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9. ASSESSMENT OF ENVIRONMENTAL FACTORS

9.1 TERRESTRIAL FLORA AND VEGETATION

9.1.1 EPA OBJECTIVE

The EPA's objective for flora is to maintain the abundance, diversity, geographic distribution and productivity of flora at the species and ecosystem levels through the avoidance or management of adverse impacts and through improvement in knowledge.

9.1.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to the assessment of impacts on flora and vegetation include:

- *Environmental Protection and Biodiversity Conservation Act (1999)*;
- *Wildlife Conservation Act (1950);*
- *Agricultural and Related Resources Protection Act 1976;*
- EPA (2000) Position Statement No. 2: Environmental Protection of Native Vegetation in WA;
- EPA (2002) Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection;
- EPA (2006) Position Statement No. 9 Environmental Offsets;
- EPA (2008) Guidance Statement No. 33 Environmental Guidance for Planning and Development; and
- EPA (2004) Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA.

9.1.3 POTENTIAL IMPACTS

The Project will require clearing of approximately 7719 ha of vegetation. Of this, 772 ha will be cleared for the expansion pits, 1,785 ha for the IWL and 3,301 ha for the infrastructure (including buffers, processing plant, drainage, topsoil storage, construction camps, airport, borefield infrastructure, roads and turn-around areas). Vegetation complexes occurring within the Project area are generally well represented. Cleared areas will be progressively rehabilitated following completion of construction (i.e. IWL walls), operations (construction camps) or decommissioning (Stage 1 infrastructure areas). The remainder of the cleared areas will be rehabilitated during the life of mine, or following mine closure. The most significant potential impacts on flora and vegetation associated with the Project are the loss of individuals or populations of Priority flora and PECs as a result of clearing.

Other potential direct and indirect impacts on vegetation and flora associated with the Project are identified below:

- clearing of a total of 7719 ha of vegetation;
- habitat fragmentation;
- alteration of vegetation composition or possible vegetation death resulting from altered surface hydrology and drainage (addressed in section Section 9.5);
- increased risk of fire;
- soil degradation and erosion;
- introduction or spread of weeds; and
- potential vegetation death resulting from contamination of soil, groundwater or surface water (addressed in section Section 9.9).

As part of the Jack Hills Stage 1 project commitments, CRL are undertaking native vegetation and flora monitoring on an annual basis. The monitoring has not identified any impacts to flora and vegetation from dust deposition or from the water used for dust suppression.

9.1.3.1 PRIORITY FLORA

Surveys carried out by Mattiske in 2005, Meissner, on behalf of the DEC in 2005, Ecologia in 2006 and GHD in 2009 have recorded twelve species of Priority listed flora within the Jack Hills range and adjacent areas. Surveys carried out by GHD in 2009 have also recorded four Priority listed flora along the gas pipeline route and six within the potential impact area of the services corridor. To quantify the impact of the Project on these species, GHD also completed targeted surveys of the broader Jack Hills area. The majority of Priority flora species, recorded outside of the Project area, are found on the ridge formation, to the south of the existing Jack Hills mine.

The proposed Project will not impact on the recorded populations of three of the twelve Priority flora species identified during baseline surveys, these being *Calytrix verruculosa* (P1), *Dodonaea amplisemina* (P3), *Gunniopsis propinqua* (P3) and *Gunniopsis divisa* (P1). The Project area will, however, directly impact on nine other Priority flora species.

Although Priority flora have been recorded along the gas pipeline corridor and services corridor, the final corridor routes will be designed to avoid all Priority flora recorded during baseline surveys.

The local impact of the Project on populations of these species within the Jack Hills Range is quantified in Table 9.1. The regional impact on the known Priority flora species within the Project Area was also calculated where possible using data available from the WA Herbarium records and NatureMap (the Declared Endangered Florabase and the Banded Ironstone Formation and Greenstone survey data). These records of known plant numbers are very conservative because the majority of the FloraBase and NatureMap records do not accurately state population sizes but rather describe their occurrence in terms of abundance. In using this information, individual records that did not state plant counts from a single location were counted as a single plant only. Furthermore, the database records are only provided for surveyed areas and do not take into account populations that may occur outside areas previously surveyed.

As such, the calculation of regional impact of a particular species provided in Table 9.1 is generally very conservative, with the likelihood that greater than one plant is present for records which do not give population sizes and that additional populations are present outside surveyed areas.

In addition, it is considered that there is potential for many of these species to be further recorded in the greater Jack Hills Range. Due to the size of the Range not all areas have been surveyed. Suitable habitat exists for additional populations of each Priority flora species to be found.

During survey flora surveys 20 range extensions were recorded within the Project area. Many of the species with range extensions are not listed as priority or otherwise conservation significant species. Given that the habitats present are well represented elsewhere in the region, it is expected that the identification of these range extensions is largely due to a lack of surveys within the Murchison Area.

A discussion of each of the Priority species impacted by the Project is provided below.

Acacia sp. Jack Hills

The Priority 1 species, *Acacia* sp. Jack Hills, is only currently known from the Jack Hills Range and is as yet undescribed. It is closely related to the more common, *Acacia cockertoniana*. The population of *Acacia* sp. Jack Hills has been estimated based on quadrat data, general vegetation descriptions and known distribution across the range. It is widespread and common across the range, but appears to be more dominant in the middle to upper altitudes. Estimations of population numbers and of the impact from the mine pit have been made based on known numbers and densities of the plants in quadrats across the range. These numbers were then extrapolated across the range in three bands of 'low', 'medium' and 'high' densities. Calculations of 'take' of the plants were then calculated using the measured areas for each of the bands both within and outside of the mine impact area.

A total of 3,504,000 *Acacia* sp. Jack Hills plants are estimated to occur in the broader Jack Hills Range. Approximately, 403,000 plants or 11.5% of the total population occur within the Project footprint.

Calytrix verruculosa

A total of 549 *Calytrix verruculosa* (P3) plants were recorded within the Project area, three of these plants (0.55% of the local population) will be impacted by the Project. The impact on the three individuals represents a loss of 0.23% of the known regional population (562 individuals).

Verticordia jamiesonii

Surveys have identified the presence of 2453 *Verticordia jamiesonii* (P3) plants in the Project Area, and these records combined with previous records indicate a population of 3017 regionally.

The Project will impact upon three known individuals, representing only 0.1% of the local Jack Hills population and 0.01% of the regional population.

Prostanthera ferricola

A total of 319 plants *Prostanthera ferricola* (P3) which represents 62.4% of the known population at Jack Hills will be impacted by the proposed Project. The total number of plants however, inclusive of records held by the DEC is 1394, representing a loss of approximately 23% of total known plant numbers at a regional scale.

Prostanthera petrophila

Surveys have identified the presence of 820 *Prostanthera petrophila* plants within the Jack Hills Range, the Project will result in the loss of 713 individuals, representing a loss of 87%. At a regional scale records indicate the occurrence of 1077 plants, therefore the Project will result in a 66.6% loss regionally.

