



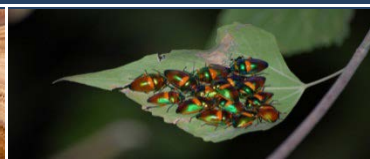
EcOz

Environmental
Services

Chapter 3 Risk Assessment



Sherwin Iron (NT) Pty Ltd
Sherwin Creek Iron Ore Project
Environmental Impact Statement



2013



Document Control Record

Document Code:	EZ13503-C0301-EIA-R-0016
Catalogue Number:	35324
Project Manager:	Justine Shailes
Author(s):	Narelle Walkom, Mike Welch, Chris Brady, Ian Brown, Howard Smith, Keith Munson
Approved by:	
	Jeff Richardson
Approval date:	4 December 2013

DOCUMENT HISTORY

Version	Issue Date	Brief Description	Reviewer/Approver
1.A	6 November 2013	Report compilation	N. Walkom
1.0	4 December 2013	Final	J. Richardson

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd.
EcOz Environmental Services
ABN: 81 143 989 039
Winlow House, 3rd Floor
75 Woods Street
DARWIN NT 0800
PO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Internet: www.ecoz.com.au



RELIANCE, USES and LIMITATIONS

This report is copyright and is to be used only for its intended purpose by the intended recipient, and is not to be copied or used in any other way. The report may be relied upon for its intended purpose within the limits of the following disclaimer.

This study, report and analyses have been based on the information available to EcOz Environmental Services at the time of preparation. EcOz Environmental Services accepts responsibility for the report and its conclusions to the extent that the information was sufficient and accurate at the time of preparation. EcOz Environmental Services does not take responsibility for errors and omissions due to incorrect information or information not available to EcOz Environmental Services at the time of preparation of the study, report or analyses.

Table of Contents

3	Risk assessment	3-1
3.1	Introduction	3-1
3.1.1	Risk assessment.....	3-1
3.1.2	Risk groupings	3-3
3.1.3	Data supporting risk assessment.....	3-4
3.2	Risks to human health and safety	3-5
3.2.1	Food hygiene	3-6
3.2.2	Biological hazards.....	3-6
3.2.3	Odour	3-6
3.2.4	Air emissions.....	3-6
3.2.5	Noise and vibration	3-7
3.2.6	Hazardous substances	3-8
3.2.7	Drinking water supply	3-8
3.2.8	Pest management and disease vectors	3-9
3.2.9	Wildlife hazards.....	3-10
3.2.10	Waste.....	3-10
3.2.11	Heat	3-10
3.2.12	Intense storm event or cyclone.....	3-10
3.2.13	Fire.....	3-11
3.2.14	Alcohol and drug related incidents.....	3-11
3.2.15	Manual handling	3-11
3.2.16	Vehicle collisions	3-12
3.2.17	Interaction with machinery	3-13
3.2.18	Lighting	3-13
3.2.19	Electrical energy	3-14
3.2.20	Working at heights and falling objects	3-14
3.3	Risks to hydrology and water quality	3-24
3.3.1	Surface water hydrology	3-24
3.3.2	Surface water quality	3-25
3.3.3	Groundwater levels	3-27
3.3.4	Groundwater quality.....	3-28
3.4	Risks to terrestrial and aquatic biodiversity	3-32
3.4.1	Terrestrial biodiversity-flora and fauna	3-32
3.4.2	Aquatic fauna	3-36
3.4.3	Pest species.....	3-37
3.4.4	Weeds.....	3-38
3.5	Rehabilitation and mine closure	3-41

3.5.1	Rehabilitation and mine closure inherent risk profile	3-41
3.5.2	Rehabilitation and mine closure risk mitigation	3-42
3.5.3	Rehabilitation and mine closure residual risk	3-44
3.6	Aboriginal and historic cultural heritage	3-46
3.6.1	Introduction	3-46
3.6.2	Aboriginal sacred sites.....	3-46
3.6.3	Aboriginal archaeology	3-47
3.6.4	Aboriginal cultural knowledge	3-48
3.6.5	Historic cultural heritage	3-49
3.6.6	Potential impacts on cultural heritage.....	3-50
3.7	Socio-economic risks	3-56
3.7.1	Introduction	3-56
3.7.2	Stakeholder engagement and consultation	3-56
3.7.3	Project economics and feasibility.....	3-58
3.7.4	Regional social profile.....	3-60
3.7.5	Inherent risk of regional socio-economic impacts.....	3-61
3.7.6	Management of regional socio-economic risks	3-63
3.7.7	Residual risk of regional socio-economic impacts.....	3-65
3.8	Transport.....	3-74
3.8.1	Unsecured loads	3-75
3.8.2	Poor driving standards.....	3-75
3.8.3	Fatigue	3-75
3.8.4	Vehicle breakdown	3-76
3.8.5	Fauna strike	3-76
3.8.6	Explosives.....	3-76
3.8.7	Overloading of trucks.....	3-77
3.8.8	Junction design	3-77
3.8.9	Road maintenance.....	3-77
3.8.10	Sight distances.....	3-77
3.8.11	Culverts.....	3-78
3.8.12	Overtaking.....	3-78
3.8.13	Noise	3-78
3.8.14	Road network capacity	3-79
3.9	Other risks.....	3-83
3.9.1	Cumulative impacts	3-83
3.9.2	Bushfires	3-86
3.9.3	Biting insects.....	3-87
3.9.4	Noise and vibration	3-87
3.9.5	Greenhouse gases	3-87
3.9.6	Waste.....	3-87

Tables

Table 3-1. Consequence ranking	3-2
Table 3-2. Qualitative measures of likelihood	3-2
Table 3-3. Risk rankings used by combining consequence with likelihood levels for each aspect identified	3-3
Table 3-4. Residual risks to human health and safety	3-15
Table 3-5. Risks to hydrology and water quality.....	3-29
Table 3-6. Residual risks to terrestrial and aquatic biodiversity	3-39
Table 3-7. Risk assessment related to rehabilitation and mine closure	3-45
Table 3-8. Summary of artefact types identified from sites adjacent to Deposit C.....	3-48
Table 3-9. Basic language groups spoken at communities near the project.....	3-49
Table 3-10. Summary of risks to cultural heritage at the Sherwin Creek Iron Ore Project	3-50
Table 3-11. Summary of Cultural Heritage risk management options	3-51
Table 3-12. Risks to Cultural Heritage.....	3-53
Table 3-13. Estimated median values for key economic characteristics of the project.....	3-59
Table 3-14. Summary of beneficial community and regional impacts anticipated for the SCIOP.....	3-61
Table 3-15. Summary of socio-economic risks identified for the Sherwin Creek Iron Ore Project	3-61
Table 3-16. Summary of management options for major risks associated with the project.....	3-64
Table 3-17. Risks to regional socio-economic impacts	3-66
Table 3-18. Residual transport risks.....	3-80

Figures

Figure 3-1. Map showing location of project area in context of the Roper River region	3-84
---	------

3 Risk assessment

3.1 Introduction

This risk assessment describes the process and presents results of an assessment of the environmental risks relevant to the Sherwin Creek Iron Ore Project (SCIOP). It is designed to identify the potential hazards that affect human health, the socio-cultural environment, and the natural environment. The approach is systematic and congruous with international best practice standard methodologies including:

- AS/NZS ISO 31000:2009: Risk management - Principles and Guidelines (Standard)
- HB 203:2006: Environmental risk management - Principles and process (Guide)
- HB 158:2010: Delivering assurance based on ISO 31000:2009 - Risk management - Principles and Guidelines (Guide)

The project's key risks were provided by NTEPA through the EIS Guidelines (Appendix A), secondary risks identified during the development of this EIS are also presented.

The implementation of the risk management program is outlined within the Environmental Management Plan (EMP); Appendix D.

3.1.1 Risk assessment

Risk is defined as the chance of something happening that will have an impact on objectives. The risk assessment process involved reviewing the objectives and outcomes from the Guidelines and identifying the hazards (defined as anything that will cause harm and can affect meeting of outcomes and objectives). Each hazard was analysed for likelihood and consequence and a risk ranking was developed for the inherent value. Management programs were considered for each hazard and a new likelihood, consequence and risk ranking (now the residual risk) was defined.

The ranking for event consequence is shown in Table 3-1. The likelihood of an event occurring provides a measure of the known or anticipated frequency of occurrences (see Table 3-2). Combining likelihood with consequence (see Table 3-3) provides guidance on risk levels of each aspect and enables ranking of priorities.

The following sections describe in detail for each risk the development of the inherent risk rankings, the proposed hazard management and the subsequent residual risk. These sections also make reference to the data and information that supports these decisions.

For this risk assessment, aspects are defined as activities associated with the project that may result in an impact to the natural environment, human safety, and/or socio-economic situation and historic and cultural heritage. These aspects are then related to each risk grouping to determine potential impacts on the environment. This provides a basis for ensuring that appropriate mitigation measures are adopted for the operation and are included in program designs and management plans.

Table 3-1. Consequence ranking

Consequence		
1	Insignificant	No measurable impact on the environment. No injuries. Low-nil financial loss.
2	Minor	Minor, temporary environmental impact. No publicity likely and no stakeholder concerns. First aid treatment required. Medium-low financial loss.
3	Moderate	Substantial temporary or permanent minor, localised environmental damage. Stakeholder enquires (this may include government, unions or public). Medical attention required. High-medium financial loss.
4	Major	Substantial or permanent environmental damage. Prosecution possible. Loss of company credibility and high stakeholder interest. Permanent injuries. High financial loss.
5	Catastrophic	Widespread severe and permanent environmental damage. Major stakeholder and media interest. Prosecution likely. Permanent injury or death. Extreme financial loss.

Table 3-2. Qualitative measures of likelihood

Probability/likelihood			Likelihood criteria
A	Rare:	Practically impossible, will only occur in exceptional circumstances. Has never occurred in the industry.	0-1%
B	Unlikely:	Could occur at some time but highly unlikely. Has occurred in the industry previously.	1-10%
C	Moderate:	Might occur at some time. Has occurred in associated companies previously.	11-50%
D	Likely:	Known to occur or will probably occur in most circumstances. Has occurred several times/year in associated companies.	51-90%
E	Almost certain:	Common or repeating occurrence. Is expected to occur several times/year in any associated business.	91-100%

Table 3-3. Risk rankings used by combining consequence with likelihood levels for each aspect identified

Consequence						
Likelihood		1	2	3	4	5
	A	1	3	6	10	15
	B	2	5	9	14	19
	C	4	8	13	18	22
	D	7	12	17	21	24
	E	11	16	20	23	25

Where;

Red	extreme risk	intolerable
Purple	high risk	intolerable or tolerable
Yellow	moderate risk	tolerable or acceptable
Green	low risk	acceptable

3.1.2 Risk groupings

The Guidelines present six key risk groupings relevant to this development; these and the objectives relevant to these risks are given below:

1. Risks to human health and safety:

- Prevention and mitigation of risks to human health and safety are addressed in the design specifications.
- The risks will be managed effectively during the construction, commissioning, operation, and decommissioning of the development.

2. Risks to hydrology and water quality:

- To ensure that surface water and groundwater resources and quality are protected both now and in the future, such that ecological health and the health, welfare and amenity of people and land uses are maintained.

3. Risks to biodiversity:

- To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts.

4. Rehabilitation and mine closure:

- Rehabilitation of the site will be done in a manner that requires minimal inputs of maintenance post closure, but maximum protection of the environment from seepage of contaminants, weed incursion, erosion or other impacts.

5. Historic and cultural heritage impacts:

- i. Detailed assessment of the risks demonstrates that the Proponent is fully aware of the risks and mitigation measures to existing areas of historic and cultural heritage value.

6. Socio-economic risks:

- i. To analyse, monitor and manage the intended and unintended social consequences, both positive and negative, of the project and any social change processes.

3.1.3 Data supporting risk assessment

A range of environmental surveys were undertaken for this risk assessment, including:

- Noise baseline
- Hydrogeology and ground water testing
- Acid mine drainage investigations
- Surface water investigations
- Terrestrial and aquatic flora and fauna studies
- Biting insect surveys
- Archaeological investigations
- Dust baseline monitoring
- Soil analysis
- Biting insect monitoring.

3.2 Risks to human health and safety

The health and safety vision for this project is to operate a safe, incident free workplace. All activities that have the potential to impact on occupational health and safety are to be carried out in a manner that complies with all relevant legislation, advisory standards and codes of practice.

Sherwin Iron recognises that the safety and health of employees, contractors, visitors and the local community is paramount and is a fundamental requirement of its operation.

This section examines the potential risks to human health and safety associated with the construction, operation, maintenance, decommissioning and rehabilitation phases of the project, and the storage and transport of materials to and from the work sites.

The discussion includes risks to the health and safety of employees, contractors, visitors and the community.

The mining and associated ground disturbing activities associated with this development are in an isolated area resulting in there being no sensitive receptors such as kindergartens, aged care facilities, schools, hospitals, residential areas or commercial places in close proximity to it. The nearest sensitive receptors are located in Jowar (Family Outstation) approximately 9 km east of the project area. As such, it is considered unlikely that the mining operations will adversely impact upon public health. Off-site impacts associated with activities such as transportation do have the potential to impact sensitive receptors.

A summary of the potential health risks is summarised in Table 3-4. The detail of how risk ranking was determined is provided in Table 3-4 i.e. consequence and likelihood ranking. The control strategies address legislative and Australian Standard requirements where applicable.

For purposes of this discussion, key risks have been divided into the following sections:

Health impacts and mitigation measures

- Food hygiene
- Biological hazards
- Odour
- Air emissions
- Noise and vibration
- Hazardous substances
- Drinking water supply
- Pest management and disease vectors
- Wildlife hazards
- Waste
- Heat
- Intense storm event or cyclone
- Fire
- Alcohol and drug related incidents
- Manual handling

Safety impacts and mitigation measures

- Vehicle collisions
- Interaction with machinery
- Lighting
- Electrical energy
- Working at heights and falling objects.

3.2.1 Food hygiene

Food hygiene inherent risk profile

In reference to the provision of meals to employees: Without proper food hygiene standards and adequate storage of food items, food poisoning may occur. The inherent risk is medium.

Food hygiene risk mitigation

Food supplied by Sherwin Iron will be transported, stored and prepared in accordance with the *NT Food Act* and national Food Safety Standards. Sherwin will engage trained chefs to prepare food. Appropriate food storage facilities, such as portable cooler and freezer rooms, will be provided to ensure appropriate food hygiene standards are met. Appropriate cooking equipment and facilities will also be utilised.

Food hygiene residual risk

The residual risk will be greatly reduced through basic mitigation measures. The residual risks from food hygiene will be low.

3.2.2 Biological hazards

Biological hazards inherent risk profile

Personnel may be at risk of bacterial or infectious disease from a number of sources including, body fluids and contact with treated effluent.

Without appropriate training, handling and personal protective equipment (PPE) the inherent risk to staff from biological contamination is high.

Biological hazards risk mitigation

Gloves and other protective equipment will be worn by first aid personnel when treating injuries to protect against infectious diseases from bodily fluids.

Safe operating procedures will be developed for working on or near the waste water treatment facility, including the use of appropriate PPE and hygiene practices (e.g. thoroughly washing hands during and after working in these areas). Maintenance of this facility will be conducted in accordance to the manufacturer's specifications.

Biological hazards residual risk

With the proposed control measures in place, the residual risks associated with biological hazards are considered to be medium.

3.2.3 Odour

The proposed mining operations are not expected to produce any odour. No impacts to employees or the community are expected. As a result, no risk management or specific management strategies are discussed here.

3.2.4 Air emissions

Air emissions inherent risk profile

Dust is the primary atmospheric contaminant applicable to the proposed mining operations.

Dust analysis for the proposed mining operations has been conducted to gain a baseline (see Appendix M).

Dust generated by moving vehicles and wind can have a negative effect on persons health if they breathe in this dust.

The crystalline silica (quartz) component of dust from iron mining is of interest due to its potential for causing silicosis. The national recognised level (*NOHSC: 1003 Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment*) for crystalline silica is 0.1 mg/m³ (exposure based on an eight hour working day, five days a week). Respirable crystalline silica monitoring will be routinely conducted to ensure exposure is within acceptable limits. Levels of crystalline silica will be measured in accordance with the methodology in the *Australian Standard Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Respirable Dust AS2985-2004*.

The inherent risk associated with exposure to emissions is high.

Air emissions risk mitigation

Procedures will be implemented to ensure that employees and contractors do not suffer adverse health effects in the work environment from particulates or gas/vapours, either used or generated by the mining activities. These procedures will include a dust monitoring program and use of respiratory protection devices where necessary.

A water cart is to be used over high dust areas (e.g. internal haul road to ROM pad and around the mine site) and enforce speed limits on dirt tracks. Dust mitigation polymer is to be utilised at site whenever possible.

Air emissions residual risk

The health risks associated with air emissions are expected to be medium with the implementation of the control measures outline above.

3.2.5 Noise and vibration

Noise and vibration inherent risk profile

The noise amenity in the vicinity of the SCIOF area is dominated by natural noise sources, traffic along the Roper Highway and occasional noise associated with pastoral operations. The proposed iron ore extraction and transport activities will introduce additional noise from the plant and equipment at the extraction site, blasting activities along the Roper Highway and other ancillary infrastructure including the airstrip and mine camp. The operation of the mobile (bulldozers, excavators and trucks) and static plant (power generators, crushers etc.) will be associated with localised ground vibration.

Although cumulatively these noise emissions can be significant, the nearest sensitive receptors (approximately 9 km) will mean that noise emissions will be inaudible beyond the immediate project area. However, the potential noise impact from power generators with respect to individual units within the accommodation area, and on site offices and administration buildings at the processing area, requires careful consideration.

The inherent risk for noise is considered high due to the considerations of hearing loss to onsite personnel.

Noise and vibration risk mitigation

A number of mitigation measures have been specified to minimise potential noise and vibration impacts associated with discrete components of the project. These include strategic siting of buildings and infrastructure; the use of natural acoustic barriers (i.e. elevated terrain); acoustically attenuated generators; noise reduction systems on mobile or stationary plant and equipment; acoustic design of buildings; shock absorbing (vibration dampening) devices or materials around primary sources of vibration; and restricting the extent of the mine face and idle operation of plant and equipment. Hearing protection will also be used when needed.

Blasting at the mine is to only take place between 7am and 7pm Monday to Saturday and 9am and 6pm on a Sunday or public holiday. Blasting activities are to be advertised at least 48 hours before the commencement of blasting.

Refer to the Environmental Noise Baseline Data at Appendix P for more details.

Noise and vibration residual risk

With the mitigation measures above, the residual risk is still considered medium.

3.2.6 Hazardous substances***Hazardous substances inherent risk profile***

Fuels (predominantly diesel), lubricants, oils, solvents, degreasers, paint and domestic cleaning agents will form the majority of hazardous substances required at the mine site. The inherent risk is medium.

Hazardous substances risk mitigation

To reduce the impacts to health and safety of people and the environment, the following controls will be implemented:

- All hazardous substances will be managed and stored in accordance with relevant standards:
 - o NOHSC: 1015 National Standard for the Storage and Handling of Workplace Dangerous Goods
 - o NOHSC: 1005 National Model Regulation for the Control of Workplace Hazardous Substances
 - o NOHSC: 1008 Approved Criteria for Classifying Hazardous Substances
 - o Australian Standard 1940: 2004 The Storage and Handling of Flammable and Combustible Liquids.
- A register of all approved hazardous substances will be maintained
- Fuels will be stored and handled in accordance with the relevant standards. Diesel is the predominant fuel to be stored on-site and presents a low risk of combustion
- PPE (e.g. gloves, face shields or respiratory-protection devices) and first-aid equipment (e.g. emergency showers and eye-wash stations), will be maintained and available for use
- Awareness training will be provided to all personnel with regard to the correct handling and storage of hazardous substances and the procedures to follow in the event of a spill.

Fuel tankers will travel onto the site to refill bulk storage tanks as necessary.

Hazardous substances residual risk

The health risk associated with hazardous substances is expected to remain medium with the implementation of these management measures.

3.2.7 Drinking water supply***Drinking water supply inherent risk profile***

Should potable water not be provided by Sherwin then the inherent risk might be higher (because personnel would take water from rivers for drinking), but Sherwin will provide potable water that has received treatment. The inherent risk profile is therefore low.

Drinking water supply risk mitigation

Where water is required for human consumption (drinking or washing) it would receive primary treatment in the form of ultra-violet treatment and reverse osmosis filtration. Raw water will be stored at the camp area in tanks prior to treatment. All potable water will need to be tested against the Australian Drinking Water Guidelines. If there is a period where potable water is unavailable, bottled water will be sourced.

Drinking water supply residual risk

It is expected that the health related impacts associated with drinking water supply are to remain low.

3.2.8 Pest management and disease vectors***Pest management and disease vectors inherent risk profile***

The proposed mining activities are not expected to increase the number of pests or weeds. However, if significant areas of weed infestation or other declared pest species are identified, appropriate eradication and management measures would need to be undertaken. This is further discussed in the Environmental Management Plan (Appendix D) and the Pest and Weed Management Plan (Appendix I).

Of most importance to human health and safety is the possibility of contracting mosquito borne diseases. Mosquitos are disease vectors and their control is necessary for the health of mine employees and the community. A vector is an organism that does not cause disease, but transmits infections by transferring pathogens from one host to another. Dengue fever, Ross River fever, Barmah Forest virus and the potentially fatal Murray Valley encephalitis virus are diseases that can be transmitted by mosquitos. Rats are also disease vectors and can cause salmonellosis and scrub typhus in humans.

