 am to 5.00 pm excluding public holidays and may at times require more than one (1) blast per day.

The wider period (i.e. 7am instead of 9am) for blasting is proposed to provide operational flexibility and allow blasting to take advantage of calmer winds, having consideration to the higher potential for inversions to occur during this time.

Table 5.23: Airblast overpressure impact assessment criteria.

Receiver	Airblast Overpressure Level (dB(L) in Peak)	Allowable Exceedance
Residence on privately owned land	115	5% of the total number of blasts over a period of 12 months
	120	0%
Residential or Industrial buildings	133	If required to limit building damage under AS 2187

Table 5.24: Ground vibration impact assessment criteria.

Receiver	Peak Particle Velocity (mm/s)	Allowable Exceedance
Residence on privately owned land	5	5% of the total number of blasts over a period of 12 months
	10	0%
St Clements Church	5	0%
AAPT Optic Fibre	100	0%

5.9.3 Blast and Vibration Assessment Method

The following sections provide standard equations for predicting blast overpressure and ground vibration levels, sourced from the United States Bureau of Mines.

5.9.3.1 Blast Overpressure

Unweighted airblast overpressure levels (OP) are predicted from **Equation 1** below.

$$OP = 165 - 24(\log_{10}(D) - 0.3\log_{10}(Q)),\quad dB \qquad (Equation\ 1)$$

where *D* is distance from the blast to the assessment point (m) and *Q* is the weight of explosive per delay (kg).

Analysis of 12 months blast data for a coal mine in the Hunter Valley has shown Equation 1 to underestimate overpressure levels by up to 3 dB for small blasts (MIC 100-400kg) and overestimate by 1 dB for larger blasts (MIC > 400kg). These correction factors will be applied as appropriate.

5.9.3.2 Blast Vibration

The basic equations for calculation of peak particle vibration (PPV) levels from blasting are as follows:

$$\mathrm{PPV} = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6}$$, mm/s (for average ground type) *(Equation 2)*

$$\mathrm{PPV} = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6}$$, mm/s (for hard rock) *(Equation 3)*

where *D* and *Q* are defined as in Equation 1.

The ground in the area is generally sandstone and conglomerate (hard materials), indicating that Equation 3 may be appropriate for blast vibration impacts. The difference between Equations 2 and 3 is the value of the coefficient 1140 or 500 and, for conservatism, a coefficient of 1000 has been used.

5.9.4 Blast and Vibration Impacts

Blasting will be required for open cut mining. **Table 5.25** shows the distances to each assessment point, the predicted overpressure (OP) and peak ground vibration (PPV) levels, and applicable criteria for an arbitrary maximum instantaneous charge (MIC) of 503 kg (based on existing ACP blasts). It is proposed to vary the MIC based on the location of the blast relative to the receiver such that impacts are maintained below the criteria for residences outside the Noise Acquisition Zone.

Table 5.25: Predicted blast overpressure and vibration.

Receiver	Distance (m)	OP (dB) Predicted	OP Criterion	PPV (mm/s) Predicted	PPV Criterion
Optic fibre	88	140	-	108	100
R46[1]	185	132	133	33	10
R51[2]	185	132	133	33	10
R50[2]	220	130	133	26	10
R8[2]	345	125	133	12	10
R130A	800	117	133	3.3	10
R130B	1100	113	133	1.7	10
R151[3]	794	117	133	3.3	5
R84[4]	1250	112	115	1.6	5
R111[4]	2000	107	115	0.8	5
R184A[4]	2950	103	115	0.4	5

[1] Disused Community Hall.
[2] Residences within SEOC noise acquisition zone.
[3] St Clement's Church.
[4] Residences outside SEOC noise acquisition zone.

The results in Table 5.25 suggest that residences in the SEOC noise acquisition zone, within approximately 350m of blasting, will receive sufficiently high vibration levels to cause cosmetic cracking in the dwellings. Vibration levels well in excess of personal comfort criteria will occur at these residences, as well as unacceptably high overpressure levels.

Vibration levels at the two Bowman properties (R130A and R130B) are predicted to be well below the building damage criteria, and below the more stringent personal comfort criteria. Increasing the blast MIC to 850kg would still result in compliance with the personal comfort (vibration) criterion at these locations.

Blasting with 503kg MIC should not occur within 100m of the AAPT optic fibre, or the MIC should be reduced to 450 kg based on an 88m separation, in order for the 100mm/s vibration criteria to be achieved. Larger blasts with 850kg MIC should be set back at least 150m from the optic fibre and 875m from St Clement's Church to achieve the relevant criteria. The Camberwell Community Hall will receive ground vibration above the criteria.

No exceedances of the overpressure or ground vibration criteria are predicted at residential receivers outside the SEOC noise acquisition zone for 503 kg MIC blasts. Calculated maximum blast MIC to achieve the overpressure and vibration criteria are 1100kg (R84), 2500kg (R111) and 4500kg (R184), although typical blasts would be smaller than these limiting values.

5.9.5 Blast Monitoring and Response to Exceeedance

Blast monitoring will be undertaken at St Clements Church, constraining infrastructure (e.g. the AAPT optic fibre) and at select receivers outside of the noise acquisition zone.

Should exceedances of blast criteria be identified they will be notified to the appropriate authority and the residence will also be advised of the exceedance. An investigation will be undertake to determine the cause of the exceedance and corrective action implemented to prevent reoccurrences.

5.9.6 Blasting and Vibration Safeguards and Mitigations

Blast management at the SEOC will be generally consistent with the existing Ashton BVMP that will be amended to address blasting constraints within the SEOC.

Initial blasts will be smaller and monitored intensively at nearby infrastructure to assess the response of the ground to blasting. This will allow the calibration of blast vibration calculations that will allow subsequent blasts to be sized and designed to minimise offsite impacts.

Prior to each blast, ACOL will consider the prevailing meteorological conditions, having particular regard to the wind direction and speed (where privately owned receptors outside the affection zone are down wind) and where inversions are detected. No blasting will be undertaken where an inversion has been detected that may increase impacts to privately residences outside the affection zone.

A typical buffer of 500m is applied to all blasts as a preventative measure in the event of unanticipated blast results, smaller buffer zones may be applied where a risk assessment process justifies a reduction. This is commonly referred to as the blast exclusion zone. In the early stages of mining the New England Highway and properties adjoining the highway may need to be temporarily closed or evacuated during blasts. The highway and potentially affected roads or properties within the zone are then inspected prior to allowing people to re-enter the zone. After the first 1 to 2 years the New England Highway would be outside the exclusion zone. Agricultural properties outside the direct impacts of mining will also need to be consulted to ensure no stock or farming is undertaken within exclusion zones during a blast.

The blast schedule for the proceeding months will be posted on the Ashton website. A schedule of blasts will be distributed weekly to the community. The schedule will notify land owners and residents as to the time and location of blasts and road closures. Telephone contract will be made prior to blasting with residents of area. Residents within 500 metres of a blast will be evacuated and returned to their dwelling after the blast has occurred.

In conjunction with the above procedures public notices will be placed in the Singleton Argus newspaper advising details of blasting and road closures. The RTA will be kept informed of closures associated with the New England Highway, signs (located on the highway) updated and traffic control implemented for blasting operations. Generally, the New England Highway would be closed for approximately 5 to 10 minutes.

The proposed office and workshop facilities are located predominantly outside the blast exclusion zone while the ROM facility will be within the exclusion zone and will need to be evacuated as required during nearby blasts.

The SEOC pit will need to have variable size blasts based on both the thickness of the overburden or interburden, the proximity infrastructure and sensitive receptors. Blast size will typically be larger as the open cut moves to the south away from St Clements Church, the New England Highway and the AAPT Optic Fibre. Larger blast sizes means less blasts are required, while smaller blast sizes will require more frequent blasts.

5.10 Groundwater

Aquaterra Consulting Pty Ltd was engaged to investigate the state of the groundwater environment within the SEOC and surrounds and assess the potential impacts from the ACP on groundwater levels and quality, and the impacts this may have on the environment, groundwater dependant ecosystems and existing users. A copy of the report is contained in **Appendix 5** in **Volume 3**.

5.10.1 Assessment Methodology

The assessment of groundwater and the associated impacts from the SEOC is a complex study consisting of multiple facets. A summary of the following key steps is proved below:

- Statutory
  - Review of the relevant statutory provisions.
  - Review of relevant guidelines to be followed.
- Groundwater Investigations
  - Investigation of existing groundwater and surface water information in the area.
  - Identification of potential deficiencies in information and undertake additional investigation.
  - Sample and test bores and piezometers.
- Interpretation of Investigations
  - Review physical characteristics of the site from field survey and aerial photography.
  - Analyse the results of the investigation including structure, chemistry, permeability.
  - Developing an understanding of the interaction between soils, geology, groundwater and surface water in the area.
  - Determine key hydraulic parameters such as horizontal and vertical permeability's, model boundary conditions.
- Groundwater Modelling
  - Develop a model using MODFLOW with the SURFACT module to determine the potential extent of impacts from the proposal.
  - Review results and calibrate model against known parameters.
- Mitigation and Management
  - Determine potential mitigation and management measures to minimise impacts, and a monitoring regime to measure impacts.
  - Determine potential contingency response plans to be enacted where monitored results do not represent modelled conditions, or other adverse impacts are observed.

The following sections provide a summary of each aspect of the assessment methodology. For a more detailed understanding the reader is directed to Appendix 5 of Volume 3.

5.10.1.1 Statutory Requirements, Policies and Guidelines

Statutory requirements pursuant to water under the Water Act 1912, Water Management Act 2000 and Water Sharing Plans, are addressed within *Section 2* of this document.

The key policy document relating to groundwater is the NSW State Groundwater Policy Document released in 1998 by the then Department of Land and Water Conservation (DLWC – now DECCW).

The groundwater assessment has also been prepared with consideration of the following documents:

- Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report 3 (MDBC 1993).
- Murray-Darling Basin Commission. Groundwater Flow Modelling Guideline (MDBC, 2001).
- Hunter River Groundwater Water Sharing Plan Draft (DECCW).
- Management of Stream / Aquifer Systems in Coal Mining Developments (Hunter Region) Draft (DIPNR, 2005).

5.10.2 Groundwater Investigations

Numerous groundwater investigations have been undertaken in the existing ACP operations and SEOC area.

To assist the reader the following terms are frequently used in this section. They are generally defined as follows:

- *Alluvium* is clay, silt, sand, gravel type material deposited by running water (i.e. Glennies Creek and the Hunter River).
- *Colluvium* is soil and rock deposited at the base of a slope made up of highly weathered parent material (in this case coal measures).

5.10.2.1 EIS Investigations

Between 2000 and 2003 groundwater was studied in support of the original ACP EIS by HLA Envirosciences (HLA 2001) for both the open cut and underground operations. The investigations focused on the impacts associated with the proposed underground mining of the Pikes Gully Seam and deeper seams to the west of Glennies Creek.

The studies (HLA 2001) recognised two distinct aquifer systems in the ACP area being a fractured rock aquifer system associated with the coal measures and a shallow porous aquifer associated with the unconsolidated alluvium.

5.10.2.2 Investigations associated with the ACP Underground Mine

In support of the operational and regulatory requirements several additional investigations have been undertaken over the period 2004-2008 for the ACP underground and open cut mine. These studies include:

- Ashton Coal Mine Longwall Panels 1 to 4, Subsidence Management Plan, Groundwater Assessment. (PDA, 2006).
- Ashton Coal - End of Panel 1 Groundwater Report (Aquaterra, 2008a).
- Ashton Underground Mine – Bowmans Creek Alluvium Investigation (Aquaterra, 2008b).
- Ashton Underground Mine, LW/MW5-9 Pikes Gully Seam, Groundwater Impact Assessment (Aquaterra, 2008c).
- Ashton Coal – End of Panel 2 Groundwater Report (Aquaterra, 2009).

Although the primary focus of these studies has been west of Glennies Creek, the hydrogeological conditions are expected to be generally similar within the seams to be mined in the SEOC.

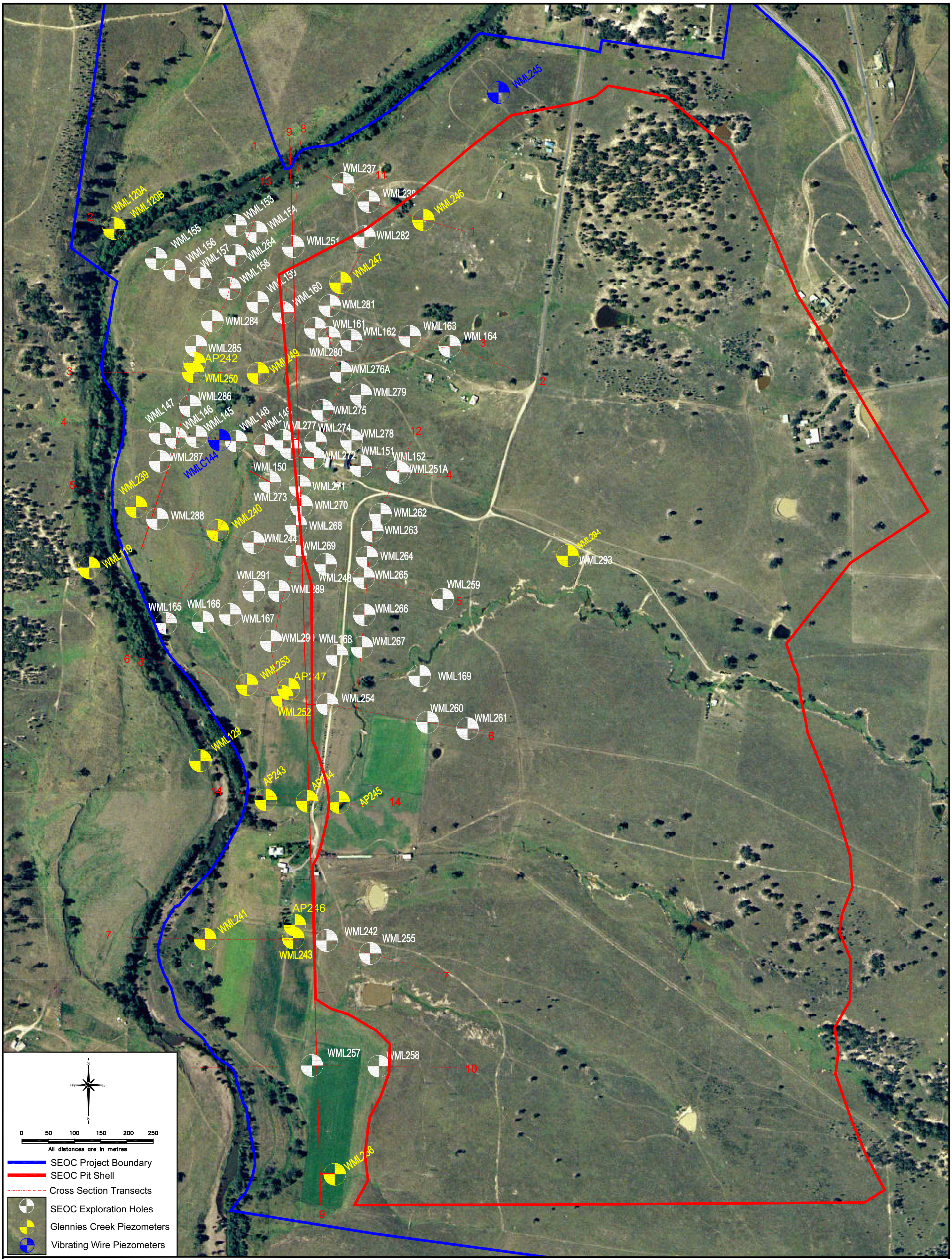
5.10.2.3 Exploration Drilling and Piezometer Installation

Exploration drilling has been undertaken at numerous sites across the ACP, both within the Permian, and alluvium /colluvium. **Figure 5.12** illustrates the various drill holes.

Within the Permian coal measures piezometers have been installed in the key economic seams including the Upper and Middle Liddell and Upper Barret Seams and the Lower Barret – Hebden interburden.

Three drilling programs (in 2007, 2008, and 2009) have been undertaken within the alluvium and colluvium adjoining Glennies Creek. The purpose of the drilling programs was to:

- Delineate the extent of saturated alluvium west of Glennies Creek, and its relationship to surface water levels in the creek itself.
- Determine the properties (spatial distribution of chemistry, physical parameters and hydraulic conductivity) of the alluvium/ colluvium aquifer system.
- Explore the nature and extent of zones of high hydraulic permeability.



South East Open Cut Project

Exploration drilling and investigation locations

Aquaterra

Figure 5.12

Plan 36

Prepared by Pegasus Technical

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Drilling in September to October 2007 provided indicative conditions of the alluvium and colluvium, but due to the drilling method, not all holes where able to reach fresh bedrock.

During October to December 2008, 57 additional bores where drilled to ensure the full depth of the alluvium and colluvium was better understood; 12 of these where converted to piezometers.

In April and May 2009 an additional six (6) large diameter bores were drilled in areas of potential high permeability identified during previous drilling. The larger diameter holes allow for more accurate estimates of the aquifer properties. Where possible these were converted to piezometers.

Bores that were not converted to piezometers had all available data collected before being cemented and rehabilitated. Licence applications were made for all drilling activities.

5.10.2.4 Baseline Monitoring

A baseline monitoring program of groundwater has been undertaken in the ACP area since the commencement of studies relating to the original ACP EIS. Monitoring has primarily focused on underground mining of the Pikes Gully Seam and the NEOC west of Glennies Creek.

Recent drilling has expanded this monitoring network to include the eastern side of Glennies Creek as well. The monitoring program includes piezometers both within the Permian coal measures and unconsolidated sediments.

Figure 5.13 illustrates the groundwater and surface water monitoring sites in the vicinity of the SEOC.

Groundwater Sampling

Groundwater sampling using piezometers has varied across the investigations undertaken. Detailed sampling of the early drilling programs was largely restricted to measuring EC, however as sampling continued it has generally included:

- Purging in accordance with AS/NZS 5667 (Standards Australia 1998).
- Field analysis of pH, EC, and temperature.
- Laboratory analysis by a National Association of Testing Authorities (NATA)-accredited laboratory for:
    - pH and EC.
    - Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).
    - Alkalinity.
    - Major cations and anions.
    - Dissolved metals (As, B, Cd, Cr, Cu, Fe, Ni, Pb, Mn, Se, Zn, Hg).

The ongoing monitoring program for the established piezometers comprises the collection and analysis of the above parameters on a quarterly basis.

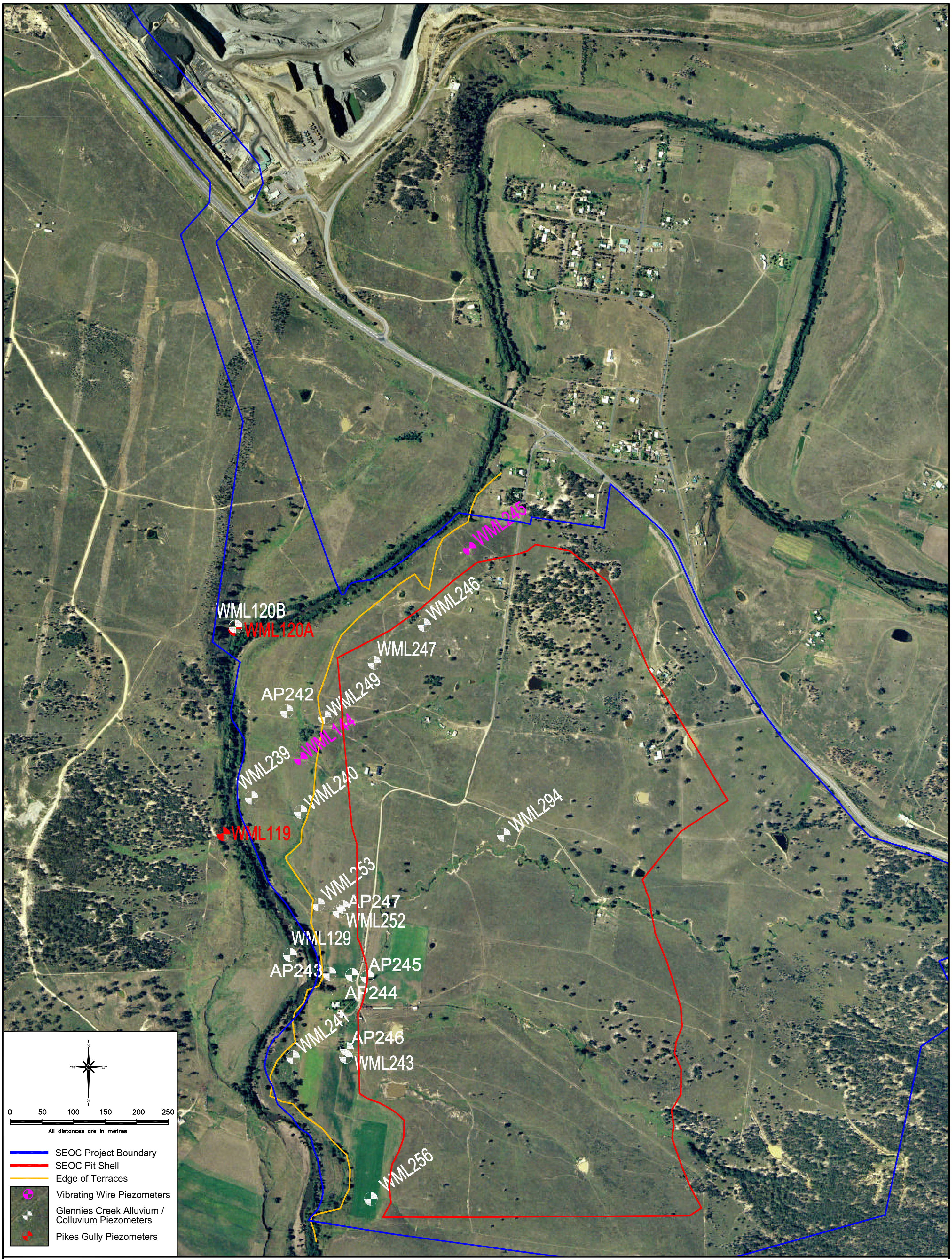
Groundwater Levels

Monitoring of groundwater levels has been undertaken in some piezometers since 2001. Two sets of vibrating wire piezometers have been installed to provide continuous measurement of water levels in the Upper Liddell, Upper Lower Liddell, Lower Barret, Middle Liddell 1 and 2, Lower Lower Liddell, Upper Barrett coal seams and the Lower Barrett-Hebden Seam interburden.

All other designated piezometers are monitored on a monthly basis.

Hydraulic Testing

Falling head slug tests and Constant Rate Tests were undertaken for 19 piezometers predominantly east of Glennies Creek to provide data to estimate the average conductivity of the saturated alluvium and colluvium. Where the Constant Rate Tests were only partially successful the large diameter



AshtonCoal

South East Open Cut Project

Groundwater Monitoring Sites

Aquaterra

Figure 5.13

Plan 37

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drilling allowed for greater certainty in the conductivity estimates. Detailed results of the hydraulic testing are contained in *Table 3.5* of the *Groundwater Report* in *Appendix 5*.

No hydraulic testing was undertaken in the Permian coal measures within the footprint of the SEOC, however testing undertaken to the west associated with the ACP underground (refer *Section 5.9.3.2*) are considered appropriate.

5.10.3 The Existing Groundwater Environment

Investigations detailed within Section 5.9.3 above have allowed the formation of a detailed understanding of the geology, structure and chemistry of the groundwater environment in the area of the SEOC. This section details the findings of the investigations.