Indigofera gilesii subsp. gilesii ms

Until recently, the known range extent of *Indigofera gilesii* subsp. *gilesii* ms (P3) was restricted to the Pilbara bioregion. Recent surveys undertaken by Ecologia (2006) and GHD Pty. Ltd. (2009) have recorded 16 plants from the Jack Hills area, four of which are located in the Project Area. Regionally, a total of 68 plants have been documented in records kept by the WA Herbarium. The loss of four plants represents only 6% of the total number of known plants for this species.

Ptilotus tetrandrus

There are two records of *Ptilotus tetrandrus* (P1) lodged at the WA Herbarium and a total of 5 plants documented. Two individuals were recorded by Ecologia (2006) inside the Project infrastructure area. Current flora surveys undertaken by GHD in 2009 have failed to locate this species using the locality co-ordinates recorded by Ecologia (2006). This species is known from the literature as an annual herb and has recently been recorded at Weld Range (Wayne Ennor, Manager, Project Approvals, Sinosteel Midwest Corporation, pers. comm. October 2009).

Homalocalyx echinulatus

A total of 19,761 *Homalocalyx echinulatus* (P3) plants have been recorded by Ecologia (2006) and GHD Pty. Ltd. (2009) within the vicinity of Jack Hills. Collection records held at the WA Herbarium indicate that the frequency of occurrence of this species is isolated to sparse. However, a population of 3000 plants was recorded from within the Project area on the lower slopes of Jack Hills. Approximately 82.8% of the total number of plants recorded at Jack Hills will be impacted by the Project.

Stenanthemum mediale

Stenanthemum mediale (P1) was recorded at several locations on Jack Hills by Ecologia (2006) and GHD Pty. Ltd. (2009). 77 plants were documented, of which 51 will potentially be impacted by the Project (66%). Previous records and GHD surveys have identified the presence of 120 plants regionally. The Project will result in the loss of approximately 42.5% at a regional scale. However, this species is heavily impacted by goat grazing within Jack Hills and it is possible that more plants are present in the general area, but are not recognisable due to grazing pressure.

TABLE 9.1 COMPARISON OF NUMBERS OF PRIORITY FLORA IDENTIFIED AS OCCURRING WITHIN THE PROJECT AREA

Taxon	Status	Total number of plants recorded in the Jack Hills Area	Number of plants recorded in the Project Footprint	Local Percentage (%) Impact	Number of Collection Records across WA (known plant numbers)[2] (FloraBase Data)	Estimated Regional Percentage (%) Impact
Acacia sp Jack Hills	P1	3,504,000[1]	403,000[1]	11.5%	3,504,105	9.95%
Calytrix verruculosa	P3	549	3	0.55%	562	0.23%
Dodonaea amplisemina	P3	92	0	0%	222	0%
Gunniopsis divisa	P1	2	0	0%	132	0%
Gunniopsis propinqua	P3	1	0	0%	16	0%
Homalocalyx echinulatus	P3	19,761	16,367	82.8%	19,861	82.4%
Indigofera gilesii subsp. gilesii ms	P3	16	4	25%	148	2.7%
Prostanthera ferricola	P3	511	319	62.4%	1,394	22.9%
Prostanthera petrophila	P3	820	713	87%	1,077	66.6%
Ptilotus tetrandrus	P1	2	2	100%	7	28.6%
Stenanthemum mediale	P1	77	51	66.2%	105	42.5%
Verticordia jamiesonii	P3	2453	3	0.10%	2,893	0.01%

[1] Population numbers were estimated from densities recorded during priority flora searches across Jack Hills. Individual number of this species could not be counted as distribution and density of the populations was too great across the Jack Hills range.

[2] Population numbers were estimated based on records in FloraBase. The population estimates are likely to be very conservative as many records in FloraBase do not give numbers of plants and the number was therefore only calculated as being one.

9.1.3.2 SIGNIFICANT ECOLOGICAL COMMUNITIES

Definition and Mapping of the Jack Hills PEC

The DEC has identified a Priority Ecological Community (PEC) occurring on the Jack Hills range. This is the "Jack Hills Vegetation Complexes on Banded Ironstone" which is listed as a Priority 1 PEC. Priority 1 PECs are defined as:

'Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.' (DEC, 2007)

Within the Jack Hills PEC there is one vegetation complex in particular which has been identified as potentially being restricted, due to altitude and habitat. This is a hummock grassland community of *Triodia melvillei* and associated species, which occurs over upland areas of the Jack Hills Range (Mattiske (2005) and Meissner and Caruso (2008)).

Upland *Triodia melvillei* communities within the general Project area have previously been mapped by Mattiske (2005) and Ecologia (2009). The mapping and delineation of sub-communities by Mattiske and Ecologia has varied significantly, due potentially to the scale at which the vegetation was mapped and also to the difficulty in accurately defining sub-communities. Because of this, and the potential impact on the *Triodia* community by the Project, further quadrat data was gathered and delineation of the apparent boundary of the whole *Triodia* community was undertaken by GHD in 2009. The mapping was at a detailed scale using a visual analysis of the extent of communities dominated by *Triodia melvillei* across the entire Jack Hills range.

Local Triodia PEC impact

However, despite the description of four sub-communities of *Triodia melvillei* in Mattiske (2005), the decision was made by the DEC and EPA to consider the upland *Triodia* community as the one vegetation type (EPA Bulletin 1220). Subsequent PATN analysis (Austin and Belbin 1982, Belbin 1995) and flexible UPGMA technique (Blatant Fabrications Pty Ltd 2006) by Mattiske (2009) has confirmed the correctness of this decision stating that: "It is not feasible to justify on the basis of presence/absence data the split between the delineated "T" - *Triodia melvillei* communities".

As a result of this confirmation, and the detailed mapping by GHD in 2009, the impact of the Project on the single *Triodia* PEC community at Jack Hills is approximately 76%, with 24% of the community being outside the Project footprint area.

Regional *Triodia melvillei* community impact

There are potentially many upland *T. melvillei* communities across the Murchison and Pilbara. GHD (2009c; Appendix F) provide an overview of the known locations (as supplied by the Western Australian Herbarium) of *T. melvillei*.

Surveys to assess the regional extent of the *T. melvillei* communities were undertaken between the 18th and 21st of July, and 20th and 21st of August, 2009 (GHD, 2009c). Areas surveyed included the Kennedy Ranges, Glengarry Ranges, Mt Puckford, Mt Laboucher, Robinson Ranges and Mount Gould. GHD visited these areas to compare the communities present with those at Jack Hills. The extent of *T. melvillei* in these areas was mapped from the air between the 27th and 29th of August, 2009. Sites with *T. melvillei* were assessed using 20 m x 20 m quadrats and the community extent mapped by helicopter or on foot, where relevant. A figure showing the areas where the *Triodia* communities were sampled is provided at Appendix F. Table 9.2 below shows the amounts of *Triodia* community calculated at each of the areas where the community was identified and mapped.