The inherent risk is considered to be medium to high.

Pest management and disease vectors risk mitigation

There are no vaccinations or medical cures for many arboviruses, and preventing mosquitos from breeding is the most effective action for limiting both mosquito numbers and the viruses they transmit.

Where possible any constructed earthworks that will collect water (sediment traps, garbage pits) will be designed to be free draining within five days. Where these structures will hold water for more than five days, they will be steep sided, have a sloping base to one end and kept free of vegetation. Natural drainage patterns will be maintained wherever possible.

Artificial containers and receptacles will be managed to prevent mosquito breeding. Depending on the container this management might include:

- Screening of inlets
- Storage under cover
- Provided with drainage holes
- Emptied at least every 5 days
- Treated with appropriate pesticides
- Removed off site

Rehabilitation of the site will ensure that the area is contoured to be free draining with no surface depressions collecting pooled water.

Personnel will wear hats, socks, long-sleeved shirts and long pants while on the mine site. Head nets and gloves, if required, will also be worn. Where possible, personnel will avoid peak biting times, specifically at dusk. Employees, contractors and visitors will be supplied with insect repellent. The workforce will be educated on mosquito health risks and mitigating measures. On-site office areas will be screened and yellow lighting installed.

These measures are further detailed in the Biting Insect Management Plan at Appendix N.

Rats will be discouraged from inhabiting the infrastructure areas by the removal of perishable waste on a daily basis (see Section 3.9).

If necessary, areas that cannot be managed with other methods will be treated with pesticides. Pesticide applications for disease vectors and other insects will be undertaken by a licenced Pest Control Technician.

Pest management and disease vectors residual risk

Even though the likelihood of increased pest or disease vector diversity or abundance is considerably reduced by the mitigation measures proposed, the residual risk remains high.

3.2.9 Wildlife hazards***Wildlife hazards inherent risk profile***

Wildlife such as venomous snakes and spiders create a health risk to workers if they are bitten. The inherent risk is considered to be high.

Wildlife hazards risk mitigation

During the staff induction process, mine personnel will be made aware of the potential wildlife hazards and the best methods to avoid negative encounters. Appropriate training for the treatment of snake bite will also be provided to all staff. First-aid facilities will be equipped to respond to incidents of this type and provide appropriate treatment.

To provide protection against snake and spider bite, PPE such as boots, trousers and long sleeves will be required on the mine site. Gloves will also be provided for use during relevant tasks.

Wildlife hazards residual risk

It is anticipated that the rate of encounter with hazardous wildlife, and the associated health and safety risks, will still be low.

3.2.10 Waste

Waste risks associated with human health and safety are discussed in Section 3.9.

3.2.11 Heat***Heat inherent risk profile***

Working in an outdoor tropical environment increases ultra-violet radiation exposure and risk of heat induced medical conditions. The inherent risk of heat injury is extreme.

Heat risk mitigation

All employees and contractors will be required to wear long-sleeve shirts, trousers and hats to help reduce sun exposure. Sunscreen will also be made available to all employees.

To mitigate the risk of heat induced medical conditions, all personnel will be made aware during staff induction training of the signs and symptoms of overexposure to heat and its effects, including dehydration. Drinking water will be readily available to all staff.

Heat residual risk

It is anticipated that the health risks associated with heat exposure will be medium.

3.2.12 Intense storm event or cyclone***Intense storm event or cyclone inherent risk profile***

Cyclones have passed through the area on previous occasions and the potential consequences are catastrophic. The inherent risk is extreme.

Intense storm event or cyclone risk mitigation

In the event of a cyclone the Cyclone Response Plan (Section 21 of the Emergency Response Plan – see EMP Appendix) will be implemented.

Intense storm event or cyclone residual risk

The residual risk would be medium.

3.2.13 Fire***Fire inherent risk profile***

This does not include bushfires – see Chapter 3.9 Other Risks for Bushfire Risk

Fires in buildings, vehicles and other locations around site have the potential to cause catastrophic damage and can even result in death to personnel.

For these reasons the inherent risk is considered to be extreme.

Fire risk mitigation

Fire safety devices such as emergency exit lighting, smoke detector alarms, fire extinguishers and fire blankets etc. will be installed in all buildings and outdoor areas as is required by the Building Code of Australia and the NT Fire and Emergency regulations.

Fire residual risk

Residual risk is considered to be medium.

3.2.14 Alcohol and drug related incidents***Alcohol and drug related incidents inherent risk profile***

During the construction phase the camp will not be licensed but an application to become a licensed premise will be lodged following completion of the construction stage. Residual risk for alcohol and drug related incidents are considered high.

Alcohol and drug related incidents risk mitigation

No alcohol will be sold on site however staff will be allowed to consume alcohol on site when not on duty. A strict Fitness For Work (FFW) policy will be implemented and enforced. Daily alcohol screening and monthly drug screening will be undertaken to ensure compliance with the FFW policy.

Alcohol and drug related incidents residual risk

With the above mitigation measures in place the residual risk is considered to be low.

3.2.15 Manual handling***Manual handling inherent risk profile***

Manual tasks are carried out in most types of work. Manual tasks can contribute to injuries affecting all parts of the body, particularly the back, shoulders and wrists and are commonly referred to as musculoskeletal disorders. An injury can be caused by a one-off overload situation, intense or strenuous activity or, more commonly, by on-going wear and tear to the soft tissue structures of the body (joints, ligaments, muscles and intervertebral discs). The inherent risk for manual handling is high.

Manual handling risk mitigation

In order to minimise the health risks training in manual handling will be provided to all personnel. Advice such as that listed below will be provided:

- Eliminate or minimise the degree of handling required where ever possible
- If working with a bent back: take short breaks to straighten your back and stretch
- If lifting repeatedly: take regular breaks, particularly in hot weather when you fatigue faster
- If continuously sitting: stand and walk occasionally
- If standing for long periods: occasionally sit on a high stool or a sit/stand chair
- When you need to position a load in another direction: turn with your whole body. Do not twist your trunk
- Store loads close to where you need them to save double handling
- Return mechanical aids to where they should be stored so others can locate them easily and not take risks lifting heavy equipment unassisted
- Alternate heavy jobs with light jobs
- Use assistance to move heavy or awkward loads.

Manual handling residual risk

The risk of injury caused by manual handling injuries remains medium to high with mitigation in place.

3.2.16 Vehicle collisions

Vehicle collisions inherent risk profile

Vehicles on the proposed mine will include articulated trucks, front-end loaders, bulldozers and light vehicles (4WD). While the number of these vehicles operating at any given time is limited, collisions between these vehicles have the potential to cause serious injury or death. There is also the potential for pedestrians to be hit by vehicles and machinery onsite.

Increased vehicle movements, especially trucks, along the Roper and Stuart Highways will also increase the likelihood of accidents.

The inherent risk of a traffic collision is considered to be extreme.

Vehicle collisions risk mitigation

All vehicles will be maintained in a roadworthy condition. All mine personnel operating vehicles on-site will be trained and appropriately licensed. Speed limits around the site will be imposed both for safety and to reduce the amount of dust generated. Dust control, in the form of polymers and road watering will be implemented to improve driver visibility. All mine vehicles will be regularly inspected and fitted with two-way radios. Pedestrian access will be limited, and all staff and site visitors will be made aware of the dangers of heavy trucks and machinery operating in their surrounding environment. It is important that machinery operators are aware of any situations where there are likely to be persons on the ground in their vicinity. All personnel will use two-way radios to communicate movement of personnel and vehicles around the site.

Risk mitigation measures employed on the Roper Highway will include:

- Upgrading of identified sections of the highway
- Installation of vehicle activated warning signs at the approaches to single-lane bridges
- Limiting operations to those periods when there are no restrictions on the use of the highway (~310 days/year).

These measures are detailed in the Traffic Management Report at Appendix L. A Fatigue Management Policy has been developed.

Vehicle collisions residual risk

The potential for injury from vehicles on the mine site and public roads is considered high.

3.2.17 Interaction with machinery***Interaction with machinery inherent risk profile***

Interaction with non-vehicular machinery and heavy equipment during mining operations can result in injury or death. The inherent risk associated with interactions of personnel with machinery with heavy equipment and machinery is considered to be extreme.

Interaction with machinery risk mitigation

Implementation of standard work practices will mitigate these risks. To minimise this risk, the following strategies will be implemented:

- High visibility clothing and direct radio contact when working alongside or within range of heavy machinery
- Coordination of activities
- Fixed plant will have appropriate safety and avoidance structures included in their design and construction
- Barricades will be erected around temporary or disabled plant or machinery to reduce the risk of interaction between people and machinery.

Interaction with machinery residual risk

With these measures in place, the risks of physical interaction with machinery are considered to be high.

3.2.18 Lighting***Lighting inherent risk profile***

Poor lighting levels or a lack of emergency lighting has the potential to cause a hazard. The inherent risk is considered to be medium.

Lighting risk mitigation

Mining operations will take place 24 hours a day, 7 days per week. Artificial lighting will still be required in some areas, particularly accommodation areas and within the mining area. To reduce the health and safety risks associated with poor lighting, the following will be installed:

- Task lighting where required to complete a specific task safely e.g. in offices and in operation areas
- Access and stair lighting
- General lighting around night shift work areas
- Emergency lighting in the Administration Building and selected staff common areas.

A minimum interior lighting level of 160 lux for general work areas and 40 lux for walkways and access areas will be installed in accordance with the AS1680 Interior Lighting. Emergency lighting will be installed in accordance with the AS2293 *Emergency Escape Lighting and Exit Signs for Buildings*.

Orange, red or yellow low pressure sodium vapour lamps will be used for exterior lighting, except where safety considerations require otherwise. Where other coloured lights are used, the light spilt will be restricted with shades (to prevent sky glow) or orientation. Pathway lights will be low to the ground and shaded where possible.

Lighting residual risk

With the implementation of proposed controls, the health and safety risk presented by poor lighting is expected to be low.

3.2.19 Electrical energy

Electrical energy inherent risk profile

A diesel-fuelled generator will be used to provide power for mine-site facilities and plant and will be located in the vicinity of the infrastructure area. The inherent risk of electrocution is considered to be high to extreme.

Electrical energy risk mitigation

Australian Standards (i.e. AS3000 *Electrical Installations* and AS3007 *Electrical Installations for Surface Mines*) will be observed to when designing, installing and maintaining electrical systems.

Electrical energy residual risk

The risk of injury caused by electrical energy is high.

3.2.20 Working at heights and falling objects

Working at heights and falling objects inherent risk profile

Working at heights is defined as working in any position where a person can fall from, into or through one level to another. Should a fall occur, there is potential to cause injury or death. There will be times where workers are required to work at height during the construction phase (e.g. mine site building construction) and the operation phase (e.g. maintenance of facilities). The inherent risk associated with working at heights is considered high to extreme.

Working at heights and falling objects risk mitigation

Where ever possible, work will be performed at ground level. Where this is not possible, work shall be performed from either a fixed, temporary or elevated platform. Alternatively, a person restraint system can be used. Fall protection equipment must be worn at all times and be connected to an appropriate anchor point when undertaking a task at a height. Personnel working at heights must be trained to do so.

Items falling from height can also present a safety risk. PPE that protects against objects falling from height include steel-capped boots and hard hats; these will be worn at all times while on-site. No personnel should be underneath another employee working at height.

Working at heights and falling objects residual risk

The residual risk of injury caused by a fall from a height is high.

Table 3-4. Residual risks to human health and safety

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Food hygiene	- Poor hygiene standards - Ineffective storage - Food poisoning	3	C	H 13	Adhering to appropriate standards and legislation e.g. <i>NT Food Act</i>.	2	B	L 5
Human health & safety	Biological hazards	- Poor hygiene standards - Contact with bacterial and/or infectious disease	3	C	H 13	- Gloves and other protective equipment will be worn by first aid personnel when treating injuries to protect against infectious diseases from bodily fluids. - Safe operating procedures will be developed for working on or near the waste water treatment facility, including the use of appropriate PPE and hygiene practices	3	B	M 9
Human health & safety	Air emissions	Inhalation of crystalline silica dust	3	C	H 13)	Respirable crystalline silica monitoring will be routinely conducted to ensure exposure is within acceptable limits. Levels of crystalline silica will be measured in accordance with the methodology in the <i>Australian Standard Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Respirable Dust AS2985-2004</i>.	3	B	M 9
Human health & safety	Air emissions	Inhalation of other air emissions e.g. dust, vapours etc.	3	C	H 13	Procedures will be implemented to ensure that employees and contractors do not suffer adverse health effects in the work environment from particulates or gas/vapours, either used or generated by the mining activities. These procedures will include a dust control program and use of respiratory protection devices where necessary. Dust from heavy machinery will be controlled by dust suppression	3	B	M 9

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						measures such as watering of roads and work areas.			
Human health & safety	Noise and vibration	Disturbance and possible hearing loss to surrounding areas and onsite personnel	4	B	H 14	- A number of mitigation measures have been specified to minimise potential noise and vibration impacts associated with discrete components of the project. These include strategic siting of buildings and infrastructure; the use of natural acoustic barriers (i.e. elevated terrain); acoustically attenuated generators; noise reduction systems on mobile or stationary plant and equipment; acoustic design of buildings; shock absorbing (vibration dampening) devices or materials around primary sources of vibration; and restricting the extent of the mine face and idle operation of plant and equipment. - Refer to Environmental Noise Baseline Data at Appendix P for more details.	3	B	M 9
Human health & safety	Hazardous substances	Contact with/ inhalation of vapours	3	D	H 17	- All hazardous substances will be managed and stored in accordance with relevant standards: - NOHSC: 1015 National Standard for the Storage and Handling of Workplace Dangerous Goods - NOHSC: 1005 National Model Regulation for the Control of Workplace Hazardous Substances - NOHSC: 1008 Approved Criteria for Classifying Hazardous Substances - Australian Standard 1940: 2004 The Storage and Handling of Flammable and Combustible Liquids.	3	B	M 9

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						- A register of all approved hazardous substances will be maintained. - Fuels will be stored and handled in accordance with the relevant standards. Diesel is the predominant fuel to be stored on-site and presents a low risk of combustion. - PPE (e.g. gloves, face shields or respiratory-protection devices) and first-aid equipment (e.g. emergency showers and eye-wash stations), will be maintained and available for use. - Awareness training will be provided to all personnel with regard to the correct handling and storage of hazardous substances and the procedures to follow in the event of a spill.			
Human health & safety	Drinking water	Sickness from poor drinking water	2	B	L 5	To conform to Australian Drinking Water Guidelines.	2	A	L 3
Human health & safety	Pests	- Dengue fever - Ross River virus - Barmah Forest virus - Australian encephalitis - Salmonellosis - Scrub typhus	5	C	E 22	- Personnel will wear hats, socks, long-sleeved shirts and long pants while on the mine site. Head nets and gloves, if required, will also be worn. - Where possible, personnel will avoid peak biting times, specifically at dusk. - Employees, contractors and visitors will be supplied with insect repellent. - The workforce will be educated on mosquito and midge health risks and mitigating measures. - On-site office areas will be screened.	5	B	H 19

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						Rats will be discouraged from inhabiting the infrastructure areas by the removal of perishable waste on a daily basis.			
Human health & safety	Wildlife hazards	- Snake bites - Spider bites	5	A	H 15	- Mine personnel will be made aware of the potential wildlife hazards and the best methods to avoid negative encounters. - Appropriate training for the treatment of snake bite will also be provided to all staff. - First-aid staff and facilities will be equipped to respond to incidents of this type and provide appropriate treatment. - To provide protection against snake and spider bite, PPE such as boots, trousers and long sleeves will be required on the mine site. Gloves will also be provided for use during relevant tasks.	3	A	L 6
Human health & safety	Waste	- Increased risk of injury due to waste (e.g. scrap metal flying around) - Increased pest and disease	4	B	H 14	- Clearly labelled bins will be placed in appropriate locations to segregate and collect the waste materials generated on-site. - Perishable waste will be removed from the mine site by staff on a daily basis. - General and recyclable waste will be transported off-site by a licensed contractor for disposal at a licensed general waste facility. - Regulated or hazardous wastes will be stored in accordance with relevant Australian Standards. They will be collected from site and disposed of by a licensed waste management firm.	2	B	L 5

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						- Clinical waste such as drug and alcohol testing kits will be disposed of in accordance with the <i>Remote Health Atlas</i> (NT Dept Health and Families 2006). - Clinical waste is also classified as hazardous waste under the <i>Dangerous Goods Act</i>. Appropriate PPE (such as safety glasses and gloves) will be worn while handling clinical waste. - Treated water discharged from the on-site waste water treatment facilities will be via a reticulation system to adequately landscape areas which are not intended for human use. - The procedures for the storage, containment and disposal of waste materials will minimise potential impacts to the surrounding environment and the mine personnel.			
Human health & safety	Heat	Heat injury	5	C	E 22	- All employees and contractors will be required to wear long-sleeve shirts, trousers and hats to help reduce sun exposure. Sunscreen will also be made available to all employees. - To mitigate the risk of heat stress, all personnel will be made aware during staff induction training of the signs and symptoms of overexposure to heat and its effects, including dehydration. Drinking water will be readily available to all staff.	5	B	H 19
Human health & safety	Intense storm event or cyclone	Injury or possible death	5	C	E 22	In the event of a cyclone the Cyclone Response Plan (section 21 of the Emergency Response Plan – see EMP Appendix) will be implemented.	3	B	M 9

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Fire	Injury or possible death	5	C	E 22	Fire safety devices such as emergency exit lighting, smoke detector alarms, fire extinguishers and fire blankets etc. will be installed in all buildings and outdoor areas as is required by the Building Code of Australia and the NT Fire and Emergency regulations 2011.	3	B	M 9
Human health & safety	Alcohol and drugs	Accidents/incidents while under the influence of alcohol or drugs	4	B	H 14	- No alcohol will be sold on site however staff will be allowed to consume alcohol on site when not on duty - A strict Fitness For Work (FFW) policy will be implemented and enforced. - Daily alcohol screening and monthly drug screening will be undertaken to ensure compliance with the FFW policy.	2	B	L 5
Human health & safety	Manual handling	- Lifting - Sitting or standing for a long period	4	C	H 18	- Eliminate or minimise the degree of handling required where ever possible. - If working with a bent back: take short breaks to straighten your back and stretch. - If lifting repeatedly: take regular breaks, particularly in hot weather when you fatigue faster. - If continuously sitting: stand and walk occasionally. - If standing for long periods: occasionally sit on a high stool or a sit/stand chair. - When you need to position a load in another direction: turn with your whole body. Do not twist your trunk. - Store loads close to where you need them to save double handling.	4	B	H 14

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						- Return mechanical aids to where they should be stored so others can locate them easily and not take risks lifting heavy equipment unassisted. - Alternate heavy jobs with light jobs. - Use assistance to move heavy or awkward loads.			
Human health & safety	Vehicle collisions	Severe injuries or death	5	C	E 22	- All vehicles will be maintained in a roadworthy condition. - All mine personnel operating vehicles on-site will be trained and appropriately licensed. - Speed limits around the site will be imposed both for safety and to reduce the amount of dust generated. - Dust control, in the form of road watering, will also be implemented to improve driver visibility. - Speed limits around the site will be indicated by appropriate signage. - All mine vehicles will be regularly inspected and fitted with two-way radios. - Risk mitigation measures employed on the Roper Highway will include: - Upgrading of identified sections of the highway - Installation of vehicle activated warning signs at the approaches to single-lane bridges - Limiting operations to those periods when there are no restrictions on the use of the highway (~310 days/year).	5	B	H 14

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Interaction with machinery	Severe injury or death	5	C	E 22	- Implementation of standard work practices will mitigate these risks. - To minimise this risk, the following strategies will be implemented: - High visibility clothing - Coordination of mine traffic - Appropriate speed limits and traffic rules will be enforced for the mine area - Barricades will be erected to reduce the risk of interaction between people and machinery.	5	B	H 14
Human health & safety	Lighting	Poor lighting levels or a lack of emergency lighting has the potential to cause a hazard.	2	C	M 8	- Task lighting where necessary - Access and stair lighting - Emergency lighting in the Administration Building.	2	B	L 5
Human health & safety	Electrical energy	- Electric shock injuries - Death	5	C	E 22	Australian Standards (i.e. <i>AS3000 Electrical Installations</i> and <i>AS3007 Electrical Installations for Surface Mines</i>) will be adhered to when designing, installing and maintaining electrical systems.	5	B	H 14
Human health & safety	Working at heights and falling objects	Severe injuries or death from falling	5	C	E 22	- Where ever possible, work will be performed at ground level. - Where this is not possible, work shall be performed from either a fixed, temporary or elevated platform. Alternatively, a person restraint system can be used.	5	B	H 14

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood RS=Risk Score)			Management measures	Residual risk (C=Consequence L=Likelihood RR=Residual Risk)		
			C	L	RS		C	L	RR
						- Fall protection equipment must be worn at all times and be connected to an appropriate anchor point when undertaking a task at a height. - Personnel working at heights must be trained to do so. - Items falling from height can also present a safety risk. PPE that protects against objects falling from height include steel-capped boots and hard hats; these will be worn at all times while on-site. - No personnel should be underneath another employee working at a height.			

3.3 Risks to hydrology and water quality

This section examines the potential impacts that the proposed mining project may have on surface and groundwater resources and values. For both surface and groundwater, the primary risks are associated with water quality and/or quantity and for the purposes of this discussion, have been divided into the following themes:

- i. Surface water hydrology
- ii. Surface water quality
- iii. Groundwater levels
- iv. Groundwater quality.