5.10.3.1 Alluvium/ Colluvium Deposits

Within the project area, alluvium occurs in association with the deposition of paleo-sediments by Glennies Creek. These deposits occur within two main terraces as follows:

- A lower terrace adjacent to the river.
- An upper terrace that merges with colluvium and finally regolith associated with the slopes of the rising Permian subcrop to the east.

The areal extents of the alluvial terraces can be defined visually. The terraces are tiered, with an elevation change between terraces in the order of 1 to 3 m.

Investigation drilling of the Glennies Creek floodplain and regolith indicated up to about 8 to 10 m of sandy silts, silts and silty clays, generally overlying coarse sandy gravels, where they reached a maximum recorded saturated thickness of 6m.

A series of transects were constructed from the drilling results to better understand the alluvium and colluvium deposits. A basic description of the transects is provided in **Table 5.26**.

Table 5.26: Description of the interface between the Glennies Creek and the SEOC.

Transect	Direction and Location	Features
1	West to East Most northern transect.	Shallow basement, unsaturated gravels overlying Permian coal measures. Water table west of SEOC pit shell, no connection to Glennies Creek.
2-4	West to East, Northern portion.	Alluvial sediments up to 7m thick, with the lower terrace widening substantially. Increasing angularity of gravels away from Glennies Creek suggesting a gradual transition from alluvium to colluvium away from Glennies Creek. East of the lower terrace the SEOC intercepts up to 2m of saturated colluvial gravels, however in Transect 3 the gravels are absent and the water table intersects basement 60m west of the SEOC pit.
5-6	West to East, Central area.	The gravel thickness decreases in thickness (5m-2m) away from Glennies Creek, with gravels on the lower terrace being more rounded as opposed to gravels on the upper terrace that are more angular. The gravels in this area also have a greater concentration of clay.
7	West to East, Southern portion.	Alluvium/colluvium sediments rapidly thin to the east from Glennies Creek. Saturated gravels encroach within the SEOC pit, with basement well below the level of Glennies Creek. No gravels were observed, only silty sandy sediments comprised of alluvial and colluvial material.
8	North to South	Gravels become unsaturated in the north of the SEOC, a large ridge of Permian

Transect	Direction and Location	Features
	Western boundary of the SEOC pit.	sub-crop runs in an east-west direction almost to the Glennies Creek near the house on Property 129 (W. Bowman), this effectively separates the unconsolidated sediments north and south of the ridge.
10	West to East. Southern most transect.	In the south of the SEOC rising Permian basement creates a narrower band of alluvium adjacent to Glennies Creek, gravels are absent in some areas and the sediments are unsaturated at the edge of the SEOC pit.

5.10.3.2 Hydrogeology

Drilling and investigation of water levels has identified two aquifer systems within the SEOC area, which are made up of:

- A hard rock aquifer system in the Permian coal measures. Because of the impermeable nature of the interburden sediments, groundwater flow within the hard rock is predominantly confined to the cleat fractures in the coal seams. This means the coal seams themselves form the main aquifer within the hard rock system.
- Unconsolidated sediments made up of alluvium, colluvium and regolith, comprising clay-bound and silt bound sands and gravels with occasional lenses or coarser horizons of gravels and sands, where;
  - *Alluvium* is clay, silt, sand, gravel type material deposited by running water (i.e. Glennies Creek and the Hunter River); gravels are typically well rounded from being transported long distances.
  - *Colluvium* is similar to alluvium but has been transported shorter distances, is more angular in nature and is deposited at the base of a slope (where its source was immediately upslope).
  - *Regolith* is insitu weathered basement material, in this case, weathered coal measures.

5.10.3.3 Groundwater Levels and Flow Patterns

Based on data collected in November 2008, groundwater levels in the alluvium/colluvium range from 53m AHD upgradient to 50.5m within the Glennies Creek floodplain. **Figure 5.14** illustrates the groundwater contours of the alluvium/colluvium in November 2008. Groundwater gradients indicate a groundwater flow direction following topography and slope to the west although the gradient is generally very flat.

Groundwater levels in the upper part of the Permian coal measures generally reflect the local topography, with higher levels in elevated areas and lower levels in the valleys. Groundwater levels deeper in the Permian coal measures are more regionally controlled and are independent of topography.

While historical mining in the area has had an impact on groundwater levels, monitoring data indicates that prior to the commencement of mining at the ACP groundwater levels in the Permian coal measures and the alluvium /colluvium were higher. Higher groundwater levels in the Permian coal measures meant that under natural conditions, groundwater discharged from the Permian to the alluvium and to the surface streams. This is still occurring in some places, and is reflected in occasional relatively higher salinities in the alluvium, and also in the surface flow at times of low rainfall and runoff.

5.10.3.4 Recharge and Discharge

Recharge to the aquifers occurs by the infiltration of rainfall and local runoff.

Recharge to the colluvium / alluvium system is likely to occur by rainfall infiltration and runoff from the higher colluvial slopes east of Glennies Creek.

Figure 5.14: Groundwater levels in the alluvium/ colluvium in November 2008.

Recharge to the Permian coal seam aquifers is primarily by direct recharge where the various seams outcrop or subcrop beneath the alluvium or regolith layer. Recharge via downward leakage through overburden and interburden layers is considered to be a very minor or negligible component of recharge due to the very low vertical permeability of the interburden layers.

Regional studies suggest approximately 0.5% to 1.0 % of the annual rainfall percolates to the coal measures groundwater system (HLA, 2001). Based on observation of responses to rainfall in the ACP area, it is considered that recharge rates are likely to be highest in areas where the coal seams either outcrop or subcrop beneath alluvium or colluvium, and a recharge rate of 1.7% has been assigned to these areas in the modelling studies. Conversely, recharge rates into weathered coal measures is generally quite low, probably in the order of 0.2% of rainfall. This would result in overall coal measures recharge rates similar to those suggested by HLA (2001) in previous groundwater investigations within the immediate area.

5.10.3.5 Groundwater Quality

Studies for the existing Ashton underground and open cut mines (refer *Section 5.9.3.2*) determined the groundwater in the coal measures (i.e. hard rock aquifer systems) is saline with electrical conductivities (EC) in the range 2,000 to more than 10,000 µS/cm, but usually between 5,000 and 8,000 µS/cm. Groundwater in the alluvium aquifer system commonly has lower salinity and is usually below 2,000 µS/cm, although there are some locations where the EC reaches 6,000 µS/cm EC.

Both alluvium and coal measures groundwater have a near-neutral pH.

Groundwater Salinity

Salinity data collected during the groundwater investigations in the SEOC identified an abruptly increasing EC trend (approximately +4000µS/cm/100m) with distance from Glennies Creek. This increase is believed to reflect the proximity to Glennies Creek as well as the transition from alluvium deposits (within the terrace) to the colluvial deposits on the eastern side of the terrace. Contours of the salinity trend are shown in **Figure 5.15**.

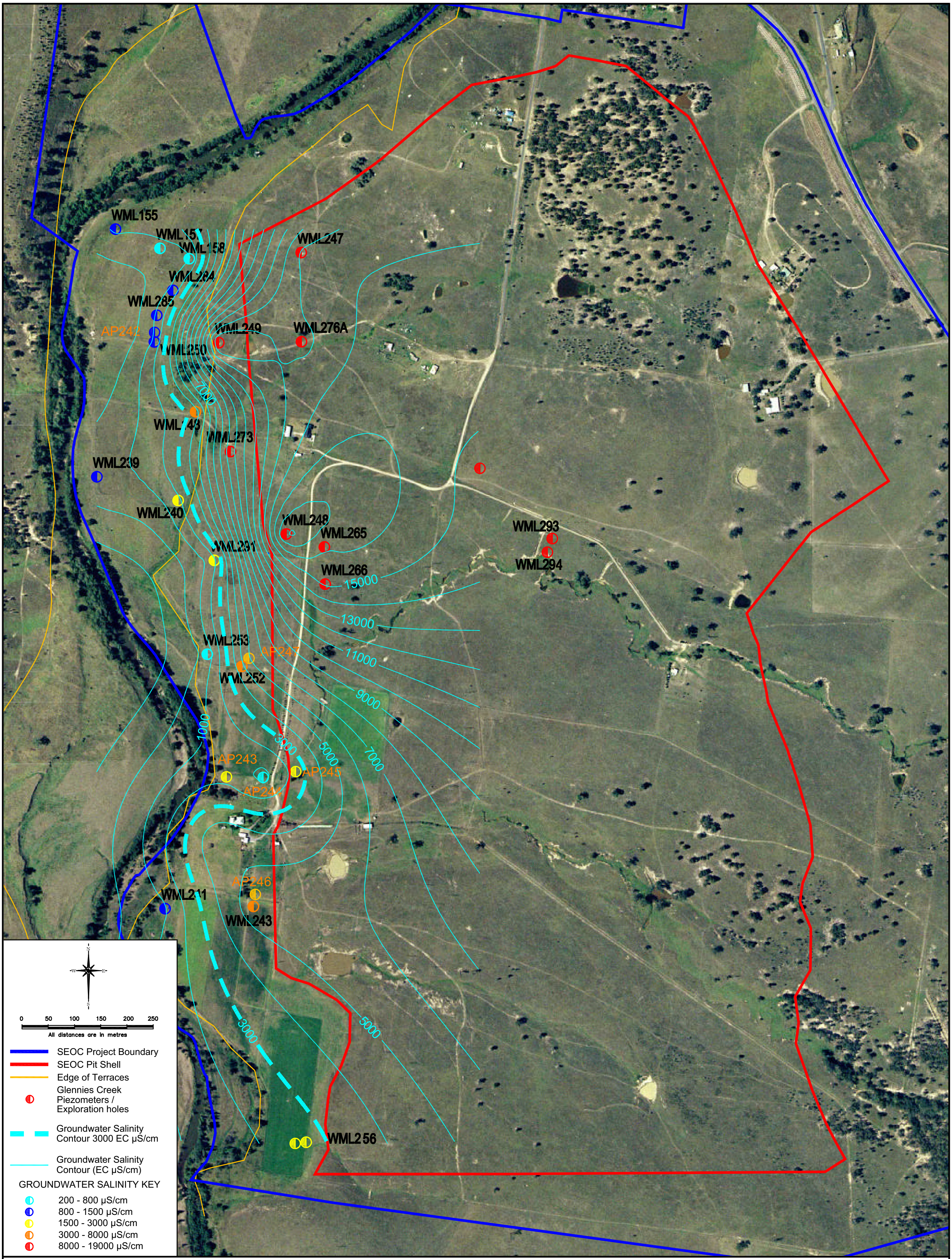
Within the floodplain/lower terrace, the alluvium groundwater salinity is typically less than 1500 µS/cm EC, slightly higher than the salinity range of Glennies Creek (230-903 µS/cm). Higher salinities, ranging from 8,000 to 17,000 µS/cm EC, were recorded in exploration holes drilled further east from Glennies Creek. The high salinities encountered here are generally associated with colluvium and/or weathered Permian. The higher salinity is considered to be due to a greater dominance of leakage from the more saline Permian groundwater, and minimal connectivity to where colluvium (or other silt/clay deposits) have mixed with the alluvial sands and gravels reducing connectivity to Glennies Creek.

The groundwater in the coal measures aquifer system is saline. Typical salinities range up to more than 8,000 µS/cm EC, or more than 6,000 mg/L TDS throughout the SEOC area.

Major Ion Chemistry

Major Ion Chemistry (i.e. the concentration of cations calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K); and the anions chloride (Cl), carbonate (CO_3), bicarbonate (HCO_3) and sulphate (SO_4) were plotted within Piper Trilinear Diagrams and ratio plots. The relative concentrations of these can assist in determining the likely source of groundwater within natural waters. In natural waters close to recharge sources Ca and HCO_3 typically dominate, while in older waters not near recharge sources Na and Cl dominate. This is observed in bores close to Glennies Creek in the alluvium that have a dominance of HCO_3 (i.e. recent recharge), while bores further east in the colluvium have a dominance of Cl (older water/ recharge).

The analysis of major ion chemistry generally supports the conclusion that alluvial waters to the west (nearer to Glennies Creek) tend to contain a greater proportion of more recent, recharge sourced



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Glennies Creek Alluvium / Colluvium Groundwater Salinity Contours

Aquaterra

Figure 5.15

Plan 39

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groundwater, either due to connection with the creek or higher rainfall recharge rates compared to groundwater further east toward the SEOC pit shell.

Dissolved Metals

Laboratory analysis of samples indicates moderately elevated dissolved metals concentrations. Some exceedences of ANZECC (2000) freshwater ecosystem protection guideline values have been recorded. Some bores exhibited exceedances in cadmium, copper and zinc.

5.10.3.6 Hydraulic Parameters

Hydraulic testing of the Glennies Creek alluvium revealed a high variability in hydraulic conductivity, with values in the range of 0.1 to 80m/d, and a mean value of 4.3 m/d. However, very high values were found to be very localised and unrepresentative of the alluvium as a whole. The geometric mean was found to be much lower, at only 0.6m/d.

Note. The geometric mean is similar in value to the median and is regularly used in data that is significantly skewed by large values. For example from 10 bores it is established that hydraulic conductivity is (0.1, 0.001, 0.1, 1, 80, 0.2, 0.1, 0.1, 0.1, 0.01) m/d, the arithmetic mean is 8.17m/d, which is greater than 90% of the data. However, the geometric mean of the same data is 0.17m/d, which is more representative of the actual hydraulic conductivity in the majority of the bores.

Colluvium hydraulic conductivity ranged from 0.0007m/d to 0.025m/d.

Studies for the existing Ashton underground and open cut mines (refer *Section 5.9.3.2*) determined hydraulic conductivity in the coal seams west of Glennies Creek to be generally in the range 0.01 to 10m/d, with the values at the high end of the range occurring close to outcrop. The interburden is much less permeable than the coal seams, and would have a horizontal hydraulic conductivity in the order of 0.001 m/d or less, and vertical conductivity much less than 0.0001 m/d.

Within the Permian coal measures, vertical hydraulic conductivities are considered to be 2-3 or more orders of magnitude lower than the horizontal hydraulic conductivity for all units, based on the very strongly bedded nature of all units and the role of bedding plane features in controlling groundwater flow. This applies both to the coal seams (which are broken up by interbeds of siltstone/sandstone/claystone) and especially to the interburden sediments which comprise interbedded siltstones, sandstones, claystones and shale.

5.10.3.7 Connectivity of Alluvial Deposits

The lateral, saturated extent of the Glennies Creek alluvium has been determined from a combination of aerial photography, ground mapping, the results of exploration drilling, groundwater levels and groundwater salinity. The alluvium merges with colluvium along the flanks of the floodplain. Generally speaking the permeable layers are associated with sands and gravels at the base of the sequence, which grade to low permeability silts and clays nearer the surface. Within the basal alluvium there is a general transition from higher permeability, lower EC sands and gravels that are hydraulically connected to Glennies Creek, to silt- and clay-bound alluvial gravels that may be intercalated with colluvium closer to the pit shell.

Alluvium in the north is constricted by the Permian basement but gradually widens and deepens to the south approaching the residence on Property 129 where a large Permian ridge subcrop running east west again constricts the alluvium to Glennies Creek.

The limits of saturated alluvium are shown on cross sections 1-12 in Appendix B of the Groundwater Report.

Saturated Extent of Alluvium in the North of SEOC

In the northern area and the northern part of the alluvium to the west of the pit shell, extensive areas of the alluvium are dry to the full depth, where the upper surface of the underlying Permian rises above the water table in the north of the proposed SEOC. This means that the terraces and the groundwater contained in the alluvium adjacent to the pit are not in direct hydraulic connection with Glennies Creek and its associated alluvium.

Characterisation of the Alluvium to the West of the Pit Shell

Along the western and southern portion of the SEOC, the basement elevation decreases and saturated thickness increases to a maximum of 4.5m. Borehole samples indicated that there is significant intercalating of alluvium and colluvial sediments in this area, which makes it hard to delineate the boundary of alluvial gravels associated with Glennies Creek based simply on the drill cuttings. The potential for inflow from the alluvium is significantly reduced by the presence of silt and clays, so demarcation of the boundary between the higher permeability alluvium that is connected to Glennies Creek was necessary in this area.

Because of the uncertainties in the interpretation of lithology, groundwater chemistry indicators have been used to help identify this boundary. The chemical analyses described previously indicate that there is a general relationship between EC and the occurrence of lower permeabilities and limited connectivity associated with the colluvium. While the alluvium and colluvium are both recharged primarily by infiltration of rainfall, the highly connected alluvium drains readily to Glennies Creek, whereas the poorly connected alluvium and colluvium does not, leading to the higher groundwater salinities.

Figure 5.15 shows the transition in groundwater salinity from the higher salinities associated with colluvium in the east to the lower salinities associated with the alluvium within the floodplain (and lower terrace in the north western area). It can be seen that the EC contours generally provide a good indication of the transition from higher permeabilities associated with the upper terrace, to lower permeabilities associated with the higher terrace and colluvium.

Geochemical signatures also help to identify the origins of groundwater and further differences can be seen between the alluvial and colluvial groundwaters when ionic ratios are compared. The Piper Trilinear diagram demonstrates the transition from colluvium to alluvium, with water changing from a sodium chloride type to a calcium bicarbonate type.

The fact that EC and chemical differences exist indicates that there is poor horizontal mixing of groundwater between the alluvium and colluvium, confirming that there is a lack of hydraulic continuity between the two aquifer bodies.

Hydraulic tests showed that there were a number of localised, high permeability areas within the alluvium. These higher permeability areas or zones coincide with surface drainages from the east reaching the edge of the alluvium. These high permeability zones do not extend inside the proposed SEOC pit shell.

The Permian out-crop beneath the residence on Property 129 has influenced east-west surface water drainage in that area. There is a localised area of low EC just to the north of this outcrop (boreholes AP243 – 245), which is associated with the current ephemeral stream where it crosses onto the lower terrace. Weathering of the creek line has allowed surface runoff and recharge to penetrate through the overlying clays and into the underlying sands and gravels, causing the low EC values that have been recorded near the drainage channel. These low EC values are not necessarily associated with high permeability, as borehole AP244 has an EC of only 600µS/cm, but a permeability of only 0.4m/d.

Based on the above assessment, it is considered that the EC contours represent the best method for defining the boundary between the alluvium that is directly hydraulically connected to Glennies Creek, and the poorly connected, clay and silt-bound alluvium to the east. Overall it is considered that the 3,000µS/cm EC contour provides the best representation of this boundary. This value was chosen as it represents the inflection point in the salinity gradient between the unconnected alluvium/colluvium to the east, and the Glennies Creek alluvium to the west. The only exception to this is in the area just to the north of the Permian outcrop at the residence on Property 129, where there is localised occurrence of low groundwater salinity in poorly permeable unconnected alluvium/colluvium (bore AP244). The edge of the connected alluvium in this area is considered to be to the west of borehole AP244, which is around 100m outside the proposed pit shell.

The boundary of the hydraulically connected alluvium has been used within the groundwater model. Hydraulic properties within the alluvium have been modified to allow for the higher permeability.

5.10.4 Groundwater Modelling

The MODFLOW numerical groundwater flow modelling package has been used for this study with the SURFACT module (SURFACT Version 3, HydroGeoLogic, Inc., 2006), operating under the Groundwater Vistas Version 5 graphic interface software package (Environmental Simulations, Inc., 2005).

The groundwater model utilised for this project is based on the model constructed for assessment of impacts from the ACP underground mine to the west of Glennies Creek (Aquaterra, 2008). The model has been calibrated using actual data obtained from the underground mining operations. Several modifications were made to the model structure and parameters to improve the representation of the groundwater and geological environment for the SEOC project.

The model covers an area of 132km^2 including the NEOC, Ashton Underground and the proposed SEOC. The model is made up of series of cells that vary in size from 100m x 100m on the outer extents to 50m x 50m around the SEOC to provide greater model sensitivity.

The model comprises 19 layers consisting of alluvium, colluvium, regolith and other mine spoil in one layer and coal seams and interburden represented as independent layers.

Sensitivity analysis of the model was carried out on recharge, vertical conductivity (kv) and horizontal conductivity (kh) parameters for the model layer containing the Glennies Creek alluvium. The assessment determined that the model was relatively stable with a range of values plausible. Uncertainity analysis of the model determined that impacts from the SEOC to Glennies Creek were sensitive to horizontal conductivity but not vertical conductivity. A range of horizontal conductivity values were used to assess impacts to the alluvium.

The model was established to run for two years prior to the commencement of the SEOC to establish existing conditions. The model was then run for each of the seven (7) years of the SEOC mining operation. A post mining recovery period of 100 years was modelled to determine the recovery of groundwater after mining.

5.10.5 Prediction of Groundwater Impacts from the SEOC

Mining activities associated with the operation of SEOC will have some impact on the groundwater environment on a local scale and, to a more limited extent, regional scale.

Potential impacts to the groundwater system may include the following aspects, each of which is discussed in further detail in the following sections:

- Water inflows into the SEOC requiring operational management.
- Groundwater level impacts.
- Potential impacts on Glennies Creek alluvium and baseflow.
- Groundwater quality impacts.
- Potential impacts on groundwater users.
- Potential impacts on Groundwater Dependant Ecosystems (GDE's).

The base case groundwater model (transient model) was designed to predict the impact from all three projects - NEOC, Longwall/Miniwall Panels 1 to 9 and SEOC - each operating concurrently. The NEOC, Longwall/Miniwall Panels 1 to 9 and SEOC are in sufficiently close proximity that some impacts of all three mines will mutually interfere. The base-case modelling therefore assessed the cumulative impacts of all three mines operating concurrently, and separated the impact from the SEOC as appropriate.

5.10.5.1 Groundwater Inflow

The SEOC will generate water from flow into the pit from the alluvium/colluvium, Permian coal measures, and direct rainfall recharge. Predictions of inflows are as follows:

- Total predicted groundwater inflow to the pit ranges from 56 m^3/d in year 1 to around 200m^3/annum for mine years 2 to 7. The direct rainfall recharge component of this increases as the area of the pit increases. Groundwater flow net of direct recharge peaks at years 2 to 4, at around 120 – 140m^3/annum.
- Groundwater inflow mostly occurs from the Permian coal measures and colluvium/weathered overburden intersected by the open cut. By year 7, only 24 m^3/d of the inflow that is entering the pit originates from the alluvium associated with Glennies Creek to the west.
- The prediction of inflow rates from the alluvium associated with Glennies Creek is relatively sensitive to values of Kh for the alluvium. Doubling Kh increases pit inflows from the alluvium on the western side of the pit by about 35% to a maximum rate of 33 m^3/d in Year 7. Halving Kh similarly reduces maximum inflow by about 28%, reducing it to a maximum of 18m^3/d.

Figure 5.16 illustrates the predicted mine inflow rates from the alluvium /colluvium and the Permian coal measures.

5.10.5.2 Groundwater Level Impacts

Predicted Impacts on Permian Coal Measures

The most significant impacts to groundwater levels are predicted to occur within the Permian coal measures which, as the targeted resource, will undergo dewatering during mining activities. Drawdowns as a result of dewatering the coal measures within the SEOC are predicted to be generally contained within the project boundary. At the end of the simulated recovery period (100 years) there are no residual impacts on groundwater levels in the Permian due to the SEOC.

Figure 5.17 and **Figure 5.18** illustrate the predicted drawdowns in the main upper coal seam (Upper Lower Liddell seam) at the completion of mining, and at 100 years after mining.