TABLE 9.2 EXTENT OF REGIONAL *TRIODIA MELVILLEI* COMMUNITIES MAPPED BY GHD (2009C)

Location	***Triodia melvillei* community area (ha)**
Mt Puckford	360
Mt Gould	9.3
Glengarry Range	885
Robinson Range	143
Mt Laboucher (Nth Robinson)	530
Jack Hills (Total Extent)	359
Approximate Total Regional Extent	**2,286 ha**
Project Footprint (total amount removed)	273
Project Impact (% total extent removed from Jack Hills)	76% Removed
Regional Impact (% removed of known regional populations)	12% Removed

Following the collection of this data, statistical analysis of the regional *Triodia* communities, and comparison with the Jack Hills *Triodia* community, was undertaken by Mattiske (2010) (Appendix F). This analysis was undertaken using PATN analysis (Austin and Belbin 1982, Belbin 1995) and flexible UPGMA technique (Blatant Fabrications Pty Ltd 2006), which is the same analysis undertaken by Meissner and Caruso (2008) in their consideration of the Jack Hills PEC communities. Dendrograms and a species matrix for each quadrat used in the analysis are found in Mattiske (2010; Appendix F). The dendrogram for all the Jack Hills data as compared with other ranges is shown in (Mattiske, 2010; Appendix F, Figure 5).

The outcome of the comparison of regional *Triodia* communities with the Jack Hills *Triodia* community provides some confidence that these communities are similar in some components with those from the nearby ranges (Glengarry Ranges, Mt Puckford, Mt Labouchere (North Robinson), Robinson Ranges and Mount Gould). The *Triodia* community on the Kennedy Ranges (a conservation reserve) shows the greatest similarity with Jack Hills compared to the other ranges (Mattiske 2010, Figures 5 and 6). The Kennedy Ranges contains an extensive *Triodia* community, which has not been quantified. These statistical associations challenge the argument that the Jack Hills ranges are in some ways ecologically and botanically different from other upland areas in the region.

If the extent of the *Triodia* communities on the regional ranges (with the exception of Kennedy Range) is calculated against the loss of the *Triodia* community on Jack Hills, loss of the PEC community regionally is approximately 12%, with an impact on 273 ha out of a total of approximately 2,286 ha, potentially less than 10% with the inclusion of Kennedy Range.

Conclusion

CRL has undertaken a number of studies to further assess the extent and significance of the Jack Hills *Triodia melvillei* PEC and makes the following conclusions:

1. The quadrat and species classifications were undertaken using the Bray and Curtis coefficient and Flexible UPGMA (Unweighted pair-group mean average; â = - 0.1; Belbin) as used previously by Meissner and Caruso 2008). The result of this statistical analysis of quadrat data at Jack Hills is consistent with the DEC/EPA assessment that there is only one *Triodia melvillei* community on the Jack Hills range.
2. The Project does not alter the conservation status of any species present within the Project Area. That is, all species present within the *Triodia* community are well represented in other vegetation communities both locally and regionally.
3. Approximately 76% of the *Triodia melvillei* community on Jack Hills will be directly lost as a result of the whole Jack Hills Mine project (cumulative impact).

4. Analysis shows that after taking into account similar *Triodia melvillei* communities in the region, less than approximately 12% of this type of community will be lost as a result of the cumulative impacts of the Jack Hills mine.
5. CRL commits to undertaking further survey and assessment of the identified similar regional *Triodia melvillei* communities to assist in determining possible offset areas.

9.1.3.3 WEEDS

Weeds compete with native species for space, nutrients and water, and have the potential to alter the structure and composition of vegetation communities. Weeds are commonly spread by wind, surface runoff or animal movement. There is the potential for Project activities to increase the spread of weeds via the transportation of seeds on vehicle tyres and machinery and movement or stockpiling of soil. A number of weed species are known to be present within the Project area (Section 8.4.7). None of the weed species, recorded during baseline surveys, are listed as Declared Plants pursuant to Section 37 of the *Agricultural and Related Resources Protection Act 1976.*

9.1.3.4 FIRE

Construction and operational activities, particularly hot works, are potential ignition sources, and could result in a bushfire. In addition, it may be necessary to conduct controlled burns to minimise fuel loads in the vicinity of the mine site. Without adequate fire management in place, there is potential for these activities to result in bushfires in the surrounding area.

9.1.4 MANAGEMENT AND MONITORING

9.1.4.1 VEGETATION AND FLORA

CRL has an existing Vegetation and Flora Management Plan for the Stage 1 Jack Hills Mine Project, which will be amended to include the broader scope of the Project. Management actions for vegetation and flora are provided in the CEMP and OEMP (Appendix A). This includes management for a range of potential impacts, including clearing, rehabilitation, weeds, soil erosion and compaction, fire management and contamination.

CRL will implement the following measures during the Project to minimise impacts on vegetation and flora, and maximise the conservation of Jack Hills botanical values:

- the Project will be designed to minimise the area of clearing as far as practicable;
- where possible, existing cleared areas will be utilised for stockpiles and laydown areas;
- existing access tracks and roads will be utilised wherever possible;
- no clearing will commence without prior approval of an internal Land Clearing Approval Form;
- clearing lines will be marked on the ground in accordance with the CRL Demarcation and Flagging Work Instruction;
- known occurrences of Priority flora will be marked in the field, and wherever possible, clearing of Priority flora will be avoided;
- clearing of upland Triodia vegetation within the approved footprint will be minimised and avoided as far as practicable;
- the site induction will include information relating to the presence and significance of PECs and Priority flora within the region; and
- specific training of contractors and employees involved in vegetation clearing to ensure areas outside of the approved footprint are not impacted.

CRL will establish a vegetation monitoring program that can measure natural variability in the environment and compare this to any potential variation that may be caused by mining operations and associated activities. Vegetation monitoring will be conducted in the following areas:

- Jack Hills Range adjacent to disturbed pit area;
- flat areas adjacent to IWL and infrastructure;
- borefield vegetation; and
- riparian areas of the Murchison River adjacent to the IWL and downstream.

A Vegetation Monitoring Strategy will guide the establishment of a long-term vegetation monitoring program including:

- monitoring program design, including the type, number and location of monitoring and reference (control) sites for both remnant and rehabilitated areas;
- the type of data, and data analysis, needed for effective monitoring;
- the timing and frequency of monitoring events; and
- reporting requirements.

Monitoring has already commenced in the proposed expansion areas with the establishment of monitoring transects across the Murchison River in the vicinity of Kalamunda Pool, within the area of the proposed borefield and in vegetation between the proposed IWL and the Murchison River. This program will be expanded as the proposed Project is implemented. Reference sites will also be established in areas not impacted by mining operations as they are an integral part of a vegetation monitoring program and can also be used to guide rehabilitation efforts.

9.1.4.2 WEEDS

Weed control measures include:

- regular monitoring of the Project area (including rehabilitated areas) and surrounding vegetation to identify new weed populations and monitor the effectiveness of weed control measures;
- all vehicles and equipment to be inspected for soil, seed and plant material prior to entering the site;
- during operations, vehicle access will be restricted to designated roads and access tracks;
- areas supporting existing weed infestations, or vulnerable to weed infestation, will be avoided where practicable;
- topsoil from weed affected areas will be stockpiled in a designated area with appropriate signage and bunding. Weed infested topsoil will be treated as required to eradicate weeds prior to re-spreading in rehabilitation areas; and
- all staff and contractors will be informed of weed hygiene measures and weed reporting requirements during the site induction.

9.1.4.3 REHABILITATION

A Rehabilitation Strategy, prepared by Landloch and G&G Environmental, is based on the same principles and processes implemented by Minara Resources Murrin Murrin mine site, winning them a Golden Gecko Award in 2009.