In some cases, a particular activity may pose a risk to both surface and groundwater or in cases where there may be a surface-groundwater interaction, changes in groundwater levels may influence surface water hydrology. Aquatic ecosystem health is closely linked to surface water quality and hydrology and risks to aquatic biodiversity are discussed in further detail in Section 3.4.

Background information, inherent risks, mitigation measures and residual risks in relation to the above four themes are summarised in Table 3-5 and discussed in further detail. The detail of how risk ranking was determined is provided in Table 3-5 i.e. consequence and likelihood ranking.

3.3.1 Surface water hydrology

The main potential risks to surface water hydrology are the alteration to surface water flows associated with:

- i. Road crossing of Sherwin Creek
- ii. Modification of natural drainage flow paths associated with mining infrastructure.

Hydrology inherent risk profile

The proposed road between the mine site and Roper Highway crosses Sherwin Creek (see Water Management Plan; Appendix F1). In the absence of appropriate design and construction, stream crossings (e.g. bridges, culverts, causeways) could lead to a localised alteration of stream hydrology (e.g. increased velocities associated with constriction of flows); which may affect upstream movement of aquatic fauna (e.g. fish) and lead to increased localised erosion. While there are no recorded or expected threatened species within the local waterbodies (see Aquatic Fauna Report; Appendix H3) this may have an effect on accessible wet season habitat for some species. This is considered to be of minor consequence with a moderate likelihood, resulting in a medium inherent risk.

There will be some modification and removal of the upper sections of several drainage lines in the catchment of a minor tributary of Sherwin Creek associated with construction of the mine site, with potential impacts on flows to downstream areas. However, as these drainage lines are located at the top of their respective catchments, this is considered to be a minor consequence (i.e. minor, temporary environmental impact) and in the absence of any mitigation measures is moderately (i.e. might occur at some time) likely to occur. This results in a low inherent risk of impact to downstream aquatic environments.

Hydrology risk mitigation

To minimise the potential risks of alteration to surface water flows associated with the road crossing of Sherwin Creek and other minor drainage lines, their design and construction will incorporate appropriate engineering principles and natural flows will be maintained at all times. Construction will be cognisant of fish passage principles (e.g. Fairfull and Witheridge 2003).

Natural surface water flows will be maintained within the mine site area as far as practicable and where minor drainage diversions are required (e.g. around waste dumps/stockpiles), consideration will be given to ensuring that water flows resume their natural flow paths as close as possible downstream of disturbed areas.

Hydrology residual risk

The above mitigation measures reduce the risk of hydrological impacts associated with both the construction of haul road stream crossings and modification of natural drainage flow paths to a 'low' level.

3.3.2 Surface water quality

Surface water systems are particularly susceptible to changes in water quality associated with mining activities that may lead to inputs of contaminants from:

- Acid/metalliferous drainage (AMD) from ore and/or waste rock
- Suspended solids and turbidity in run-off from disturbed areas
- Spills/leaks of hazardous chemicals
- Sewage and other wastes

Surface water quality inherent risk profile

The transfer of rock materials from underground to the ground surface may result in the mobilisation of solutes (e.g. metals, salts), which may in turn lead to degradation in quality of downstream surface and/or groundwaters. The risk of contaminant mobilisation is increased significantly with the occurrence of potentially acid forming (PAF) materials and as outlined in the AMD/PAF Report (Appendix G), detailed investigations indicate that there are small quantities of PAF materials located in the north-western section of the proposed pit shell. In the absence of appropriate management, acid/metalliferous drainage has the potential to impact water quality and subsequently, aquatic ecosystem health for a considerable distance downstream. An example of a potential 'worst-case scenario' in relation to downstream impacts of AMD is the former Rum Jungle mine in the NT, where significant ecological impairment was recorded for a distance of up to 15 km downstream and a measurable effect for a distance of up to 30 km downstream (Jeffrey and Williams 1975). Given the relatively small quantities of PAF likely to be encountered in this project and absence of groundwater influx to the mine pit (see Groundwater Report; Appendix F2), in the absence of appropriate management and/or mitigation measures, both the consequence and likelihood of this impact are considered to be 'moderate', resulting in a 'high' risk of impact to downstream surface water quality.

Within the project area, there are some soil types that pose an inherently high risk of erosion, as outlined in Soil Survey Report (Appendix Q). Land clearing for mining and ancillary activities (e.g. pits, stockpiles, waste dumps, roads, processing areas, etc.) involves the removal of vegetation and in many cases, the soil surface cover. This may lead to erosion of soils/subsoils and subsequent transport of sediments into downstream aquatic environments in surface run-off. Increased sedimentation and turbidity can affect the functioning of aquatic environments in a number of ways, such as smothering of habitats, inhibition of photosynthetic activity and ecological effects (e.g. changes in visibility affecting predatory species). In the absence of appropriate mitigation measures, there are likely to be 'major' consequences (i.e. substantial or permanent environmental damage) with a 'moderate' likelihood (i.e. might occur at some time), resulting in a 'high' risk of impact to downstream aquatic environments.

As outlined in Chapter 2, there are to be no chemicals used in the ore extraction process, with the storage and handling of hazardous materials being primarily associated with hydrocarbons (i.e. fuel for mining equipment). Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream surface quality. In the absence of appropriate mitigation measures, there are likely to be 'major' consequences (i.e. substantial or permanent environmental damage) with a 'moderate' likelihood (i.e. might occur at some time), resulting in a 'high' risk of impact to downstream aquatic environments.

As outlined in Chapter 2, treated sewage water will be treated and used for dust suppression. If the disposal location has a connection to a drainage line, there is a risk of impacts on downstream surface water quality associated with elevated nutrient concentrations, which may in turn cause nuisance/toxic algal blooms. Irrigation of water in a small area could also lead to waterlogging of the soil and potentially a localised effect on vegetation (e.g. change in species composition). If not located or managed appropriately, domestic waste disposal may also pose a risk to surface water quality. Remaining non-hazardous (inert and putrescible) solid wastes will be disposed of in an on-site, trench type landfill. If the disposal trench location has a connection to a drainage line, there is a 'moderate' consequence (i.e. substantial temporary or permanent minor environmental damage) and 'moderate' likelihood (i.e. might occur at some time), resulting in a 'medium' risk of impacts on downstream surface water quality associated with elevated nutrient concentrations.

Surface water quality risk mitigation

Proposed measures to manage any PAF materials that are encountered are summarised below and details provided in the AMD/PAF Report (Appendix G):

- Demarcation, progressive excavation and immediate implementation of measures such as burial, sealing and compaction to contain/encapsulate/cover and prevent oxidisation of any PAF materials.
- Benching where possible will be excavated in lengths that permit easy extraction, remediation and closure.
- Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling.
- Implementation of construction methods to prevent long-term PAF exposure to oxygen (e.g. sheet piling) will be considered.
- Any generated AMD will be monitored, managed and treated using appropriate methodologies.

To mitigate potential impacts of increased turbidity and suspended solids associated with construction and mining works, monitoring and management of runoff will be undertaken in accordance with the Erosion and Sediment Control Plan (Appendix E) and Water Management Plan (Appendix F1). This will include the construction of sediment basins in key areas, to enable adequate settling of suspended materials prior to use or discharge. Wherever possible, any discharge points will be located so that water flows into relatively flat, vegetated areas rather than directly into drainage lines.

Hazardous materials and wastes will be stored in appropriately labelled containers within purpose-built dangerous goods and chemical storage containers. These will be self-bunded, ventilated and compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the *UN Recommendations for the Transport of Dangerous Goods – Model Regulations*) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery and appropriate disposal of contaminated soil).

All sewage wastewater generated from the mine site and camp will be treated to a high quality and recycled. The recycled water will be used for irrigation within the camp area and dust suppression around the mine site. Irrigation of recycled water will be in accordance with the *Guidelines for Management of Recycled Water Systems* (Department of Health 2011a) and *Environmental Health Factsheet No. 513 Recycled Water Irrigation: Information Guide for Applicants* (Department of Health 2011b). The trench landfill will be located at least 150 m away from any surface water pathways.

A comprehensive surface water monitoring program will be undertaken at the mine site, which will include sampling of both potential sources of contamination (e.g. sediment basins) and natural surface waterbodies upstream and downstream of mining infrastructure. Details of the proposed monitoring program are provided in the Water Management Plan (Appendix F1). Data will be stored in an appropriate database and reviewed

at regular intervals (i.e. as data become available), to assess whether mining activities are impacting on surface water quality or if there are any trends in water quality that provide early warning of potential impacts.

Surface water quality residual risk

The mitigation measures outlined above will reduce high risks to surface water quality to moderate or low risks.

3.3.3 Groundwater levels

The main potential risk to groundwater levels is from abstraction for potable and operational mine water supplies (i.e. primarily dust suppression), in the absence of other users.

Groundwater levels inherent risk profile

It was concluded in the baseline groundwater assessment (Appendix F2) that influx of groundwater to the mine pit and hydraulic connectivity of ground water to surface water resources in the vicinity of the mine (including GDEs) are not considered risks and will not be impacted by mining and processing. Dewatering to facilitate open pit mining will not be required and therefore no safeguards or management measures in relation to groundwater levels are required. However, the groundwater resources identified to date in the vicinity of the mine site (i.e. long-term sustainable yield = 12 ML/a) are inadequate to meet the total operational requirements of the mine (i.e. 50 ML/a).

Although the operational risk associated with depletion of local groundwater resources is relatively high, there is considered to be a 'minor' environmental consequence (i.e. minor, temporary environmental impact) and 'unlikely' likelihood (i.e. could occur at some time but highly unlikely), resulting in a 'low' inherent risk of environmental impacts.

Groundwater levels risk mitigation

To minimise water use and therefore the risk of lowering of groundwater levels, Sherwin will implement of water saving strategies, including (but not limited to) the following:

- Minimise use (e.g. education of workers in camp, use of polymers on roads to reduce requirements for dust suppression)
- Recycling of wastewater for dust suppression (i.e. sewage treatment plant)
- Re-use of rainfall/run-off captured in disturbed areas of the mine site for dust suppression.

In order to identify additional groundwater resources to meet mining operational requirements, Sherwin will undertake geophysical exploration, bore drilling, testing and sampling. Sherwin will assess potential impacts of extraction and sustainable yields from these additional groundwater resources (i.e. potential GDE's, other users, etc).

In order to minimise the operational and environmental risks (if any) associated with depletion of groundwater resources, Sherwin will ascertain/set operational controls for ground water exploitation (i.e. sustainable safe yield, allowable drawdown and distance to zero drawdown) and monitor bore yields, groundwater level behaviour and water quality, in accordance with the Water Management Plan (Appendix F1). Further investigations have been initiated to firm up a reliable water source for the project.

Groundwater levels residual risk

The above mitigation measures further reduce the 'low' risk of impacts associated with changes to groundwater levels associated with extraction for mining operations.

3.3.4 Groundwater quality

As outlined in Appendix F2, existing groundwater quality within the project area is variable but relatively good and there are no major regional aquifers in the immediate area. The main potential risks to groundwater quality are localised and associated with inputs of contaminants from:

- i. Acid/metaliferous (AMD) drainage from ore and/or waste rock; and
- ii. Spills/leaks of hazardous chemicals.

Groundwater quality inherent risk profile

The baseline AMD assessment (Appendix G) indicated that potentially acid forming (PAF) bodies are relatively small, isolated and largely confined to the north-west of the proposed open pit. The volumes of PAF requiring disposal will be relatively low, with the primary risk associated with AMD for this project being infiltration of rain water from a partially backfilled open pit during mining and post-closure, which may leach through PAF materials located below or downstream of the pit and therefore impact on downstream groundwater quality. In the absence of appropriate mitigation measures, there is a 'moderate' consequence (i.e. substantial temporary or permanent minor, localised environmental damage) and 'moderate' likelihood (i.e. might occur at some time), resulting in a 'high' inherent risk of impact to groundwater quality.

As outlined in Chapter 2, the storage and handling of hazardous materials is primarily associated with hydrocarbons. Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream groundwater quality and, in the absence of appropriate management/mitigation measures, there is a 'high' risk of this occurring.

Groundwater quality risk mitigation

Proposed measures to manage any PAF materials that are encountered are summarised below and details provided in the AMD/PAF Report (Appendix G):

- Demarcation, progressive excavation and immediate implementation of measures such as burial, sealing and compaction to contain/encapsulate/cover and prevent oxidation of any PAF materials.
- Benching where possible will be excavated in lengths that permit easy extraction, remediation and closure.
- Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling.
- Implementation of construction methods to prevent long-term PAF exposure to oxygen (e.g. sheet piling) will be considered.
- Any generated AMD will be monitored, managed and treated using appropriate methodologies.

In order to mitigate the potential risk of groundwater contamination from spills/leaks of hazardous materials and wastes, these will be stored in appropriately labelled containers within purpose built dangerous goods and chemical storage containers. These are self-bunded, ventilated and are compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the UN Recommendations for the Transport of Dangerous Goods – Model Regulations) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery of contaminated soil).

Groundwater quality residual risk

The mitigation measures outlined above will reduce high risks to groundwater quality to low risks.

Table 3-5. Risks to hydrology and water quality

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Surface water hydrology	Change in hydrology due to road crossings from mine site to Roper Highway.	- Impeded fish migration - Increased erosion	2	C	M 8	Ensuring that creek crossing design (culverts) will have limited influence on flows.	2	B	L 5
Surface water hydrology	Change in hydrology due to modification of upper parts of catchment.	Reduced stream flow into Sherwin Creek	2	C	M 8	- Natural surface water flows will be maintained within the mine site area and where minor drainage diversions are required. - Consideration will be given to ensuring that water flows resume their natural flow paths as far as possible.	2	B	L 5
Surface & ground-water quality	Storage of ore and/or waste rock	Contamination of downstream surface and/or groundwaters associated with acid mine drainage (i.e. acid and/or heavy metal contamination).	3	C	H 13	- Ongoing characterisation of materials and storage and management methods. - Demarcation and progressive excavation and implementation of immediate remediation measures such as burial, sealing and compaction to prevent PAF materials to oxidise. - Where PAF is exposed, sealing and compaction of the sides and base of the excavation will be undertaken before backfilling. - Implementation of construction methods to prevent	2	B	L 5

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
						long-term PAF exposure to oxygen (e.g. sheetpiling) will be considered.			
Surface water quality	Land disturbance	Erosion leading to transport of sediments in run-off, resulting in impact on downstream surface water quality (e.g. increased suspended solids, turbidity).	4	C	H 18	Management of runoff in accordance with Erosion and Sediment Control Plan (Appendix E) and Water Management Plan (Appendix F1).	3	B	M 9
Surface & ground-water quality	Storage & handling of hazardous materials (e.g. hydrocarbons)	Spill or leak to environment with potential to contaminate downstream surface and/or groundwaters.	4	C	H 18	- Appropriate storage of hazardous materials and monitoring of storage facilities, in accordance with Standard Operating Procedures, Environmental Management Plan and relevant standards/guidelines. - Adequate training (e.g. inductions).	3	B	M 9
Surface & ground-water quality	Disposal of sewage & other waste	Contamination of downstream surface and/or groundwaters.	3	C	H 13	Appropriate design, location and operation of waste facilities, in accordance with operational procedures and Environmental Management Plans.	2	B	L 5

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Ground-water levels	Groundwater abstraction (e.g. water supply, pit dewatering)	Alteration to local or regional groundwater levels and availability	2	B	L 5	- Implementation of water saving strategies (i.e. minimise use, recycling of wastewater, use of polymers on roads to reduce requirements for dust suppression) - Undertake geophysical exploration, bore drilling, testing and sampling to identify additional nearby groundwater resources. - Assess potential impacts on additional nearby groundwater resources (i.e. potential GDE's, other users, etc) - Ascertain/set operational controls for ground water exploitation (i.e. sustainable safe yield, allowable drawdown and distance to zero drawdown). - Monitor bore yields, ground water level behaviour and water quality: implement Water Management Plan.	2	B	L 5

3.4 Risks to terrestrial and aquatic biodiversity

One of the objectives described in the EIS for this project was in regards to biodiversity, specifically:

To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts.

This section examines the potential impact that this development will have on the terrestrial and aquatic biological values of the region; this includes all species that spend the major part of their existence in freshwater or on land. This discussion is supported by literature review, as well as desktop and field survey done specifically for this development.

The region of the proposed development has significant biodiversity conservation values. East of the development is the recently declared Limmen National Park and to the north is the Roper River, considered an important boundary between different biogeographic and climatic regions (LRM 2013). Additionally, a number of threatened species have been reported nearby to the development (see EIS appendices for fauna (Appendix H1) and flora (Appendix H2)). These values are reviewed, risk determined and mitigation measures identified.

For this discussion terrestrial and aquatic biodiversity has been subdivided into the following groups:

- (i) Terrestrial biodiversity-flora and fauna and sensitive habitats
- (ii) Aquatic fauna
- (iii) Vegetation communities
- (iv) Pest species
- (v) Weeds.

For each of these groups the status, supporting data, inherent risks, mitigation strategies and residual risks will be identified. A summary of this discussion is in Table 3-6. The detail of how risk ranking was determined is provided in Table 3-6 i.e. consequence and likelihood ranking.

3.4.1 Terrestrial biodiversity-flora and fauna

To understand the regional assemblage of terrestrial species the following studies were performed:

- (i) Desktop survey
- (ii) Flora and fauna field survey.

The results of field and desktop surveys can be found in Appendix H1 (fauna) and H2 (flora), which, amongst other things, analyses the likelihood of occurrence of threatened species within or nearby to the disturbance area. They conclude that it is unlikely that threatened fauna will be affected by this development; however one species of migratory bird (as listed in the *Commonwealth EPBC Act*) the Buff-sided Robin (*Poecilodryas cerviniventris*) may be locally affected through loss of gorge habitat; it is noted that this species was also recorded off-site during fauna survey.

In the development of the EIS it was thought that one species of threatened plant (*Solanum carduiforme*) may exist within the mined area; a targeted survey found this not to be the case.

This risk analysis examines not only threatened species but also terrestrial species more generally. The potential impacts of this development on terrestrial biodiversity are:

- (i) Direct mortality
 - a. due to mine construction or operations
 - b. for fauna due to increased traffic on the Roper Highway.

(ii) Changes in habitat quantity (loss of habitat) including:

- a. vegetation clearing generally
- b. sensitive habitat clearing

(iii) Changes in habitat quality by:

- a. Fire¹
- b. Erosion²
- c. Poor rehabilitation³
- d. Dust⁴
- e. Noise
- f. Pests and weeds⁵
- g. Alteration/loss of ecological processes such as ecological connectivity/fragmentation.

Each of these is discussed in detail below and given risk rankings which is summarised in Table 3-6 below.

Dust discussed here is dust due to mining, management of dust during transport is dealt with in Section 3.2.4 and Section 3.8.1. The impacts of noise in relation to human receptors are discussed in Section 3.2; here the effect of noise on environmental receptors is considered.

Terrestrial biodiversity inherent risk profile

Direct mortality is deaths during construction or operation; this is death during clearing of vegetation and, for fauna, operating the mining roads or mining vehicles along the Roper Highway. The consequence of direct mortality during construction is considered minor: minor temporary environmental impact; the likelihood of such an event is considered moderate: might occur at some time. This gives a risk score of medium. During operations the risk score for direct mortality on fauna is medium: minor consequence and moderate likelihood. The consequence of direct mortality due to increased traffic volume is insignificant at the population level with the likelihood of such an event is considered moderate: will probably occur in most circumstances.

The EIS Guidelines identify concerns around vegetation clearance, rehabilitation and the spreading of weed species. The rehabilitation and weeds are dealt with elsewhere within this risk chapter, here vegetation clearance is considered. Important considerations for vegetation clearance include the type of vegetation cleared (i.e. restricted or rare vegetation communities), the extent of the clearance (including implications on connectivity as well as buffering for creek side vegetation), how it is cleared (including blade depth) and the stability of the soils of the cleared site (this has implications for erosion).

Most of the vegetation types being cleared for this development is open eucalypt woodland which is common and widespread across the region (Appendix H2); the area being cleared (approximately 350 ha) is negligible in the regional context for this habitat type. A small portion of the gorge habitat that would be cleared as part of this project supports dry monsoon rainforest (approximately 0.65 ha). Dry monsoon rainforest is considered a sensitive vegetation community in the Northern Territory (LRM 2010) due to its species

¹ Changes in fire regimes are implicated as one of the most important landscape scale ecological threatening processes in northern Australia. In the context of this development, however, the development's proponents are not obligated to manage fire except in protecting life and property through fire-break installation (see Section 3.9). Consequently, this hazard will not be further discussed.

² Erosion and sedimentation is discussed in detail in Appendix E and Section 3.3.

³ Rehabilitation procedures are outlined in the Rehabilitation and Mine Closure Plan (Appendix J) and rehabilitation risks (Section 3.5).

⁴ Dust mitigation strategies are dealt with in Section 3.2.4

⁵ This section will examine weeds and pests in a biodiversity sense; biting insect pests are dealt with in Section 3.2.8.

richness, supporting approximately 13% of the Northern Territories flora species whilst occupying just 0.2 per cent of the land area.

The inherent risk to vegetation relates to inappropriate clearing as described above. *The Flora of the Sherwin Leases* (Appendix H2) shows a fine scale vegetation map of Deposit C and the area to be cleared. Without a proper clearing planning framework supported by relevant knowledge and information over-clearing, clearing of the additional habitat, may result. For this development, after considering the clearing profile the consequence is minor (2) and the likelihood is moderate (C) giving a risk rating of medium.