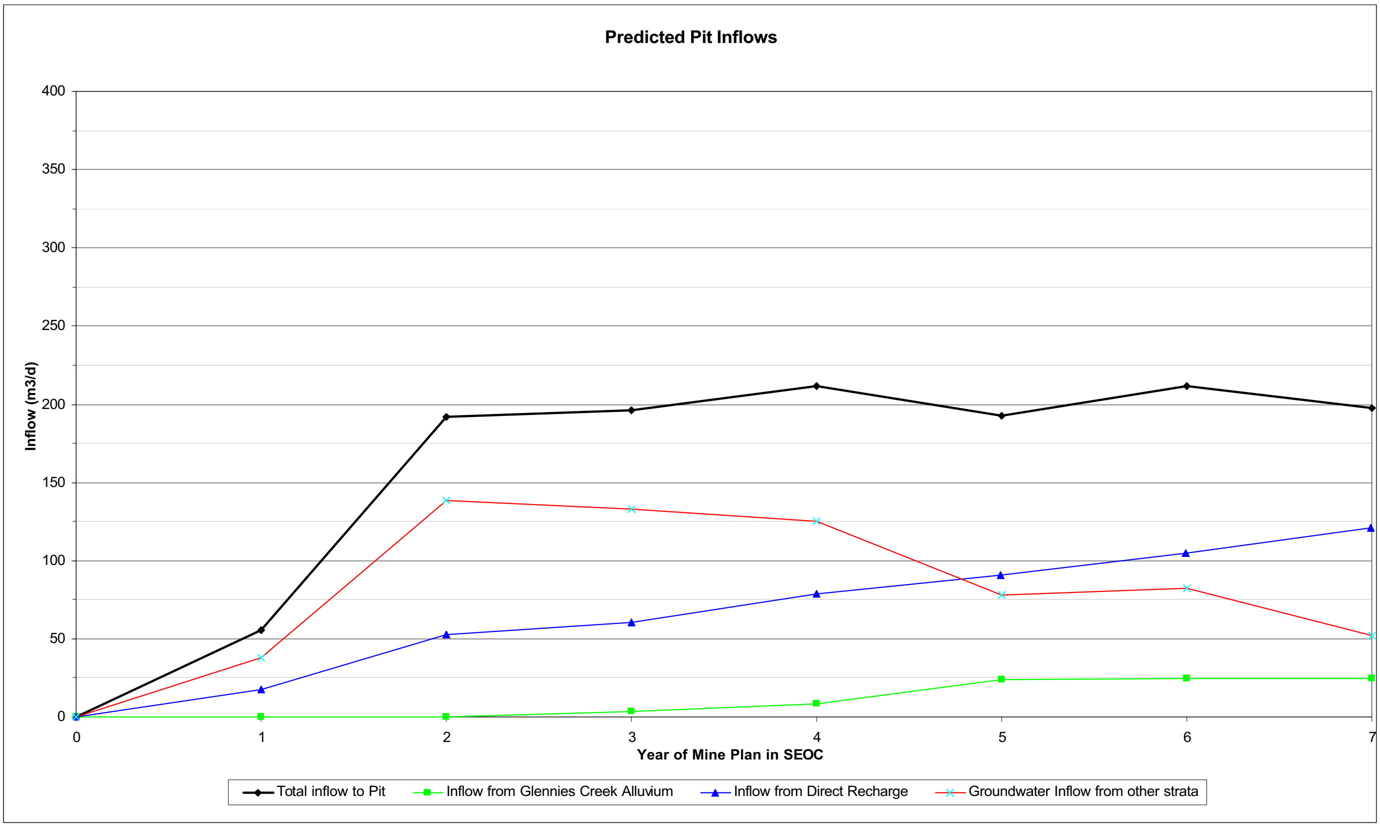
Figure 5.19 and **Figure 5.20** illustrate the predicted drawdowns in the main basal coal seam (Upper Hebden to Lower Hebden seams) at the completion of mining, and at 100 years after mining.

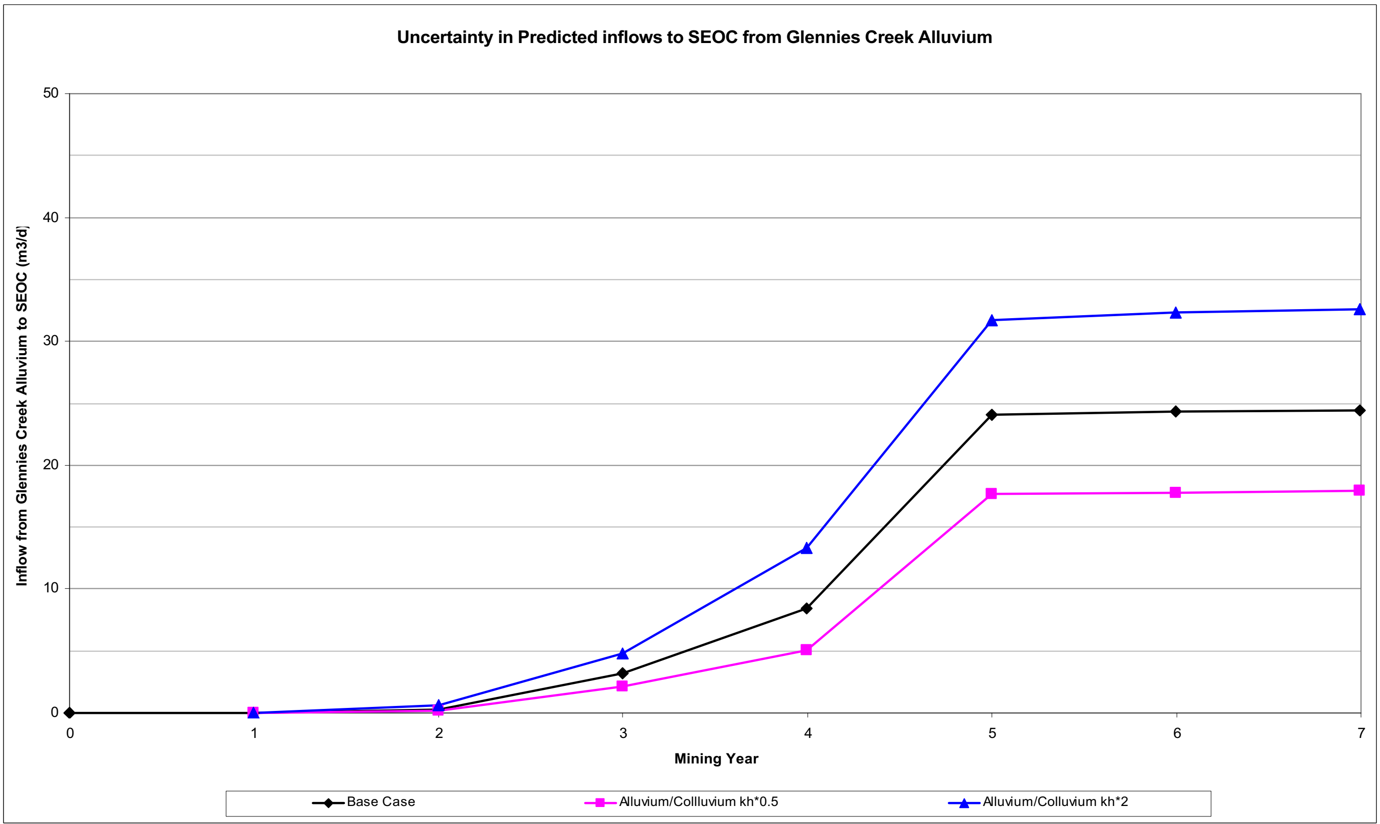
Predicted Impacts On Groundwater Levels In The Alluvium

Mining of the SEOC has the potential to influence groundwater levels within the alluvium sediments associated with Glennies Creek. The maximum drawdown in the Glennies Creek alluvium predicted by the model is less than 1.5m. Drawdown of this extent is limited to a small area near the pit shell where the alluvium is intercalated with colluvial sediments. Impacts on the alluvium nearer the creek are much less, generally less than 0.5m. The predicted reduction in groundwater storage volume within the Glennies Creek alluvium is less than 3%.

Although hydraulic connectivity between the alluvium and colluvium on the western side of the pit is limited, some water does flow through to the pit. Inflows from the alluvium to the pit on this western side are predicted to start in Year 3 of mining and then increase to a maximum of 24 m^3/d by year 7 of mining. However, flows from the Glennies Creek alluvium only constitute around 10-15% of the total groundwater flows that are predicted for the pit, with up to 200m^3/d entering the pit from the Permian aquifers and other superficial deposits.

The SEOC is predicted to reduce saturated alluvium aquifer storage near the SEOC from 10.7 million cubic metres (Mm^3) to 10.4Mm^3 or by less than 3% by year 7 of the SEOC.





AshtonCoal

Prepared by Pegasus Technical

South East Open Cut Project

Predicted open cut groundwater inflows

Aquaterra

Figure 5.16

Plan 40

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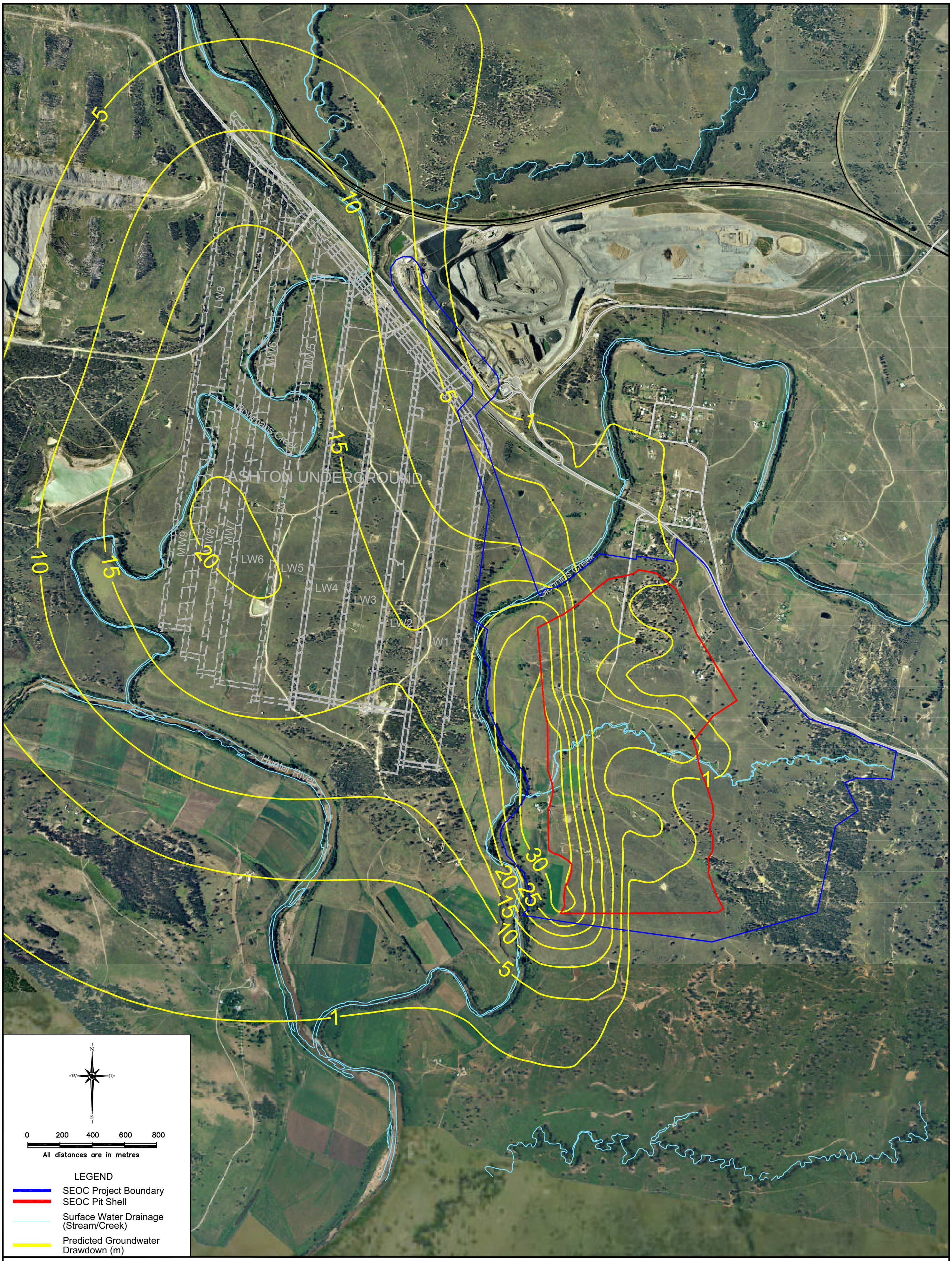

AshtonCoal

South East Open Cut Project

Predicted drawdowns in the Upper Lower Liddell Seam in Year 7 (including ACP Underground)

Aquaterra

Figure 5.17

Plan 41

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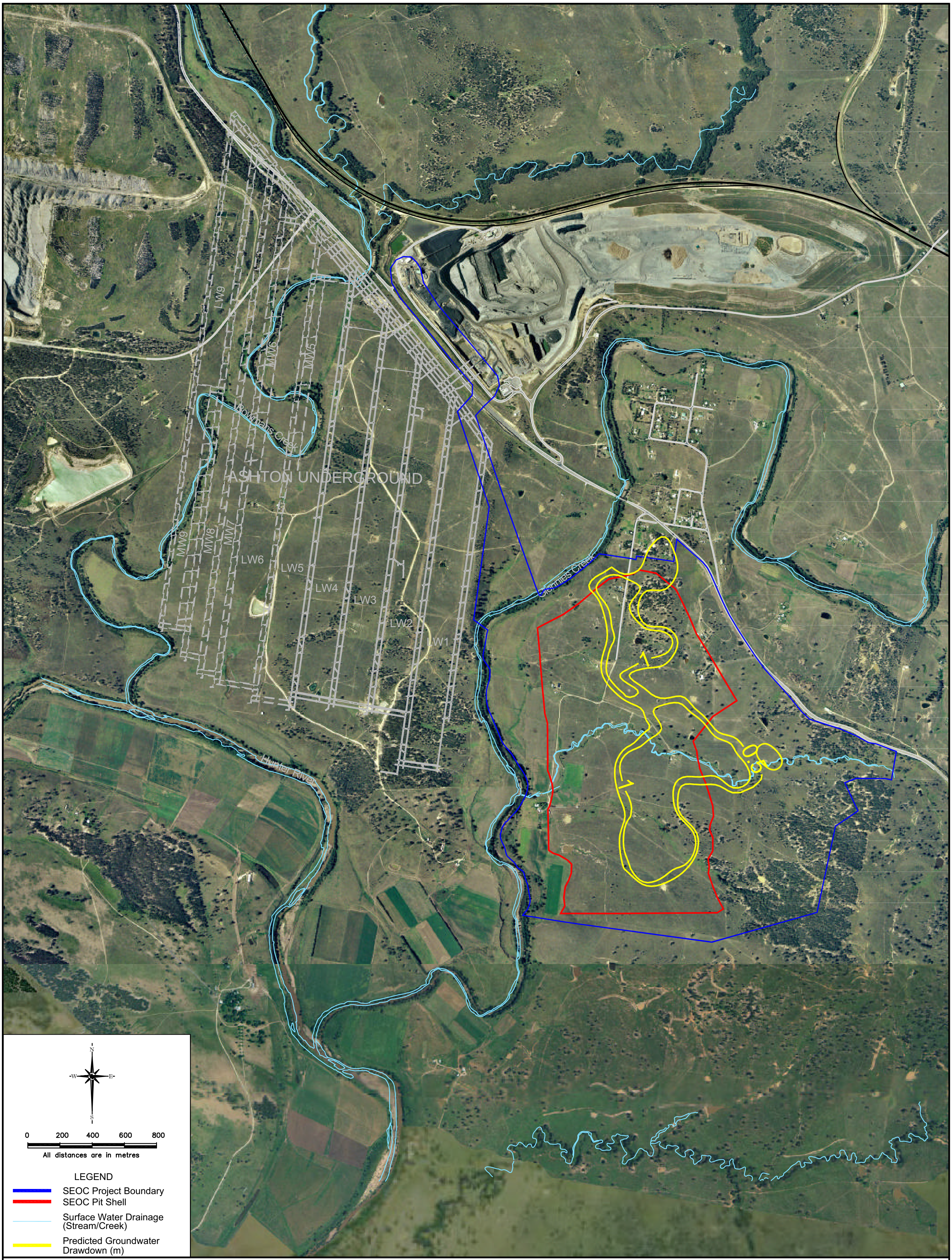

AshtonCoal

South East Open Cut Project

Predicted drawdowns in the Upper Lower Liddell seam
100 years after mining ceases
Aquaterra

Figure 5.18
Plan 42

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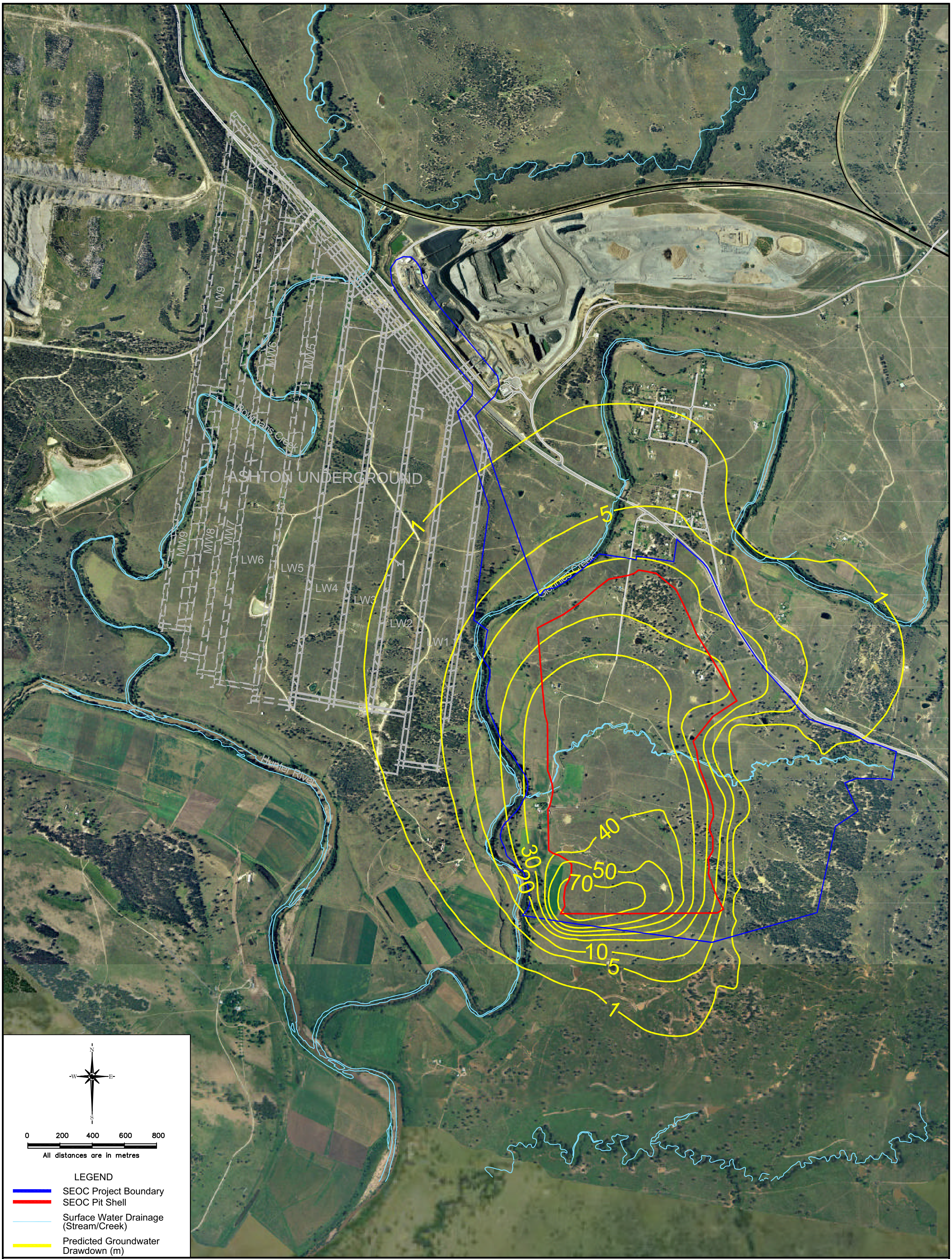

AshtonCoal

South East Open Cut Project

Predicted drawdowns in the Hebden seams in Year 7 at the completion of mining

Aquaterra

Figure 5.19

Plan 43

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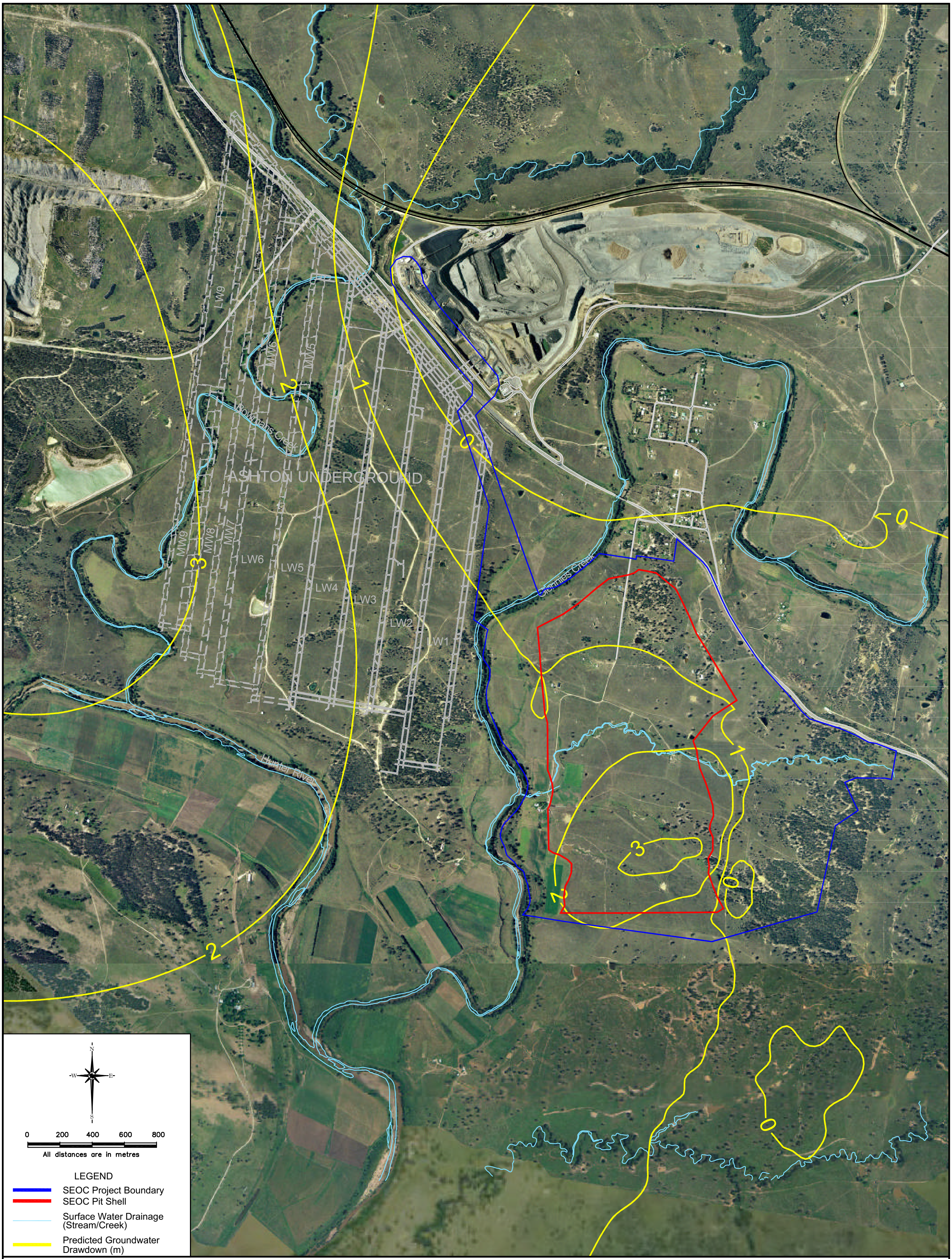

AshtonCoal

South East Open Cut Project

Predicted drawdowns in the Hebden seams 100 years after mining ceases

Aquaterra

Figure 5.20

Plan 44

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As with baseflow impact assessments, impacts on saturated thickness and flows within the alluvium are transient, and will return to the pre-mining condition within 100 years of the end of mining. There is therefore no risk of stream capture or loss in the long term from this project. **Figure 5.21** illustrates the predicted drawdown in the alluvium /colluvium in Year 7.