CRL has an existing Land Clearing and Topsoil Stockpiling Work Instruction and Rehabilitation and Monitoring Work Instruction, which will be adopted for the Project. Specific management measures documented in these Work Instructions include:

- areas not required for ongoing operations will be progressively rehabilitated with local provenance native species;
- topsoil will be stripped and stockpiled in a designated area, to prevent erosion or run-off;

- seeds collected for the rehabilitation program will be sourced locally, within a 10 km radius of the Project area, wherever possible. Should insufficient quantities of seed be available within the area, seed of local provenance will be sourced. If alternative seed sourcing strategies will be required then this will be determined in consultation with the DEC and DMP;
- where possible, *Triodia melvillei* seeds will be collected and used in rehabilitation;
- Priority flora species will be re-grown in rehabilitation where possible;
- annual monitoring of rehabilitation areas will be undertaken prior to, and following completion of rehabilitation; and
- if monitoring identifies that completion criteria are not being met, additional rehabilitation and monitoring will be completed until such criteria are met.

Completion criteria have been developed for revegetation associated with Stage 1 closure. These criteria will also be applicable to the closure requirements for the Project. Additional criteria will also need to be identified for some areas of disturbance. Additional information relating to rehabilitation and closure is included in Section 9.2.

9.1.4.4 FIRE

Fire management measures to be adopted include:

- all welding, cutting and grinding works undertaken require prior approval of an internal hot works permit;
- all site personnel will be required to undertake fire control training, including the correct use of extinguishers;
- all vehicles are required to carry a fire extinguisher and two-way radio; and
- emergency procedures.

In addition, CRL has an Emergency Response Team trained to respond to a bush fire.

9.1.5 PREDICTED OUTCOME

The Project will require clearing of approximately 7719 ha of vegetation over the life of the Project. CRL will progressively rehabilitate all areas not required for ongoing operations. Following mine closure, all areas cleared over the life of the mine, apart from the mine pit itself, will be rehabilitated. CRL will, as far as reasonably practicable, attempt to re-establish *Triodia* vegetation in areas of rehabilitation.

9.2 REHABILITATION AND MINE CLOSURE

9.2.1 EPA OBJECTIVE

The EPA's objective for decommissioning is:

- to ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.
- to ensure that self sustaining native vegetation communities are returned after mining, which in species composition and ecological function, are as close as possible to naturally occurring analogue sites.

9.2.2 RELEVANT LEGISLATION AND STANDARDS

The key standards and guidelines relevant to rehabilitation and closure include:

- EPA (2006) *Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems*;
- ANZMEC/MCA (2000) *Strategic Framework for Mine Closure*; and
- Chamber of Minerals and Energy WA Inc. (2000) *Mine Closure Guideline for Mineral Operations in Western Australia*.

9.2.3 POTENTIAL IMPACT

The Project will alter the landforms and ecosystems in the immediate area of mine disturbance. During mining, it will be necessary to ensure that the IWL is self-sustaining and representative of the Jack Hills ranges, and progressively rehabilitated to represent the ecosystems within the immediate area of the Jack Hills Range. Other aspects that determine the functionality and success of the final landform and landscape values upon closure include water management, tailings management, landform design, weed prevention and control, feral animal control, revegetation success, and erosion prevention. These aspects will be managed during the operation of the mine.

9.2.4 MANAGEMENT AND MONITORING

CRL's existing EMS consists of a series of work instructions that include, but is not limited to land clearing and topsoil stockpiling, dust control and monitoring, groundwater and surface water management and monitoring, rehabilitation procedure and monitoring, weed management and closure management. As part of the Project development, the work instructions will be reviewed.

9.2.4.1 REHABILITATION

Rehabilitation will be undertaken progressively where possible to minimise erosion. Progressive rehabilitation undertaken over the project area will be guided by the following principles:

- locate and design landforms to be rehabilitated to optimise blending with the surrounding topography;
- minimise soil erosion particularly on the batters of the waste rock stockpile;
- stockpile vegetative material and topsoil for later use;
- minimise length of stockpiling of vegetation and topsoil;
- rehabilitate completed areas as soon as practicable;
- seed and plant using stockpiled vegetative material and topsoil; and
- seed and plant material to be collected from local native plant species.

Propagation and restoration trials of the dominant species in the floristic communities of the PEC have been initiated for the Stage 1 mine, and will continue into the Project's operations. CRL will establish a research and propagation area at the mine site, consisting of shade house, tubestock storage area and seed storage and analysis facility. Designated topsoil stockpile locations will be identified on mine plans and signposted in the field.

Grazing has not impacted rehabilitation to-date, however, if feral animal populations increase, the success of rehabilitation may be hindered. The potential impact on rehabilitation from grazing pressures will be monitored and incorporated into rehabilitation procedures.

Key Performance Indicators (KPIs) and Completion Criteria have been developed specific to revegetation at the Jack Hills Stage 1 mine (G&G Environmental, 2009; Appendix A). Prior to disturbance, vegetation community structure was assessed at randomly selected quadrats within each representative vegetation type, to provide visual and quantitative completion criteria for the assessment of revegetation success. G&G Environmental (2009) established KPIs and Completion Criteria for five stages of rehabilitation: Planning, construction, initial performance, monitored performance and sustainability (Appendix A). This approach will also be implemented for the Project.

CRL also commissioned Landloch and G&G Environmental (2009) to develop a Rehabilitation Strategy for rehabilitation activities associated with the IWL (waste rock dump and encapsulated tailings) for the Project (Appendix A). The Rehabilitation Strategy establishes KPIs and Completion Criteria specific to the IWL, including landform shape, waste characterisation, stability and erosion and revegetation success.

Rehabilitated areas will be monitored to ensure the success of the rehabilitation programme and impacts from mining activities. Monitoring of rehabilitated sites will be undertaken annually until completion criteria have been met. The monitoring will assess the species diversity, plant density and community structure against agreed completion criteria, which include:

- species richness, species diversity and plant density of the restored community exceeds the median in the range of values established for baseline vegetation communities; and
- dominant species in the restored community are also dominant in the baseline vegetation communities.

9.2.4.2 CLOSURE

CRL has developed a Decommissioning and Closure Management Plan for the Project (Appendix A). The plan outlines general and area specific decommissioning and closure measures, completion criteria and post closure monitoring requirements for the Project. The Decommissioning and Closure Management Plan aims to ensure that:

- mining is planned and carried out so to ensure a sustainable mine closure outcome is achieved, consistent with mining industry best practice as set out in the Australia and New Zealand Minerals and Energy Council / Minerals Council of Australia, 2000, Strategic Framework for Mine Closure;
- self-sustaining native vegetation communities are returned after mining, which in species composition and ecological function are representative of naturally occurring analogue sites; and
- final mine pit lakes do not cause significant environmental impacts through:
  - » groundwater pollution;
  - » attracting wildlife, birds or stock which may be harmed by contact with contaminated water; or
  - » attracting increased numbers of grazing and predatory animals, which may consequently impact on the ecology of the surrounding area.

A post-closure monitoring programme will be initiated, with the aim of confirming that the rehabilitation and closure has been effective and the closure criteria satisfied. Post-closure monitoring will include assessments of public safety, geotechnical stability, physical stability, chemical stability and revegetation success.