Sensitive habitats is a term used in the EIS Guidelines that includes ecosystems that provide important ecological functions including e.g. riparian vegetation, protected area buffer zones, refugia, important habitat corridors, or geological features which may support unique ecosystems (escarpments, gorges, gullies etc.). Some gorge areas will be impacted by this development, less than 25 ha of gorge habitat (and 0.65 ha of the associated dry rainforest) will be removed. Gorges are regarded as significant habitat as they provided enhance moisture and fire protection and therefore support species that are unable to persist elsewhere (Morton et al. 1995). However the gorges to be disturbed by the proposed project are considered unlikely to support populations of any threatened species (see Appendix H2) but were found during survey to support an *EPBC Act* migratory species also considered Near Threatened in the Northern Territory. This species, the Buff-sided Robin (*Poecilodryas cerviniventris*) has an association with dense vegetation and gorge country across its range; as this development is removing gorge country around Deposit C this development will have a localised effect. However, as there is other gorge country nearby it is not consider to be a significant impact. Specifically, it is thought that the consequence of sensitive habitat clearing is minor with an unlikely likelihood giving an inherent risk profile of low.

Habitat quality may be affected by:

- Dust
- Noise effects (for fauna)
- Pests and weeds
- Ecological processes.

Dust generated on a mine site has the potential to affect air quality in the vicinity of the mine site and therefore fauna and flora on or nearby the mine site and associated plant. Dust emissions during establishment, operation and rehabilitation of the proposed project are of primary concern in regards to the potential air quality impacts. However, it is thought this will be localised and have no major effect. Dust at the mining area deposited at close proximity to the mining face has the potential to increase sediment loads in receiving waterways. These impacts are not considered to be substantial with an insignificance consequence and an unlikely likelihood of an impact on objectives, the inherent risk ranking is low.

Noise may have a deleterious effect on fauna that live or travel through or nearby to the mine site and associated plant. There will be an increase of noise in these areas, however it is thought that this will be localised and have no major effect. The consequence of the effect of noise from the mine on terrestrial fauna species is expected to be minor. The likelihood of this hazard is considered to be unlikely. This gives an inherent risk profile of low risk.

Pest animals are also of concern (note biting insects are dealt with in Section 3.2.8). Pests can aid in the spread of weeds, lead to a decrease in populations of native species, increase erosion and be a hazard for vehicles. There are a number of pests known from the development area such as cats, pigs, rats and donkeys (see Appendix H1 for a full list). Development can lead to an increase in pest populations through the provision of food from poor management of mine waste and/or by creating artificial pools of water. It is not expected that these effects are substantial though with a consequence of insignificant and a likelihood of unlikely giving a risk ranking of Low.

Weed invasion due to the establishment of the mine and associated ancillary infrastructure is a high risk for retaining habitat quality. The construction stage of the development will involve significant ground disturbances potentially allowing for the establishment of weeds. Surveys of the project area recorded only

six introduced plant species, two of which are listed weeds (Appendix H2). Without any mitigation it is thought that it is likely that new species of weed will be established and that existing weed species will increase in population and extent.

Terrestrial fauna biodiversity mitigation

Clearing of vegetation during construction will result in a localised impact to native terrestrial fauna species. The following mitigation methods can be used to address the issues outlined above:

- Plan clearing so that vegetation removal is as minimal as possible
- Show clearing boundaries on maps
- Incorporate the above commitments into the MMP auditing process.

Direct mortality due to traffic on mining roads will be mitigated by enforced speed limits on the Roper Highway (80 km/h) with the trucks travelling in convoy.

The impact of reduction of habitat quantity is mitigated by ensuring disturbance is retained within the approved clearing envelope and ensuring successful post-mining rehabilitation (Appendix J). Sherwin Iron commits to only operating within the approved disturbance envelope.

There are no specific mitigation measures for noise.

A Pest and Weed Management Plan (PWMP) will reduce the impact of pests and weeds on local biodiversity (through a reduction in habitat quality) (see Appendix I). Pest management for this development focuses on ensuring that pest populations are not increased by any of the activities associated with this development, this includes waste management so that waste is not available for food for pests and by fencing artificial water points that could provide a source of drinking water to vertebrate pests.

For weeds the PWMP describes the procedures by which Sherwin will ensure that no new weeds will establish on their leases and the procedures and timing to support weed control and containment.

Terrestrial fauna biodiversity residual risks

The total area of woodland being cleared for the development is negligible in the regional context, and habitat fragmentation is unlikely due to the contiguous nature of woodland in the area. Impacts to terrestrial species by habitat clearing during construction, as a consideration for habitat quantity, is therefore considered to be minor and a likelihood of unlikely giving a risk profile of low.

During the operational phase the on-going risk to terrestrial fauna is road kill. The risk of a road kill event is much higher along the Roper Highway than the relatively short mining roads at Deposit C. Mitigation methods, such as enforced speed limits (80 km/h) and traveling in convoys, will decrease the likelihood of fauna mortality; however the risk is still considered low.

As the area of sensitive habitats (gorges) to be impacted by the development is considered to be inconsequential in the context of the region and has been rated as a low risk there are no specific mitigation measures identified.

The habitat quality threats operative on terrestrial fauna species in this development are weeds and pests, noise and dust. The risk from dust was also assessed as low, however as it also a risk to human health there will be mitigation measures (see Section 3.2.4), further reducing the risk. There will be no specific management response for noise in relation to fauna; as discussed above the risk is low and there are limited opportunities to mitigate further.

Implementation of the PWMP will reduce the risk weed and pest species pose to biodiversity. By removing potential food and water sources for pests it is thought that this will marginally reduce the likelihood of pest animal occurrence. The residual risk to terrestrial fauna biodiversity from pests is considered low.

It is thought that the weed management strategy outlined in the PWMP will decrease the likelihood of declared weeds spreading as a consequence of this development. The risk residual profile has a moderate consequence, but a reduced likelihood of moderate giving a risk ranking of high.

3.4.2 Aquatic fauna

Deposit C is located at the upper catchment of a small tributary to Sherwin Creek. This creek does not flow until significant rainfall occurs during the wet season. During the dry season the creek dries out, although some water is likely to remain through the dry season in at least some years. Such pools may provide a drought refuge used by the many invertebrate animals that occur in the ephemeral creeks, and are also used by native fish. These pools are vulnerable to water extraction.

A desktop study and aquatic survey has been performed for this EIS. A list of threatened species, probability of their occurrence and potential impacts to these species due to the development is outlined in the *Aquatic Report* (see Appendix H3) which concludes no species considered threatened by either the Commonwealth or NT governments would be affected by this development. This risk assessment will analyse the impact of the development on aquatic fauna generally.

Aquatic species can be affected by changes in habitat condition, namely changes in water quantity and quality. Hazards to water quality and quantity for this development specifically include:

- Changes in water quantity due to extraction or changes in hydrology
- Changes in water quality from turbidity due to erosion
- Changes in water quality due to pollutants (e.g. hydrocarbons)⁶

These impacts may result in a lower diversity and populations of aquatic fauna occurring within the project area, as certain species are unlikely to survive the stress of changes to habitat quantity and quality.

Aquatic fauna inherent risk profile

While there are no plans to dam the Sherwin Creek tributary flowing from Deposit C the nature of the development will influence the hydrology and thus may impact the quantity of water flowing along the tributary. It is not thought that this will have a major influence on the water quantity to either this tributary or Sherwin Creek as both catchments extend wider than this tributary, thus the consequence is considered minor and the likelihood that this will affect aquatic biodiversity is unlikely giving a risk ranking of low.

While the rivers and creeks in the area are already turbid (see *Aquatic Report*, Appendix H3) it is possible that without mitigation this could be made worse by erosion from the minesite and associated areas. This increased turbidity can lead to reduced light in the water and increase sedimentation on pools. It is thought the consequence to aquatic fauna from this is moderate and the likelihood moderate giving a risk ranking of High.

Aquatic fauna risk mitigation

There are no specific mitigation measures for changes to water quantity.

Any action that reduces the potential for or the quantity of erosion will have a beneficial impact on water quality. There are three such actions proposed. Firstly, the company has committed to not clearing vegetation outside of their approved boundaries; this will reduce the potential eroded area. Secondly, Sherwin Iron is committed to implement the Erosion and Sedimentation Plan (Appendix E) which has the stated aim of aims to reduce the water flowing off the mine site and surrounds. Finally, the company has committed to a post-mining rehabilitation program as outlined in Appendix J which will ensure, amongst other things, that the post-mine landscape soil surface will be stable and non-eroding.

Aquatic fauna residual risk

As the inherent risk profile for water quantity is low and there are no mitigation measures changes in water quantity retains a low risk to aquatic biodiversity.

⁶ Hydrocarbon management is discussed within the Environmental Management Plan, Appendix D.

Risks to water quality due to changes in sedimentation and erosion would be reduced by the three mitigation strategies outlined; giving a residual risk profile of low risk (5).

Water extraction from the project area will be via a deep aquifer and therefore will not impact upon the groundwater dependent Sherwin Creek. This will decrease the likelihood of aquatic fauna being impacted to unlikely; the consequence would be unchanged as minor and therefore the risk will be low (5).

3.4.3 Pest species

Pest species can aid in the spread of weeds, lead to a decrease in populations of native species, increase erosion and be a hazard for vehicles. Fifteen vertebrate pest animal species have been identified as potentially occurring within the project area (Appendix I). Of these species two were recorded during fauna surveys in Deposit C:

- Cane Toad (*Rhinella marina*)
- Cattle (*Bos taurus*).

A further two pest species were recorded in surrounding areas during the surveys, namely:

- Donkey (*Equus asinus*)
- Water Buffalo (*Bubalus bubalis*).

Database searches did not identify any species of tramp ants occurring within the development boundaries. However there is the potential for tramp ants to be introduced to the area. Three tramp ant species occur in the NT that are recognised as a national priority for management.

Pest species inherent risk profile

Pest animals may benefit from this development without mitigation activities, specifically poor waste management will lead to an increase in population of existing pests (for instance cats, pigs and rats) or allow the establishment of new pests (for instance tramp ants).

Artificial water sources and unsecured organic waste material may attract some animals to the project area. These animals may already be recognised as feral pests, or they could be native species which due to the availability of resources might become pests.

Tramp ants can be readily transported in containers, soil, plants, timber, machinery and electrical items. Hence the movement of most gear and equipment to this area presents a risk of introducing tramp ants.

Without a program to mitigate creating conditions favourable to pest species the risks to biodiversity from pests would have minor consequence with a likelihood of moderate giving a risk ranking of medium.

Pest species risk mitigation

A Pest and Weed Management Plan (PWMP) has been developed as part of the EIS (Appendix I).

For pest species the Sherwin commitment is to limit the availability of food and water resources through waste and artificial water supply management. Section 3.9.6 explores waste risks generally with the PWMP (Appendix I) outlines the strategy such as:

- Regular collection of waste from covered bins and transferral to landfill
- Separation of wastes into different types
- Erection of fencing around landfill
- Burning of putrescible wastes.

Attempts will be made to exclude large vertebrate pest species, such as pigs and cattle, by erecting large exclusion fencing around the project area as well as cattle grids.

While the chance of introducing tramp ants is low Tramp ants will be regularly audited (see Appendix I).

Pest species residual risk

Implementation of recommendations outlined in the PWMP will have an impact on the likelihood of pest species benefiting from the development. The risk residual profile has a minor consequence and an unlikely likelihood giving a risk ranking of low.

3.4.4 Weeds

Weeds are serious issue as they reduce habitat quality and adversely affect rehabilitation programs. Movement of machinery and people to and from the site will provide opportunity for the introduction of additional weed species. The construction stage of the proposal will involve significant ground disturbances potentially allowing the establishment of weeds. In addition to ground disturbance, other factors such as discharge of water and general poor land management may also increase the opportunity for weeds to proliferate by providing additional nutrients, moisture or disturbance.

Sherwin have committed to a pre-mining survey of weeds to map and characterise existing infestations to inform future weed management.

Weed inherent risk profile

Without a strategic program to mitigate the further spread of existing weeds or the importation of new weeds it is expected that the consequence will be minor with a likelihood of likely giving a medium risk ranking.

Weed risk mitigation

A Pest and Weed Management Plan (PWMP) has been developed for this project (Appendix I). To support the development of the PWMP a desktop survey of known weeds was performed, this identified 109 regional introduced plants. Weed mitigation strategies will focus on preventing the establishment of any new listed weed species within the project area.

Weed residual risk

It is thought that the weed management strategy outlined in the WMP will have an impact on the likelihood of listed weeds spreading as a consequence of this development. The risk residual profile has a minor consequence a likelihood of unlikely giving a risk ranking of low. This can be reassessed during the annual weed audit.

Table 3-6. Residual risks to terrestrial and aquatic biodiversity

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Terrestrial and aquatic biodiversity	Clearing of vegetation	Direct mortality of fauna: Construction and Operation	2	C	M 8	Vegetation clearing and disturbance will be kept to a minimum by staying within the approved clearing envelope.	2	B	L 5
Terrestrial and aquatic biodiversity	Increased highway traffic	Road impact to fauna	1	C	L 4	- Trucks to travel in convoys. - Enforced speed limit of 80 km/h.	1	C	L 4
Terrestrial and aquatic biodiversity	Clearing of vegetation	Reduction in local species diversity	2	C	M 8	- Vegetation clearing and disturbance will be kept to a minimum by staying within the approved clearing envelope. - Post- mining rehabilitation.	2	B	L 5
Terrestrial and aquatic biodiversity	Clearing of sensitive habitats	Reduction in local species diversity	2	B	L 5	Stay within approved development areas	2	B	L 5
Terrestrial and aquatic biodiversity	Clearing of groundcover and moving machinery	Increased dust affecting local environments	1	C	L 4	Regular dust control including, where appropriate application of a dust reducing polymer	1	B	L 2
Terrestrial and aquatic biodiversity	Use of machinery	Reduction in local species diversity due to excessive noise	2	B	L 5	No specific management responses.	2	B	L 5
Terrestrial and aquatic biodiversity	Produce waste and artificial water pools	Reduction in Habitat Quality	1	B	L 2	- Sherwin will not contribute to pest animal populations by: - Ensuring mine waste does not end up as food for pests - Ensuring that artificial water pools are fenced.	1	B	L 2

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Terrestrial and aquatic biodiversity	Clearing of vegetation	Reduction in Habitat Quality: • Increased weed extent • Increased weed species.	3	D	H 17	• Weed and Pest Management Plan (Appendix I).	3	C	H 13
Terrestrial and aquatic biodiversity	Water extraction	Reduction in local aquatic species diversity.	2	B	L 5	• No specific mitigation measures	2	B	L 5
Terrestrial and aquatic biodiversity	Clearing of vegetation	Reduction in local aquatic species diversity.	3	C	H 13	• Vegetation clearing and disturbance will be kept to a minimum by staying within the approved clearing envelope. • Erosion and Sedimentation Control Plan • Post- mining rehabilitation.	2	B	L 5
Terrestrial and aquatic biodiversity	Produce waste and artificial water pools	Pest species can increase the spread of weeds, cause erosion, be a vehicle hazard and affect native species.	2	C	M 8	• Mine waste will be promptly cleaned up and disposed of so that food is not made available for pest species (see section 3.9.6). • Ensure that no artificial water pools are created.	2	B	L 5
Terrestrial and aquatic biodiversity	Use of machinery	Mining activities may lead to: • Increased weed extent • Increased weed species.	2	D	M 12	• Implement the PWMP including: Stopping the introduction of new weeds o Controlling the spread of existing weeds o Auditing the effectiveness of the above strategy as outlined in the Weed and Pest Management Plan.	2	B	L 5

3.5 Rehabilitation and mine closure

This section examines the potential risk associated with the rehabilitation and closure of the project and is based on the information contained within the Closure and Rehabilitation section of Chapter 2 and the Draft Rehabilitation and Mine Closure Plan (RMCP) (Appendix J). The environmental objective of the RMCP is to ensure that rehabilitation of the site is undertaken in a manner that requires minimal maintenance inputs post closure, but maximum protection of the environment from seepage of contaminants, weed incursion, erosion or other impacts.

The project draft RMCP has been developed in accordance with the document *Leading Practice Sustainable Development in Mining – Mine Rehabilitation* (DITR 2006), and the West Australian Environment Protection Authority and Department of Mines and Petroleum *Guidelines for Preparing Mine Closure Plans*. The key message and goals associated with the Rehabilitation and Mine Closure document include:

- The development of a rehabilitation plan which will evolve as results from research and on-site trials become available
- Ensuring early characterisation of the materials to be rehabilitated to identify potential issues in time for them to be resolved
- The understanding of the environmental externalities which have the potential to constrain rehabilitation success
- The setting of realistic rehabilitation objectives.

As the site will be progressively rehabilitated, there will be several different stages of rehabilitation during the projects operational stage. This will allow for research and trials of the techniques used and these should inform the need for contingency measures.

Background information, inherent risks, mitigation measures and residual risks in relation to rehabilitation and mine closure are summarised in Table 3-7 and discussed in further detail. The detail of how risk ranking was determined is provided in Table 3-7 i.e. consequence and likelihood ranking.

3.5.1 Rehabilitation and mine closure inherent risk profile

The EIS guidelines for this project identified the following key risks associated with rehabilitation and mine closure:

- The mine may be forced to close earlier than expected leaving the site exposed if closure planning is inadequate at any stage of the development
- Rehabilitation of the mine site may not be successful leading to erosion, significant contaminant seepage and degradation of ecosystems important for listed threatened and migratory species
- Ongoing management of the site could be required well after mining is completed.

For the purposes of this discussion these are all considered as a failure of rehabilitation and therefore combined to give an inherent risk score. Failure to manage the rehabilitation and revegetation of mine sites carries with it considerable inherent risk. There are numerous examples of poor rehabilitation, particularly in legacy mines where areas have been left to naturally regenerate. The inherent risk of unmanaged or failed rehabilitation and revegetation is considered to be extreme (21) based on the consequences being major (4) and the probability being likely (D).

As well as total failure of the rehabilitation several potential hazards that may affect the rehabilitation have been identified, these are:

- Fire destroying/damaging rehabilitation

- Weeds and feral animals destroying/damaging rehabilitation
- Erosion removing soil preventing establishment of vegetation
- Uncovering potentially acid forming (PAF) materials.

A risk assessment for each of these hazards has been undertaken and the risk scores are provided in Table 3-7.

3.5.2 Rehabilitation and mine closure risk mitigation

The overall objective of the RMCP is to mitigate all potential risks, and in line with views expressed during stakeholder consultation, create a stable final landform, with a sustainable, resilient ecosystem compatible with the surrounding landscape. The rehabilitation strategy will remain flexible and will be amended as new rehabilitation techniques emerge and as environmental investigations progress.

Forced early closure

The requirement for provision in the event of unexpected closure will be addressed annually as part of the submission of the Mining Management Plan (MMP). The MMP will contain a summary of the current disturbed areas and the progressive rehabilitation status. Closure costs are re-calculated annually and are included in the MMP, providing a detailed allocation for decommissioning and rehabilitation costs, including a contingency. Closure costs provide the basis for the security bond. The Northern Territory requires a 100% security bond which is payable before the commencement of mining.

In the event of unexpected closure,

- An environmental audit of the site will be conducted immediately and provided to the Department of Mines and Energy (DME)
- Mine access and security and will be reviewed
- Storage of chemicals and hydrocarbons will be reviewed and removal if necessary
- A programme to address incomplete rehabilitation and revegetation works will be developed
- Any contaminated material will be relocated from hardstand areas to a suitable holding facility, and any PAF material will be placed within an open pit and suitably encapsulated within an appropriate landform
- The stability of landforms, water quality and revegetation will be monitored.

It is intended that as much rehabilitation as possible will be undertaken progressively during the life of the mine, thereby limiting the amount of land requiring rehabilitation at the time of any forced early closure. Sherwin have identified that physical and financial resources will be provided to assist rehabilitation and closure, and the planning and studying of these activities from the beginning of operations. In the worst case scenario the Northern Territory Government will have received a 100% security bond to ensure rehabilitation can continue. The security bond will fund activities so that the site can be rehabilitated in accordance with the closure plan.

Rehabilitation not successful

The draft RMCP outlines strategies to mitigate the risk of rehabilitation failure including:

- Establishment of rigorous revegetation trials to refine best practice and maximise revegetation success
- Exclusion of fire from the progressively rehabilitated areas for a period of several years
- Establish quarantine and control measures in an attempt to maintain the site as weed free

- Erection of fences around the project area to exclude stock and feral animals
- Install erosion and sediment control measures to manage silt laden run-off during vegetation establishment
- Prevent impacts to surface and groundwater resources from potentially acid forming (PAF) materials
- Conduct ongoing monitoring and take corrective actions when necessary.

Revegetation trials

Revegetation trials will commence as soon as practicable upon land becoming available. This will allow rehabilitation methods to be tested, refined and adapted. Initial rehabilitation will involve the use of topsoil and the natural seed bank. The rehabilitation will be monitored to determine if this method results in an appropriate species mix and ground cover. If required experiments with additional seeding and planting of tube stock will be undertaken.

Fire

Fire will initially be excluded from rehabilitation areas to allow vegetation to establish by means of a firebreak. In the longer term rehabilitation areas will be exposed to the local fire regime, as such the revegetation will be dominated by species that are resilient to fire.

Weeds and feral animals

A Pest and Weed Management Plan (PWMP) has been established will reduce the impact of pests and weeds on rehabilitation areas and the local biodiversity more generally (see Appendix I). Pest management for this development focuses on ensuring that pest populations are not increased by any of the activities associated with this development. For weeds the PWMP describes the procedures by which Sherwin will ensure that no new weeds will establish on their leases and the procedures and timing to support weed control and containment.