5.10.5.3 Potential Baseflow Impacts on Glennies Creek

Figure 5.22 illustrates the baseflow impacts to Glennies Creek over the mining period as a result of the SEOC project. As illustrated by Figure 5.22, the reach of Glennies Creek next to the proposed SEOC changes from a slightly gaining stream (years 1 to ~2.5) to a slightly loosing stream (i.e. water flows from the stream to the groundwater) (year approximately 2.5 to 7) during the SEOC mining period. Some of the impact is caused by other mines during the SEOC mining period, but the net predicted impact of the SEOC on baseflows in Glennies Creek is around $47m^3/d$.

The existing ACP underground reduces baseflows by approximately $10m^3/d$, making a cumulative impact from the ACP on Glennies Creek baseflow of approximately $57m^3/d$.

This impact is very small in relation to the flows in Glennies Creek, representing around 0.03% of the average flow. Because the creek flows are regulated by upstream dams at a minimum of $10,000m^3/d$, the impact is still only 0.33% of the 5 percentile flows in this section of the creek.

These impacts are transient and will recover back to pre-mining conditions within 100 years of the end of mining.

5.10.5.4 Uncertainty Impact Assessments

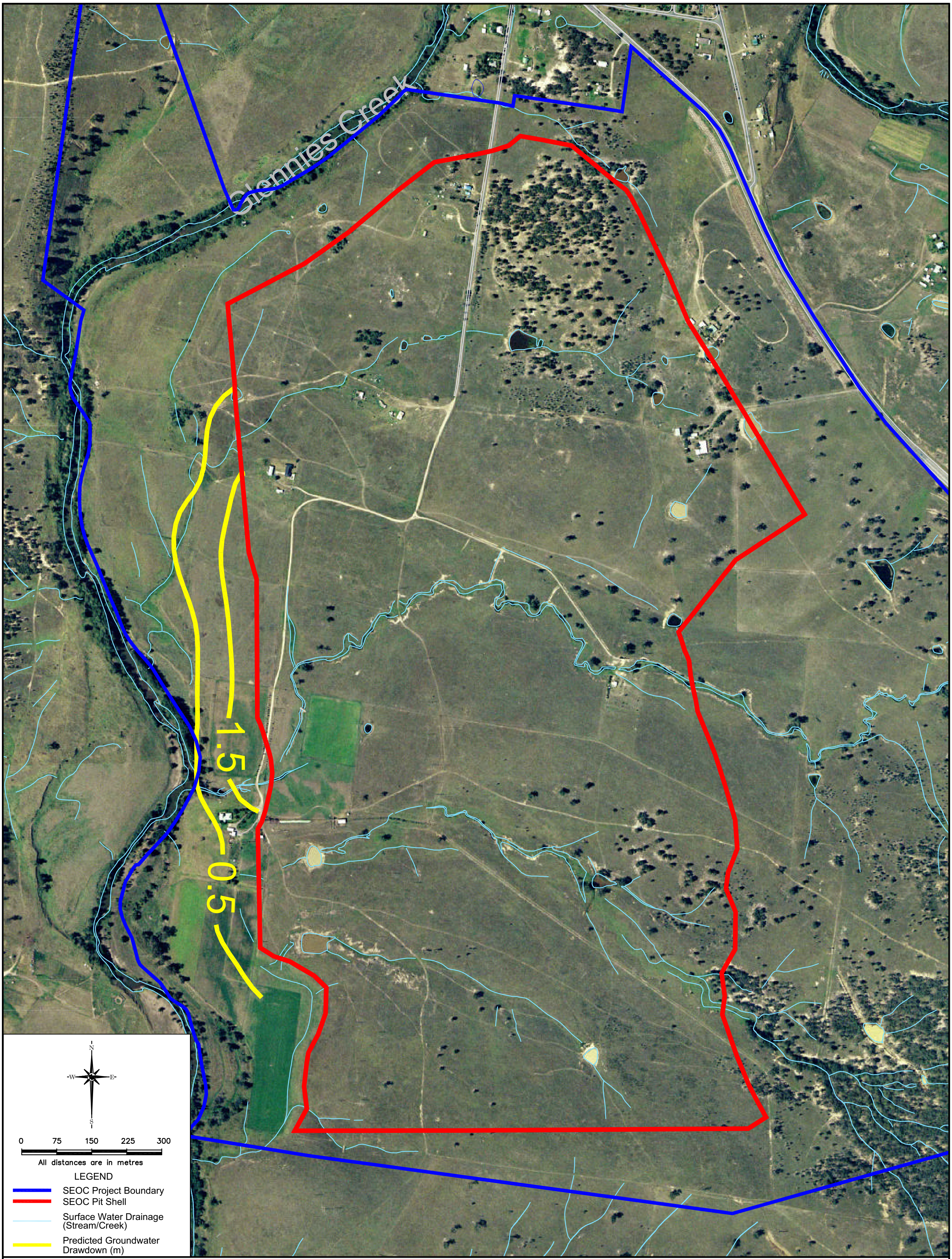
The key uncertainty in the impact of the SEOC on baseflows to Glennies Creek, and on inflows from the Glennies Creek alluvium to the mine pit relates to the hydraulic conductivity of the alluvium/colluvium between Glennies Creek and the western side of the SEOC. Pit inflows increase almost linearly with horizontal hydraulic conductivity, and baseflow changes are also significant in relation to this parameter. Detailed drilling investigations and a conservative assessment of kh have therefore been used to support the assessment of impacts contained within this report. Some uncertainty will remain, particularly if lenses of 'clean' alluvial gravels remain at or close to the western side of the pit shell.

5.10.5.5 Groundwater Quality Impacts

The initial average water quality of mine inflows is expected to be a composite blend of the water qualities from any groundwater intercepted by the mine, however it is anticipated that groundwater quality will be dominated by the main inflow zones, i.e. from the various seams intersected and sediments. It is expected that there will be some variation in inflowing groundwater quality from year to year within each area as mining progresses. Initially, there is likely to be an increase in salinity as saline groundwater is intersected along the northern end of the mine footprint. Subsequently, salinity may reduce as the mine progresses towards the southern area, where the saturated thickness of alluvium increases, and there is some possible hydraulic connection with Glennies Creek alluvium.

Overall, the average quality of Permian groundwater (based on the conductivity of the main coal seam aquifers) collected within the pit during initial mining operations will be around 5,400 µS/cm. This compares with average alluvial/colluvial water quality of 4,400 µS/cm. This figure is reduced by the presence of alluvial samples taken closer to the creek, so the salinity in the colluvium in and around the pit is very similar to the Permian aquifers.

Initial calculations for the long term post mining condition indicate that there should be a reasonable balance between rainfall, recharge and evaporation from the mine pit void and backfill material, so groundwater levels are likely to return to approximately pre-mining conditions. Flows from the pit area to the Glennies Creek alluvium should therefore be similar to pre-mining conditions.



AshtonCoal

South East Open Cut Project

Predicted drawdown impacts in the alluvium / colluvium at Year 7

Aquaterra

Figure 5.21

Plan 45

Prepared by Pegasus Technical

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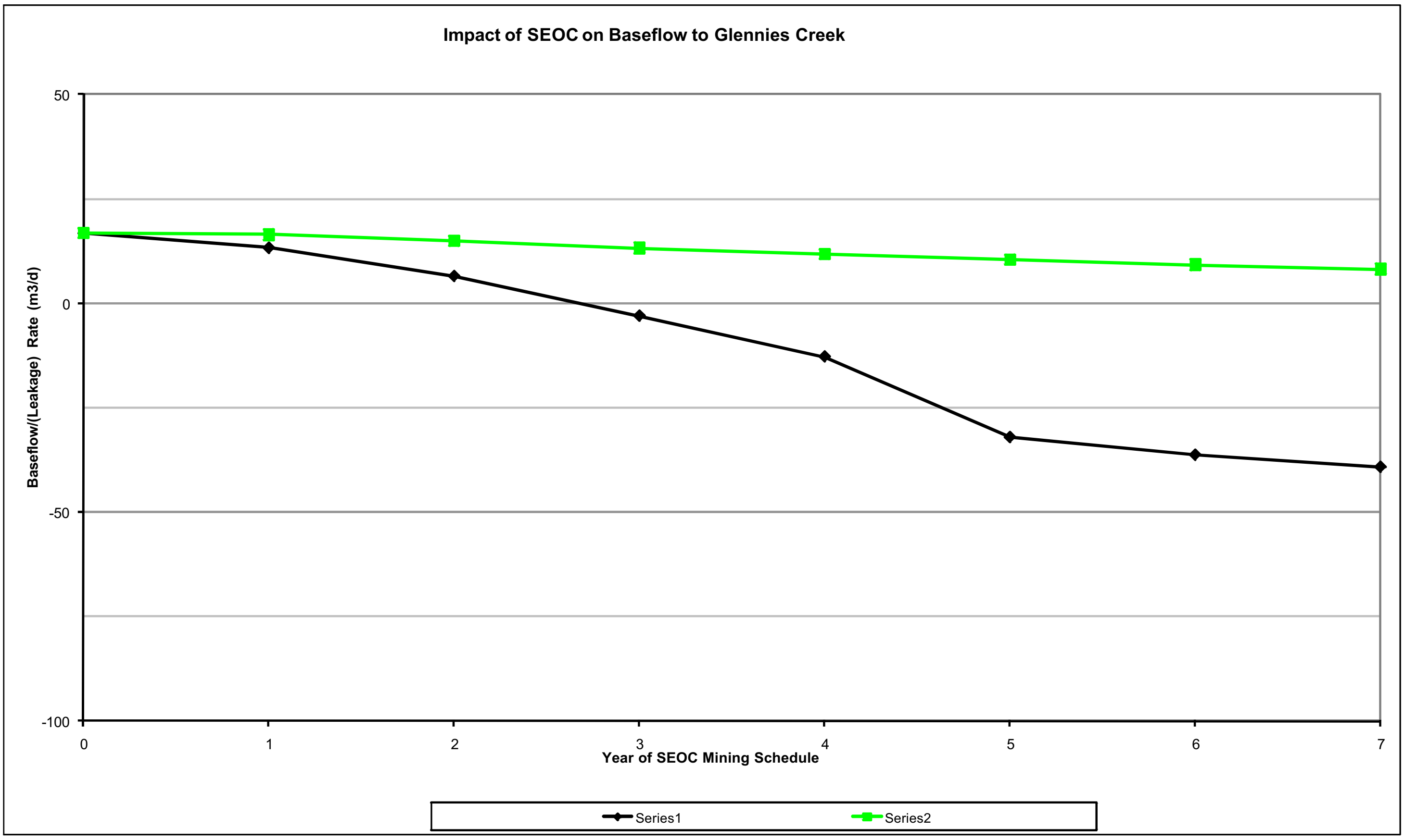

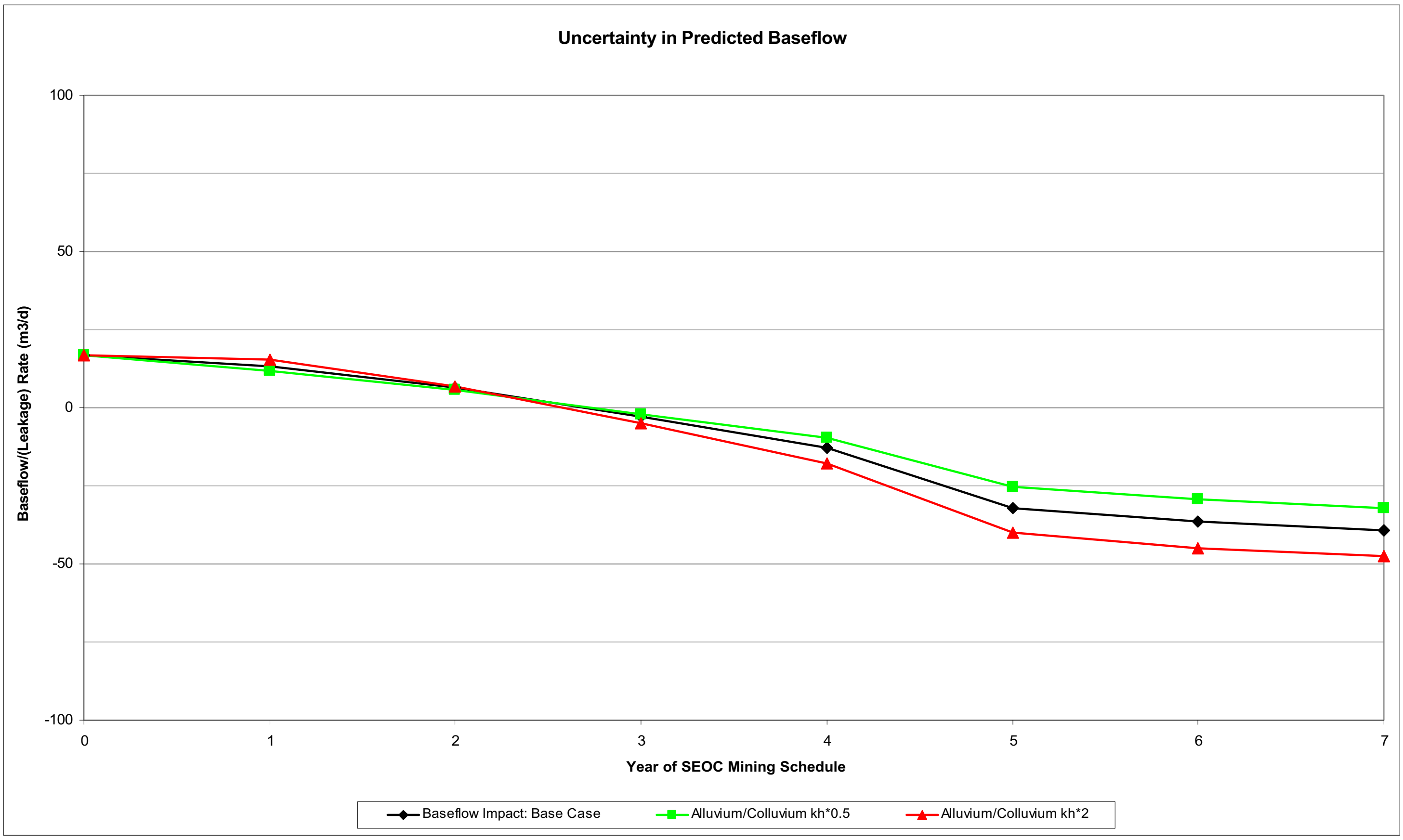

AshtonCoal

Prepared by Pegasus Technical

South East Open Cut Project

Baseflow impacts to Glennies Creek

Aquaterra

Figure 5.22

Plan 46

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This, combined with the fact that the composite groundwater quality within the pit should be very similar to the colluvium/weathered overburden water table that it replaced, means that overall groundwater quality impacts during the post closure phase are expected to be minimal.

5.10.5.6 Surface Water Quality

The reversal of hydraulic gradient within the alluvium, and hence the reduction in base flow to Glennies Creek, as a result of mining the SEOC, is expected to result in an overall reduction in salt load to the creek and to the Hunter River. In the long term, there may be some flow of water from the pit shell to the creek as the pit void and overburden become saturated, but, as detailed above, this should cause a negligible difference in overall water quality.

5.10.5.7 Potential Impacts On Existing Groundwater Users

Groundwater users include licensed bore users and the environment.

A search of the DECCW groundwater bore database identified no bores within the coal measures within the area or predicted impact. One registered bore was identified in the Glennies Creek alluvium in Camberwell, however no impacts to this bore are expected.

Environmental users of groundwater extend to vegetation that draws water from shallow groundwater tables, such as Groundwater Dependant Ecosystems (DGE’s) and to a lesser extent groundwater recharge to surface water systems. The isolated stands of River Red Gum on the banks of Glennies Creek are potentially dependant on alluvial groundwater or flows in Glennies Creek. With predicted impacts to alluvial groundwater relatively minor and localized, with no appreciable difference to the surface water flows in Glennies Creek, no significant impact to the River Red Gums or other groundwater dependant ecosystems is predicted.

5.10.5.8 Groundwater Licensing

Mining activities will be undertaken beneath the current water table. Therefore groundwater extraction licences will be required prior to intersection of significant groundwater. A licence should be sought for the impacts on Glennies Creek and the Glennies Creek alluvium.

5.10.6 Groundwater Impact Mitigation and Management

The mitigation management and monitoring of groundwater will be addressed through the integration of the SEOC with the existing ACP Groundwater Management Plan (GWMP).

5.10.6.1 Mine Design and Impact Avoidance

The SEOC pit shell has had various revisions since an economic coal resource was identified. The mine design has at all times been cognisant of the potential for impact to Glennies Creek and the associated alluvium. The SEOC pit shell was shaped through the groundwater investigations and has been constrained on the western boundary to reduce potential flows into the pit and minimise groundwater impacts.

5.10.6.2 Monitoring

It is recommended that all groundwater discharges be monitored closely through the project life. This would include recording the volume and quality of water discharged from the mine and/or pumped from dewatering, or open-cut sumps. It is also recommended that the current baseline monitoring program be continued, with a modified network of selected monitoring points determined prior to commencement of mining.

Data collected will enable the SEOC to establish and continually assess the impact mining activities have on the groundwater environment. Collection of these data will also enable continual periodic review of any observed impacts against those predicted during numerical modelling, and will allow further refinement of the Model as the mine develops.

It is recommended that the proposed project monitoring program include recording of the following:

- Groundwater extraction volumes / rates – monthly totals from all open cut sumps (increased from weekly specified within the groundwater report to account for operational limitations).
- Groundwater extraction quality – monthly measurements on site of the EC and pH of water discharged from the mine and/or pumped from dewatering, or open-cut sumps.
- Quarterly sampling of water transferred from the mine or open-cut sumps for comprehensive hydrochemical analysis as detailed in **Table 5.27.**
- Monthly monitoring of water levels in the network of monitoring bores.
- Annual sampling of representative monitoring bores for laboratory analysis (as outlined in Table 5.27).

Table 5.27: Recommended laboratory analysis suite for groundwater monitoring.

Class	Parameter
Physical parameters.	EC, TDS, TSS and pH.
Major cations.	calcium, magnesium, sodium and potassium.
Major anions.	carbonate, bicarbonate, sulphate and chloride.
Dissolved metals.	aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, zinc.
Nutrients.	ammonia, nitrate, phosphorus, reactive phosphorus.
Others.	Fluoride, cyanide.

5.10.6.3 Review and Reporting

The above monitoring data will be subjected to an annual review by an approved experienced hydrogeologist to assess the impacts of the project on the groundwater resources, and compare impacts with the groundwater model predictions. Two years after the commencement of coal production, a modelling post-audit be carried out, in accordance with industry best-practice (MDBC, 2001), and if necessary the model be recalibrated and confirmatory forward predictions made at that time. Further post-audits should be carried out during the fourth or fifth year of mining, as this represents the most vulnerable time in relation to potential inflows from Glennies Creek.

Should any review or post-audit indicate a significant variance from the model predictions with respect to either water quality or groundwater levels, then the implications of such variance should be assessed, and appropriate response actions should be implemented in consultation with DII and DECCW (includes the former DWE) as appropriate.

These review and reporting actions will be incorporated in to the existing water management plan for the ACP to ensure the integrated management and monitoring or groundwater and surface water resources in the ACP and SEOC area.

5.10.6.4 Groundwater Response Plan

The SEOC will be integrated with the existing ACP Groundwater Management Plan (GWMP) developed (Ashton, 2009) that incorporates response plans in the event of unforeseen adverse impacts on either groundwater or surface water from the SEOC.

The sections below detail the criteria for how groundwater levels and water quality will be assessed in order to determine the need to implement mitigation actions as outlined in the Groundwater Response Plan.

It should be noted that, as groundwater levels and quality will naturally vary over time, the setting of specific trigger levels, for either quality parameters or water-levels, is not considered practical. For example, water levels will vary considerably across the area of the SEOC in response to natural climatic variations and recharge patterns, and due to the impacts of neighbouring mining projects. Likewise seasonal variations in water quality as a result of varying rates of recharge will occur.

It is recommended that the assessment is made based on the variation of levels and quality parameters from their recorded baseline range, combined with the recorded variation from predicted impacts (for those bores within the zone of influence of dewatering). Trigger levels will be set, for selected sites, to be applied during the initial stage of mine construction and Mining Years 1 to 3, after which time all trigger levels will be reviewed with reference to the baseline data records available at that time, and revised as appropriate through consultation with the DWE.

Water Levels

In the event that groundwater level drawdowns exceed predicted drawdowns by 20% or more for any consecutive three month period, then the monitoring data should immediately be referred to an approved Hydrogeologist for review. The reviewer should assess the data to establish the nature of the exceedence and the reasons for it, and should recommend an appropriate response action plan for implementation in consultation with DWE. The response action may involve one or more of the following:

- Modification to the mining plan, if appropriate.
- Continuation of mining, with closer monitoring.
- No change to the operations.

Pit Inflows

It is recommended that the volume of pit inflows during dry periods should be periodically assessed (at least twice per year), particularly on the western side of the pit. If dry weather inflows exceed anticipated inflows on the western side by more than 50%, then the data should immediately be referred to an approved Hydrogeologist for review, with outcomes and response plans as described for water levels above.

The staged mine plan allows time to implement mitigation measures should the inflows be higher than anticipated. Potential mitigation measures include:

- Construction of a low permeability cut-off wall, possibly comprising bentonite or natural clays emplaced in a trench keyed into the underlying low permeability Permian rocks. Such a trench would not be required at the start of mining as the northern section of the proposed mine does not intersect saturated unconsolidated sediments.
- Increase the rate of backfill, and or backfill against the highwall with a low permeability material (such as clay).
- If the above measures are not successful, or feasible, increase the distance between the western batter of the open cut from Glennies Creek.

Groundwater Quality

Salinity decreases noted in either the alluvium monitoring bores, mine inflows or dewatering discharge, would suggest dewatering impacts to Glennies Creek alluvium.

Should the water quality of the monitoring piezometers (alluvium) mine inflows or dewatering discharge indicate a decrease in salinity of more than 50% from base line levels, it is recommended that the nature of the decrease and all relevant monitoring data be provided to an approved experienced Hydrogeologist for review and assessment of the impact on the environment.

If remedial action is recommended by the reviewer on the basis of the changes in water quality, the recommended action will be implemented in consultation with, DII and DECCW as appropriate. It is envisaged that the remedial action may include one or more of the following:

- Modification to the mining plan, if appropriate.
- Continuation of mining, with closer monitoring.
- No change to the operations.

5.11 Surface Water

WorleyParsons Services Pty Ltd was engaged to undertake a surface water assessment of the SEOC project.

A copy of the report is contained in **Appendix 6** in Volume 4.