A Final Decommissioning and Closure Plan will be developed at least two years prior to the anticipated date of decommissioning and closure, or at a time agreed with the EPA. The final plan will be developed in consultation with the EPA, DEC and DMP, to satisfy the Minister for the Environment.

9.2.5 PREDICTED OUTCOME

The Project area will be progressively rehabilitated to achieve a stable, functioning and integrated landscape. The success of rehabilitation will be monitored against established completion criteria and KPIs and additional rehabilitation undertaken until the criteria are met.

9.3 VERTEBRATE FAUNA

9.3.1 EPA OBJECTIVE

The EPA's objective for fauna is to maintain the abundance, diversity, geographic distribution and productivity of native fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

9.3.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to the assessment of impacts on vertebrate fauna include:

- *Environmental Protection and Biodiversity Conservation Act (1999);*
- *Wildlife Conservation Act (1950);*

- EPA (2002) *Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection*;
- EPA (2008) *Guidance Statement No. 33 Environmental Guidance for Planning and Development*; and
- EPA (2004) *Guidance Statement No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in WA*.

9.3.3 POTENTIAL IMPACT

As described in Section 9.1, the Project will require clearing of 7719 ha of vegetation, which may result in the loss or fragmentation of fauna habitat, increased risk of fire or loss of habitat due to the introduction or spread of weeds. Other potential impacts to fauna associated with the Project include:

- increased mortality of fauna from vehicle strikes;
- increased movement of feral fauna in the area resulting in increased predation and competition pressure; and
- disruption to resident fauna due to increased noise, light and dust pollution (Ecologia, 2009c).

Although disturbance will occur on a local scale and may impact on individual animals, it is considered unlikely that the Project will have any significant impacts on fauna populations. Habitat fragmentation resulting from clearing may disrupt fauna movements within the local area, and potentially prevent the natural movements of locally occurring species. Habitats along the Jack Hills to DBNGP and Jack Hills to Weld Range services corridors are not specific to the Project area, and are well represented in surrounding areas.

9.3.3.1 MINE AREA

Two conservation significant species were recorded during baseline surveys of the mine area, the Long-tailed Dunnart and Rainbow Bee-eater.

Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 3

This species was trapped at four of the six trapping sites within the Project mine area. The preferred habitat of the Long-tailed Dunnart is rugged rocky areas with open woodland or shrubland over a grassy understorey (Ecologia, 2009b). The disturbance area associated with the mine is likely to represent a small proportion of the total available habitat for this species (Ecologia, 2009b). Displaced animals are expected to disburse into surrounding habitats.

Rainbow Bee-eater (*Merops ornatus*) – EPBC Migratory

Two Rainbow Bee-eaters were recorded by Ecologia (2009b) flying overhead near a drainage line within the mine area, during baseline surveys. Impacts of the Project on Rainbow Bee-eaters are not expected to be significant as suitable habitat is widely available in adjacent areas (Ecologia, 2009b).

A summary of potential impacts to other significant species considered likely to occur within the mine area is included below.

Peregrine Falcon (*Falco peregrinus*) – Schedule 4

This species has previously been recorded in the Jack Hills area. The Project area is likely to support some suitable breeding habitat for the Peregrine Falcon. However it is not known whether or not the Peregrine Falcon breeds in the Project area (Ecologia, 2009b). The Project will impact on a relatively small area of available suitable habitat within the Jack Hills and hence impacts to this species at a local or regional scale are not expected to be significant (Ecologia, 2009b).

Bush Stone-curlew (*Burhinus grallarius*) – DEC Priority 4

Bush Stone-curlews have previously been recorded within the Project area. They are unlikely to be present along the ridgeline where mining is proposed. Some impact to individual birds is possible during clearing, which may result in the destruction of nests. Adult birds are expected to relocate to adjacent areas, which support extensive areas of suitable habitat (Ecologia, 2009b).

Australian Bustard (*Ardeotis australis*) – DEC Priority 4

This nomadic species occurs Australia-wide and utilises a number of open habitats. The Australian Bustard has been recorded on Mileura Station, approximately 30 km south of the Project area and may occur on lower slopes and flatter parts of the Project area (Ecologia, 2009b). Given its highly nomadic lifestyle and extensive suitable habitat in surrounding areas, the Project is not expected to have a significant impact on this species.

Ghost Bat (*Macroderma gigas*) – DEC Priority 4

The ghost bat is a potential transient species that may utilise Jack Hills Range for feeding. There are no deep caves or mine adits within the Project area which would be suitable for roosting locations for this species. Therefore the impacts would be minimal if they do use the area for foraging.

Fork-tailed Swift (*Apus pacificus*) – EPBC Migratory, Marine

This small insectivorous species is nomadic and may at times fly over the Project area. However, as this species is almost entirely aerial, they are unlikely to be significantly impacted by the Project activities.

9.3.3.2 JACK HILLS TO DBNGP SERVICES CORRIDOR

One conservation significant species, the Nankeen Kestrel (*Falco cenchroides*) was recorded at the western extremity of the pipeline route during baseline vertebrate fauna surveys. This species is listed as marine under the EPBC Act, however is not considered to be under threat by the DEC and is not listed under the *Wildlife Protection Act 1950*. Potential impacts on other significant species which may occur along the corridor are discussed below:

Australian Bustard (*Ardeotis australis*) – Priority 4

The gas pipeline corridor is not considered to contain significant habitat for this species, hence impacts associated with the construction and operation of the gas pipeline are unlikely to have a significant impact on this species (GHD, 2009a).

Southern Crested Bellbird (*Oreoica gutturalis* subsp. *Gutturalis*) – Priority 4

The gas pipeline corridor is located within the northern extent of the known range of this species. Vegetation within the corridor may potentially support this species, however individuals are expected to move to adjacent areas if disturbed (GHD, 2009a).

Major Mitchell's Cockatoo (*Cacatua leadbeateri*) – Schedule 4

The Major Mitchell's Cockatoo may use the gas pipeline corridor as opportunistic feeding areas. There is very little fresh water available along the pipeline corridor, with the exception of the crossing of the Murchison River. Large *Eucalyptus victrix* in the vicinity of the river pool may contain nesting hollows that could support this species (GHD, 2009a).

EPBC Listed Marine and Migratory Bird Species

Given the linear nature of the proposed gas pipeline, impacts associated with the construction and operation of this infrastructure are not expected to have a significant impact on any marine or migratory bird species (GHD, 2009a).

9.3.3.3 JACK HILLS TO WELD RANGE SERVICES CORRIDOR

No conservation significant species were observed during the field assessments. Potential impacts on other significant species which may occur along the corridor are discussed below:

Australian Bustard (*Ardeotis australis*) – Priority 4

The services corridor does not contain significant habitat for the Australian Bustard, hence impacts associated with the construction and operation of the services corridor are unlikely to have a significant impact on this species (GHD, 2009b).

Southern Crested Bellbird (*Oreoica gutturalis* subsp. *gutturalis*) – Priority 4

The proposed services corridor is located within the northern extent of the known range of this species. Vegetation within the corridor may potentially support this species, however individuals are expected to move to adjacent areas if disturbed (GHD, 2009b).