Sediment and erosion control

The prevention of erosion and sedimentation is critical to the success of the long term stability of any disturbed or rehabilitated area. An Erosion and Sediment Control Plan (ESCP) has been developed for the project (Appendix E). The ESCP will focus on the prevention of sediment leaving the site via the implementation of sediment ponds and other geotechnical measures adopted in the construction of the pit bunds, waste rock dumps, and other mine infrastructure. The principles and guidance presented within these documents will be adopted in an updated RMCP.

Potentially acid forming material

In general, the mine waste is considered to be non-acid forming. Very minor occurrences of potentially acid forming (PAF) material were discovered in initial surveys and will be further studied. The mitigation of risk associated with PAF material is covered in Appendix G of this EIS.

Monitoring

Monitoring is essential to determine whether the rehabilitation program is achieving its goals. At the completion of rehabilitation establishment operations, monitoring can assess early rehabilitation success and reveal the need for any remedial actions. In the event that monitoring shows that rehabilitation is not on a trajectory to meet the success or completion criteria, Sherwin will modify the rehabilitation program. Specifically, where monitoring has identified development of acid effluents, erosion, weed invasion, or failure of revegetation (to any material degree) maintenance activities will be implemented to ensure rehabilitation progresses effectively and swiftly. This might include the propagation of different plant species, modification of erosion and sedimentation control structures, and/or the implementation of supportive management such as irrigation.

On-going management

The risk of the site requiring on-going management, well after mining is complete, will be mitigated through progressive rehabilitation occurring as soon as practicable when land becomes available and carrying out on-going monitoring of rehabilitation areas. Progressive rehabilitation during the life of the mine helps to reduce the overall liability for rehabilitation works particularly after decommissioning of the site when there is no direct income to offset costs. In addition, mine planning and design layouts have been developed to minimise the amount of disturbance for the area of operations.

Progress, success and the endpoint of rehabilitation will be assessed by an industry best practice monitoring regime, designed to test if the rehabilitation is on a trajectory towards the desired self-sustaining community exhibiting landscape functionality and resilience. Rehabilitation areas not considered on the correct trajectory will be the subject of remedial work.

3.5.3 Rehabilitation and mine closure residual risk

With the implementation of these mitigation measures through a Rehabilitation and Mine Closure Plan, the overall residual risk of rehabilitation failure is considered to be high (14), but tolerable. This is based on a consequence of major (4) and a probability of unlikely (B). The residual risk of each of the hazards identified in section 0 is given in Table 3-7.

Table 3-7. Risk assessment related to rehabilitation and mine closure

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Rehabilitation and mine closure	Failure of rehabilitation	Poor implementation or failed activities.	4	D	E 21	On-going trails, monitoring and when required remedial action.	4	B	H 14
Rehabilitation and mine closure	Failure of rehabilitation	Fire destroying rehabilitation.	3	D	H 17	- Maintenance of a fire break. - Including fire resilient species in revegetation.	3	B	M 9
Rehabilitation and mine closure	Failure of rehabilitation	Weeds and feral animals destroying / damaging rehabilitation.	3	D	H 17	Management of weeds and pests as per the Weed and Feral Animal Management Plan.	3	B	M 9
Rehabilitation and mine closure	Failure of rehabilitation	Erosion removing soil and preventing establishment of vegetation.	3	D	H 17	Erosion and sediment control plans will be in place and updated regularly	3	B	M 9
Rehabilitation and mine closure	Ongoing management issues due to rehabilitation failure	Uncovering PAF materials.	4	C	H 18	AMD management plans to ensure appropriate management of PAF materials.	4	B	H 14

3.6 Aboriginal and historic cultural heritage

3.6.1 Introduction

By way of definition, cultural heritage is an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. It has both tangible and intangible components (ICOMOS 2002) and is an important, defining part of human history.

The history of the Northern Territory is steeped in both an Aboriginal cultural tradition that extends for thousands of years and a much newer, non-Aboriginal cultural tradition, which developed from the integration of cultures from many parts of the world. It is therefore important to preserve all aspects of the two cultural traditions because it enables the Northern Territory's history and development to be recorded and described in detail. All aspects of cultural heritage in the Northern Territory are protected by legislation including:

- The *Northern Territory Aboriginal Sacred Sites Act 1989 (NTASS Act)*
- The Aboriginal and Torres Strait Islander Heritage Protection Act 1984
- The *Environment Protection and Biodiversity Conservation Act (EPBC Act) 2000*
- The *NT Heritage Act 2012*.

Being located in a remote part of the Roper River region, the SCIOP is on land dominated by Aboriginal culture and tradition. Consequently, a major focus of this part of the assessment has been on Aboriginal culture, both past and present. Current cultural issues are important because the connection between Aboriginal traditional owners and their cultural heritage in the Northern Territory is still expressed through traditional knowledge and connection to places (especially sacred sites) and archaeological features.

As part of its assessment of risks to cultural heritage, Sherwin Iron undertook desktop analysis of literature, followed by field-based studies and consultations to document the Aboriginal and historic cultural heritage in the vicinity of the project area. Relevant information concerning Aboriginal sacred sites, archaeology, traditional knowledge and history was gathered and is presented below in conjunction with an assessment of how any potential impacts to the values identified will be managed through appropriate mitigation measures.

Background information, inherent risks, mitigation measures and residual risks in relation to aboriginal and historic cultural heritage are summarised in Table 3-12 and discussed in further detail. The detail of how risk ranking was determined is provided in Table 3-12 i.e. consequence and likelihood ranking.

3.6.2 Aboriginal sacred sites

Aboriginal sacred sites comprise landscape features that vary in size and nature, but have special significance under Aboriginal social and cultural tradition. They may also contain archaeological objects that may hold sacred values; or be repositories for human remains.

Sacred sites are an integral part of the practices and beliefs that are derived from Aboriginal traditions and law; and there may be consequences in terms of disturbance to spiritual relationships in the land and for the custodians should a site be damaged. Sites are the responsibility of recognised custodians; and Aboriginal law dictates that other Aboriginal people will hold custodians responsible for damage to a sacred site.

The *NTASS Act* protects all Aboriginal sacred sites in the Northern Territory regardless of whether they are registered, are protected, or not. Under this legislation, it is an offence to desecrate a site or enter, remain on, or carry out work on a sacred site except with the appropriate authorisation. This is obtained in the form of an Authority Certificate issued by the Aboriginal Areas Protection Authority (AAPA) of the Northern Territory.

Under the *NTASS Act* a sacred site is defined as:

‘...a site that is sacred to Aboriginals or otherwise of significance according to Aboriginal tradition and includes any land that, under law of the Northern Territory, is declared to be sacred to Aboriginals or of significance according to Aboriginal tradition.’

To ensure sites are identified and protected, the AAPA maintains a formal Register of Sacred Sites, which contains comprehensive details about the sites. The register serves a dual function: (i) to allow the Authority Certificate to be produced and (ii) to facilitate discussions between site custodians and developers, that aim to avoid and protect sacred sites. The developer will be protected from prosecution under the *NTASS Act*, provided that they comply with the requirements issued on the Authority Certificate.

Consultation and sacred site identification

Extensive consultation with traditional owners (through the Northern Land Council) regarding protection of sacred sites was undertaken during sacred site surveys as part of the development of the Ancillary Mining Agreement. The Northern Land Council (NLC) completed sacred site surveys over the project area in 2011 and as required under the *NTASS Act*, Sherwin iron applied to the AAPA for an Authority Certificate showing the restricted work areas. Authority Certificate C2012/185 was issued to Sherwin Iron in September 2012 (see Appendix O2).

Detailed information on the exact location and nature of registered and recorded sacred sites near Deposit C and the haul road is considered confidential in nature and has not been provided to Sherwin Iron. Publication and transmission of specific details regarding sacred sites in the project area is culturally sensitive and consequently the sacred site information reported is generalised in nature, but adequate for the purpose of protecting the sites.

The Authority Certificate indicates that only one restricted work area (5768-13) is encompassed by part of Deposit C. This is a long-narrow gorge situated towards the north-west of the deposit and close to the Roper Highway.

3.6.3 Aboriginal archaeology

Archaeology is the study of past cultures through the material remains people left behind. In Aboriginal Australian tradition, stone tools and rock art normally dominate the archaeological record. Little archaeological study has been undertaken near the project area and none in close proximity to Deposit C until the fieldwork undertaken as part of this assessment and reported below.

No archaeological material was found on the plateaus and slopes of Deposit C where mining is to occur. Neither was any archaeological material found along the road connecting Deposit C with the Roper Highway, or at the proposed campsite. However, parts of the surrounding topography, particularly the ravines and valleys are rich in shelters some of which contain archaeological material. Items identified as having archaeological interest and importance include rock art sites, open sites and a variety of isolated or grouped stone artefacts. Exact locations of more than twenty sites have been recorded, but they have not been reported here at the request of traditional Aboriginal owners. Additional detail related to site descriptions, contents and rock art styles is contained in the Archaeology Report, attached as Appendix O1.

Although focused in the valleys, sites are well spread across the landscape and many of the sandstone and mudstone shelters that contain archaeological material are large enough to house families. This alone suggests the area was well utilised, an observation that is consistent with information obtained during consultation with traditional Aboriginal owners. Outcomes of consultations indicated that people used to live in the shelters, hunting and foraging as they moved to and from the ceremony grounds located towards the north-east. Traditional Aboriginal owners advised that they were aware that the shelters and caves existed, but no longer remembered the locations of many.

Where artwork exists, it has been rendered using a number of different methods including brushing, engraving, printing and stencils. There is significant diversity in style and motifs, with some exhibits of what is believed to be rare artwork observed. Hand stencils are common and many of the monochrome or

bichrome motifs are naturalistic including emus and kangaroos, however there are also representations of anthropomorphic figures, suggesting a cultural background steeped in animism and a reverence for the natural environment.

A diverse range of artefact types, consistent with Australian small stone tool tradition that appeared during the mid-Holocene period about 5,000 years ago has been found near Deposit C, but these seem to have been concentrated in only a small number of larger shelters. The types of artefacts found and their locations are consistent with the nomadic/semi-nomadic subsistence style living known to exist in the Roper Valley at the time of first European contact. It is likely that excavation of the floors of many more of the shelters visited, particularly those adorned with artwork, will reveal additional stone artefacts.

The types of artefacts identified are summarised in Table 3-8.

Table 3-8. Summary of artefact types identified from sites adjacent to Deposit C

Quantity	Artefact type	Raw material
Not specified	Coolamons	Wood
3	Portable grindstones	Sandstone
1	Portable grindstone	Unidentified
1	Core	Unidentified
6	Grinding hollows or cupules	Unidentified
6	Flakes or broken flakes	Siltstone and chert
2	Crayons	White clay or chalk
100+	Scatter containing flakes, broken flakes, blades, unifacial points, bifacial points and retouched flakes	Siltstone and chert

Significance

Collectively, these particular archaeological sites are of significance for two reasons. Firstly, because traditional Aboriginal owners have indicated that some of the sites still possess a high degree of cultural significance and second, because there have been few archaeological surveys undertaken in this region. Consequently, the sites may contribute a lot to the continually developing understanding of pre-contact Aboriginal life across the Roper Valley.

In particular, rock art from the Roper River region has not been subjected to detailed scientific study and a high level of protection should be afforded to art sites at least until a detailed understanding of the art has been obtained.

3.6.4 Aboriginal cultural knowledge

It is widely recognised that the Aboriginal people of Australia have the oldest, or one of the oldest continuous living cultures in human history. It has developed over tens of thousands of years and includes repositories of knowledge that are suited to specific environmental regimes. Their culture has developed around this to create a wider cultural knowledge database that reflects the sustainability of their spiritual connection, belonging, obligations and responsibilities to care for their land, their people and their environment. It is reflected in their art, their language and ceremony.

One of the more practical aspects of Aboriginal cultural knowledge relates to values placed on particular flora and fauna species. Many of the species have spiritual value, being special totems to certain family groups, while others, especially plants have physical uses as food resources and medicines. Linking these together are land management practices that have evolved over tens of thousands of years into a complex system of integrated environmental management at subsistence level.

With the encroachment of non-Aboriginal cultures, cultural knowledge has begun to be lost. This is most evident in language where English or Kriol (a form of pidgin English) have replaced many native tongues. Of the local languages, Ngalkan and Alawa are now considered critically endangered and almost entirely replaced by Kriol. A summary of the most dominant languages spoken in the communities close to the project is provided in Table 3-9.

Table 3-9. Basic language groups spoken at communities near the project

Community	Kriol	Aboriginal language(s)	
Minyerri	96.4%	3.0%	Alawa
Jilkmanggan	90.3%	Not recorded	
Ngukurr	87.4%	2.0%	Anindilyakwa, Djambarrpuynu, Mirnung

Significance

Cultural protection is a significant part of cultural heritage management, because as language becomes extinct, other aspects of cultural knowledge begin to disappear. Efforts to protect language and culture have been undertaken in many areas through various recording projects, which include recording of language and environmental information such as patterns of resource use, types and uses of plants and general methods of land management such as the use of fire. Many of these key aspects of Aboriginal culture are important to Sherwin Iron because they serve to guide the outcomes of progressive rehabilitation to ensure that the proposed final land use can be met and that impacts to Aboriginal cultural practices are minimised.

3.6.5 Historic cultural heritage

Historic cultural heritage may be defined as the remnants of the non-Aboriginal traditions that have developed in the modern era (i.e. over the past 200 years). Much of this will be related to the pastoral industry, which was first established in the project area in the early 1880's, following creation of a stock route by D'arcy Uhr in 1872. Following unrest in the region, a Church Missionary Society mission was set up at Ngukurr in 1908 followed shortly by a police presence at the Roper Bar. Pastoralism has continued to dominate the region, although there have been some instances of localised exploration for minerals since the mid 1950's.

Sherwin iron has undertaken an assessment of historical and heritage sites via desktop studies and fieldwork held in conjunction with the archaeological survey. Details of the field survey can be found in Appendix O1.

Heritage sites

The AAPA Authority Certificate indicates that there is one known Aboriginal heritage place (5768-18) within the project area. This is an occupation site situated approximately three kilometres south-east of Deposit C.

A search of the National Heritage List did not reveal any additional European or Aboriginal places listed under Heritage Legislation on or near Deposit C. The closest listed Heritage area is at Roper Bar, some 30km to the east of the project area. This is the site of the original Roper River police station, constructed in 1937. Although the site is clearly of high historical significance, it is not on the transport route, nor close to the project's proposed area of operations.

Historical sites

The field survey identified one historical site containing a number of concrete slabs, metal drums and discarded drill core close to Sherwin Creek. This is believed to be the location of BHP's exploration camp dating back to the 1950's. An isolated metal axe head was found to the north of the camp remnants. Its origin is unknown, but may have been associated with the camp, with post-contact Aboriginal activities or from pastoral activities. Both sites (the camp and the isolated axe head) have been assessed as having low significance. No other sites or items of historical significance have since been found.

3.6.6 Potential impacts on cultural heritage

The aspects of the project with the potential to affect Aboriginal sacred sites, archaeological and historical heritage sites are primarily those associated with large-scale disturbance of the landscape. Primarily these are:

- Clearing and earthworks for infrastructure and mining that disturb physical features in the natural landscape that have attached cultural values as ascribed to an Aboriginal sacred site.
- Unauthorised or unintentional access (through the non-observance of Restricted Work Areas) to Aboriginal sacred sites by the workforce.
- Indirect impacts arising from failure to observe cultural protocols associated with specific sacred sites (e.g. gender rules).

These were then subjected to a standard risk analysis procedure in accordance with ISO 30000 risk management standards and the outcomes reported in Section 3.1.

Inherent risk of cultural heritage impacts

Two major areas of risk were identified as part of the risk assessment process. These were: failure to comply with legislation and damage to (or loss of) contemporary culture. These risks, along with their associated causes and likely consequences are summarised in Table 3-10.

In undertaking the significance of these risks, it is recognised that cultural change is on-going and subject to factors beyond the control of Sherwin Iron. Projects that aim at recording of language and associated cultural information exist and some of this material is already available in the public domain, so the risk that the project poses to these aspects of cultural heritage is rated as low.

The more significant risks are more practical and relate to possible breaches of the *NTASS Act* and the *Heritage Act*. These are largely within the control of Sherwin Iron and will be managed accordingly because they carry with them consequences not only to the sites and physical materials, but also to continuation of the project and the socio-economic benefits that may be derived.

Table 3-10. Summary of risks to cultural heritage at the Sherwin Creek Iron Ore Project

Significance	Inherent risks	Potential causes	Potential consequences
High	• Failure to comply with <i>NTASS Act</i> • Damage to sacred site(s)	• AAPA data not correctly entered into database • Willful trespass • Failure to follow procedure • RWA and sites not demarcated	• Court-imposed penalties • Temporary or permanent closure of project • Alienation of Aboriginal stakeholders • Loss of future access to land • Spiritual discomfort to local Aboriginal custodians and landowners
Moderate	• Failure to comply with <i>Heritage Act</i> • Destruction or removal of archaeological or historic material	• Willful acts • Failure to follow procedure • Sites and material not recorded in database • Sites and material not demarcated • Work is too close to the site	• Court-imposed penalties • Temporary closure of project • Alienation of stakeholders • Physical loss of part of the historical record

Significance	Inherent risks	Potential causes	Potential consequences
Low	- Loss of contemporary culture - Cultural change is too rapid	- Loss of language - Dependency on income from mining	Loss of other aspects of traditional knowledge applicable to the project (e.g. ecological knowledge)
Low	Loss of control over or rights to proprietary cultural information	Widespread dissemination of traditional knowledge	Loss of potential future business or development opportunities for local communities

Mitigation and management

Sherwin Iron will manage risk to Aboriginal sacred sites primarily through avoidance. Grants of Authority Certificates that identify restricted work areas in the project area will ensure that all known Aboriginal sacred sites are identified and avoided. Mining plans will be designed to ensure no Ore is recovered from culturally sensitive or restricted areas and that no sacred sites will be directly impacted.

Sherwin Iron will negotiate management measures that will minimize the risk of non-observance of protocols and unauthorized visitation to sacred sites, with the traditional Aboriginal owners and the NLC. These may include a Land Access Protocol, work-place procedures and delivery of mandatory cross-cultural awareness training that ensures employees are aware of Restricted Work Areas and cultural protocols. This will minimise the risk of inadvertent or unauthorised access to Aboriginal sacred sites that are in close proximity to the project area.

A Cultural Heritage Management Plan (CHMP) will be developed in consultation with the NLC and Aboriginal traditional owners to formalise these arrangements. A provisional CHMP can be found attached to this document (Appendix O3). Where significant archaeological sites are in close proximity to an area subject to disturbance, the CHMP will include reduction of working widths when practicable and active controls, such as temporary fencing of sites and work restrictions, to prevent unauthorised access and indirect disturbance. Where required, salvage procedures will be developed in consultation with traditional owners and implemented in accordance with relevant conditions of consent under the *Heritage Act*. These procedures may include surface collections and / or excavations of archaeological material, followed by storage and return to a location as close as possible to where it was found.

Table 3-11. Summary of Cultural Heritage risk management options

Inherent risk	Options for management and mitigation of risk	Relevant plan(s) or procedures
Failure to comply with NTASS Act	- Regular contact will be maintained with site custodians and traditional Aboriginal owners - All AAPA provided information will be recorded in land management database - All workers will be briefed on the importance of sacred site protection	- Stakeholder Engagement Plan - Standard Operating Procedure / Cultural Heritage Management Plan - Workplace Cultural Induction
Damage to Sacred Site	- All Restricted Work Areas will be demarcated prior to work - Work plans will be developed with locations of sacred sites in mind	- Standard Operating Procedure / Cultural Heritage Management Plan - Standard Operating Procedure / Cultural Heritage Management

Inherent risk	Options for management and mitigation of risk	Relevant plan(s) or procedures
		Plan
Removal of cultural heritage material(s) from site(s)	• All workers will be briefed on the importance of cultural heritage protection • Locations of archaeological and historical sites will not be made public • A register of sites and their contents will be prepared and maintained	• Workplace Cultural Induction • Standard Operating Procedure • Standard Operating Procedure
Damage to Cultural Sites	• All workers will be briefed on the importance of cultural heritage protection • Locations of archaeological and historical sites will not be made public • A register of sites and their contents will be prepared and maintained • Work plans will be developed with locations of sacred sites in mind • Where material must be removed it will be done in accordance with the <i>Heritage Act</i>	• Workplace Cultural Induction • Standard Operating Procedure • Standard Operating Procedure • Standard Operating Procedure
Loss of culture	• A language recording project will be initiated • Traditional ecological knowledge will be recorded and used where possible in rehabilitation and closure planning • If requested by traditional Aboriginal owners a keeping place for artifacts or museum may be established	• Cultural Heritage Management Plan • Cultural Heritage Management Plan • Cultural Heritage Management Plan
Loss of proprietary rights	• On-going engagement of traditional Aboriginal owners • Preparation of Agreement to manage proprietary cultural information	• Stakeholder Engagement Plan • Agreement

Residual risk

In addition to its management plans, Sherwin Iron has made a number of commitments to traditional Aboriginal owners to ensure protection of cultural material. These include development and maintenance of a cultural heritage register to assist with recording matters of cultural significance. In the specific case of Aboriginal cultural material, the possibility of developing a keeping place or a small museum for retention and display of artifacts and information (including language) will be discussed with traditional owners.

In general the residual risk to cultural heritage is considered MODERATE.