5.11.1 Assessment Methodology

The surface water assessment methodology to assess the impacts of the SEOC project is briefly outlined as follows:

- Research and collect available information on the existing environment to assist in the study, including aspects such as: stream gauge readings, climate data, surface water quality information, catchment topography.
- Review statutory requirements.
- Develop RAFTS model to determine the existing catchment characteristics.
- Develop an understanding of the SEOC project and its potential impacts to surface water.
- Develop water balance for the SEOC and existing ACP to understand water demand and storage requirements.
- Develop a conceptual water management plan to adequately manage surface water and reduce impacts to the receiving environment.
- Assessment of the cumulative impacts to the surface water environment.
- Develop monitoring and reporting procedures to ensure potential impacts are avoided, identified, managed and ameliorated.

The following sections provide a summary of the above components of the surface water assessment for the SEOC project.

5.11.2 The Existing Surface Water Environment

The SEOC project is located within the lower reaches of the Glennies Creek (or Fal Brook) catchment, a large sub-catchment of the Hunter River. Several smaller unnamed tributaries exist within the SEOC project area.

5.11.2.1 Glennies Creek

Catchment Description

The SEOC project is located within the lower reaches of the Glennies Creek (or Fal Brook) catchment. Glennies Creek is approximately 45km long and flows from its headwaters at Mount Royal (1184m AHD) to the Hunter River (50m AHD). Glennies Creek has a catchment of approximately 515km^2 of which approximately 40% is impounded within Lake St Clair (Glennies Creek Dam) approximately 20km north-east of the SEOC.

The Glennies Creek dam was built in 1983 and has a capacity of 283,000 ML. The dam has a significant impact on flows in Glennies Creek, with regulated flows being released to maintain sufficient environmental flows.

The Glennies Creek Catchment is generally characterised by agricultural properties with some remnant forest, and two operating coal operations (the ACP and the Integra Complex) undertaking both open cut and underground coal mining.

Glennies Creek confluences with the Hunter River approximately 2.0km south of the SEOC.

Glennies Creek Flow

The Middle Fal brook stream gauge has been operating since 1955 and provides a reliable record of stream flows prior to and after the construction of the Glennies Creek Dam. Prior to the construction of Glennies Creek dam, flows in the creek were characterised as follows:

- 10% of the recorded flows were 0.0ML/day.
- 50% of the recorded flows were less than 32.1ML/day.
- 90% of the recorded flows were less than 312.2ML/day.
- Average recorded flows were 228ML/ day.

Following the construction of the dam, flows in the creek were characterised as follows:

- 10% of the recorded flows are less than 20.7ML/day.
- 50% of the recorded flows are less than 61.6ML/day.
- 90% of the recorded flows are less than 228.5ML/day.
- Average recorded flows are 152ML/ day.

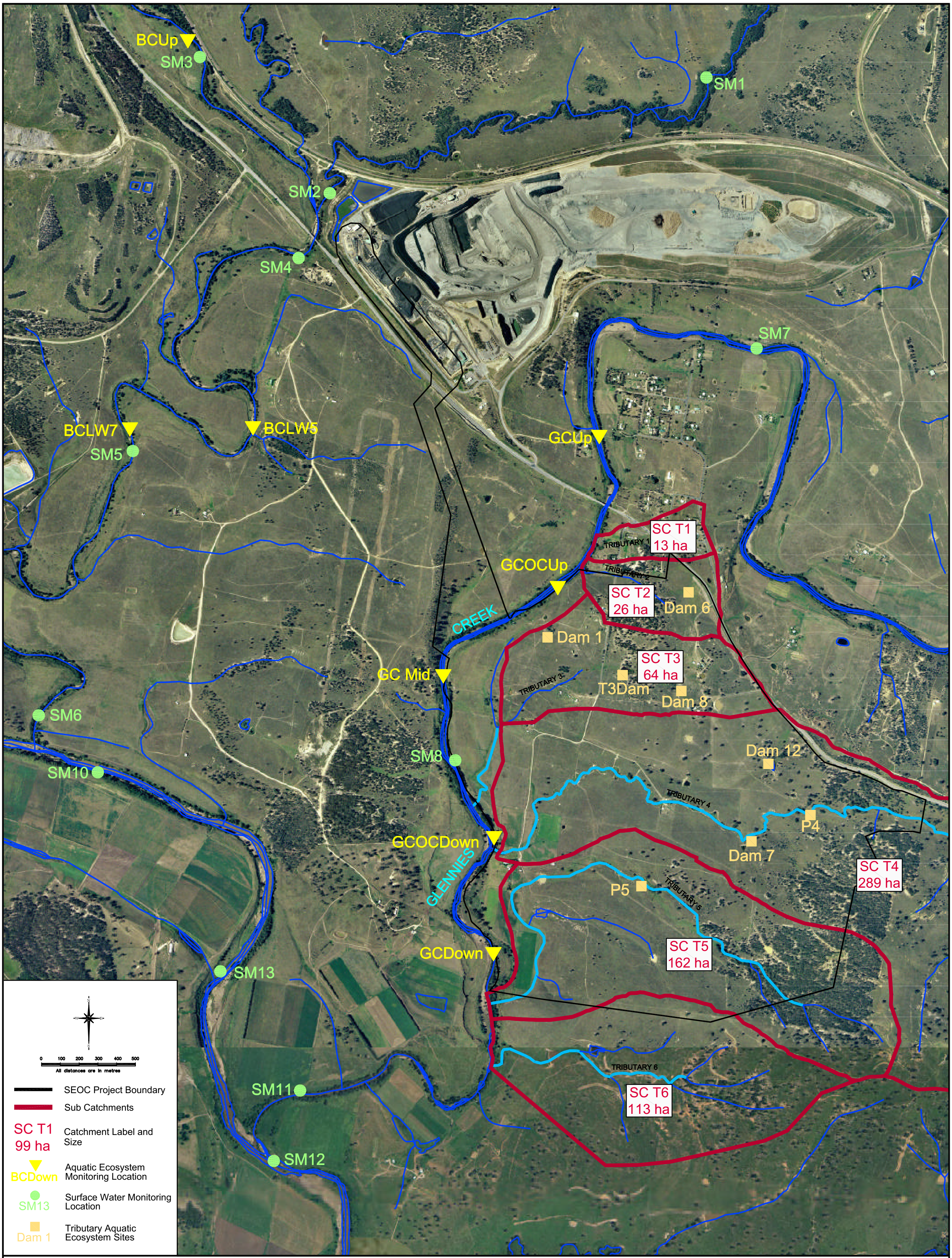
The construction of the dam has stabilised creek flows increasing the low flow and 50 percentile volumes but has reduced the overall average and peak flows.

5.11.2.2 Local Unnamed Tributaries

The SEOC is located on the eastern side of Glennies Creek, where six (6) unnamed tributaries drain generally in a westerly direction to Glennies Creek. The tributaries consist of first and second order streams. The streams have been numbered sequentially from north to south for the purposes of identification. **Table 5.28** details the key attributes of the six streams, while **Figure 5.23** illustrates their location.

Table 5.28: Local unnamed tributaries in the SEOC area.

Name	Order (Strahler System)	Catchment Size	Key Features
Tributary 1 (T1)	-	13ha	No well defined channel, not shown on 1:25,000 topographic map, catchment includes New England Highway. One small farm dam.
Tributary 2 (T2)	1st	26ha	No well defined channel, catchment rural and vegetated lands. Catchment includes New England Highway. One small farm dam.
Tributary 3 (T3)	1st	64ha	No well defined channel, catchment rural and vegetated lands. Catchment includes New England Highway. One small farm dam.
Tributary 4 (T4)	2nd	289ha	Largest catchment in project area. Well defined channel, extends over 3km to the east. Numerous small, primarily offline, dams in the catchment. Upper portion of tributary in good condition, well vegetated and little erosion. Lower portion moderately degraded, with stream bed erosion and erosion prevalent in catchment. Consists of a series of deep pools connected by open channel, water in pools varies and is likely to dry up in times of low rainfall. Has a starting elevation of 170m AHD in the east to less than 60m on Glennies Creek.
Tributary 5 (T5)	2nd	162ha	Rural, vegetated on the upper slopes. Two online farm dams.
Tributary 6 (T6)	2nd	113ha	Cleared rural lands, several online farm dams. Predominantly south of the SEOC and will not be directly impacted by the development.



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South East Open Cut Project

Local unnamed tributaries, surface water and aquatic sites in the SEOC Project Area

Worley Parsons

Figure 5.23

Plan 47

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5.11.2.3 Surface Water Quality

ACOL have operated a water quality monitoring program since 2004 as part of the existing ACP operations, pursuant to an approved Water Management Plan (WMP).

The monitoring program includes three (3) sites on Glennies Creek and five (5) sites on the Hunter River, refer to Figure 5.23. These sites are monitored on a monthly basis for:

- pH and Electrical Conductivity (EC).
- Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).
- Total Hardness/ Alkalinity.
- Oil and Grease.

Results of the monitoring program for these sites are presented in **Table 5.30** (over page).

The monitoring indicates that water quality within Glennies Creek is consistently better than that of the Hunter River. Average electrical conductivity, TDS, TSS and alkalinity observations are 30% to 50% lower in Glennies Creek. This is likely to be attributed to the two catchments and the relative base flows. Lake St Clair (or Glennies Creek Dam) is at the headwaters of Glennies Creek and captures water from a relatively pristine catchment. This water is then released in controlled flows, improving the overall quality of the water.

Water quality results were generally within the ANZECC trigger value for lowland rivers, and are also generally consistent with the *Integrated Hunter Catchment Management Plan for the Hunter River Catchment, 2003.*

5.11.2.4 Surface Water Users

The proposed SEOC site is located adjacent to Glennies Creek in the lower section of Zone 3a of the Hunter Regulated Water Source. There are approximately 1500 water extraction licenses within the total Hunter Regulated Water Source.

Licence information for the properties located in the local vicinity of the SEOC project are tabulated in **Table 5.29.**

Table 5.29: Water extraction licences in the local vicinity of the SEOC.

WAL	Licence	Uses	Source	Total Allocation (ML/Yr)	Sub-Category
10354	20AL201200	Irrigation	Hunter River	195	General Security
10355	20AL203011	Irrigation	Hunter River	92	Supplementary
13381	20AL201348	Diversion Works	Glennies Creek	6	High Security
13382	20AL201349	Diversion Works	Glennies Creek	156	General Security
990	20AL201293	Farming	Hunter River	3	High Security
991	20AL201294	Irrigation	Hunter River	888	General Security
13389	20AL201716	Irrigation	Glennies Creek	120	General Security
Water Extraction Licenses currently used by ACOL #					
997	20AL201311	ACOL Mining operation	Glennies Creek	11	High Security
8404	20AL200491		Glennies Creek	80	High Security
15583	20AL204249		Glennies Creek	354	General Security
1358	20AL203056		Glennies Creek	4	Supplementary
1120	20AL201624		Hunter River	3	High Security
1121	20AL201625		Hunter River	335	General Security
6346	20AL203106		Hunter River	15.5	Supplementary
# ACOL control additional irrigation licences on Bowmans Creek, and some domestic and stock licences as a result of lands purchased by ACOL, but are not used for operations.					

Table 5.30: Water quality results ending May 2009 for the Hunter River and Glennies Creek near the SEOC.

	Monitoring Locations	Site No.	pH			EC (µS/cm)			TDS (mg/L)			TSS (mg/L)			Alkalinity (mg/L CaCO3)			Oil & Grease (mg/L)		
			10% tile	90% tile	Average	10% tile	90% tile	Average	10% tile	90% tile	Average	10% tile	90% tile	Average	10% tile	90% tile	Average	10% tile	90% tile	Average
Glennies Creek	Upstream of Camberwell	SM 7	7.5	8.1	7.8	223	639	393	13.0	230.6	152.1	5.0	22.6	14.5	75.4	165.7	108.9	0.0	5.0	3.8
	Adjacent to SEOC	SM 8	7.5	7.99	7.8	235	704	394	13.7	239.9	153.1	8.0	39.3	18.8	77.0	157.2	107.1	0.0	5.0	3.9
	Upstream of Hunter river confluence	SM 11	7.7	8.1	7.9	236	690	396	14.0	226.5	151.7	6.0	25.8	14.0	75.4	181.9	110.8	0.0	5.0	3.9
	Middle Fall Brook Stream Gauge					240	588	403												
Hunter River	Upstream of Bowmans Creek	SM 9	7.9	8.3	8.1	550	1039	753	23.7	504.4	289.5	6.7	36.3	24.7	159.9	305.7	227.8	0.0	5.0	3.7
	Downstream of Bowmans Creek	SM 10	7.9	8.4	8.2	571	1063	779	21.4	536.0	300.8	6.0	42.3	25.2	165.5	310.6	230.5	0.0	5.0	3.8
	Midway between Bowmans and Glennies Creeks	SM 13	7.9	8.3	8.2	561	1060	764	20.7	475.2	289.7	7.7	42.7	27.5	164.1	292.5	226.3	0.00	5.0	3.8
	Upstream Glennies Creek Confluence	SM14	7.9	8.4	8.2	621	1060	832	18.4	533.2	239.6	8.8	56.4	32.5	176.8	333.8	249.1	0.0	5.0	2.6
	Downstream of Glennies Creek Confluence	SM 12	7.7	8.2	8.0	248	820	519	18.7	317.6	190.5	6.7	34.5	22.1	84.0	241.3	154.9	0.0	5.0	3.7
WQ Guidelines	ANZEC –Default trigger values for lowland rivers		6.5-8.0			125-2200 µS/cm for East Coast of Australia 200-300 µS/cm for coastal rivers in NSW			NA			NA			NA			NA		
	Integrated Catchment Management Plan for the Hunter River		NA			P50 Salinity < 670µS/cm P80 Salinity < 920µS/cm At Singleton			NA			NA			NA			NA		

5.11.3 Conceptual Surface Water Management

This section details the conceptual surface water management strategy to be employed across the SEOC project. A schematic of the water management system is shown by **Figure 5.24**.

5.11.3.1 Surface Water Management Objectives

The objectives of water management for the SEOC project are as follows:

- Minimise the disturbance area throughout the life of the mine.
- Where practical, separate clean water, sediment laden water and mine water circuits within the mine site.
- Collect clean water runoff from the upper portion of Tributary 4 and 5 catchments that would otherwise drain through the site and become contaminated.
- Provide sedimentation treatment for all runoff from disturbed areas.
- Store and re-use all mine water generated from the mine operation.
- Undertake monitoring to confirm the water management plan is operating in accordance with its design objectives.
- Where required provide erosion control measures such as drop structures and channel armouring to protect channel stability.
- Develop a drainage solution that is consistent with the design objects of the staged and final landform of the mine.

5.11.3.2 Surface Water Management Strategy

Clean Water

Clean water is surface water runoff from undisturbed and fully rehabilitated areas. Clean water can be discharged into Glennies Creek without any treatment.

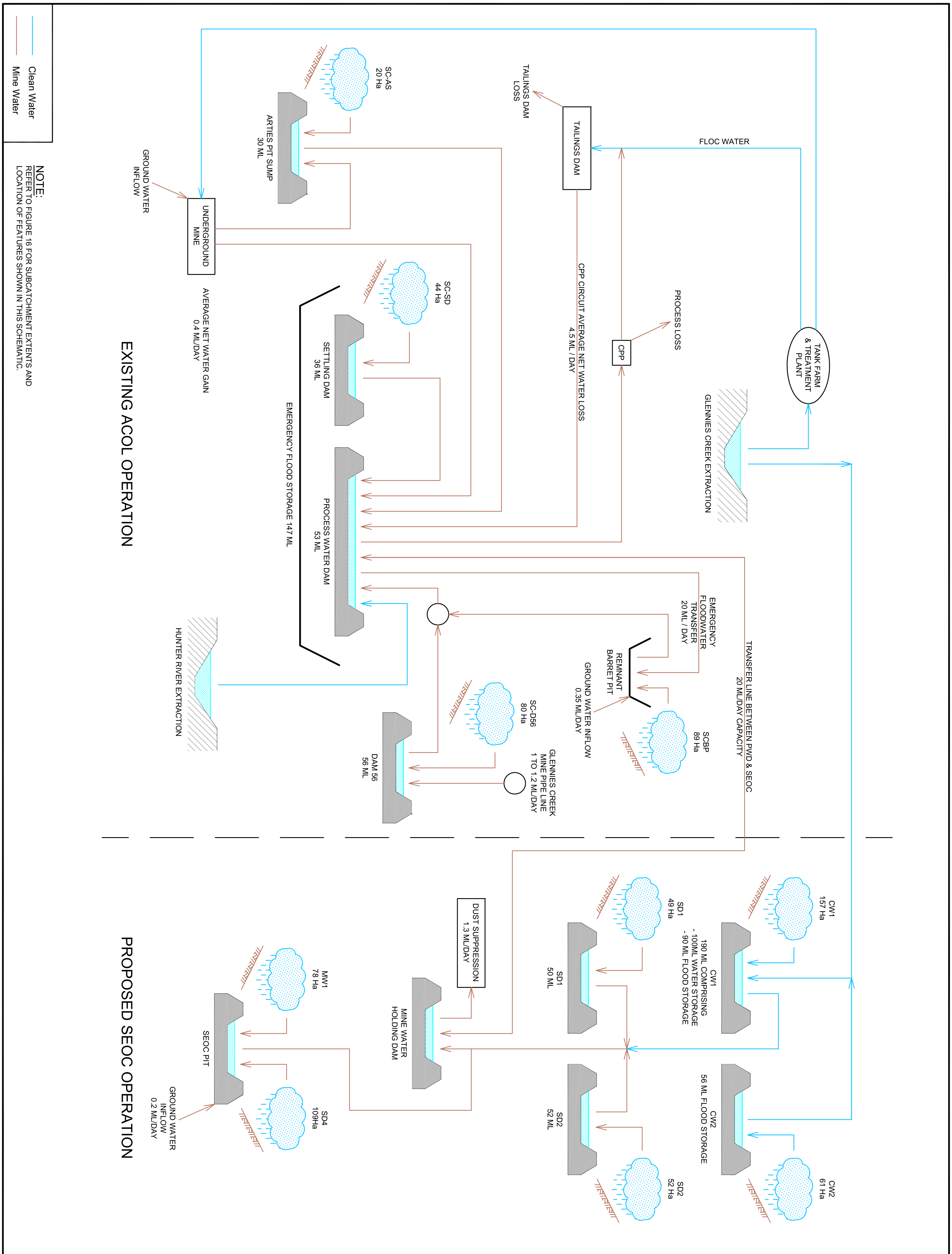
A network of clean water drains will be established to collect and convey clean water runoff around the proposed disturbed areas. The clean water diversions will limit the volumes of mine and sediment laden water as well as minimise the volume of runoff captured by the mining operation.

Tributaries T4 and T5 start upslope of the SEOC. To prevent water ingress from these catchments it is proposed to construct two clean water dams in each respective catchment. The dams will have the following functions:

- Provide flood mitigation by capturing water from events up to a 1 in 20 year, 12 hour event. Water in excess of storage capacity will overtop across a spillway and enter the mine water circuit. Dams will be accompanied by pumping infrastructure to allow the transfer of clean water directly into Glennies Creek.
- The dam in the T4 catchment (CW1) will provide 100ML of clean water storage in addition to the flood mitigation capacity for operational uses. To provide flood mitigation and water storage the dam will have a capacity of 190ML. Water in excess of the 100ML within the dam will be transferred directly to a discharge location on Glennies Creek, to ensure sufficient capacity for another event.

All clean water drains are designed to convey the peak 100 year ARI flow.

Risks associated with limiting the containment of CW1 to a 1 in 20 year ARI event has been assessed within Section 6.5.4 of the Surface Water Assessment. The assessment concluded that water flows into the SEOC during events greater than 1 in 20 year will result in some operational delays, however it is considered these delays can be adequately managed through operational practices.



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South East Open Cut Project

Water management system for the Ashton Coal Project, including the SEOC

Worley Parsons

Figure 5.24

Plan 48

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Sediment Laden Water

Runoff from disturbed areas is likely to have elevated levels of suspended sediments. Suspended sediments are the result of an increase in soil loss rates from exposed or partially exposed areas. Sediment laden water catchments will generally consist of shaped overburden areas where rehabilitation has commenced, but is not complete.

Sediment dams will be sized to capture a 1 in 20 year ARI 12 hour design storm, with an additional sediment storage volume equal to half the runoff retention volume to cater for incoming sediment. The sediment catchment drains will be designed to convey a 100 year peak flow rate, with appropriate scour protection (*i.e. jute mesh or rock armouring, depending on the velocities*) as required.

Sediment dams are required as an interim measure to protect receiving waters from sediment laden runoff from disturbed areas. Sediment laden water can be treated using gravity settlement using a holding dam. Once the contributing catchments are fully rehabilitated, the sediment dam can be removed to allow the catchment runoff to discharge into the receiving waters.

It is proposed to re-use water captured within the sediment dams for either dust suppression or process water for the processing of coal. However, during extended periods of rainfall or during a significant storm event (*i.e greater than a 20 year ARI storm*), some overflow from the dams may occur. If overflow does occur, the sediment dams would facilitate the removal of the majority of the coarse sediment through gravity settlement.

Mine Water

Mine water is considered to be the most contaminated water on a mine site. The primary contaminant is elevated salt levels, which arise from contact with both coal and saline overburden material. Mine water can also be acidic (*low pH*), however, as discussed in *Section 5.15*, the pit floor, overburden and washery rejects are expected to be non acid forming overall.

Mine water catchments are principally all catchment areas draining to the open pit, as well as all haul roads and ROM storage areas. As the base of the open cut is the lowest point on the site, all groundwater inflow and seepage through the overburden will seep into the pit.

Mine water will be generated from the workshop facilities that will include vehicle wash down and maintenance areas, as well as fuel storage and refuelling areas. Runoff from these areas will be treated in an appropriately sized sedimentation chamber and an oil and grease separator prior to being either recycled or discharged into the mine water circuit.

It is proposed to use all mine water within the mining operation, principally for dust suppression (where quality is acceptable) and process water for the coal processing plant. In addition, some mine water will be lost through evaporation. During major storm events, excess mine water will be pumped to the final void of the Barrett Pit within the NEOC (refer to Figure 4.2, 4.3, and 4.5 or Plans 5, 6 and 8 in Volume 2 for its location) that will provide over 2,000ML of contingency storage.

Potable Water

Potable water refers to water used for human consumption. It is proposed to import potable water from external sources. Potable water will be stored onsite and distributed through an isolated network.

The existing ACP operations require on average 20,000L per week for potable water supplies delivered by two (2) 10,000L water trucks. This water is sourced from a local licensed water contractor that utilises the Singleton reticulated water network.

The SEOC Project will be a continuation of the existing potable water supply arrangements importing up to 20,000L per week from the Singleton reticulated water supply.

5.11.3.3 Conceptual Surface Water Management Plans

Construction Phase

Erosion and sediment control measures will be implemented during the construction phase of the SEOC project to control the quality of runoff from the site. These measures will include:

- Construction and regular maintenance of catch drains, silt fences and sedimentation ponds to contain sediment downslope of disturbed areas.
- Revegetation and landscaping of construction areas during and following construction.
- Development of an appropriate inspection, maintenance and management system.
- Placement of oil management systems downslope of high trafficked hardstand areas and storage areas.

Operational Phase

The conceptual water management strategy for the SEOC project was developed for Year 1, Year 3, Year 5, Year 7, Year 9 and the final landform in Year 18, as shown in **Figure 5.25**, **Figure 5.26**, **Figure 5.27**, **Figure 5.28**, **Figure 5.29** and **Figure 5.30** respectively. **Table 5.31** details the prevailing features of each plan.