EPBC Listed Marine and Migratory Bird Species

A number of species of migratory and marine birds protected under the EPBC Act may potentially occur along the services corridor. However, many of these species have large home ranges and are unlikely to utilise the Project area exclusively. The services corridor does not contain significant habitat for migratory species, hence potential impacts are considered to be negligible (GHD, 2009b).

9.3.4 MANAGEMENT AND MONITORING

In addition to the vegetation management strategies outlined in Section 9.1.4, CRL will implement the following management measures to minimise or mitigate any impacts to fauna associated with the Project:

- clearing will be planned to retain fauna habitat corridors wherever possible;
- areas not required for ongoing operations will be rehabilitated as soon as practicable;
- cleared vegetation and logs will be placed within adjacent vegetated areas, as these provide fauna refuge;
- clearing of *Triodia* vegetation communities and large eucalypts will be minimised wherever possible;
- vehicle speeds will be reduced at dawn and dusk. Any road kill will be removed from close proximity to roads and tracks;
- the feral animal control program developed in consultation with the DEC for the Stage 1 Jack Hills mine will continue to be implemented;
- feral animal sightings will be recorded and monitored;
- all open drill holes will be capped each day before nightfall;
- trenches will remain open for a maximum of 21 days, excluding bell holes;
- all open trenches will have an exit point for fauna and will be monitored twice daily to ensure the safe removal of fauna;
- no domestic pets shall be allowed on site;
- all wastes will be disposed of in containers with secure lids and seals; and
- site personnel will be familiarised with potential species of conservation significance and any sightings shall be recorded.

9.3.5 PREDICTED OUTCOME

The proposed expansion project will result in the loss of 7719 ha of potential fauna habitat over the life of the mine. The anticipated likely impacts to populations of significant species observed or potentially occurring in the area on a local and regional scale are summarised below.

9.3.5.1 SIGNIFICANT SPECIES KNOWN TO OCCUR IN THE AREA

Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 3

This species is found in the rocky areas of the Jack Hills Range, with the proposed impact area being approximately 10% of the locally available Long-tailed Dunnarts habitat. Of the suitable habitat for this species in the local area, 90% is predicted to be unchanged and although individuals may be displaced, the proposed disturbance is not considered likely to impact on the population of this species within the Jack Hills Range.

Regionally the Long-tailed Dunnart has a large but scattered distribution. Many populations are protected in conservation land in Western Australia and the Northern Territory (IUCN 2009, Strahan 2008). Therefore regionally the proposed expansion project is not expected to impact on the species.

Rainbow bee-eater (*Merops ornatus*) – EPBC Migratory

This species visits the local area seasonally during the spring and summer months, moving to the south areas within there range to breed. Much of the region is rocky and not suitable for the species to breed, however opportunistic breeding events may occur. The species is very mobile and likely to move outside of the impact area when disturbed. Therefore the species is not likely to be impacted on a local level.

Regionally the Rainbow bee-eater has a large distribution. Combined with its migratory nature and ability to avoid the impact area, this species is not considered likely to be affected on a regional level.

Nankeen Kestrel (*Falco cenchroides*) EPBC Marine

This species is known to exist in the local area. Kestrels' utilise a wide range of habitats, from grasslands to coastal sand dunes including rocky areas. Based on the amount of available habitat in the region and the ability of this species to move away from the disturbance area, impacts to the Nankeen Kestrel at a local scale are expected to be negligible.

This species has a large distribution, across most of Australia. The proposed Jack Hill Expansion Project is not expected to impact this species on a regional level.

9.3.5.2 SIGNIFICANT SPECIES POTENTIALLY OCCURRING IN THE AREA

Peregrine Falcon (*Falco peregrinus*) – Schedule 4

The Peregrine Falcon has previously been recorded in the area. The species breeds on cliffs and utilises surrounding habitats as foraging areas. Within the project area there are no cliffs suitable for the species to breed. There are however, potential breeding areas outside of the impact area. As this species is able to move away from the disturbance area and no potential breeding sites will be impacted, no impacts on the Peregrine Falcon are expected at a local scale.

Regionally this species has a large distribution with large areas of habitat suitable for breeding and foraging in the surrounding environment. The Peregrine Falcon is not expected to be impacted on a regional scale as a result of the Project.

Bush Stone-curlew (*Burhinus grallarius*) – Priority 4

The Bush Stone-curlew has previously been recorded in the area. The species is regarded as nomadic, utilising areas suitable at optimal times for feeding and breeding. The species are not expected to use the rocky areas of the range, however, may opportunistically use the surrounding flats. Bush Stone-curlew are present in the area are expected to move away from disturbance areas. Given the vast amount of land available in surrounding areas, this species is not likely to be impacted on a local level.

The Bush Stone-curlew has a large distribution, and there are large areas of suitable breeding and foraging habitat in the surrounding environment.

Australian Bustard (*Ardeotis australis*) – Priority 4

Australian Bustard potentially occur in the region. The Australian Bustard is a nomadic species that move into areas when conditions are favourable. Vast areas of suitable habitat are available in surrounding areas; hence impacts to this species on a local level are expected to be negligible.

Regionally, the Australian Bustard has a large distribution and is highly nomadic and capable of moving away from the disturbance. The species is not predicted to be impacted on a regional scale.

Fork-tailed Swift (*Apus pacificus*) – EPBC Migratory, Marine

The Fork-tailed Swift potentially occurs in the region; however this species is a migratory visitor to Australia and very rarely perches, being almost entirely aerial. No breeding occurs in Australia and the species is able to move outside of the impacted area. This species is therefore not expected to be impacted locally or regionally.

Crested Bellbird (southern) (*Oreoica gutturalis* subs. *gutturalis*) – Priority 4

The Crested Bellbird has not been observed in the area and it is considered to be outside of its known distribution. If present in the area, this species would be expected to move away from any disturbance and is not likely to be impacted at a local or regional scale.

Major Mitchell's Cockatoo (*Lophochroa leadbeateri*) – Schedule 4

Historically the Major Mitchell has been recorded in the Jack Hills region. It is considered unlikely that the species would use the range area, however it may potentially utilise the flats for feeding and breeding. A small amount of breeding habitat persists along the Murchison River and may be used opportunistically by the species. There are large amounts of habitat remaining in the surrounding environment and therefore the species is considered unlikely to be affected locally or regionally.

9.4 INVERTEBRATE FAUNA

9.4.1 EPA OBJECTIVE

The EPA's objective for fauna is to maintain the abundance, diversity, geographic distribution and productivity of native fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

9.4.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to the assessment of impacts on invertebrate fauna include:

- *Wildlife Conservation Act 1950*;
- EPA (2002) Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection;
- EPA (2003) Guidance Statement No. 54. Consideration of Subterranean Fauna in Groundwater and Caves During EIA in WA;

- EPA (2008) Guidance Statement No. 33 Environmental Guidance for Planning and Development; and
- EPA (2004) Guidance Statement No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in WA.

9.4.3 POTENTIAL IMPACT

Short Range Endemic Fauna

Short Range Endemic (SRE) fauna surveys identified three species within the Project area. These are the Shield-back Trapdoor Spider (*Idiosoma nigrum*), *Cethegus* sp., and *Eucyrtops* sp. The *Cethegus* sp. is widespread and abundant in the Jack Hills range and adjacent floodplains are not expected to be significantly impacted by the Project. The *Eucyrtops* sp. represents a range extension of an undescribed species from the Carnarvon Basin and therefore the species is more widespread than the Jack Hills Range and is not expected to be significantly impacted by the Project.