Table 3-12. Risks to Cultural Heritage

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Failure to comply with NTASS Act	Unintentional or deliberate unauthorised entry to sacred site	• Alienation of traditional Aboriginal owners	3	D	H 17	• Ongoing engagement with traditional Aboriginal owners	3	B	M 9
		• Loss of future access to land	4	C	H 18	• Employees will be made aware of responsibilities to abide by legislation	3	B	M 9
		• Temporary closure of project	3	B	M 9	• Mining Plans will be prepared such that all sites are avoided	3	A	L 6
	Mining operations	• Damage to site	2	C	M 8	• Sites will be demarcated prior to work commencing • Buffer zones will be provided around sites • Mining Plans will be prepared such that all sites are avoided	2	A	L 3
Failure to comply with Heritage Act	Unauthorised entry to heritage site	• Removal of cultural objects	3	C	H 13	• Ongoing engagement with traditional Aboriginal owners	3	B	M 9
		• Destruction of archaeological or historic materials	5	B	H 19	• Employees will be made aware of responsibilities to abide by legislation	4	A	M 10
		• Court imposed penalties affecting economic viability of project	3	A	L 6	• Mining Plans will be prepared such that all sites are avoided	3	A	L 6

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		• Temporary closure of project	4	B	H 14	• Site locations will not be made public	3	A	L 6
		• Permanent closure of project	5	A	H 15	• A site register will be prepared and maintained	4	A	M 10
	Mining operations	• Damage to site	3	B	M 9	• Sites will be demarcated prior to work commencing • Buffer zones will be provided around sites • Mining Plans will be prepared such that all sites are avoided	3	A	L 6
Loss of contemporary culture	Language	• Language is lost	5	B	H 19	• Language recording project	4	A	M 10
		• Traditional Knowledge is lost	5	B	H 19	• Keeping place/museum for artefacts • Traditional Knowledge recording project	4	A	M 10
							4	A	M 10
	Traditional environmental knowledge	• Closure and rehabilitation outcomes are unacceptable to traditional Aboriginal owners (landowners)	3	B	M 9	• Traditional Knowledge recording project • Traditional knowledge applied during progressive rehabilitation	3	A	L 6

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Loss of control over proprietary cultural information	Traditional knowledge	Potential future business opportunities are lost	3	B	M 9	Intellectual Property Management Agreement	3	A	L 6
		Application of aspects of traditional knowledge to environmental management may be precluded	3	B	M 9	Patent applications if and where practical	3	A	L 6

3.7 Socio-economic risks

3.7.1 Introduction

Regional and community economics and social demography may be significantly altered in the face of mining operations, increased human activities and an influx of people. Each community's response to this level of change is driven by elements of the social context in which people live. Context itself relies upon interdependent social systems - such as families, neighbourhoods, workplaces, and institutions (e.g. health and education) - in which changes to one system influence the others. Influences may be positive or negative, large or small and the ultimate aim of Sherwin Iron is to do no harm to the community while constructing and operating its mine.

Social change represents a key project-based risk, which if not handled correctly, may lead to detrimental rather than positive outcomes. Community impacts will be driven by the nature of the functional and affective relationship that the community has with the area. Functional relationships are related to infrastructure and social capital such as land uses, recreation, employment opportunities and other physical activities. Affective relationships relate to perceptions, attitudes and emotions that influence people's behaviour. For example anxiety, stress and reduced feelings of attachment and belonging created by working in remote areas can lead to changes in family and neighbourhood relations and health and lifestyle behaviours. This can be particularly devastating where people are working in unfamiliar or cross-cultural environments.

This section provides a summary of the projects economic and social values interpreted in terms of direct and indirect impacts (both positive and negative) and risks to functional and affective relationships in the Roper River region. Its ultimate objective is to provide a balanced analysis of the intended and unintended social consequences of the project and to outline how Sherwin Iron will monitor and manage any social change that might occur. The social impact assessment is part of an on-going and iterative process that will continue throughout the life of the project, enabling Sherwin Iron to adapt and revise its management strategies to continually improve the beneficial outcomes and reduce the severity of any negative impacts encountered.

Background information, inherent risks, mitigation measures and residual risks in relation to socio economic risks are summarised in Table 3-17 and discussed in further detail. The detail of how risk ranking was determined is provided in Table 3-17 i.e. consequence and likelihood ranking.

3.7.2 Stakeholder engagement and consultation

Stakeholder engagement and consultation is an essential and on-going feature of the project, commencing during the consultation phase of the EIS and continuing until well after the mine has reached closure. It allows two-way sharing of information to regulators and the public, allowing the company to provide genuine and appropriate responses to risks and impacts that are considered important by the community. This is of particular importance to Sherwin Iron, whose workers will be required to live and work in an environment that is dominated by Aboriginal culture.

Consultation was undertaken in accordance with the requirements and objectives stated in the Northern Territory (NT) Government's Environmental Protection Authority's (NTEPA) EIS Guidelines released in June 2013. Consultations has focused largely on the two key stakeholder groups who will be most affected by the project – traditional Aboriginal land owners who have key cultural connections to the land; and pastoralists who operate cattle stations where the mine is located and in the immediate vicinity. Other important, interested parties consulted include those who have responsibilities for community or regional governance, who operate businesses within the region or have an interest in maintaining environmental, aesthetic or recreational values attached to the region.

The active consultation process is well supported by information drawn from previous stakeholder consultations undertaken for the Western Desert Resources (in 2012) and Australian Ilmenite Resources (in

2012) projects, both of which are operating in the same vicinity and impact on the same groups of people. This, along with background statistical information gleaned from the 2011 Australian Census provided the background for targeted and well-focused consultations. A synopsis of the community consultation and engagement process undertaken by Sherwin Iron is attached to the back of the Economic and Social Impact Assessment (ESIA), presented in Appendix K2.

Key findings

Stakeholder engagement has been on-going since mining agreement negotiations commenced in early 2011 and Sherwin iron has endeavoured to address each and every issue as they arise. Consultations have taken place primarily on the affected cattle stations; and at two Aboriginal communities located along the Roper Highway – Minyerri and Ngukurr. Other affected Aboriginal people who reside at Jilkminggan, Numbulwar and Urapunga were brought into these communities as part of the engagement process. Many members of these five communities hold traditional cultural ties and Native Title rights to the land targeted for mining.

There is a high degree of consistency between the areas of interest raised during Sherwin Iron's consultation process and those of Western Desert Resources and Australian Ilmenite Resources. These include:

- Employment, training and business development opportunities
- Cultural protection
- Environmental protection
- Cumulative impacts from other planned exploration
- Improvement to local infrastructure, especially roads
- Establishment of trusts or schemes that benefit the community.

If social aspects of the project can be managed correctly, there are a number of long-term community and regional benefits that can be derived. For example, Urapunga community has provided Sherwin Iron with a copy of their community development plan, which aims at improving services and facilities and attracting an increased share of the tourism market. It involves development of a number of small Aboriginal owned and operated businesses that can provide services not only to the community, but also to the mine. This plan represents just one example where Sherwin Iron may seek to develop social capital and leave a lasting positive outcome.

Key concerns raised by community members relate to the potential negative flow-on effects from increased wealth and potential unequal stratification of wealth were also raised. Many community members are wary of the potential for increase in crime, alcohol and drug abuse and related health issues. Concerns were raised about the shortage and standard of accommodation that might be available for mine workers and the increase in pressure on existing service facilities that this might cause. Associated concerns were raised about the possible impacts on family cohesion and child development in communities should one or more parents be absent working at the project for long periods of time.

Traditional owners, pastoralists, service providers and other community members have also flagged road safety, maintenance and usage as an important consideration. The main access route to the mine is the Roper Highway, a largely single lane road that often becomes degraded during the wet season, the last 50km of which is unsealed. It was felt that increased volumes of heavy vehicular traffic from the mine in conjunction with road trains to and from cattle stations and communities may become excessive and create a dangerous situation leading to increased potential for traffic fatalities. Some individual parties have also raised specific issues and these will be addressed along with the key findings as part of Sherwin Iron's on-going stakeholder engagement process.

On-going stakeholder engagement

Sherwin Iron views management of stakeholder issues as critical to its success and has committed to a continuous process of engagement as the mine develops and progresses towards closure. Sherwin Iron's

principal social management objectives are to work with the community to develop its current capacity and to leave a sustainable, positive legacy that lasts well beyond closure of the project. To achieve this, the on-going stakeholder engagement framework will be structured around key principles that aim towards:

- Understanding the socio-cultural context and appreciating the values that are important to each of the stakeholder groups affected by the project
- An ethical, open and transparent process
- Strong, positive and long term but adaptable relationships with all stakeholders over the life of the project
- Closer involvement of all stakeholders, but particularly traditional Aboriginal owners to seek mutually beneficial outcomes
- Promoting cooperation, convergence and consensus building to address confrontational matters that may from time to time arise
- Timely responses and resolutions to all stakeholder enquiries and concerns
- Incorporating, where possible, the knowledge, skills and experience of stakeholders
- Being flexible in how information is sourced and provided.

Details of this process and how it will be managed are available in the 'Stakeholder Engagement Plan', included as part of the broader 'Social Impact Management Plan' (SIMP), presented in Appendix K1. The SIMP is a risk-based document that considers the key findings of the stakeholder engagement and consultation process, interprets them in terms of project feasibility and the regional social profile and defines strategies through which impacts and risks can be managed. A more detailed outline of the SIMP is provided in section 4.7.6.

3.7.3 Project economics and feasibility

This section describes the key economic characteristics of the project, based upon current market predictions and outlines the key social risks and mitigation measures associated with them. Market predictions are influenced by a number of variables (e.g. exchange rates and commodity prices), which are notoriously difficult to predict. In preparing its economics and feasibility assessment, Sherwin Iron has used what it believes to be consensus based market data to determine a statistically based, but conservative prediction of market influences on its project. Further detail is available in the 'Economic Evaluation' presented in Appendix K2 of the EIS.

Project summary

The project is located approximately 570 km south-east of Darwin, approximately 150km east of the town of Mataranka. It is within the Roper-Gulf Shire and located on land subject to Native Title Claim DC01/64. The principal claimant groups for DC 01/64 are the Alawa, Ngalkan and Rembarranga people. These groups still maintain a rich cultural heritage that extends many thousands of years into the past and their connection to the land remains expressed primarily through a body of traditional knowledge inexorably connected to places (sacred sites) and archaeological features. Agreement negotiations were undertaken through the Northern Land Council (NLC) over the period 2011 to 2013 and are expected to conclude by the start of 2014.

The project was afforded 'Major Project' status by the Northern Territory Government in 2012. This status is part of a NT government scheme aimed at advancing the mining industry in the Northern Territory and increasing the gross state product (GSP). Under this status, Sherwin iron receives government support for the project, including fast-tracking through normal government procedures.

The initial focus of the project will be mining of DSO from Deposit C. The total J.O.R.C. indicated resource for Deposit C (but excluding Area A) is estimated at 256Mt @ 42.6% Fe, which includes a high-grade

potential DSO component of 18.4Mt at 58.3% Fe or greater, with a 55% Fe lower cut-off grade. It is anticipated that mining of DSO from Deposit C will be completed over a seven-year period and the mine closed by 2021.

During this period, Sherwin iron will be actively exploring and proving up further resources known to exist on their tenements. Consideration will also be given to widening the scope of mining to include recovery of close to 500 Mt of lower grade ore that can be beneficiated prior to export. It is expected that, if feasible, additional mining activities will extend the presence of the company in the region for a further 20 to 30 years.

Potential economic contribution

The most significant impact on the project's viability will result from changes to economic growth in key international markets. However, based on current market values and future predictions, the project remains economically viable for at least ten years.

The remote location of the project means that capital and annual operating expenditure will be high, but this will be balanced by the high grade and market value of DSO produced. In addition, Sherwin Iron will continually review and actively manage its mining operations in a manner that will continually maintain or improve the viability of the project. If a conservative view of market performance is taken, it is anticipated that total project revenue from sales of DSO will amount to around \$1,680 million (AUD) over the seven year mine life. This figure will increase significantly should additional DSO deposits be mined or if lower grade ore is recovered and beneficiated.

If a conservative view of market performance is taken, it is anticipated that total project revenue from sales of DSO will amount to around \$1,680 million (AUD) over the seven year mine life. This figure will increase significantly should additional DSO deposits be mined or if lower grade ore is recovered and beneficiated.

Table 3-13. Estimated median values for key economic characteristics of the project.

Characteristic	Value
Production Rate	1Mtpa in the year 1, increasing to 3Mtpa by year 3 and then for the duration of the project.
Capital Expenditure	\$50 million
Total Project Revenue (Income)	\$1,680 million
Total Operating Expenditure	\$790 million

While the project's contribution to Australia's GDP is expected to be small, there is potential for a far greater economic impact at Northern Territory and regional level. There will be a number of government income streams generated by the project in the form of taxes (e.g. Company tax, Payroll tax, GST, Carbon Tax) and royalty revenue. Combined, this is expected to increase the mining sector's contribution to the Territory's GSP by an estimated 4-5%.

It is difficult to fully quantify the potential economic contribution at regional and community level because benefits will accrue from a range of tangible and intangible inputs including:

- Contract revenue payable to affected Aboriginal groups through the negotiated Native Title Agreement
- Direct income from purchase of goods and service from community business and stores by Sherwin Iron
- Direct income from local employment and business development opportunities

- Indirect income or other benefits derived from improvements to regional infrastructure and services.

It is anticipated that in total, the net economic contribution at regional level would be in the vicinity of \$5 to \$10 million per annum (AUD).

3.7.4 Regional social profile

This section briefly describes the existing regional socio-economic profile. The data presented represents a baseline against which social and community change may be measured and against which potential impacts and risks may be interpreted. The profile has been prepared primarily from 2011 Australian Census data, although alternative sources of data have been used where they are necessary or offer greater detail.

Sherwin Iron has developed its regional profile primarily from census data because it:

- Is collected every 5 years and can be used for future analyses of community change independent of Sherwin Iron's own monitoring programs; and
- Allows community, regional, state and national profiles to be prepared in a uniform way.

However, this approach has its limitations because not all social factors can be derived from census data. Alternative sources for tourism, health and crime statistics had to be identified and although these sources do not necessarily present data according to the same regional breakdown patterns or timeframes as the census, they nevertheless provide an important insight into the wider region and are still useful indicators.

The next Census is due in 2016, towards the end of the project and potentially the start of additional mining operations near Sherwin Creek, while other statistics will become available each year. When combined, these create a strong basis for monitoring and managing social change and an ideal platform for on-going stakeholder consultation and engagement. A detailed regional social profile is contained within the Social Impact Assessment, attached as Appendix K1.

Summary findings

Population distribution in the project area is sparse, with around 1900 people spread across 4 main communities – Jilkminggan, Ngukurr, Minyerri and Urapunga. Larger urban populations are based at Mataranka, Katherine and Borroloola, but these are outside the main areas of the mine's influence. The population is characteristically young, predominantly Aboriginal and has undergone slow growth over the past 5 years. The rate of growth is around 1.6% per annum and this is expected to continue in the near future.

Development in the region is sporadic, with most of the lands used for cattle. Heavy industry is limited to: the lime plant at Mataranka; a small Ilmenite mine on Numul Numul station, which commenced production in 2012; and the Western Desert Iron Ore mine at St Vidgeon, which has yet to reach production. Tourism ventures are few and generally confined to periodic travellers using the Savannah Way to visit isolated areas such as the Limmen National Park. The lack of heavy industry and investment has created a situation where the region appears to have stagnated. Although industrial development is occurring, it is too early to determine what level of positive impact the two mines have had or will have on the social situation.

Communities within the impacted region are generally impoverished, with personal income levels less than 50% of those received across the Northern Territory. Jilkminggan, Ngukurr, Minyerri and Urapunga receive limited government service and are characterised by high levels of unemployment (24%) and underemployment (34%). The government has commenced programs to address community infrastructure issues, but a shortage of housing remains and those dwellings that are occupied are generally overcrowded and in a poor state of maintenance.

Schooling is provided, but opportunities to progress beyond secondary school level appear to be limited, with the possible exception of Minyerri. Consultation with community members and traditional Aboriginal owners indicates that despite the opportunities for education that are provided, low levels of literacy, numeracy and

European style life skills are encountered. Combined, these issues appear to be major contributors to significant unemployment across the region.

Consultation with health workers indicates that the general health of community members is good, but alcohol and drug related issues and diabetes are of concern. These claims are supported by 2008 health statistics from the Katherine region which show moderate increases in incidences of diabetes, heart disease and nutrition related problems over a 15 year period; while hospital admissions related to mental disorders have almost doubled over the same period. There has been an increase in self-harm and suicide and many of the health and mental problems have been attributed to the impacts of alcohol, drugs and tobacco on individuals and relationships.

While communities like Minyerri are relatively peaceful, police estimate that more than 90% of crime is related to alcohol or illicit drug sales or use. The situation is more complicated in Ngukurr, where several tribal groups live together and there is a propensity for inter-clan rivalry and tension of historic origin.

3.7.5 Inherent risk of regional socio-economic impacts

Three broad drivers of change were considered when determining the likely significance of impacts and risks. These were: mining operations, population influx and income. A qualitative risk assessment was then undertaken to assess the significance of potential social impacts of the project. The assessment was undertaken in accordance with ISO 31000 risk management standards and the outcomes are reported in section 3.1, while Table 3-14 and Table 3-15 contain summaries of the beneficial impacts and risks associated with the project.

This project is of significance to the Roper River region because there is little in the way of industrial development and economic stimulus in the immediate vicinity of Minyerri and Ngukurr. This is one of two medium to large iron ore mines that have the potential for long-term contribution to local communities and the wider Roper River region.

Table 3-14. Summary of beneficial community and regional impacts anticipated for the SCIOP

Significance	Impact type	Origin	Potential benefits
High	Economic	Iron ore production and sales	• Increase in regional and community income through contracts and agreements • Improvements to road infrastructure
High	Social capital	Mining activities	• Increased availability of employment • General up skilling of long-term unemployed • Improved education
Medium	Infrastructure development	Income generated through community benefit trusts	• Development of local businesses • Improvements to community and regional access • Enhancement of health facilities • Increased availability of housing leading to less overcrowding

Table 3-15. Summary of socio-economic risks identified for the Sherwin Creek Iron Ore Project

Significance	Inherent risk	Potential causes	Potential consequences
High	Vehicle accidents on the Roper Highway	• Inadequate maintenance of the road • Increased volume of heavy	• Death or injury • Suspension or closure of operation

Significance	Inherent risk	Potential causes	Potential consequences
		traffic - Inadequate systems for management of traffic - Road dimensions are not suitable for ore trucks	
High	Early closure	Market downturns	- Early closure of the project - Increased regional unemployment - Loss of community and regional income and benefits
High	Increase in trafficking of drugs and alcohol into communities	- Increase in disposable income - Poor control over wet mess at camp	- Increased domestic violence - Increase in health issues - Neglect of children - Increase in crime
Medium	Insufficient work available to local people	- Insufficient number of Aboriginal people available for employment - Inadequate training and development systems - Low retention rate	- Income derived benefits are not received by communities - No change in community wellbeing - Agreement penalties may be applied - Disruption to mining schedules
Medium	Stakeholder expectations are not being met	- Expectations are unreasonable - Company revenue is insufficient to meet its commitments - Stakeholder concerns are not based in fact	- Alienation of stakeholders or creation of negative relationships - Loss of community and regional income and benefits - Loss of company credibility
Medium	Interference with Aboriginal customs or communities	Company employees not adhering to policy	- Loss of traditional culture - Loss of access to additional deposits - Negative stakeholder relationships
Medium	Excessive pressure on community services	- Influx of people seeking work - Environmental issues (e.g. dust) causing illness or respiratory distress	- Overcrowding of houses - Decreased availability of goods - Increase in crime - Delays in obtaining health care

Expectations that the project will have a net positive economic impact at regional and community levels are not surprising. Sustainable and significant impacts are anticipated in sectors directly related to income generation and employment, with flow-on effects possible for education, community services and health. It is apparent that local communities now hold high expectations in relation to the ability of the project to expand the labour market and its willingness to employ Indigenous people or offer contracts to affected communities. It is now important that, where possible, every effort is made to ensure these expectations are met and socio-economic benefits are maximised.

Sherwin Iron seeks to maximise the positive regional economic benefit through its focus on preferential local recruitment, development of local business opportunities and allocation of contracts to suitable local operators. Sherwin Iron has committed to high levels of Aboriginal employment in its Agreements and has made additional commitments to encourage and bolster local business development. It is estimated that combined, these initiatives have the potential to reduce regional unemployment to a level as low as 10% if

successful. This is an important outcome, but one that may be difficult to achieve or maintain in practice because Sherwin Iron will be in direct competition with Western Desert Resources for a relatively small pool of appropriately skilled labour.

Numerous environmental, cultural, business and social risks were identified through risk analysis and all of these contribute to some degree to the overall socio-economic impact because they will affect project profitability or company income/expenditure streams. The significance of many of these have been discussed in other sections of the EIS and have therefore not been detailed here.

The most significant and immediate risk posed by the project relates to transport of iron ore along the Roper Highway. Many stakeholders feel that the highway is not sufficiently well constructed or maintained to handle a continuous, large volume of heavy haulage vehicles. There is a high risk of a serious accident, which many feel will be exacerbated by additional traffic linked to the Western Desert Resources mine and oil and gas exploration planned for 2014 and beyond. Although this is primarily a safety risk, it holds the potential to close the project early if not rectified.

Early closure of the project may also come through market downturns and loss of sales contracts. Although negotiation of long-term contracts means that the likelihood of this occurring is low, loss of sales will always remain a major threat to the project and to the benefits it offers. This is a business risk largely beyond the control of Sherwin Iron but is one that can serve to limit the net positive impact through cutbacks to the workforce and/or reductions in the amounts of contract revenue paid to communities via the Native Title Agreement.