It should be noted that these water management plans are based on mining occurring at maximum production rates. Should the rate and mine progress be reduced, the accompanying water management would also be delayed.

ACOL are committed to an ongoing progressive rehabilitation plan where each year the overburden is revegetated reducing sedimentation. The maintenance of existing erosion and sediment controls and construction of new controls will be undertaken each year as required.

As discussed in *Section 4.4.5*, ACOL intend to trial the Natural Regrade with GeoFluv™ (Carlson Software) software (or similar) in the development of the final landform for the SEOC out of pit emplacement. The Regrade software utilises overburden materials, relief, and climate to achieve a stable landform, where resulting slopes and stream channels are stable because they are in balance with these conditions. It is an alternative to uniform slopes, terraces and drop structures (Carlson Software 2009). The successful implementation of the Regrade software will result in alternative landforms and water management structures to those contained in the presented water management plans, resulting in a more successful, long term and natural appearing drainage design. This trial is being undertaken in conjunction with an ACARP project of which the Department of Primary Industries is an active participant.

Table 5.31: Key details of the surface water management plans for the SEOC.

Mine Year	Key Features	Comments
1	• Construction of all facilities and infrastructure. • Construction of Stage 1 of the levee. • Construction of clean water diversions. • Construction of sediment and mine water catchment drains. • Mine Water Dam 1 (MW1) – 166ML • Sediment Dams (SD) constructed as follows: - SD1 – 50ML - SD2a – 19ML - SD3 – 6ML • Clean water dam (CW1) constructed at 190ML (100ML storage + 90ML in flood attenuation) in the Tributary 4.	MW1 will be decommissioned when available space is made within the open cut pit in about Year 2. SD1 receives water that overflows from CW1.

Mine Year	Key Features	Comments
3	• Construction of Stage 2 of the levee. • Construction of clean water diversions. • Construction of sediment and mine water catchment drains. • Sediment Dams (SD) constructed as follows: - SD2b - 33ML	
5	• Construction of the final stage of the levee. • Construction of sediment and mine water catchment drains. • Clean water dam (CW2) constructed at 56ML in the Tributary 5.	
7	• Construction of sediment and mine water catchment drains. • Initial stages of the proposed Tributary 4 reinstatement will be undertaken. • Sediment dams installed in Years 1 and 3, depending on rehabilitation and water quality may be decommissioned.	Final year of mining.
9	• Water management consistent with Year 7.	Void used for tailings storage.
18	• Removal of ROM facility pad. • Re-establishment of drainage lines. • Removal or significant reduction in all dam sizes. • Final stages of the proposed Tributary 4 reinstatement will be undertaken.	Tailings storage capped.

5.11.4 Site Water Balance

A detailed site water balance model was prepared to assess both the drought security of the existing ACP and SEOC operations as well as the capacity to manage surface water runoff volumes during periods of high and extreme rainfall.

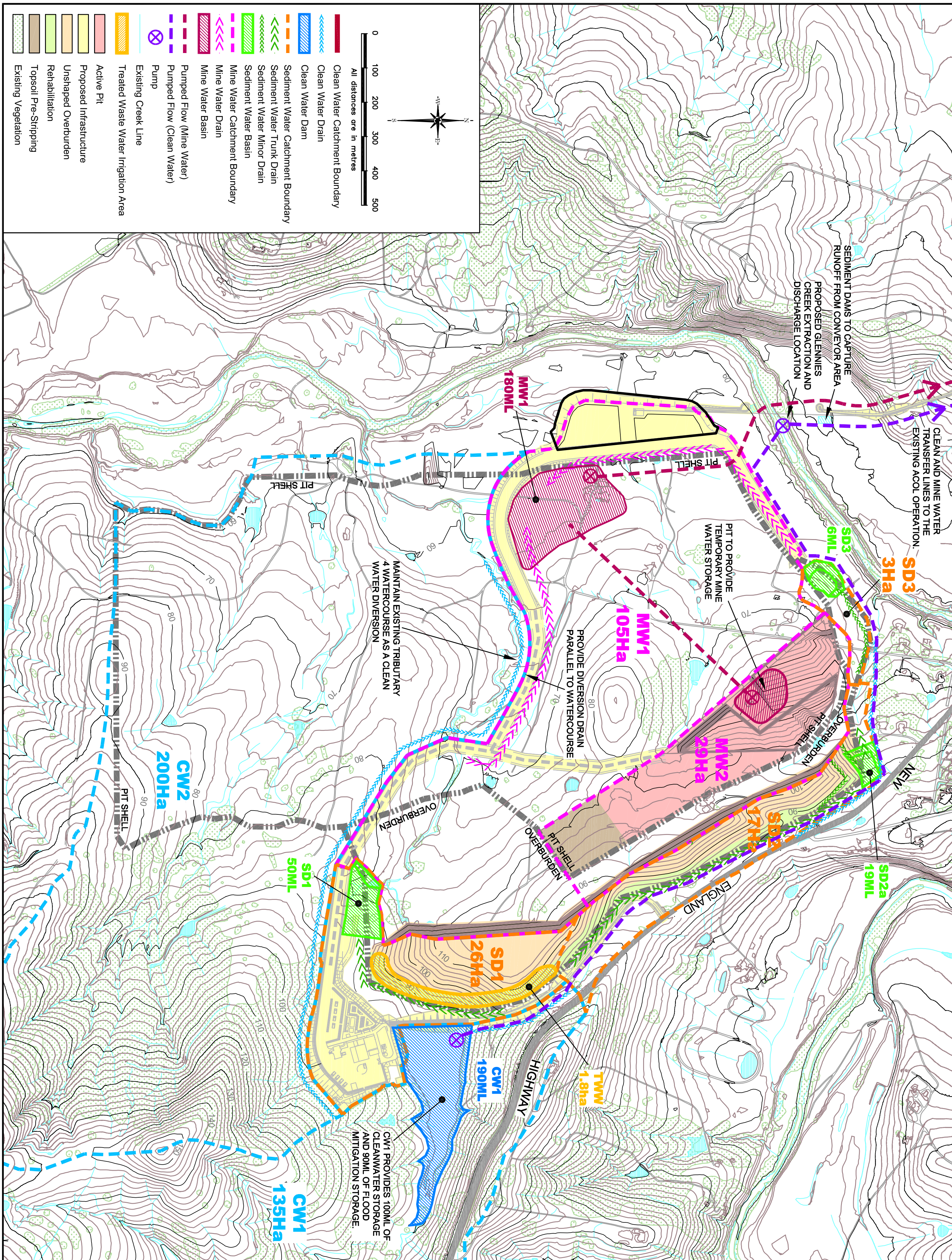
The model has been developed over the last 2 years at the existing ACP operations, and has been calibrated using data from the exiting ACP over an 18 month period. Key features of the model are as follows:

- A simplified SIMHYD rainfall and runoff model that simulates surface and baseflow runoff, taking into account soil moisture.
- All water demands and sources.
- Accommodates water transfers between storages.
- Runs on a daily time step utilising daily rainfall and runoff.
- 105 year simulation period to allow a comprehensive understanding of the mine within long term rainfall trends (i.e. drought, average and flood conditions).
- Utilises basic assumptions on water licence allocations and associated restrictions where rainfall in catchment is limited.

A schematic of the site water balance is illustrated in Figure 5.24.

Water demands have been calculated based on the maximum peak production rate from the entire ACP operation, including the proposed increase in underground mine production to 5Mtpa of ROM coal. With the addition of the SEOC this will result in 8.6Mtpa of ROM coal.

Table 5.32 provides a summary of the water balance parameters, where Year 3 and Year 7 were modelled to provide an accurate representation of the water balance. Year 3 effectively represents years 1 to 3, while Year 7 represents Years 4 to 7.



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South East Open Cut Project

Conceptual water management plan for Year 1 of the SEOC

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Figure 5.25

Plan 49

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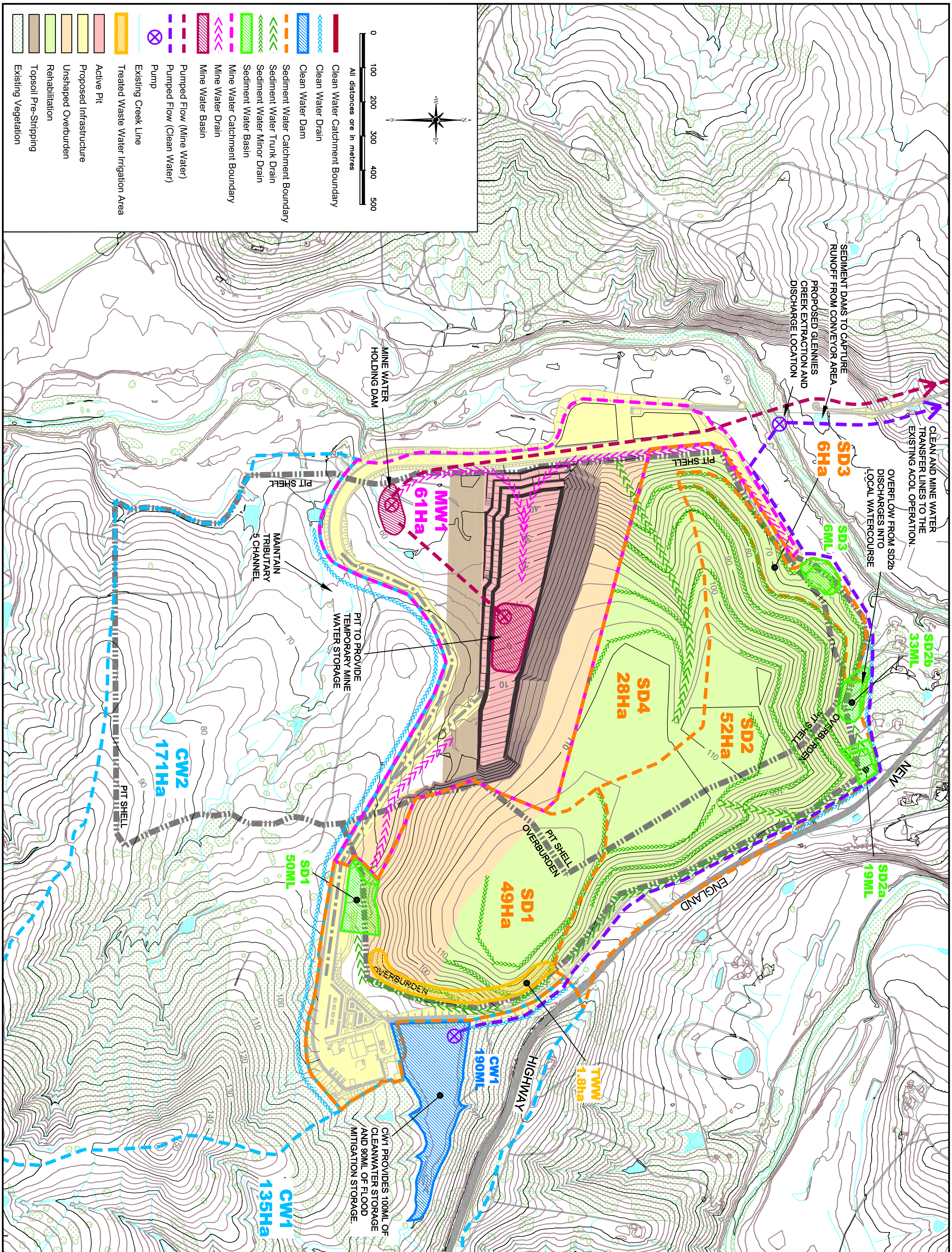

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South East Open Cut Project

Conceptual water management plan for Year 3 of the SEOC

Worley Parsons

Figure 5.26

Plan 50

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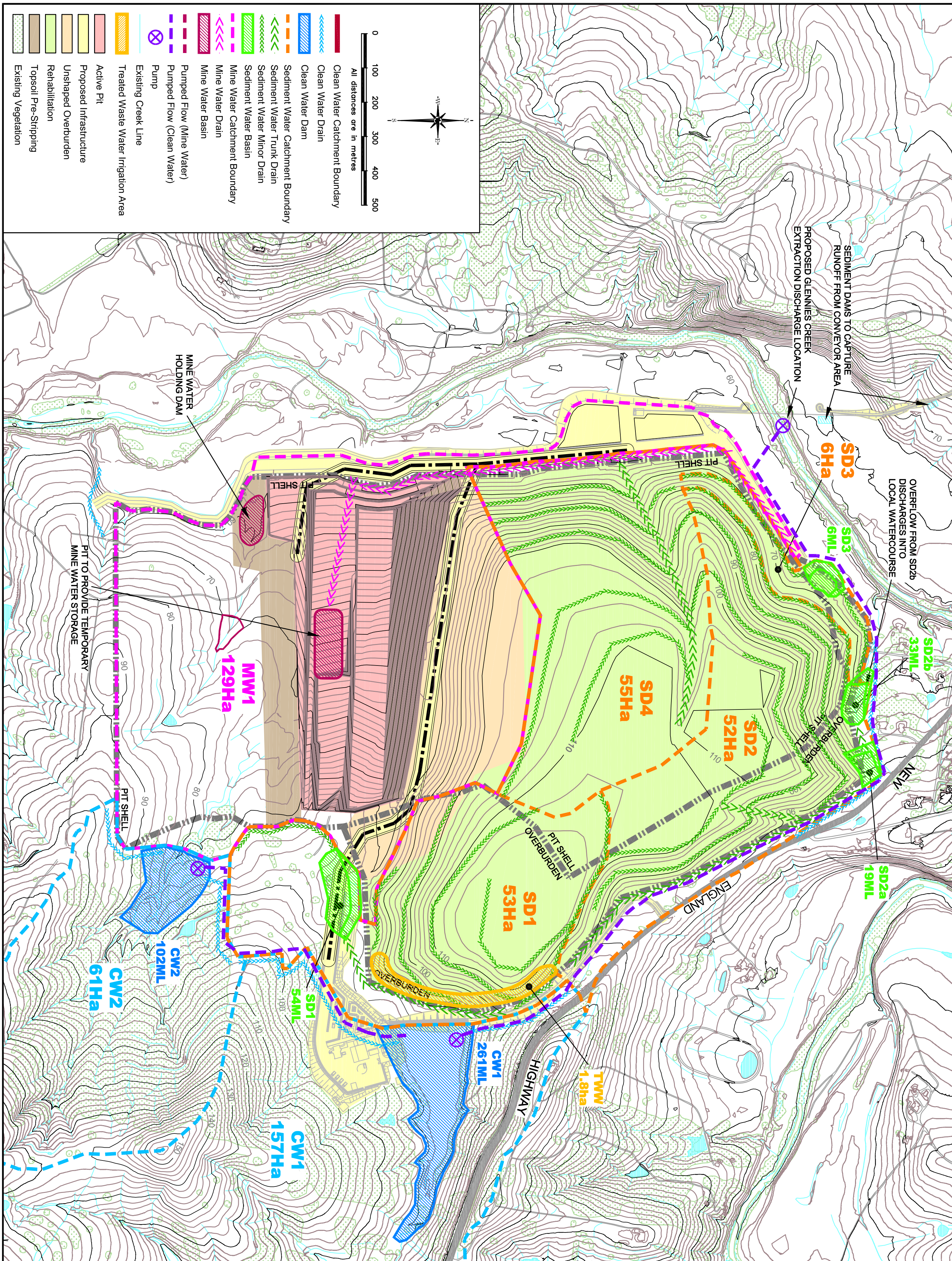

South East Open Cut Project

Conceptual water management plan for Year 5 of the SEOC

Worley Parsons

Figure 5.27

Plan 51

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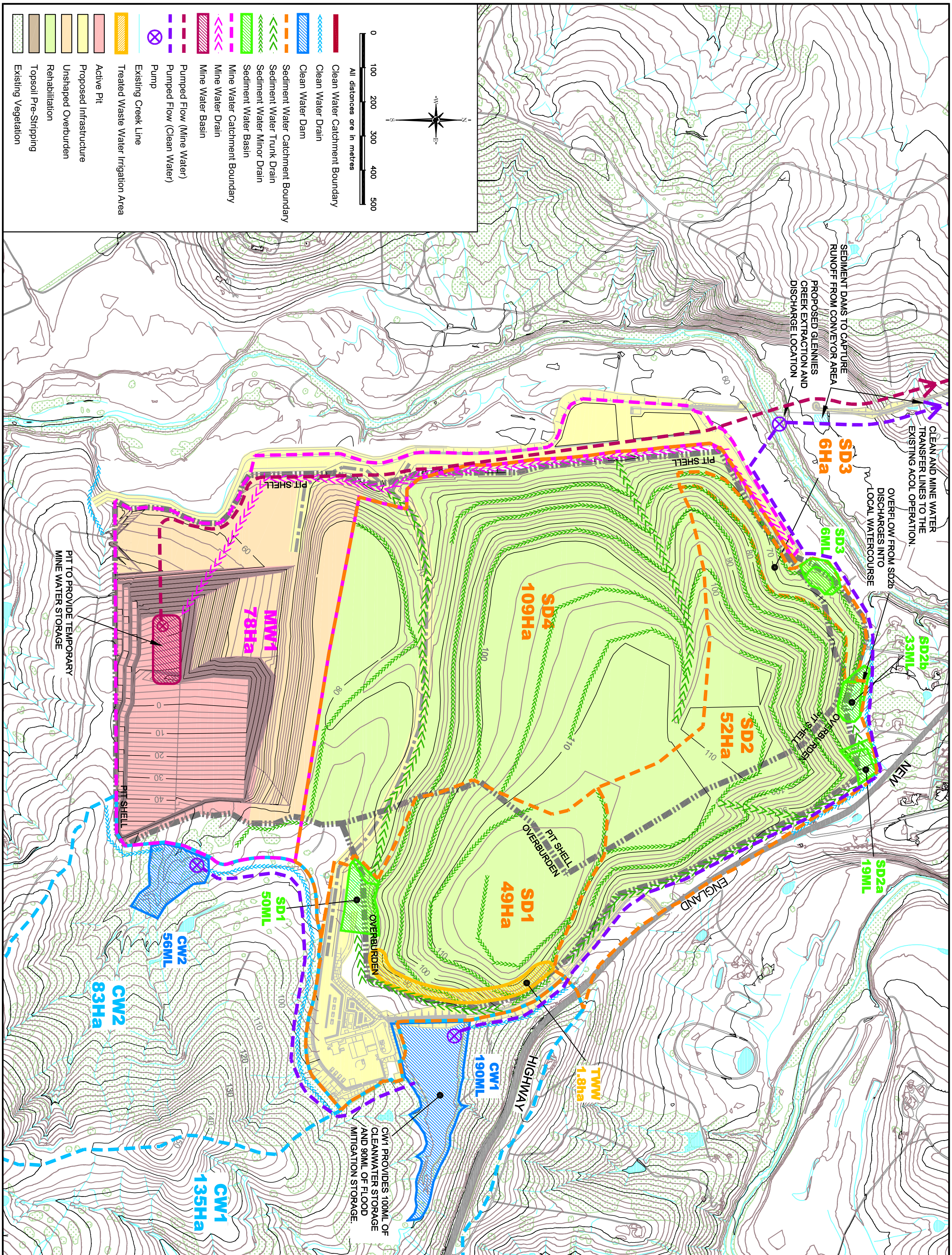

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South East Open Cut Project

Conceptual water management plan for Year 7 of the SEOC

Worley Parsons

Figure 5.28

Plan 52

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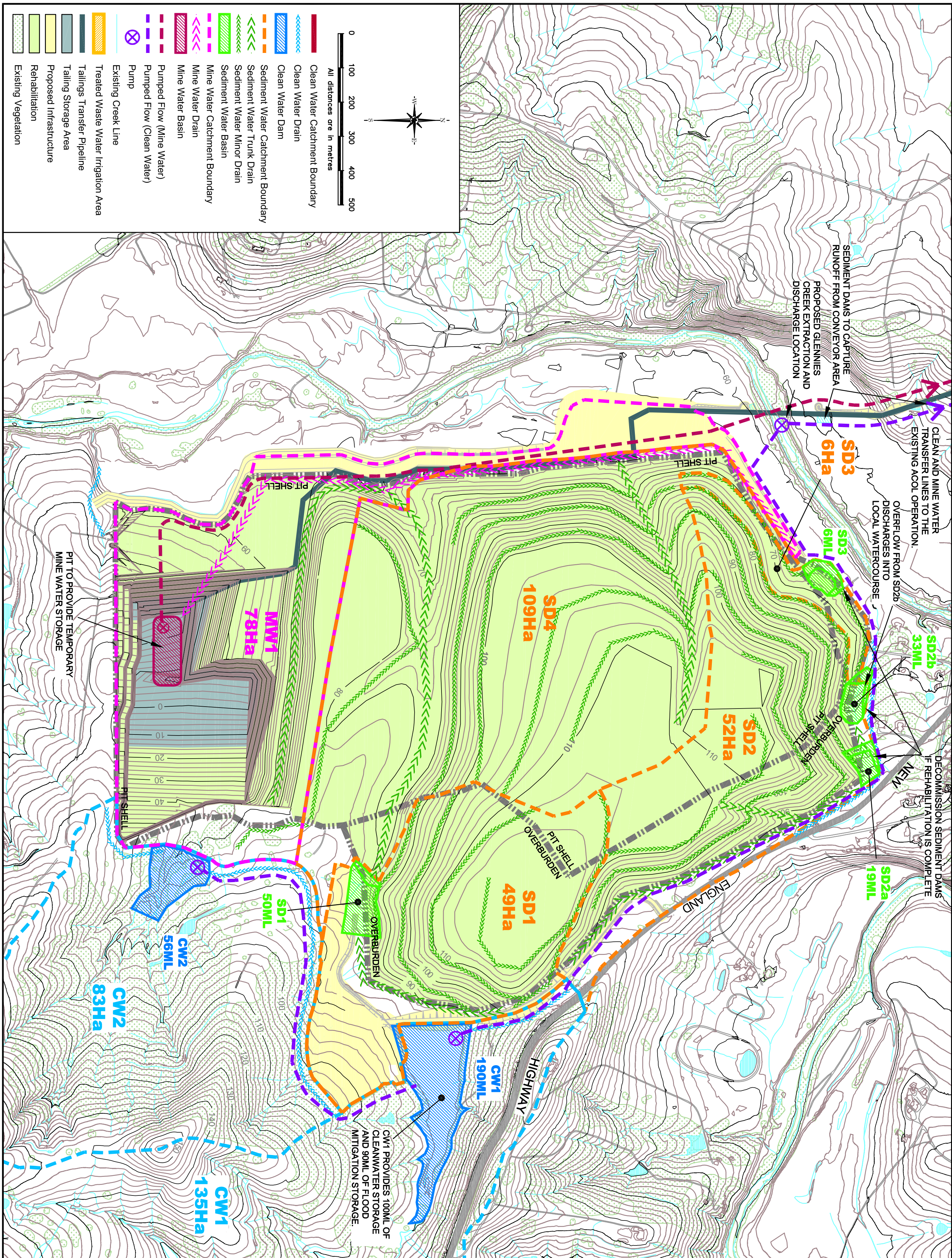