Targeted surveys for *I. nigrum* within the broader Jack Hills range indicate that the Project is likely to directly impact on 3899 burrows (18.57%), of the total local population identified to date. Cumulative impacts of the Project on this species are expected to be minimal, as resource development project in the Murchison region are impacting upon less than 15% of local *I. nigrum* populations.

Potential indirect threats to *I. nigrum* include:

- Changes to surface hydrology: The alteration of existing hydrological flow regimes may result in the inundation or destruction of *I. nigrum* burrows, particularly those located on the upper edges of creek banks.
- Grazing: Grazing by feral animals results in the trampling and destruction of burrows and removal of leaf litter and vegetation which provide shade cover.
- Fire: Fire has the potential to impact on *I. nigrum* through the loss of shade cover and direct destruction of trapdoors and burrows.
- Unauthorised clearing: Burrows range from approximately 5 - 50 cm in depth and are typically built in family clusters around the adult female matriarch. Clearing outside of approved areas, particularly in high risk areas, may result in direct impacts to *I. nigrum.*
- Weeds: The establishment of weeds in the vicinity of *I. nigrum* burrows may potentially be detrimental to spider populations.
- Vibration: There is some evidence to suggest that vibrations may cause disturbance to burrow dwelling spiders. CRL commissioned Phoenix Environmental Science (Phoenix) to undertake a research program to determine the effects of vibrations at the Jack Hills site on *I. nigrum.* Further detail on the methodology and results of this research program are discussed in Section 9.12.

Subterranean Fauna

Direct impacts are the obvious and unavoidable removal of habitat that occurs within pit voids and adjacent terrain, including any associated aquifer dewatering. Indirect impacts, however, are generally gradational, and therefore more difficult to predict and manage because they may occur at moderate to large distances from the project footprint, or are only expressed some time after mining has been undertaken. Some examples include changes to hydrology, nutrient and microclimate regimes, contamination, reduced habitat area, quality, and population viability. The zone of influence for indirect impacts may be considerably larger than the area of the mine pit and surface footprint (waste rock, stockpiles, roads and infrastructure). Potential indirect impacts of mining include:

- alteration of surface hydrology that affects groundwater recharge regimes, sedimentation, and water quality (e.g. under and proximal to overburden storage areas, roads and infrastructure);
- changes to subterranean microclimate in rock masses surrounding excavation pits (exposure to atmosphere of subsurface matrix and voids causing drying);
- changes to subterranean microclimate in the zone of influence of pit dewatering drawdown (drying of habitat);

- surface and groundwater contamination from plant equipment and infrastructure;
- reduction in organic inputs beneath areas cleared of vegetation and sealed surfaces;
- vibration disturbance from mining activities; and
- reduced area of retained habitat which may fragment habitat and populations, and influence viable population sizes and increase risk of extinction through environmental changes over evolutionary time frames.

Baseline stygofauna surveys recorded a single species of Chiltoniid amphipod, which represents a new genus and new species (R. King South Australian Museum pers. comm. 2009). The regional survey for stygofauna at Jack Hills indicates that stygofauna are absent from the fractured rock aquifer within the main Jack Hills range and Brindal deposit.

The known distribution of the Chiltoniid amphipod recorded from the Murchison Palaeochannel / calcrete aquifer falls outside the predicted drawdown area for the Project (Figure 9-1). Drawdown depths will ensure no significant impact on known stygofauna communities will occur as a result of Project activities.

The current troglofauna surveys (GHD 2009f, 2010) have shown several species possess wider distributions in the local area than previously indicated. This includes the cixiid planthopper that has been recorded from Stewart Bore area and is likely to be the same as the specimens collected from the Project area by Ecologia (2009f). A species of polyxenid millipede has also been collected from both Noonie Hills in the south and Stewart Bore in the north of the range. These distributions indicate that the subterranean fauna community in the Jack Hills Range likely forms a single, albeit low, abundance community, encompassing multiple lithologies. It is highly likely that additional surveys within the Jack Hills Range will show that troglofauna are evenly distributed throughout its length, but due to the inherent low abundance and capture rates of troglofauna (Biota 2006) extensive repeated surveying in a small area is required before all members of a community are shown to occur widely.

The presence of the troglomorphic pseudoscorpion *Tyrannochthonius*sp. *nov*. from the Stewart Bore deposit infers that the available habitat for obligate subterranean species is greater than the areas included in the Project area. Stewart Bore is located approximately 20 km to the east of the Project area. The increased distribution of the *Tyranno chthonius* pseudoscorpion shows that habitat linkages are likely to occur between areas that are covered by alluvium and/or colluvium. It is also possible that obligate subterranean species may use alluvium / colluvium as a pathway to move between areas of suitable deeper habitat (Culver and Pipan 2009).

9.4.4 MANAGEMENT AND MONITORING

Short Range Endemic Fauna

The following management actions will be implemented to minimise impacts on SRE species:

- clearing will be minimised as far as practicable and areas not required for on-going operations (including areas cleared for exploration drilling) will be progressively rehabilitated (as per the management actions described in Section 9.2);
- areas likely to contain SRE species such as drainage lines, south facing slopes and other areas with high moisture retention will be surveyed for SRE's prior to any disturbance;
- dust suppression measures will be implemented as per Section 9.10;
- fire prevention actions that will be implemented during construction and operational phases of the Project;
- all personnel and contractors will be made aware of the presence of SRE species within the Project area, and requirements to remain on designated access roads and minimise disturbance;
- areas of *I. nigrum* burrows, which can be avoided, will be excluded from clearing; and
- CRL will continue to implement a long term monitoring program to determine any impacts of vibration on the spider populations in the immediate vicinity of mining.

Subterranean Fauna

The following management actions will be implemented to minimise impacts on subterranean fauna species:

- implementation of hydrocarbon and chemical management procedures and spill response procedures;
- operation of groundwater abstraction bores in accordance with the Department of Water approved operating strategy and license conditions;
- when the depth of any drawdown cone is known, additional regional sampling for stygofauna will be conducted if required; and
- on-going regional stygofauna sampling is underway.

Regional stygofauna sampling within the Murchison calcrete aquifers is underway and will be ongoing until early 2011.

9.4.5 PREDICTED OUTCOME

The Project is expected to impact on 18.57% of the local population of *I. nigrum* identified during baseline targeted surveys. This impact is likely to be less as only areas adjacent to the Project footprint have been searched for the *I. nigrum* burrows. Cumulative impacts of the Project on this species are expected to be minimal, as other resource development projects in the Murchison region are impacting upon less than 15% of local *I. nigrum* populations. Additional populations have been discovered on DEC managed pastoral leases, namely Lakeside and Dalgaranga Stations (Brad Durrant, DEC pers. comm.). The Project is not expected to have a significant impact upon the population of *I. nigrum* at Jack Hills, or upon the species as a whole throughout its range (GHD, 2009e; Appendix F).