The next most important social concern and socio-economic risk relates to the potential for increased influx of alcohol and illicit drugs (mainly marijuana) into nearby Aboriginal communities. Community members are concerned that while employment opportunities are welcomed, the influx of large amounts of disposable income into communities will exacerbate this and associated social problems. Alcohol and drug abuse is already a long-term social issue leading to numerous negative health, safety and criminal outcomes – and does not have an easy solution. Unless income can be managed well, many of the benefits that individuals might accrue from involvement in the project may be lost.

The project presents a number of risks that may lead to less severe or temporary socio-economic impacts, but will also require good planning and management if their impact is to be minimised. These risks are closely linked with additional pressures being placed on existing infrastructure services and stakeholder expectations with particular reference to availability of employment and protection of culture. The key to successful management of these is to recognise the nature and source of the risk and use them as opportunities for development where possible. For example, while the project may create the potential to increase demand on health services, Sherwin Iron is also in a position to finance upgrades to regional health systems should the company choose to utilise community clinics as their primary point of care.

During consultation, some stakeholders also identified a small number of environmental issues that might pose low-level social risks, mainly to health and well-being. These are largely related to dust and contamination of water and discussed in greater detail in Chapter 4. As they are considered a part of the wider suite of environmental impacts, their management is dealt with through the Environmental Management Plan. Similarly, socio-cultural matters have not been considered here, but have been addressed by the Cultural Heritage Management Plan and discussed in section 3.6.

3.7.6 Management of regional socio-economic risks

Sherwin Iron is mindful of the types and level of direct and indirect social risk the project poses to local communities, people and infrastructure. A number of these risks are outside of the control of Sherwin Iron and would be better addressed by local governance, however the company remains committed to doing all within its power to ensure that they are minimised. Management of socio-economic risk is primarily performed through the Social Impact Management Plan (SIMP), attached in Appendix K. It contains a series of four individual plans that link the identified key drivers of change (mining activities, population and influx) with the key interests identified through stakeholder consultations.

The four plans are:

- the Stakeholder Engagement Plan
- the Community Cohesion and Safety Management Plan
- the Community Development (Social Capital) Management Plan
- the Community Development (Infrastructure) Management Plan.

Additional risks identified in Table 3-15 are addressed through the Cultural Heritage Management Plan and Environmental Management Plans.

Each of these plans contains a series of performance management based strategies tailored to address specific issues that have been identified. These strategies are designed to encourage development of sustainable systems and include:

- Development of corporate policies, plans and procedures aimed at minimizing each identified risk
- Development of education and training systems that address risks and the total needs of the unemployed and the company
- Reducing the risk to local communities and their culture by locating infrastructure related to mining operations and accommodation at a respectful distance
- Developing Joint Ventures and business enterprises that aim at building capacity amongst local Aboriginal people with a view to their increased involvement in mine related work
- Creation of managed community trusts and benefit schemes to reduce the risk of financial mismanagement and to protect income streams paid to the community.

Sherwin iron has identified a number of specific options for management and mitigation of socio-economic risks. These may involve management through any number of inter-related management plans and in some cases several of the identified options may be implemented in conjunction with each other. The list provided in Table 3-16 should not be considered complete as it is anticipated that alternative or additional management and mitigation options will be identified as the project progresses.

Table 3-16. Summary of management options for major risks associated with the project

Inherent risk	Options for management and mitigation of risk	Relevant plan(s)
Vehicle accidents on the Roper Highway	• Upgrade Roper Highway • Construct Alternative Haul road • Barge material down Roper River	• Community Cohesion and Safety • Health and Safety • Traffic Management
Increase in trafficking of drugs and alcohol into communities	• Routine workplace drug and alcohol tests • Education • Income management systems	• Community Cohesion and Safety • Stakeholder Engagement
Employment targets set in the ILUA are not met	• Development of training facilities and systems • Recruitment locally and through the NLC	• Community Development (Social Capital) Management • Stakeholder Engagement
Stakeholder expectations are not being met	• Social risk register • Ongoing stakeholder engagement	• Stakeholder Engagement
Interference with Aboriginal customs	• Cultural Heritage register	• Cultural Heritage Management

or communities	• Preservation of language • Preservation of traditional knowledge • Application of relevant sacred site and heritage legislation	• Stakeholder Engagement
Excessive pressure on community services	• Upgrading of community health centres • Site-based medical facilities • Site-based accommodation and recreation facilities • Site-based store	• Community Development (Infrastructure) Management
Early closure	• Long-term sales contracts • Continuous improvement of mining operations • Expansion of the project	• Business Plans

In addition to its management plans, Sherwin Iron has made a number of commitments to traditional Aboriginal owners during negotiation of the Mining Agreement. The objective of these commitments is to maximise positive individual and community benefits that may be derived from the project and reduce risk to sustainability of the project. As they have the potential to lead to improved standards of living across the region during and after mining, they are viewed by the company as a significant part of its social licence to operate and an important part of its process of stakeholder management.

Ideal commitments include:

- a total of 20 % of its workforce in the first two years will be Aboriginal employees
- a total of 30 % of its workforce in all subsequent years will be Aboriginal employees
- Sherwin Iron will build capacity amongst local Aboriginal people and business through development of joint ventures that will ultimately assume full control of the Joint Venture operations
- Sherwin Iron will create a community trust and benefits scheme for secure management of community income from its Agreements with Sherwin iron.

Sherwin Iron anticipates there will be difficulties in meeting and maintaining these commitments, but as the project develops, Sherwin Iron will be in a strong position to consider further, realistic commitments. These will be done either through additional Agreements or as outcomes of its social management process.

3.7.7 Residual risk of regional socio-economic impacts

The residual risk in most areas can be reduced to moderate with the above management.

Table 3-17. Risks to regional socio-economic impacts

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
Community cohesion and safety	Contaminants or dust	Increased pressure on community health services	2	B	L 5	Environmental systems and measures will be in place to reduce large volumes of dust or contamination of local potable water supplies.	1	A	L 1
	Separation of Aboriginal workers from their families	Mental health issues	2	A	L 3	- Develop systems and processes that encourage short-term family visits to the camp. - Consider short-term rosters for Aboriginal people (e.g. 1 week on/1 week off) with job-sharing and pooling.	2	A	L 3
		Project unable to retain workers	3	C	H 13				
	Ceremonial requirements	Project unable to retain workers	3	C	H 13	Work rosters will be developed that provide for time to attend ceremonial duties. This may include week on/ week off rosters; job-sharing or a pool of employees.	3	B	M 9
	Alcohol and drugs	increased health issues	3	C	H 13	- Alcohol types and quantities will be controlled at the mine's wet mess. - Routine testing of blood alcohol and drug levels, with zero tolerance in the workplace.	3	B	M 9
		Increased crime							

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
	Transport of ore	Vehicle accidents with the potential to cause death	5	D	E 24	- Regular maintenance of the Roper Highway in conjunction with transport protocols and procedures (e.g. trucks in convoys with escorts). - Alternative options for transport of ore (e.g. construction of a dedicated haul road, barging or rail transport) will be considered.	5	C	E 22
Community infrastructure and services	Influx of Aboriginals from other communities	Increased pressure on infrastructure and services	2	E	H 16	Transport to and from the camp and accommodation at the camp will be made available for Aboriginal workers.	1	B	L 2
	Influx of non-Aboriginals into communities	Increase in transmissible diseases	2	B	L 5	All non-Aboriginal workers will be flown into and out of Minyerri or Ngukurr and transported to and from site.	2	A	L 3
		Increased pressure on infrastructure and services	2	A	L 3	Accommodation will be provided at site effectively isolating workers from communities.	1	A	L 1
		Disruption to Aboriginal customary activities	3	C	H 13	Cultural awareness training will be provided to all workers	2	B	L 3
	Injury or illness	Increased pressure on community health services	2	B	L 5	- On-site first aid facilities and medical evacuation protocols and procedures. - Up skilling of local community health workers and upgrade of facilities will be considered.	1	A	L 1

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
	Goods and services	Mine requirements create shortage of supply to communities	3	B	M 9	An on-site store may be constructed or all goods will be provided by special contract through selected community stores.	2	A	L 3
Economic	Resumption of land	Reduction in cattle carrying capacity leading to loss of station income	1	E	M 11	The amount of land being mined will be minimised. Progressive rehabilitation will return land to cattle agistment.	1	C	L 4
	Income from ore sales	Decline in income leading to loss of community income	3	B	M 9	- Procurement of long-term contracts for the sale of ore. - Identification of additional resources including resources that can be beneficiated. - Improved management and mining practices to reduce ore production costs.	3	A	L 6
		Decline in income leading to decrease in employment levels							
	Early closure of project	Programmes that have commenced are unable to be completed	3	C	H 13	Development of a plan for early closure with a focus on contingencies to be employed while developing programmes beneficial to the community.	2	B	L 3
		Unsustainable future for community	4	B	H 14	During the early part of the project assist with development of local businesses that can cater to other users (e.g. mechanical services, tourism).	3	B	M 9
	Stratification of wealth	Increase in petty theft and income related crimes	2	B	L 5	Creation of community and family trusts with appropriate legal controls to reduce amounts of available cash.	2	A	L 3

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
	Increase in disposable income	Increase in availability of drugs and alcohol	3	D	H 17	- Income management education and awareness. - Sherwin iron will also look at developing money management and banking systems. - Creation of community and family trusts with appropriate legal controls to reduce amounts of available cash.	3	C	H 13
Land use	Resumption of land	Reduced access for recreational hunting and fishing	1	B	L 2	Mining will occur only on top of the mesas, well away from plains and rivers.	1	B	L 2
		Reduction in aesthetic appeal of environment	1	B	L 2	- Mining will occur at a distance from the Roper Highway and will be hidden from view by large areas of vegetation. - Mining will occur in phases and progressive rehabilitation will ensure that the area of disturbed land will remain at a minimum.	1	B	L 2
	Unauthorised access to land	Loss of access to future deposits	4	B	H 14	Cultural awareness training will be provided to all workers and protocols for access to land and communities will be developed.	3	B	M 9
Stakeholder engagement	Participation of stakeholders	Alienation of stakeholders	3	C	H 13	- Sherwin Iron will engage a social and cultural liaison to maintain contact with stakeholders throughout the duration of the project. - Liaison Committee meetings with Aboriginal people	3	A	L 6
		Loss of business opportunities	2	C	M 8		2	A	L 3

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
		Failure to meet employment targets	3	C	H 13	will be undertaken on a regular basis.	3	A	L 6
		Failure to identify all impacts	3	C	H 13		3	A	L 6
	Communication	Poor communication leading to negative relationships	2	D	M 12	- Regular and ongoing face-to-face communication will be undertaken with all stakeholders. - A website has been developed to allow for two-way communication and passage of information.	2	B	L 5
	Expectations	Negative relationships with stakeholders develop if expectations are not met	3	C	H 13	- Regular communication between Sherwin iron and stakeholders to ensure that expectations are known and are realistic. - An annual allocation of monies for stakeholder projects will be made to ensure that those accepted are being addressed.	2	B	L 5
Workforce	Community workforce and skills	Decrease in number of skilled workers retained by communities	3	C	H 13	- Education and training in a number of areas beneficial to both Sherwin Iron and the community will be provided. - This should enable a pool of skilled people to be developed for use at the mine or in communities.	3	B	M 9
Failure to comply with NTASS Act	Unintentional or deliberate unauthorised	Alienation of traditional Aboriginal owners	3	D	H 17	Ongoing engagement with traditional Aboriginal owners	3	B	M 9

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
	entry to sacred site	Loss of future access to land	4	C	H 18	• Employees will be made aware of responsibilities to abide by legislation	4	B	H 14
		Temporary closure of project	4	B	H 14	• Mining Plans will be prepared such that all sites are avoided	4	A	M 10
	Mining Operations	Damage to site	3	C	H 13	• Sites will be demarcated prior to work commencing • Buffer zones will be provided around sites • Mining Plans will be prepared such that all sites are avoided	3	A	L 6
Failure to comply with Heritage Act	Unauthorised entry to heritage site	Removal of cultural objects	3	C	H 13	• Ongoing engagement with traditional Aboriginal owners	3	B	M 9
		Destruction of archaeological or historic materials	5	B	H 19	• Employees will be made aware of responsibilities to abide by legislation	5	A	H 15
		Court imposed penalties affecting economic viability of project	3	A	L 6	• Mining Plans will be prepared such that all sites are avoided	3	A	L 6
		Temporary closure of project	4	B	H 14	• Site locations will not be made public	4	A	M 10
		Permanent closure of project	5	A	H 15	• A site register will be prepared and maintained	5	A	H 15

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
	Mining	Damage to site	3	B	M 9	- Sites will be demarcated prior to work commencing - Buffer zones will be provided around sites - Mining Plans will be prepared such that all sites are avoided	3	A	L 6
Loss of contemporary culture	Language	Language is lost	5	B	H 19	Language recording project	5	A	H 15
		Traditional Knowledge is lost	5	B	H 19	Keeping place/museum for artefacts	5	A	H 15
			5	B	H 19	Traditional Knowledge recording project	5	A	H 15
	Traditional environmental knowledge	Closure and rehabilitation outcomes are unacceptable to traditional Aboriginal owners (landowners)	3	B	M 9	- Traditional Knowledge recording project - Traditional knowledge applied during progressive rehabilitation	3	A	L 6
Loss of control over proprietary cultural	Traditional Knowledge	Potential future business opportunities are lost	3	B	M 9	Intellectual Property Management Agreement	3	A	L 6

Risk	Aspect	Potential impact/hazard	Inherent risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management measures	Residual risk (C=Consequence; L=Likelihood; RS=Residual Risk)		
			C	L	RS		C	L	RR
information		Application of aspects of traditional knowledge to environmental management may be precluded	3	B	M 9	Patent applications if and where practical	3	A	L 6

3.8 Transport

Sherwin Iron intends to transport iron ore from the site to the Darwin Port by heavy vehicles (road train). In this mining phase Sherwin Iron intends to excavate 1,000,000 tonnes of ore per year which will be transported by road using quad road trains. The 570 km trip between the mine site and Darwin is estimated to take around 7.5 hours, excluding loading and unloading. Access to and from the mine is along the Roper Highway, which connects to the Stuart Highway south of Mataranka. The Roper Highway is a single lane sealed road typically in the order of 4 m wide with localised widening at intersections.

Traffic data for 2010 (TAMS 2010) indicates an annual average daily traffic flow of 76 vehicles per day long the Roper Highway to the west of the Sherwin Iron site (i.e. between the site and the Stuart Highway). This figure fluctuates between 30 and 120 vehicles per day (2 way traffic) depending on the season – with May to September being the busiest period (Appendix L). At peak production, this project will add 76 road trains (38 each way) to the number of vehicles using both the Roper Highway (between the project site and Stuart Highway intersection) and Stuart Highway (intersection with Roper Highway to Darwin).

At the junction with the Roper Highway, the Stuart Highway is a 2 lane sealed road typically in the order of 7 m wide. Traffic data for 2010 indicates an annual average daily traffic flow of 582 at ADT station RKVDC021 (approximately 80 km South of Katherine), and 1392 at UKVDP002, 20 km North of Katherine River Bridge (TAMS 2010).

This section identifies the potential risks and impacts of the project on transport infrastructure during construction, operation, and maintenance phases of the project. The main risks associated with transport are road safety, amenity, human safety, water, and biodiversity. This section will concentrate on the risks associated with road safety and amenity. Human safety has been discussed in Section 3.2, biodiversity risks are in Section 3.4, and water risks are in Section 3.3. Community Consultation regarding the use of the Roper Highway to haul iron ore has been discussed in the Provisional Social Impact Management Plan: Sherwin Creek Iron Ore Project (Appendix K1).

For the purposes of this discussion, key risks have been divided into the following sections:

- Unsecured loads
- Poor driving standards
- Fatigue
- Vehicle breakdown
- Fauna Strike
- Road network capacity
- Dangerous chemicals / explosives
- Overloading of trucks
- Junction design
- Road maintenance
- Road views
- Culverts
- Overtaking
- Visual amenity
- Sense of remoteness
- Cumulative impacts.

Background information, inherent risks, mitigation measures and residual risks in relation to transport are summarised in Table 3-18 and discussed in further detail. The detail of how risk ranking was determined is provided in Table 3-18 i.e. consequence and likelihood ranking.

3.8.1 Unsecured loads

Inherent risk profile

Unsecured loads pose a risk to the vehicle operator and other road users. When loads are not secure they may move and make the vehicle unstable. Under heavy braking, it is possible that an unsecured load could crash in to the vehicle cabin, or loads could fall out of the back of the vehicle and become a hazard for other road users. The inherent risk is extreme.

Risk mitigation

Section 4.4 of The Traffic Management Report (Appendix L) details how iron ore will be secured in accordance with the Northern Territory Traffic Regulations, Australian Road Rules and the National Transport Commission's Load Restraint Guide.

Residual risk

The mitigation measures will reduce the risk to both the vehicle operator and other road users. The residual risk will be high.

3.8.2 Poor driving standards

Inherent risk profile

Poor driving standards, such as speeding, tailgating, running through red lights etc. pose risks to all road users. The impact from poor driving ranges from stress to other road users to vehicle collisions and possible fatalities. The inherent risk is extreme.

Risk mitigation

The heavy haulage operation company contracted by Sherwin Iron will ensure that all drivers have the appropriate licence, and are competent to operate assigned vehicles. All roadtrain drivers will undergo an induction to familiarise them with site specific details and expectations.

All vehicles hauling ore to Darwin, as well as returning vehicles will have company branding to easily identify them to other road users. Vehicles travelling along the Roper Highway will travel in convoys, and will have a lead vehicle to advise other road users of oncoming wide loads. All road trains will carry In Vehicle Management Systems (IVMS) which record and report location and speed, as well as monitor driver behaviour (refer to Appendix L).

Residual risk

The mitigation measures will greatly reduce the risk to all road users. The use of several different mitigation measures will ensure drivers adhere to the high standards of driving. The residual risk will be high.

3.8.3 Fatigue

Inherent risk profile

Driver fatigue is a significant safety hazard in the road transport industry. It can significantly affect an individual's capacity to function, concentrate and react to stimuli. Fatigue has an extreme inherent risk.

Risk mitigation

In Section 4.1 of the Traffic Management Report (Appendix L) Sherwin Iron commit to develop a Fatigue Management Plan for drivers. It will include training and awareness on the issue, individual rosters, as well as showing drivers the location of rest areas, and other facilities. This management plan will adopt the NT Fatigue Management Road Transport Code of Practice.

Residual risk

The mitigation measures will reduce the risk of fatigue significantly. The residual risk will be high.

3.8.4 Vehicle breakdown***Inherent risk profile***

Vehicle breakdown can cause a safety risk to other road users as they attempt to go around immobilised vehicles. It can cause traffic jams, or possible vehicle collisions. The inherent risk of vehicle breakdown is Extreme.

Risk mitigation

An action plan will be put in place to deal with the possibility of heavy vehicle breakdown while en route by the heavy haulage operator. The plan will address the prompt, safe and efficient removal of an immobilised heavy vehicle from any public road during the course of the project (Section 4.6 Appendix L – Traffic Management Report).

Residual risk

Safe and prompt removal of broken down haulage vehicles will reduce the residual risk to high.

3.8.5 Fauna strike***Inherent risk profile***

The risk to vehicle drivers of fauna strike is the main focus of this section. The inherent risk depends on the size of the animal that is struck i.e. risk from striking a cow is much higher than the risk of striking a wallaby. For the purposes of this assessment, we will assume the inherent risk is extreme.

Risk mitigation

Sections 4.1 and 4.3 of the Traffic Management Report (Appendix L) detail Sherwin Irons response to accidents and fauna strikes. Drivers will be inducted, and trained with respect to the risks of fauna strike, as part of the safety awareness measures, and the standard heavy haulage operator's procedures will be followed.

Residual risk

The residual risk will be high.

3.8.6 Explosives***Inherent risk profile***

The inherent risk of carrying all the components of an explosive in the one vehicle is extreme.

Risk mitigation

Sherwin Iron commits to ensuring that they and their contractors will transport dangerous goods in compliance with the *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act* and regulations. Individual components of explosives are benign, and only become dangerous when they are combined. Explosive components will be transported in separate vehicles to ensure safe handling of these dangerous goods.

Residual risk

As explosive components are in different vehicles, the residual risk of explosives transportation is medium.

3.8.7 Overloading of trucks

Inherent risk profile

Axle overloading makes vehicles less stable, difficult to steer, and slower to stop. This can cause tyres to wear and deteriorate faster, and can cause greater wear and damage to road surfaces. The inherent risk of overloading is high.

Risk mitigation

Sherwin Iron will install a weighbridge to ensure that no vehicles exceed their legal axle weight limit.

Residual risk

The residual risk of overloading of trucks is medium.

3.8.8 Junction design

Inherent risk profile

Poor junction design can be a risk as other road users may not be able to see vehicles leaving the mine site, and can cause possible vehicle collision. The inherent risk of poor junction design is Extreme.

Risk mitigation

In the Traffic Management Report (Appendix L) Sherwin commits to upgrading the existing intersection between the Roper Highway and the Mine Site to the approval of the Department of Transport.

Residual risk

The residual risk of poor junction design is high.