South East Open Cut Project

Conceptual water management plan for Year 9 of the SEOC

Worley Parsons

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Figure 5.29

Plan 53

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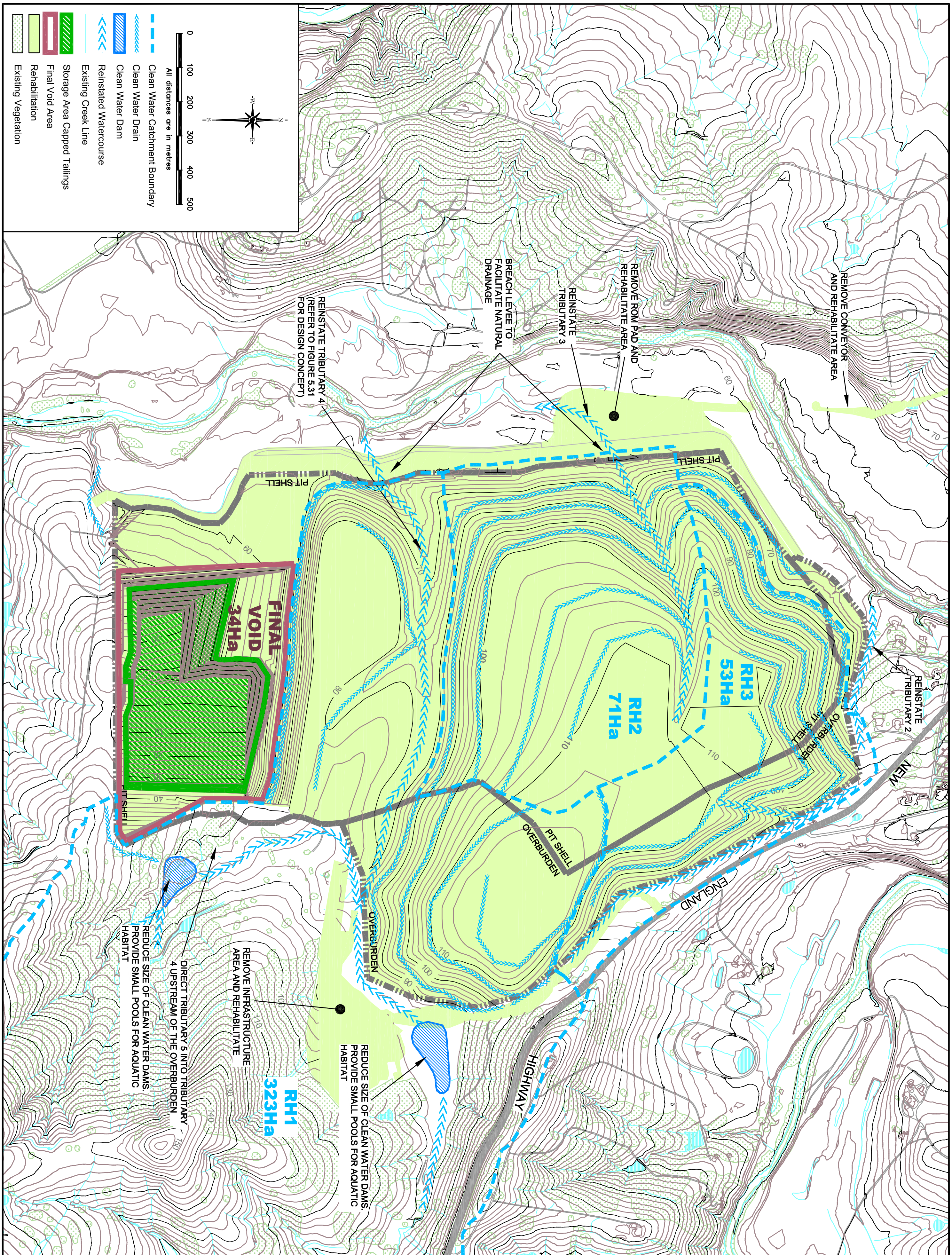

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South East Open Cut Project

Conceptual water management plan for Year 18 of the SEOC

Worley Parsons

Figure 5.30

Plan 54

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Table 5.32: Adopted water balance parameters for the existing ACP and SEOC.

	Year 3 (Generally applies to Years 1 – 3)	SEOC Year 7 (Generally applies to Years 4 – 7)	Post SEOC
Water Demands			
Dust Suppression	1.3 ML/day		0 ML/day
CPP	4.5 ML/day		3.0 ML/day
Total Demand	5.8 ML/day		3.0 ML/day
Water Sources			
Net water make from underground mine	0.4 ML/day (rate expected to increase in line with EIS as mining advances)		
Water received from Glennies Creek mine	1.2 ML/day		
Licensed Extraction	Up to 712 ML/year		
Seepage into SEOC^^	0.2 ML/day	0.2 ML/day	
Total Water Sources	1.8ML/day and up to 712 ML/year	1.8ML/day and up to 712 ML/year	
Surface Runoff – Contributing Catchment Areas			
Existing operation	233ha		
SEOC	378 ha	512 ha	
Total Contributing Catchment Area	611ha	745 ha	
^^ Refer to *Section 5.10.5* for further information on pit inflows.			

5.11.4.1 Drought Security

It is anticipated that the total ACOL operation will have an average daily water demand of approximately 5.8 ML/day when at peak production. As detailed in Table 5.32 approximately 1.8ML/day of water is received from sources such as pit seepage, water received from Glennies Creek Mine and surplus water from the underground. The remaining 4ML/day is to be sourced from rainfall dependant sources, such as harvesting surface water runoff and licensed extraction from Glennies Creek and the Hunter River.

The water balance model was used to determine the drought security of the proposed ACOL over the 105 year simulation period, taking into account a range of rainfall events, and includes predicted reduced licensed extraction availability during dry periods.

The drought security for each of the scenarios detailed in **Table 5.33** was assessed using the water balance model. For each scenario, the percentage of months where demand is fully satisfied, as well as the 50th, 70th and 90th percentile demand deficits (*i.e the volume of demand not met*) have been shown.

Table 5.33: Site water balance for wet, average and dry years.

Year of Operations	Year 3		Year 7		Year 9 - Post SEOC Mining	
Percentage of months demand is fully satisfied	35%		41%		97%	
Monthly Demand (ML/month)	180		180		93	
Estimated Demand Deficit	Demand Deficit (ML/month)	Percentage of Total Demand	Demand Deficit (ML/month)	Percentage of Total Demand	Demand Deficit (ML/month)	Percentage of Total Demand
50th Percentile	14	7%	5	3%	0	0%
70th Percentile	58	32%	44	25%	0	0%
90th Percentile	104	58%	99	55%	0	0%

With reference to Table 5.33, the water balance model estimates that the ACOL operation would have sufficient water to fully meet the estimated monthly demand in approximately 35% of months in the Year 3 scenario and 41% of months in the Year 7 scenario, when mining and processing at peak rates. The increase in water availability (i.e. 35 to 41%) is the result of an increased catchment area as the SEOC pit progresses to the south. In the post SEOC scenario, the water demand is reduced (i.e. no open cut mining or processing of coal from the SEOC) and the estimated percentage of months where demand is fully satisfied increases to 97%. The estimated magnitude of the predicted water deficits ranges from 58% of total demand in the 90th percentile case to 7% of total demand in the 50th percentile case.

The water balance model determined the following with respect to water availability at the existing ACP and proposed SEOC operations:

- Periods of water deficit are generally associated with extended dry spells, where the license extraction allocations are reduced and no significant surface runoff is collected.
- Water availability over the 7 year SEOC mining period will be governed by the rainfall patterns.
- ACOL operation is likely to have:
  - Sufficient water during above average rainfall years.
  - Possible minor water shortages during average rainfall years.
  - Likely shortages of varying levels of severity during below average rainfall years.
- As the ACP underground mine progresses the resultant water make is likely to increase generally consistent with the predictions made in the original ACP EIS. This increase may provide for the anticipated shortfall during most periods.

It should be noted that the model has been established to assess the site water balance assuming the operation is running at peak production, that includes the underground operation operating at its potential peak of 5Mtpa where only a single longwall panel move is undertaken. The overall average production is likely to be less than the peak rate and therefore the predicted water deficits would be shorter.

5.11.5 Water Course Re-establishment

The 'vision' for the reinstatement of all drainage lines and in particular Tributary 4 is the:

> *Creation of stable water courses that maintain and improve water quality, provide structure and habitat commensurate with pre-mined condition, that evolves over time to form part of the natural landscape.*

The key objectives in the reinstatement of the water courses are:

- The creation of stable water course that conveys water from the surrounding lands.
- To provide habitat similar to or better than pre-mined conditions.

- To improve habitat along water courses with appropriate riparian vegetation.
- The creation of pools and riffles to improve habitat and manage water flows.
- To monitor the success of the reinstatement and improve where required.

5.11.5.1 Guidelines for Re-establishment

Table 5.34 details general guidelines to be followed in the re-establishment of the water courses impacted as a result of the SEOC project. These guidelines will generally apply to all proposed tributaries, however because T4 coveys water from the upstream catchments of the former T4 and T5 tributaries more detailed construction techniques are required as detailed within *Section 5.11.5.3*.

Table 5.34: Guidelines for re-establishment of the water courses.

Aspect	Guide
Timing of Works	Given many of these will be constructed in mine spoil, allowing sufficient time for settlement will be necessary to maintain appropriate grades and reduce maintenance and repair costs. Refer to *Section 5.11.5.3* for more detail. Where settlement issues are not significant, 1-2 years prior to bringing online, to minimise the risk of scour during high flows.
Channel Construction	Where practical, the watercourses will incorporate a channel that meanders through a broader overbank region. The channel will have the capacity to convey the 1 to 2 year ARI flow, with higher flows conveyed as out of channel flow. A pool and riffle sequence will be incorporated into the reinstated channels where appropriate. The pool and riffle sequence will allow the channels to mimic a more 'natural' creek regime while also reducing average channel bed slopes and thereby reducing peak flow velocities.
Vegetation	Revegetate all watercourses within the project area with indigenous riparian vegetation, such as the Hunter Valley River Oak Forest, on the lower areas grading into different communities higher in the catchment. A combination of native shrubs, herbs, native grasses and tree species will be determined as part of the detail design. Native grasses and trees are proposed for the channel bench and side slopes.
Monitoring	Water courses will be monitored and maintained appropriately to ensure channel stability and revegetation is successful.

5.11.5.2 Impacts and Proposed Reinstatement

Tributary 1 (T1)

T1 is north of the open cut and will not be impacted, therefore, no remediation is considered necessary.

Tributary 2 (T2)

The T2 catchment following mining will be increased to 53ha in size (initially 26ha); the lower reaches will be largely undisturbed, while the upper reaches will comprise rehabilitated overburden. The two sediment dams will be removed and the channel reinstated where required.

Approximately 400m of channel will be constructed along the base of the overburden connecting with the existing T2 creek line.

Tributary 3 (T3)

T3 will be disturbed in the initial year from the construction of the ROM coal facility and levee. Following the removal of the ROM facility at the close of operations, the levee will be lowered and the reconstructed T3 directed into its former channel.

The T3 catchment will increase in size to 71ha (initially 64ha). A small section of channel will need to be formed following the removal of the ROM pad facility to direct the water into the existing channel west of the disturbance area.

Tributary 4 (T4)

The central section of T4 will be completely removed during mining operations and a clean water dam will be constructed upstream of the open cut.

At completion of mining it is proposed to reconstruct a drainage path essentially replacing T4. The reinstatement will require the following:

- Construction of approximately 600m of creek channel between CW1 and the open cut through virgin ground.
- Construction of 1300m of creek channel through mine spoil as discussed in *Section 5.11.5.3*.
- Clean water dam CW1 will be substantially removed at the completion of mining leaving a small dam for post mining land-uses.

Tributary 5 (T5)

Tributary T5 will be directly impacted by open cut mining. The location of the final void on the southern boundary of the SEOC effectively means the permanent loss of a section of this watercourse. Clean water dam CW2 will be constructed within T5 to prevent water entering the open cut.

At the completion of mining CW2 will be largely removed, (maintaining a small dam and overflow to maintain appropriate hydraulic grades) and 600m of creek channel will be constructed in virgin ground to direct water along the eastern boundary of the open cut to the reinstated T4.

Tributary 6 (T6)

T6 is south of the open cut and will not be impacted therefore no remediation is considered necessary.

5.11.5.3 Reinstatement of Tributary 4

Tributary T4 will be reconstructed through mine spoil where the key risks are the potential for:

- Settlement to lower the western end of the creek to below the natural surface of the land to the west of the pit.
- Differential settlement to reverse the grade of the creek in some sections.
- Settlement induced damage of the integrity of any low permeability liner that would subsequently limit the water holding capacity of the creek.

It is proposed to shape the reinstated channel following Year 5 of the mining, but defer full construction for approximately 5 to 6 years to allow for initial settlement. The creek line would then be constructed 2 to 3 years prior to the mine closure (i.e. *commence reinstatement in 2020*) to ensure the creek line is established prior to mine closure.

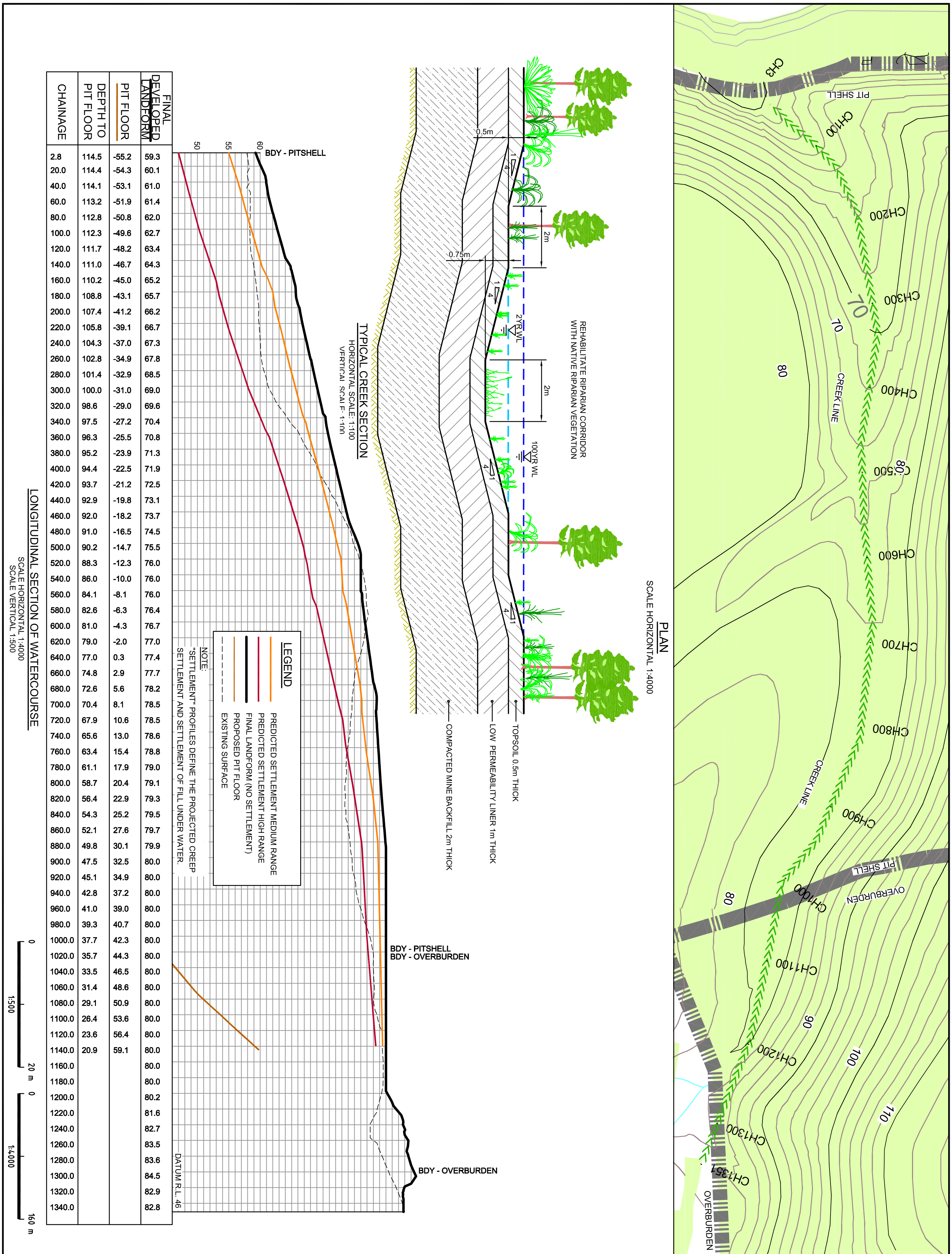
An indicative cross section of the reconstructed Tributary 4 is illustrated in **Figure 5.31**.

Estimated Vertical Settlement

As Tributary 4 is proposed to be reconstructed through mine spoil that increases in depth from east to west the potential for vertical settlement within the fill has been assessed. It is assumed that settlement will occur in localised areas primarily through three means:

- Creep settlement of the main backfill under self weight due to particles getting closer together over time (estimated to range from 1 to 7m, with 2m expected).
- Settlement of the fill due to water loading (*occurs when the water first flows down creek*) (estimated to range from 0.1m to 5m, with 2m expected).
- Collapse settlement of the fill due to water inundation or vibrations such as earthquakes or nearby blasting (estimated to range from 0m to 10m, with 7m expected).

Approximately 60% of settlement is expected to occur within 6 years of the initial channel reinstatement (i.e. by 2021).



CHAINAGE	DEPTH TO PIT FLOOR	PIT FLOOR	FINAL DEVELOPED LANDFORM
2.8	114.5	-55.2	59.3
20.0	114.4	-54.3	60.1
40.0	114.1	-53.1	61.0
60.0	113.2	-51.9	61.4
80.0	112.8	-50.8	62.0
100.0	112.3	-49.6	62.7
120.0	111.7	-48.2	63.4
140.0	111.0	-46.7	64.3
160.0	110.2	-45.0	65.2
180.0	108.8	-43.1	65.7
200.0	107.4	-41.2	66.2
220.0	105.8	-39.1	66.7
240.0	104.3	-37.0	67.3
260.0	102.8	-34.9	67.8
280.0	101.4	-32.9	68.5
300.0	100.0	-31.0	69.0
320.0	98.6	-29.0	69.6
340.0	97.5	-27.2	70.4
360.0	96.3	-25.5	70.8
380.0	95.2	-23.9	71.3
400.0	94.4	-22.5	71.9
420.0	93.7	-21.2	72.5
440.0	92.9	-19.8	73.1
460.0	92.0	-18.2	73.7
480.0	91.0	-16.5	74.5
500.0	90.2	-14.7	75.5
520.0	88.3	-12.3	76.0
540.0	86.0	-10.0	76.0
560.0	84.1	-8.1	76.0
580.0	82.6	-6.3	76.4
600.0	81.0	-4.3	76.7
620.0	79.0	-2.0	77.0
640.0	77.0	0.3	77.4
660.0	74.8	2.9	77.7
680.0	72.6	5.6	78.2
700.0	70.4	8.1	78.5
720.0	67.9	10.6	78.5
740.0	65.6	13.0	78.6
760.0	63.4	15.4	78.8
780.0	61.1	17.9	79.0
800.0	58.7	20.4	79.1
820.0	56.4	22.9	79.3
840.0	54.3	25.2	79.5
860.0	52.1	27.6	79.7
880.0	49.8	30.1	79.9
900.0	47.5	32.5	80.0
920.0	45.1	34.9	80.0
940.0	42.8	37.2	80.0
960.0	41.0	39.0	80.0
980.0	39.3	40.7	80.0
1000.0	37.7	42.3	80.0
1020.0	35.7	44.3	80.0
1040.0	33.5	46.5	80.0
1060.0	31.4	48.6	80.0
1080.0	29.1	50.9	80.0
1100.0	26.4	53.6	80.0
1120.0	23.6	56.4	80.0
1140.0	20.9	59.1	80.0
1160.0			80.0
1180.0			80.0
1200.0			80.2
1220.0			81.6
1240.0			82.7
1260.0			83.5
1280.0			83.6
1300.0			84.5
1320.0			82.9
1340.0			82.8

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South East Open Cut Project

Conceptual cross section of the reconstructed Tributary 4

Worley Parsons

Figure 5.31

Plan 55

Prepared by Pegasus Technical

CAD FILE: 05053C.dwg

Reinstatement Mitigation Measures

The following mitigation measures will be considered at the detailed design stage:

- Settlement occurs as a function of time, therefore delaying full construction of the creek is likely to reduce the settlement impacts on the constructed creek.
- Detailed mine planning and scheduling will investigate the construction of a haul road along the proposed alignment of the creek to improve settlement and compaction. However should the haul road not be feasible along the exact alignment, the haul road will be rearranged or differential settlements could occur between well compacted and poorly compacted areas.
- Providing a steeper creek grading will provide contingency for some localised settlement to occur without reversing the creek grade. In these areas the creek will be appropriately protected against scour.

Consideration will be given to allowing the creek to flow prior to the earthworks being finalised (*e.g. gravity discharge from the clean water dams for extended periods to allow for water induced surface settlements to occur, prior to final working of the area, and compaction of the surface layer and liner*). This is likely to preload the area as well as remove some of the risk of collapse settlement due to infiltration. It should be noted that this should not be undertaken whilst the mining operation is ongoing without a thorough assessment of the potential impacts on pit stability. It is unpredictable where the infiltrated water could flow and the presence of water could result in instability of ongoing pit excavations.

- Carry out additional filling as settlement and depressions occur in the backfill. The additional filling should be compacted in layers as described above. Ideally, problem areas should have a thicker area of well compacted material prior to creek construction being finalised.
- Survey creek alignment on a yearly basis to develop an understanding of actual settlement rates, as well as the change in settlement rate over time.

When Tributary 4 is reinstated in 2020 (*after approximately 5-6 years of settlement*), the following design measures are recommended:

- If required, reshape the creek alignment to amend any variation in landform resulting from settlement over the 6 year period. Depending on the degree of settlement, this may require substantial earthworks. Any filled material should be compacted using standard methods.
- Compact the upper 2m layer of the creek channel and overbank area. It is expected that compaction could be achieved by placing fill in layers, moisture conditioning and compacting to minimum 95% standard dry density ratio with moisture in the range of 85% to 115% of the standard optimum moisture content. Alternatively it is expected that an impact roller (*heavyroller with hexagonal or other straight-side wheel*) could create a 2m thick bridging layer from the surface.
- The creek should have a low permeability liner directly underneath it to minimise surface infiltration of water which could result in collapse settlement. Ideally the liner would have a coefficient of permeability ‘k’ of not greater than 1×10^{-9}m/s commensurate with the EPA’s normal requirements for liners. However it is considered that a coefficient of permeability of close to this value (*i.e.* 5×10^{-8}*m/s*) would also be appropriate. It is possible that the mine backfill material, with boulders selectively removed, may be able to be compacted to meet this permeability requirement, subject to testing. Otherwise imported select clayey material will be used for a liner.

5.11.6 Surface Water Impacts

It should be noted that there is no dirty water discharge from the SEOC project.

The clean water dam CW1 will be designed to have a permanent storage in the order of 100ML, with an additional 90ML of flood storage capacity to cater for high flow events up to a 1 in 20 year 12 hour ARI event. Clean water captured in the dam as a result of flood events will be pumped from the dam around mining operations to Glennies Creek. The point of this clean water discharge will be designed having regard to maintaining bank stability and channel integrity within Glennies Creek, given the release of clean water will be infrequent and only undertaken during periods of high flow the impacts associated with its release are expected to be minimal.

5.11.6.1 Water Quality

Sediment

The construction and operation of the SEOC project has the potential to impact on water quality within Glennies Creek and the Hunter River through export of sediment from the site. Accordingly, a range of sediment and erosion controls are proposed as part of the Surface Water Management Plan (SWMP) to address this potential impact.

All sediment control ponds within the site have been sized to retain a 20 year ARI 12 hour storm volume. Runoff collected in the dams would generally be re-used in the mining operation. Hence, overflow from the dams would only occur during extended periods of heavy rainfall, such as events greater than 1 in 20 year ARI 12 hour storm duration.