3.8.9 Road maintenance

Inherent risk profile

Increasing the traffic volume along a rural highway such as the Roper Highway could cause the quality of the road surface to deteriorate faster than with current traffic volumes. The inherent risk is high

Risk mitigation

In Section 3.1 of the Traffic Management Report (Appendix L) Sherwin commits to undertaking a condition survey of the Roper Highway, this will be followed by a monitoring program. They will also start an asset management program with all stakeholders involved in the management and continued function of the Roper Highway.

Sherwin Iron and their contractors will only operate road trains during the period when the Roper Highway has non restricted opening of the road.

Residual risk

The residual risk of overloading of road maintenance is medium.

3.8.10 Sight distances

Inherent risk profile

Inadequate sight distances on horizontal curves and to single lane bridges could lead to vehicle collisions. The inherent risk of sight distances is extreme.

Risk mitigation

Sherwin commits to making road improvements and/or installing Vehicle Activated Warning signs to warn drivers of approaching traffic along the Roper Highway.

At the junction with the Stuart Highway, there is approximately 3km of straight road in either direction.

Residual risk

The residual risk is high.

3.8.11 Culverts

Inherent risk profile

With the increase in traffic movements, the need to pull off to the side of the road will increase as vehicles pass each other. Where culverts are less than 2m from the edge of the road seal, this poses a potential threat to vehicles pulling too far off the carriageway, especially at night time. The inherent risk is Extreme.

Risk mitigation

Sherwin proposes to move culvert heads along the Roper Highway to a minimum of 2.5m from the edge of the road seal, and install 4 guideposts each side of the carriageway to highlight the location of culvert headwalls.

Residual risk

The residual risk is high.

3.8.12 Overtaking

Inherent risk profile

There are currently no constructed overtaking lanes along the Roper Highway, and limited opportunities to safely overtake at all. This creates a risk where drivers may make risky overtaking manoeuvres trying to pass slower moving quad road trains. The inherent risk in overtaking along the Roper Highway is extreme.

Risk mitigation

Sherwin proposes to construct 3 overtaking lanes along the length of the Roper Highway at positions to be agreed with the Department of Transport.

Residual risk

The residual risk is high.

3.8.13 Noise

Inherent Risk

The use of air brakes during the night time has the potential to disturb residents sleep. The inherent risk in this is medium.

Risk Mitigation

Sherwin commits to schedule vehicles to reduce traffic volumes within the Mataranka and Katherine areas between 9pm and 7am, and will adhere to existing legal requirements with regard to engine and compressions braking.

Residual Risk

The residual risk is low.

3.8.14 Road network capacity

Inherent Risk

As of 2010, an average of 76 vehicles per day use the Roper Highway. Sherwin's project will double the average daily traffic on the Roper Highway. There are two other major developments in the region; namely Australian Ilmenite Resources (AIR), and Western Desert Resources Limited (WDRL).

AIR also plans to use the Roper Highway and Stuart Highway to transport product from the region to Darwin, and at full production are expected to add another 20 vehicles per day to the traffic that uses the Roper Highway. WDRL do not currently plan to use the Roper Highway to transport ore to Darwin, however light vehicles associated with WDRL do use the Roper Highway to the east of Sherwin Iron.

There are other potential resources in the region which, if developed, could put further pressure on the Roper Highway.

The inherent risk is Extreme.

Risk Mitigation

Sherwin Iron has committed to performing a condition survey of the Roper Highway, and will put in place a monitoring and asset management program with all parties holding a stake in the management and continued function of the Roper Highway.

Residual risk

The residual risk is considered high.

Table 3-18. Residual transport risks

Risk	Aspect	Potential impact / hazard	Inherent risk (C=Consequence, L=Likelihood, RS=Risk Score)			Mitigation measures	Residual risk (C=Consequence, L=Likelihood, RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Unsecured Loads	- Destabilised vehicle - Crushed vehicle cabin - Debris on road	5	D	E 24	Ore will be secured and located in covered trailers according to the Northern Territory Traffic Regulations, and Australian Road Rules	5	B	H 19
Human health & safety	Poor driving standards	- Vehicle collision - Speeding - Unauthorised drivers	5	C	E 22	- In Vehicle Management System, - Escort, Convoys, Branded vehicles, Check appropriate licences	5	A	H 15
Human health & safety	No rest breaks, long working hours, inadequate rest, shift cycles, Inappropriate nutrition	- Tiredness - Falling asleep at the wheel - Vehicle collision - Fatality - Loss of production	5	C	E 22	- Fatigue Management Plan including: - Fatigue awareness during pre-start - Encourage healthy lifestyle - Scheduled shift hours, and rest breaks.	5	A	H 15
Human health & safety	Lack of overtaking opportunities	Overtaking in unsafe areas	5	C	E 22	Propose to add 3 passing lanes along the length of the Roper Highway	5	B	H 19
Human health & safety	Fauna strike	Collision with large fauna	5	C	E 22	Induction, Safety training, standard operating procedures, accident plan	5	B	H 19

Risk	Aspect	Potential impact / hazard	Inherent risk (C=Consequence, L=Likelihood, RS=Risk Score)			Mitigation measures	Residual risk (C=Consequence, L=Likelihood, RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Vehicle breakdown	- Road blockage - Traffic jam - Vehicle collision	5	C	E 22	Action Plan to remove immobilised vehicles quickly and efficiently	5	B	H 19
Human health & safety	Dust	- Reduced visibility - Vehicle collision - Reduced air quality	5	D	E 24	Appropriate dust suppression measures to be implemented	5	B	H 19
Human health & safety	Oversized vehicles	Vehicle Collision	5	C	E 22	Escort, Convoys, warning signage near rivers	5	A	H 15
Human health & safety	Junction design	- Vehicle unable to enter highway safely - Vehicle cannot be seen from highway	5	C	E 22	Road familiarisation as part of Induction, warning signs near Roper Highway / Stuart Highway junctions warning other road users	5	A	H 15
Human health & safety	Road maintenance	- Loose road surface - Broken seal	5	C	E 22	Upgrading of identified sections of the highway, as per Traffic Management Plan	5	A	H 15
Human health & safety	Inadequate Sight Distance along curves, and near bridges	Unable to see other road users in time to stop safely	5	C	E 22	Add more signage warning of bridges, and Vehicle Activated Signs on the approaches to bridges	5	A	H 15
Human health & safety	Culverts close to road seal	Vehicle collision with culverts	5	B	H 19	Move culvert heads to a minimum of 2.5 m from the road seal	5	A	H 15

Risk	Aspect	Potential impact / hazard	Inherent risk (C=Consequence, L=Likelihood, RS=Risk Score)			Mitigation measures	Residual risk (C=Consequence, L=Likelihood, RR=Residual Risk)		
			C	L	RS		C	L	RR
Human health & safety	Junction between Roper and Stuart Highways	Vehicle unable to enter highway safely	5	B	H 19	- Modifications to junction design - Sightline over 1km in both directions.	5	A	H 15
Socio-economic	Littering / Vehicle tyres	- Amenity - Feeling of Remoteness	2	D	M 12	Staff and contractors to be made aware of the importance of good house-keeping	2	B	L 5
Socio-economic	More vehicles using highway	- Feeling of remoteness - Traffic jams	2	C	M 8	Managed vehicle schedule (avoidance of peak traffic journeys)	2	B	L 5
Socio-economic	Vehicle noise affecting stations, and built up areas	- Lack of sleep - Loss of amenity	2	C	M 8	- Managed vehicle schedule, - Induction, training - No engine braking in Mataranka or Katherine	2	B	L 5
Cumulative impacts	Traffic Flow	Road network over capacity	2	C	M 8	Consultation with NT Government, other stakeholders	2	B	L 5

3.9 Other risks

3.9.1 Cumulative impacts

Cumulative impacts are those impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project (European Commission 1999). The environmental effects of cumulative impacts can be significant. The Guidelines specifically state that the SCIOP will not be considered in isolation and requests that the EIS consider:

- Impacts on regional ecosystems within the Roper region
- Perception of the region as remote or wilderness
- Key habitats (e.g. riparian, wetland, threatened species habitat) which retain connections with adjacent vegetation and habitat
- Hydrologically connected surface water and groundwater systems that support wetlands and base flows in rivers and creeks.

The above considerations are discussed under headings below, in addition to other potential cumulative impacts, including road traffic and employment/social implications.

Geographical boundary and timeframe

Cumulative impacts have been considered as they relate to the Roper River region over the next five years. The Roper River region, for the purposes of the cumulative impact assessment, corresponds to the entire Roper River catchment, which shares a variety of common resources, and elements of social identity (Figure 3-1).

This region is the subject of current interest and a number of recent proposals and developments, particularly in mining. As interest grows in the region, it is difficult to predict or assess any cumulative impacts beyond the short to medium term. This discussion will therefore only consider any reasonably foreseeable developments in the region in the next five years.

Current and future developments in the region

The current economy in the area is largely reliant on pastoralism and some tourism. The remoteness of the region, lack of infrastructure and strongly seasonal climate has limited its economic development.

Recently, there has been increasing activity amongst a number of mining companies to exploit the mineral resources of the region, with two mining ventures that have commenced in the past twelve months adjacent to Sherwin Iron's tenements.

Western Desert Resources Limited (WDRL) has commenced their Roper Bar Iron Ore project situated on the Towns River, approximately 100 km to the south-east of this proposal. Currently, WDRL expect to produce 24 Mt over a nine year period, though the life of the mine is expected to extend well beyond this period (WDR 2012). WDRL is also exploring other potential projects in the region.

Australian Ilmenite Resources (AIR) has also commenced mining approximately 35 km west-south-west of this proposal. AIR has 4 Mt of Ilmenite within its SILL80 project, with an expected mine life in excess of 20 years (VDM 2012).

Sherwin's Roper River Iron Ore Project encompasses six areas across three Exploration Leases. Although the final scale of the Roper River Iron Ore Project is currently undetermined, the SCIOP (i.e. the subject of this EIS) is likely to be the first stage in the development of a much larger project.

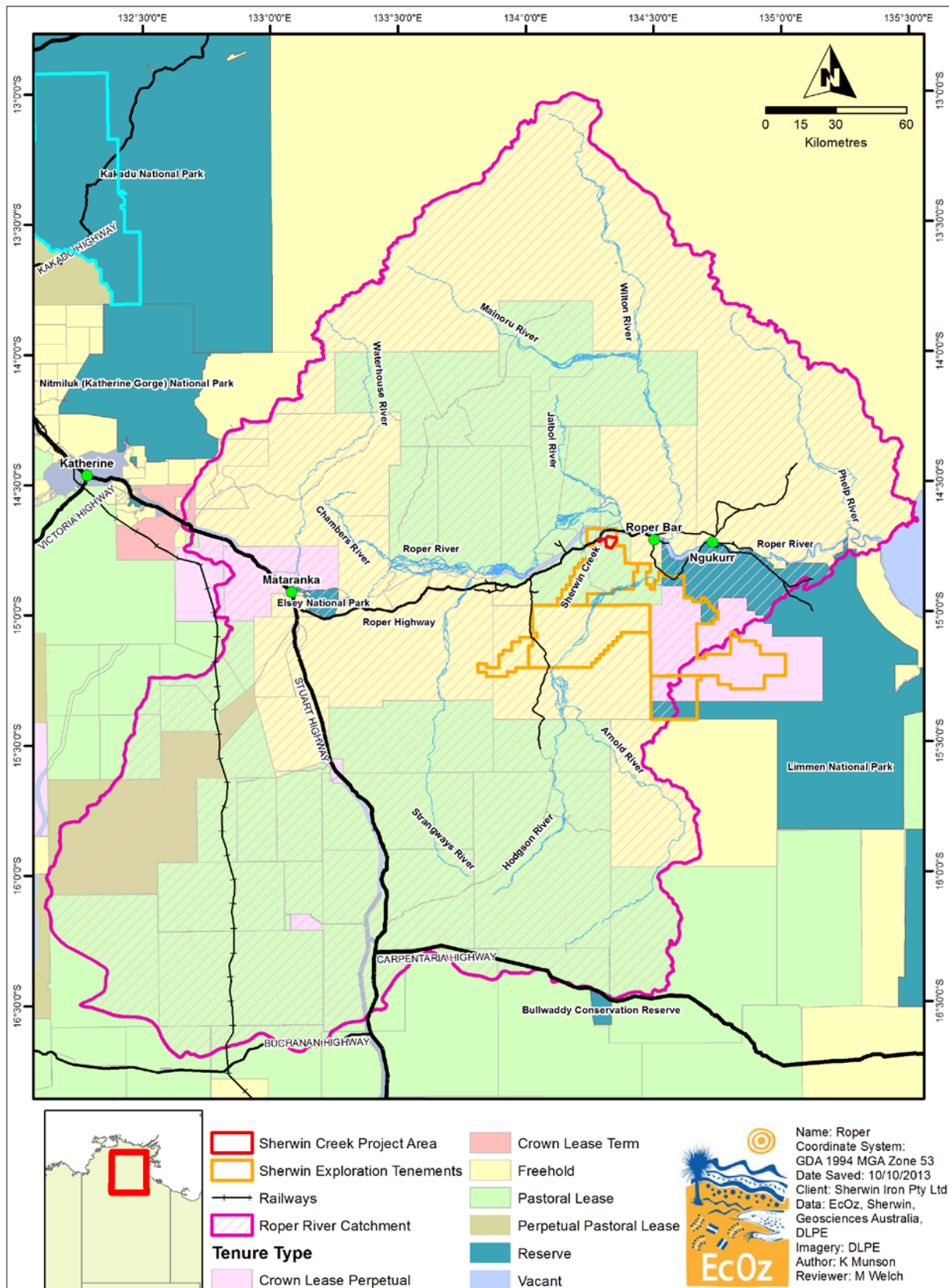


Figure 3-1. Map showing location of project area in context of the Roper River region

Impacts on regional ecosystems within the Roper River region

The Roper River region is largely undeveloped and its natural environments are generally considered to be intact. Currently, there are only two mines operating in the region and this proposal would add a third mine. The scale of these mines is relatively small at this stage but if anticipated expansions occur, there would be potential for a cumulative impact on regional ecosystems.

Perception of the region as remote or “wilderness”

The region is sparsely populated, with the largest community, Ngukurr, having a population of approximately 1 000. The communities of Minyerri, Mataranka and Bulman all have populations of around 400-500. The nearest major town (Katherine, population ~10 000) is approximately 270 km by road from the SCIOP. The development of a number of mines in the region will likely have some impact on the perception of this region as undeveloped. Increased investment, population, road traffic, infrastructure upgrades and a broader knowledge of the region and its resources will all contribute to people becoming more familiar with this region and diminish its perception as an undeveloped area.

Key habitats

The development of the SCIOP is proposed to occur over habitats which are not believed to be impacted by other developments in the region. The project is therefore not considered to contribute to any cumulative impact on key habitats in the Roper River region.

Surface water and groundwater systems

Pastoral stations and the adjacent AIR mine currently draw water from Roper River. Sherwin proposes to meet its project water demand via a combination of groundwater and surface water captured within the mine disturbance area. The project area is not located within any known significant groundwater recharge areas and Sherwin Creek is an intermittent stream system (i.e. non-perennial seasonal flow only) therefore, it is very unlikely that the project will influence any systems that support wetlands and base flows in rivers and creeks.

Road and air traffic

Current road traffic along the Roper Highway is largely limited to seasonal tourist visitation, cattle trucks and fuel tankers to stations and communities. The Roper Highway is likely to become increasingly busy with traffic associated with the mining activity in the region. AIR currently transport their ore by road train to Darwin, and Sherwin also propose to truck ore to Darwin. There will also be an increase in traffic associated with the delivery of goods and services to these mines and to WDRL, such as mining equipment, supplies, fuel tankers, explosives and waste contractors. Upgrades to the Roper Highway will be required to accommodate this increase in traffic, particularly heavy vehicles. The Traffic Management Report (Appendix L) prepared for this EIS has taken into consideration the additional traffic from AIR.

All three mines in the region will operate with the vast majority of their workforce being fly-in fly-out (FIFO). This will increase the amount of air traffic in the region, but there is not expected to be any cumulative impact associated with this.

Employment and social implications

Initially, positive impacts are expected as jobs become available in a region with a small employment base. The majority of the workforce will be sourced from outside the region on a FIFO basis. Impacts may become negative if there is a shortage of labour and companies may compete for skilled workers.

The SCIOP will require a workforce of 65 - 100 during operations (up to 150 during construction), in addition to the personnel currently operating at WDRL and AIR. This represents a significant increase in the regional population. However, as most personnel are expected to be FIFO, their potential social impact on the resident population of the region is expected to be minimal.

An increased regional population may allow diseases (particularly arboviruses) to become established.

3.9.2 Bushfires

Inherent risk bushfires

The SCIOF is located within an expanse of tropical savannah that experiences regular fire. Approximately two-thirds of Mount McMinn Station, on which the project is located, has been burnt over the past three years. Fires occur almost exclusively during the dry season when grasses have cured.

Sherwin assets and infrastructure could be damaged or destroyed by encroaching bushfires from beyond the mine site. Conversely, operations within the project area have the potential to act as ignition sources to start bushfires. These bushfires may threaten Sherwin's equipment and assets on site, or spread off site and cause environmental damage, or damage to surrounding properties, their stock and grazing resources. The inherent bushfire risk is high.

Mitigation measures bushfires

Sherwin Iron has developed a Fire Environmental Management Plan to limit the risk of bushfires within the mining lease (Appendix D).

Broadly, a twofold approach to managing fire will be adopted:

- To limit the opportunity for fire to start due to mining and associated activities; and
- To implement hazard reduction strategies to contain and limit the impacts of fire on people, assets and infrastructure.

Ignition of fire will be limited by:

- Fire being part of the training and induction
- Smoking being confined to designated areas
- Maintaining a strict no fire policy
- Spark arrestors and fire extinguishers fitted to all vehicles and machinery

Fires will be limited and/or contained by

- The establishment of trained crews to respond to outbreaks of fire
- Construction and maintenance of a fire break around the project area
- Provision/ installation and maintenance of suitable fire-fighting equipment
- The establishment of a suitable water source from which fire crews can draw water.

A Training Register is to be kept of any training received and other relevant details (e.g. who and what training received).

In the event of a bushfire the Bushfire Response Plan will be implemented (Section 17 of the Emergency Response Plan – See appendix D).

Residual risk bushfires

With the implementation of the Environmental Management Plan (Appendix D) and other mitigation measures, the residual risk is considered to be medium.

3.9.3 Biting insects

Risks and mitigation measures associated with biting insects are discussed in Section 3.2 Human Health and Safety and Appendix N Biting Insect Management Plan.

3.9.4 Noise and vibration

Risks and mitigation measures associated with noise and vibration are discussed in Section 3.2 Human Health and Safety and Appendix D Environmental Management Plan.

3.9.5 Greenhouse gases

The potential greenhouse gas (GHG) emissions were estimated using the National Greenhouse Accounts (NGA) Factors, as prepared by the Department of Climate Change and Energy Efficiency. The proposed operations are mainly associated with direct (point-source) GHG emissions. There are no indirect emissions of GHG, as Sherwin will not purchase any electricity from external sources (refer to Appendix R).

Other risks associated with air quality (dust and odour) are discussed in Section 3.2 Human Health and Safety and Appendix D Environmental Management Plan.

3.9.6 Waste

Waste inherent risk profile

Waste will be generated during all phases of the proposed project; therefore, to avoid adverse impacts on the health of the environment and/or personnel, all waste generated on-site will need to be managed appropriately.

Waste associated with the proposed project may include the following:

- Building materials e.g. scrap metal, wood, concrete
- General waste and recyclables e.g. paper, plastics, cardboard
- Regulated waste e.g. grease, oil filters, batteries
- Putrescible waste e.g. food scraps
- Sewage waste.

Examples of potential impacts associated with inappropriate waste management include the following:

- Contamination of soils, surface waters and/or groundwaters associated with inadequate management of waste (e.g. leaks, inadequate treatment and/or disposal methods)
- Disease associated with inadequate management of waste (e.g. putrescible, clinical and sewage wastes)
- Impacts on native wildlife, through competition from vermin attracted to inadequately managed perishable waste and/or increased risk of interactions with humans.

The inherent risk is considered to be medium to high.

Waste risk mitigation

Clearly labelled and secure (i.e. from wildlife) bins will be placed in appropriate locations to segregate and collect the waste materials generated on-site. Putrescible waste will be removed from the mine site by staff on a daily basis and placed in a designated fenced disposal pit for regular burning and covering. General and recyclable waste will be periodically transported off-site by a licensed contractor for disposal at a licensed waste facility.

Regulated or hazardous wastes will be stored in appropriately labelled and lined/bunded areas, in accordance with relevant Australian Standards (e.g. AS1940-2004). They will be collected from site regularly and disposed of by a licensed waste management contractor.

Empty fuel drums are to be stored in plastic lined, earth walled and bunded areas and returned to the supplier where possible. Otherwise disposal at the nearest licenced waste disposal facility. A log is to be kept showing removal of any waste from site.

Clinical waste such as drug and alcohol testing kits will be disposed of in accordance with the *Remote Health Atlas* (NT Dept Health and Families 2006). Clinical waste is also classified as hazardous waste under the *Dangerous Goods Act*. Appropriate PPE (such as safety glasses and gloves) will be worn while handling clinical waste.

Treated water from the on-site sewage treatment facilities will be discharged via a reticulation system to landscaped areas which are not intended for human use.

The procedures for the storage, containment and disposal of waste materials will minimise potential impacts to the surrounding environment and the mine personnel.

Waste residual risk

Based on the implementation of the management strategies discussed above, the risk of waste-related environmental, health and safety impacts is expected to be low.

Other waste risks are discussed in sections 3.3 (hydrology and water quality and soil contamination) and 3.4 (Biodiversity).