With the proposed sediment control measures in place, the SEOC project is unlikely to adversely impact the water quality in Glennies Creek and downstream systems.

Salinity

All mine water collected in the bottom of the pit and from surface runoff from any areas where coal is transported or processed (*i.e haul roads, and stockpile areas*) is likely to contain elevated levels of salts. Accordingly, it is proposed to store and reuse all mine water generated on site. The water balance modelling demonstrated that there would be no mine water discharge from the site. It is therefore unlikely that the SEOC will adversely impact the salt levels in Glennies Creek and downstream systems.

5.11.6.2 Watercourse Impacts

Impacts to the six tributaries located within the SEOC area are reviewed within *Section 5.11.5.2.*

5.11.6.3 Predicted Changes to Streamflow

Water balance modelling estimated the anticipated changes in stream flows as a result of the proposed development. The predicted changes to annual stream flow for Years 1 to 3 and Year 4 to 7 and the post mining period for average and 10th, 50th and 90th percentile rainfall years are presented in **Table 5.35**.

Table 5.35: Predicted changes to stream flows.

Annual Rainfall		Estimated Annual Flows Existing Conditions	Estimated Reduction in Annual Inflows			Observed Glennies Creek Flows	
			Years 1 to 4	Years 5 to 13	Final Landform	Annual Flows	Maximum reduction
		ML/Year	ML/Year	ML/Year	ML/Year	ML/Year	%
Average		451	331	451	44	55,240	0.8%
Percentile	10th	117	86	117	11	30,570	0.4%
	50th	352	258	352	34	46,670	0.8%
	90th	909	667	909	88	85,990	1.1%

The predicted temporary changes to stream flow are in the order of 0.8% of the total flow in Glennies Creek in an average rainfall year. As such, this small reduction is not expected to adversely affect any downstream license holder or the ecological function of Glennies Creek or the Hunter River.

5.11.6.4 Cumulative Impacts

The key potential cumulative surface water impacts of the SEOC project are:

- The overall demand for water in the Hunter River and Glennies Creek systems.

- The potential for land use practises to result in greater sediment generation and deposition in the Hunter River and Glennies Creek.
- The potential for increased salt loads in the Hunter River and Glennies Creek.

Water demand from the Hunter River and Glennies Creek is governed by licensing of the water under a Water Sharing Plan. Demand will therefore be considered in the granting of future licences. Mining developments in the catchment will result in minor cumulative losses in catchment runoff yields.

Glennies Creek receives increased base flows through the controlled release of water at Glennies Creek dam. These flows improve water quality within the creek. While land use practices can contribute to a degradation of water quality, monitoring undertaken by ACOL indicate that water quality controls on upstream land uses must be at least on average operating satisfactorily.

With consideration of the baseline monitoring results, and the proposed surface water management controls, it is likely that the SEOC project would not exacerbate the cumulative impact of land use practices on the water quality in Glennies Creek or its receiving water, the Hunter River.

5.11.7 Monitoring and Mitigation Measures

The mitigation management and monitoring of groundwater will be addressed through the integration of the SEOC with the existing ACP Site Water Management Plan (SWMP).

The existing ACP monitoring program involves weekly sampling of SM1, SM2, SM3, SM4 and the process water dam, monthly sampling of all monitoring sites and onsite dams (sediment dams and select clean water dams), monthly extended sampling of Bowmans Creek site SM4 and comprehensive sampling of both onsite dams and monitoring sites on an annual basis. **Table 5.36**, details the proposed monitoring schedule, which is consistent with the existing schedule.

Table 5.36: Proposed surface water monitoring schedule.

Parameter	Weekly Bowmans Creek Only	Monthly Onsite Dams	Monthly All Surface Water Stations (* = SM4)	Annually Comprehensive Testing
pH	✓	✓	✓	✓
Electrical Conductivity	✓	✓	✓	✓
Non-filterable Residue	✓	✓	✓	✓
Oil & Grease	✓		✓	✓
Total Dissolved Solids	✓	✓	✓	✓
Turbidity			✓*	✓
Hardness	✓	✓	✓	✓
Calcium			✓*	✓
Magnesium			✓*	✓
Sodium			✓*	✓
Potassium			✓*	✓
Sulphate			✓*	✓
Bicarbonate			✓*	✓
Carbonate			✓*	✓
Chloride			✓*	✓
Nitrates			✓*	✓
Ammonia			✓*	✓
Iron (total & dissolved)			✓*	✓
Manganese			✓*	✓

Parameter	Weekly Bowmans Creek Only	Monthly Onsite Dams	Monthly All Surface Water Stations (* = SM4)	Annually Comprehensive Testing
Arsenic			✓*	✓
Barium			✓*	✓
Boron			✓*	✓
Cadmium			✓*	✓
Chromium			✓*	✓
Copper			✓*	✓
Nickel			✓*	✓
Lead			✓*	✓
Zinc			✓*	✓
Mercury			✓*	✓
Selenium			✓*	✓
Fluoride			✓*	✓
Total petroleum hydrocarbons			✓*	✓
Polycyclic aromatic Hydrocarbons			✓*	✓

The monitoring and reporting program will be continued during both the construction, operational and rehabilitation phases of the SEOC project. The site water balance and other monitoring results will be used to monitor the performance of on-site water management and to upgrade or change water storages and other water management provisions that may be required at the site.

Monitoring results will be reported annually in the Annual Environmental Management Report (AEMR). All monitoring data will be retained in an appropriate database that will be available to relevant authorities at request.

In addition to water quality sampling, ACOL will continue to:

- Monitor all key water movements around the mine site. Monitoring will be recorded on a minimum monthly basis or following significant rainfall events.
- Monitor dam storage levels. Dam levels will be assessed on a monthly basis and following significant rainfall events.
- Maintain and operate the ACOL weather stations.

5.11.7.1 Operational Monitoring

In addition to the monitoring requirements described above, the following routine inspections will be undertaken:

- Inspection of all dams, drains and culverts on a monthly basis and following significant rain.
- Inspection of rehabilitation areas on a monthly basis and following significant rain.

The following routine maintenance will be undertaken:

- Removal of accumulated sediment from dams and drains as required.
- Enhancement of underperforming rehabilitation areas as required.
- Repair and installation of erosion control measures as required.
- Inspection and maintenance of the wastewater management system.
- Inspection and maintenance of the sediment chamber and oil and grease trap treating runoff from the hardstand area.

5.11.7.2 Dam Closure Guidelines

It is proposed to either fully remove or significantly reduce in size all proposed dams as part of the mine rehabilitation plan. It is important that dams are not removed until the upstream catchment areas are fully rehabilitated and stabilised. Accordingly, the following guidelines will be used to determine if a dam is ready to be removed:

- Inspection of the contributing catchment to ensure the rehabilitation is well established and there is no evidence of significant sheet, rill or channel erosion.
- Inspection of the upstream drainage network to ensure there is no significant channel erosion such as bed or bank scouring.
- Inspection of the receiving watercourse, to ensure that removing the dams will not result in erosion of downstream waterways.

5.11.8 Contingency Response

There are a range of contingency measures that can be implemented if unforeseen or unacceptable levels of impact are identified during the mine life. These include:

- In the event of operational water shortages, ACOL will implement the following measures:
  - Obtain additional water extraction licenses by purchasing available entitlements from the Hunter River or Glennies Creek in accordance with the relevant water sharing plan.
  - Reduce the throughput through the CPP, which accounts for approximately 70% of the water usage.
  - As a last resort reduce production levels.
- Increased monitoring frequency and sampling points to identify and confirm the source of any suspected degradation to water quality.
- Review the SWMP in order to identify opportunities to improve or rectify any identified problem. The data collected as part of the monitoring programme will enable fully informed decisions to be made.
- If any component of the surface water management framework is identified as creating an unacceptable environmental impact, remedial actions will be established in close liaison with the relevant authority.
- Provision of flocculation equipment on sedimentation ponds to improve the rate of sedimentation.
- Augmenting the sediment dams to create greater retention volume and residence time to increase the capacity for suspended sediment to settle out.
- Increasing pumping capacity at each of the sedimentation ponds to minimise the potential for sediment laden discharges from the ponds.

5.12 Flooding

Worley Parsons was commissioned to determine the flood behaviour of Glennies Creek and the Hunter River in the area of the SEOC and assess the impacts of the proposed SEOC project on flooding. The flooding assessment is contained within Section 4 of the Worley Parsons Surface Water Assessment in Appendix 6 in Volume 4.

5.12.1 Assessment Methodology

5.12.1.1 RAFTS Model

A hydrologic model was developed using Runoff Analysis and Flow Training Simulation (*RAFTS*) for the Glennies Creek Catchment to determine discharge hydrographs at the SEOC site for a range of Average Recurrence Interval (*ARI*) storm events. The estimated discharge hydrographs were subsequently used in hydraulic models to examine the Glennies Creek flood behaviour in the vicinity of the SEOC site.

The 515km^2 was divided into 15 sub-catchments and considered the following parameters:

- Catchment slope.
- Impervious percentage – essentially the portion of the catchment where water will not infiltrate.
- Catchment roughness – the type of ground surface in the catchment.
- Initial and continuing losses – the amount of water that is absorbed by the ground.
- Catchment lagtime – the time water takes to leave a sub-catchment.

The model was calibrated using recorded rainfall data from the BOM with comparison to stream levels in the Middle Fal Brook stream flow gauge and the Carrow Brook stream gauge. Model parameters could then be altered to improve the model's accuracy.

The storage capacity of Glennies Creek Dam was considered using its detention volume to determine how varying levels of the dam would change stream flows during large events. As previously discussed the dam moderates flows and reduces peak flows. The relative dam level has a marginal influence on the behaviour of the catchment during flood events.

The 1 in 5, 20 and 100 year ARI events were assessed across a range of duration intervals from 24 to 48 hours. A 36 hour storm was determined to be the critical storm duration, with estimated peak discharges of 834m^3/s for a 100 year event to 237m^3 for a 5 year event. These values were then used for the hydraulic analysis at the SEOC.

5.12.1.2 Hydraulic Model

A hydraulic model was developed using the HEC-RAS software package to assess the Glennies Creek flood behaviour in the vicinity of the SEOC. The model extends from the confluence with the Hunter River to approximately 500m upstream of Camberwell village. The model simulates the movement of a flood wave through a river and its floodplain. The hydraulic model incorporates channel slope, roughness, and structures such as bridges and embankments. The hydraulic model is used to determine flood levels and velocities along the river.

5.12.1.3 Impact of Climate Change

The two major anticipated flood impacts as a result of climate change are the rise in sea levels and an increase in rainfall intensities. Considering the project locality, the impacts from sea level rise would not influence flooding within the SEOC site. The anticipated increase in rainfall intensities are also not considered applicable to the flood assessment, as operations are expected to be complete by 2023, which is before the effects of climate change are likely to be realised.

5.12.2 Existing Flooding Behaviour

The Glennies Creek floodplain is characterised by a meandering main channel, residual alluvial flats and is flanked by steep geological boundaries. The majority of the floodplain has been cleared for agricultural purposes. The Glennies Creek channel is moderately vegetated with a mixture of indigenous and exotic plant species, while the floodplain generally consists of cleared land.

The New England Highway crossing to the north of the SEOC site has been identified as a key hydraulic control, primarily because of the natural contraction in the floodplain at the bridge location. In addition, the bridge and associated piers potentially create blockages during high flow events.

5.12.2.1 Hunter River

The Hunter River has a history of substantial flooding. Historically, the Hunter River floods of 1955 are regarded as the worst flood on record, and are typically described as being a 100 to 200 year ARI event, depending on the location along the River. The *DECCW* has provided historical Hunter River 1955 flood levels in the vicinity of the Glennies Creek confluence. A Hunter River 100 year flood level of **62.7m AHD** has been adopted from the locally recorded flood levels during the 1955 event.

The hydraulic modelling determined Hunter River 5 year ARI flood event level to be 58.6m AHD and the 20 year ARI flood event to be 61.6m AHD.

5.12.2.2 Glennies Creek

The hydraulic modelling determined Glennies Creek flood levels at the northern extent of the SEOC project to be as follows:

- 5 year ARI flood event level to be 57.9m AHD.
- 20 year ARI flood event to be 59.4m AHD.
- 100 year ARI flood event to be 60.7m AHD.

With the Hunter River flood levels greater than the Glennies Creek flood levels it is considered that in the area of the SEOC, backwater flooding from the Hunter River is the governing flood level for events from 5 to 100 year ARI events.

5.12.2.3 Probable Maximum Flood Assessment

An assessment of the Probable Maximum Flood (PMF) to determine the largest potential flood level was undertaken. The assessment considered the flood levels generated from the probable maximum precipitation (PMP) and the potential effects of Glennies Creek Dam. The assessment concluded that a PMP flood coinciding with a Glennies Creek Dam breach would estimate the largest flood probable in Glennies Creek in the area of the SEOC.

A 4 hour duration PMP event is estimated to generate a flood level of 63.84m at the northern extent of the SEOC, while NSW State Water estimated a breach in Glennies Creek Dam would generate a level of 79.47m AHD *(NSW State Water advised that extreme flood scenarios are not exact and accepts no liability with respect to decisions made using this data)*.

Therefore it is clearly evident that with a potential level of 79.47m AHD, a dam breach scenario is the PMF in the area of the SEOC. Effects of the Hunter River were not considered, as the dam breach scenario was estimated to take 3 hours to reach the site and would govern evacuation procedures.

5.12.3 Flooding Impacts

From the assessment of the 1 in 100 year ARI flood levels a design level of 64m AHD was adopted, providing a freeboard of 1.3m. This is supported by Clause 19 (5) of the Singleton Local Environmental Plan 1996 that restricts development upstream of the SEOC to a level above 64.1m AHD.

The SEOC design incorporates a flood levee designed at 64m AHD (refer to *Section 4.4.4.3)* for more detail) to mitigate against flooding impacts. The levee extends along both the western boundary of the SEOC pit and around the perimeter of the ROM facility.

Figure 5.32 illustrates the 5, 20 and 100 year ARI events relative to the SEOC infrastructure.

5.12.3.1 Flood Conveyance

As the SEOC project area is within an area of backwater flooding from the Hunter River, the SEOC project is not expected to impact the Hunter River flood conveyance.

The impact of the SEOC project on Glennies Creek flood conveyance was assessed using the HEC-RAS model. Modelling predicted a maximum increase in flood levels of 30mm during a 100 year ARI Glennies Creek flood event. This increase is less than 100mm, which is recommended in the *Flood Plain Development Manual* as the threshold for defining an impact on flood conveyance. Accordingly, the SEOC pit is unlikely to impact the flood conveyance of Glennies Creek, nor will the SEOC project adversely increase flood levels in Camberwell village or other upstream properties.

5.12.3.2 Flood Storage

Flood storage is classified as areas which are outside of the floodway (*area of significant flood conveyance*) and provide temporary storage of floodwaters during the passage of a flood. Flood storage areas are often aligned with floodplains and are usually characterised by deep and slow moving floodwater. Displacement of flood storage results in the loss of the natural attenuation capacity of the floodplain, which can result in a redistribution of floodwaters, an increase in flood levels or an increase in peak flows downstream of the site.

The levee along the western extent of the SEOC pit shell will result in a permanent loss to potential flood storage, however the ROM facility will at mine closure be removed and will therefore slightly reduce the calculated flood storage losses.

The SEOC would result in the loss of up to 7.5% of flood storage (calculated from the HEC-RAS model extents) in the Glennies Creek floodplain during a 100 year ARI Hunter River flood event. The loss of flood storage, as a percentage of the total storage in Glennies Creek floodplain, is reduced for the lower ARI events, as well as for Glennies Creek flood events. Figure 5.32 illustrates the floodplain storage.

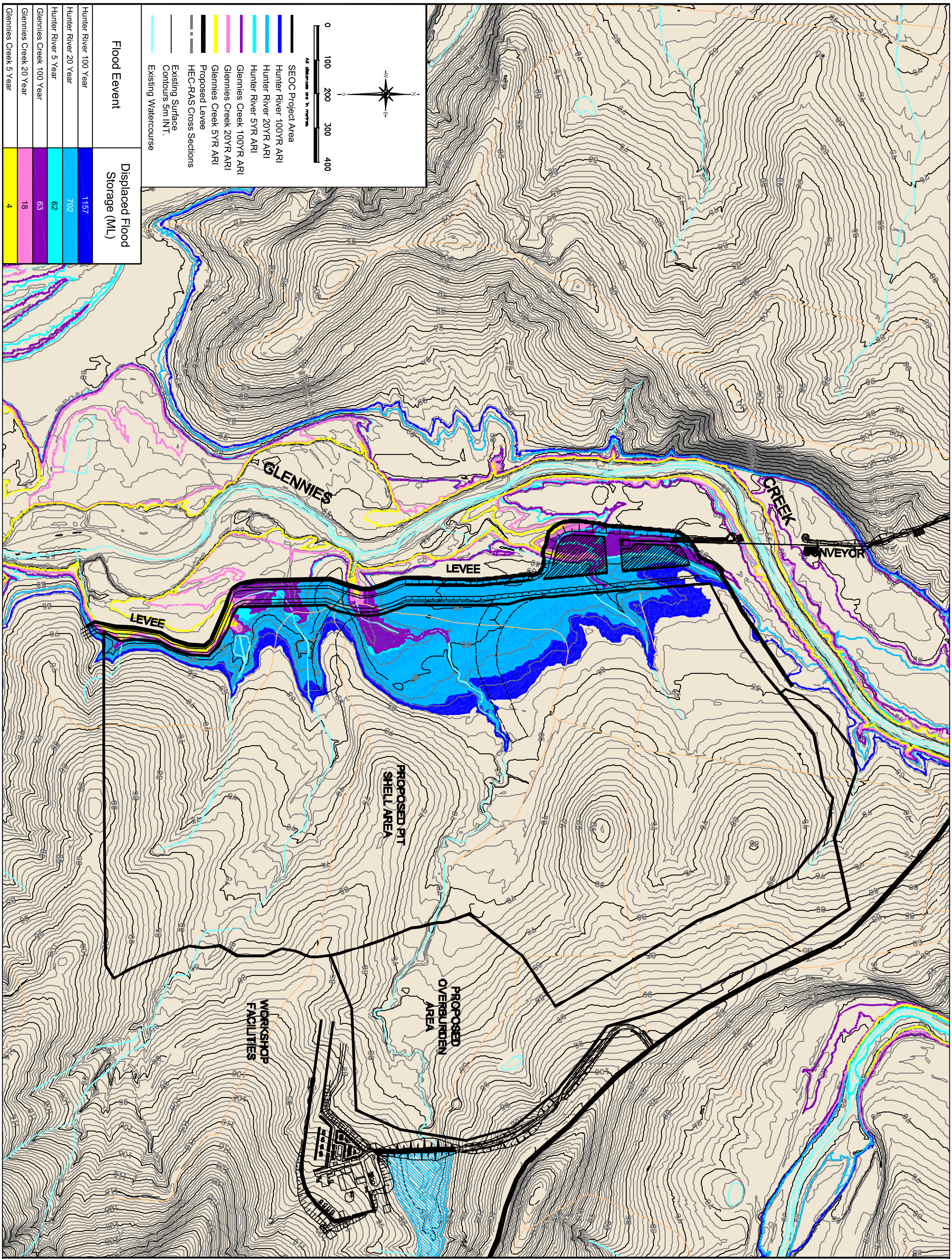
The Glennies Creek floodplain contributes only a small fraction of the total flood storage in the greater Hunter River floodplain. The loss of flood storage caused by the SEOC project in the greater Hunter River floodplain will be a fraction of a percent; accordingly the impact of the SEOC from the loss of Hunter River flood storage is immeasurable.

5.12.4 Mitigation Measures and Safeguards

The design of the SEOC project has been considerate of the potential effects of flooding and as such has incorporated into the design a flood levee designed to 64m AHD that will provide protection from the Hunter River and Glennies Creek for flood events up to 1 in 100 year ARI.

While the levee will afford significant protection for the SEOC a Flood Evacuation Plan will be developed to ensure the safety of those working within the open cut and in the ROM facilities. The Flood Evacuation Plan, in the case of a flood event occurring in either the Hunter River or Glennies Creek, will incorporate the following key elements:

- Mining operations will temporarily cease if flood levels in either the Hunter River or Glennies Creek are expected to meet or exceed a safe water level. The safe water level will be determined as part of the detailed design of the levee system.
- In the event of an extreme flood, all personnel will evacuate to the office and workshop facilities area located above the estimated Glennies Creek Dam break flood extent.
- The levee system is to be inspected and certified as adequate by a qualified engineer after a 1 in 20 year flood event.



AshtonCoal

Prepared by Pegasus Technical

South East Open Cut Project

Predicted 5, 20 and 100 ARI flood events and flood storage loss from the SEOC Project

Worley Parsons

Figure 5.32

Plan 56

CAD FILE: 05054C.dwg

5.13 Glennies Creek Geomorphology

WorleyParsons Services Pty Ltd was engaged to investigate the potential impact of the open cut mine on the geomorphology of Glennies Creek, including the potential for the creek to migrate towards the mine footprint in the longer term.

The purpose of the investigation was to consider the extent to which the upper terraces of the eastern overbank of Glennies Creek are geomorphically active. This issue and the extent of any connected alluvial aquifer are important in determining the westerly extent of the pit for the SEOC project. A copy of the report is contained with **Appendix 7** in Volume 4.

An archaeological geomorphology investigation was also conducted on the eastern side of Glennies Creek, refer to *Section 5.19* and Appendix 13 for further detail.

5.13.1 Assessment Methodology

Streams are dynamic and undergo changes in physical geometry and footprint in response to the extent and velocity of flows and the composition of the sediment load carried by the stream. There is potential for the geomorphic processes of Glennies Creek to cause long term migration of the creek and/or floodplain towards the proposed open cut area. Due to its proximity, there is also potential for geomorphic changes to the Hunter River to impact on the SEOC.

A geomorphic assessment of the stability of the lower reaches of Glennies Creek was undertaken based on the following:

- Site investigations to confirm flood terracing and assess surface features.
- Assessment of stream movement over the past 50 years using historic air photographs.
- Consideration of flooding behaviour, including flow velocities and flood extents.
- Assessment of bed, bank and floodplain stability during flooding.

The findings from these investigations were used to determine the potential for geomorphic processes to impact on the proposed SEOC mining operation. Consideration was also given to the potential for the mining operation to adversely impact on any geomorphic evolution of the stream.

5.13.2 Impacts of the SEOC on Glennies Creek Geomorphology

Historic aerial photography suggests that the main channel of Glennies Creek is stable and is not undergoing any migration towards the proposed SEOC mining operation. **Figure 5.33** illustrates the conceptual model of geomorphic processes for Glennies Creek adjacent to the SEOC.

The results of hydraulic flood modelling indicate that flow velocities across the eastern overbank of Glennies Creek are expected to be less than 0.9 m/s during events up to and exceeding the 500 year recurrence flood. As a result, the potential for erosion of the floodplain to occur across the footprint of the proposed mine is minimal.

The magnitude of flooding that would be required to provide large scale geomorphic change of the floodplain would need to be significantly rarer than the 500 year recurrence event.

Four sites along the western extent of the proposed mine have been identified as potentially being affected by geomorphic processes. However, further inspection and assessment has confirmed that the footprint of the proposed open cut mine at Sites 1, 2, 3, and 4 is not within the active geomorphic zone of Glennies Creek.

Similarly, the proposed mining operation is not expected to impact on the geomorphic processes of Glennies Creek.