Several troglomorphic taxa have been recorded only from the Project area and Brindal deposit. These taxa are likely to be more widely distributed throughout the Jack Hills Range as diamond core photo examination has revealed extensive areas of subterranean voids at varying depths, and no obvious obstructions to troglofauna dispersal exist along the range (e.g. major faults or discontinuity of geological units).

Subterranean fauna sampling conducted within adjacent tenements supports the assertion that many of the detected troglomorphic taxa have regional distributions (Hemiptera: Cixiidae, Pseudoscorpionida: Chthoniidae). The inherent low abundance and hence capture rate of troglomorphic taxa makes it difficult to adequately demonstrate the full distribution of some taxa.

The regional survey for stygofauna at Jack Hills indicates that stygofauna are absent from the fractured rock aquifer present within the Project Area. The chiltoniid amphipod recorded from the Murchison Palaeochannel aquifer represents a new species. The known distribution of this species falls outside the predicted drawdown area for the Project pit (Aquaterra, 2010; Appendix B). Additional surveys for stygofauna will be undertaken if drawdown from either pit dewatering or Borefield abstraction is likely to have a significant impact upon known stygofauna communities (GHD, 2009g; Appendix F). The potential impacts, monitoring and proposed management strategies should impacts be detected are further detailed in Section 9.6.

9.5 SURFACE WATER

9.5.1 EPA OBJECTIVES

The EPA's objectives for water management are:

- To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that the quality of water emissions (surface, ground and marine) does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.

9.5.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to the assessment of impacts on surface water include:

- ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- EPA (2004) Position Statement No. 5 Environmental Protection and Ecological Sustainability of the Rangelands in WA; and
- EPA (2008) Guidance Statement No. 33 Environmental Guidance for Planning and Development.

9.5.3 POTENTIAL IMPACTS

The proposed mining operations pose the following potential impacts relating to surface water quantity and quality:

- erosion and deposition of sediments;
- increased turbidity of runoff water as a result of construction and mining activities;
- contamination of runoff water with fuels, oils, AMD or other chemicals; and
- mine, plant and drainage infrastructure may impact on the volumes and quality of local runoff discharges to a small degree and will have some effect on drainage lines in the immediate area of the pit, plant and associated infrastructure.

9.5.3.1 MINE AREA

A Preliminary Surface Water Assessment identified the potential for regional flooding impacts on the proposed IWL during 20, 50 and 100 year ARI flood events (Golder Associates, 2009b; Appendix B). A small area of the northern portion of the proposed airstrip may also be impacted by 50 and 100 year ARI events (Golder Associates, 2009b). However, flood velocities are expected to be relatively low and therefore excessive erosion is not anticipated. The Project has the potential to alter surface water flows, thereby causing shadow effects, and changing erosion, sedimentation and scouring patterns (Golder Associates, 2009b).

Clearing and construction activities associated with the services corridor and gas pipeline may result in short-term, temporary impacts to water quality, namely an increase in sediment laden run-off entering drainage lines and/or creeklines.

9.5.3.2 JACK HILLS TO DBNGP SERVICES CORRIDOR

Clearing and construction activities associated with the services corridor may result in short-term, temporary impacts to water quality, namely an increase in sediment laden run-off entering drainage lines and/or creeklines.

The proposed gas and water pipelines will cross the Murchison River approximately 1.5 km from the Kalamunda Pool picnic area. Vegetation at the crossing location is degraded as a result of grazing. It is anticipated that the pipeline will be installed by directional drilling to minimise the potential for erosion. Preliminary analysis suggests that slopes causing sheet flow across the pipeline are not long or steep enough to generate high enough runoff volumes associated with sheet erosion. The construction and operation of the gas and water pipelines are

therefore not considered likely to have any significant impacts on surface water flows within the Murchison River. Potential impacts on surface water quality are anticipated to be minor and likely to be limited to a minor, short-term increase in turbidity during the construction phase.

9.5.3.3 JACK HILLS TO WELD RANGE SERVICES CORRIDOR

Vegetation in the vicinity of the proposed services corridor includes Mulga communities. The Mulga root system is adapted for taking up water from thin surface soils and has adaptations that concentrate soil water near the plant and conserve water within the plant. The distribution and abundance of Mulga is therefore influenced by soil moisture and surface drainage patterns (Paczkowska and Chapman, 2000). Disruption to natural or existing surface water flows has the potential to result in detrimental impacts to downstream Mulga communities.

Clearing and construction activities associated with the services corridor may result in short-term, temporary impacts to water quality, namely an increase in sediment laden run-off entering drainage lines and/or creeklines.

The service corridor will be constructed at the natural ground RL and cambered to a grade of 3% (MRWA, 2006). The implementation of this specification will ensure the impact on local or regional drainage patterns crossing the roads surface is likely to be minimal (Golder Associates, 2010).

9.5.4 MANAGEMENT AND MONITORING

Impacts on surface water quality will be minimised by constructing bunds around mine infrastructure areas which have the potential to contaminate surface water flows with fuels, oils, sediment or other contaminants. Containment bunding, silt and oil traps will be established where necessary to remove sediments or pollutants from runoff before water enters local drainage. Any spills of contaminants, such as oil or fuel, which occur outside of bunded areas will be cleaned up immediately where a risk of surface water contamination occurs.

Surface water management structures will be designed and constructed to minimise erosion and maintain drainage flows. Diversion drains will be constructed to ensure water re-enters natural drainage lines at a velocity and depth that can be accommodated by the natural stream line without increased scouring.

Surface water management structures will include:

- engineering culverts where natural watercourses intersect proposed infrastructure, designed to 1:10 year ARI events;
- environmental culverts will be installed approximately every 500 m along access roads in areas deemed sensitive to sheet flow;
- scour protection, such as rip rap, in areas prone to erosion (e.g. downstream of culverts) and areas requiring flood protection;
- engineering channels to divert natural drainage around proposed facilities to prevent potential inundation;
- sediment ponds to entrain sediment from potentially sediment-laden runoff from the IWL.;
- the services corridors shall avoid localised depressions and cross watercourses where the banks have a flatter grade (except the Murchison River where direct drilling will be employed to ensure the crossing occurs under the River);
- the corridors shall follow existing contours where possible and avoid steep slopes with dense vegetation;
- where possible, the gas and water pipeline watercourse crossings should be undertaken in the summer months;
- if required, stabilisation methods will be installed along the gas and water pipeline. This may include:
  - » installation of diversion structures, such as erosion banks, to slow overland flow and dissipate surface water flow; and
  - » surface roughening techniques to reduce the effective slope length.

Road and track drainage systems on the Jack Hills Range will be maintained to ensure runoff from roads does

not cause erosion or sedimentation. Roads and other linear infrastructure in areas where susceptible vegetation occurs (e.g. low land Mulga groves) will be constructed such that sheet flow drainage is maintained.

Regular visual monitoring of diversion channels and downstream drainage lines, and the condition of vegetation in the diversion channels will be undertaken. Should substantial erosion occur, the cause of the erosion will be identified, erosion/deposition areas rehabilitated as appropriate, and measures implemented to prevent further erosion.

During periods of heavy rainfall, the open pit will be closed to ensure the safety of workers and to prevent damage to pit ramps and roads. Local flooding issues will be addressed through engineering control structures such as culverts, diversion channels and sediment ponds, designed to minimise environmental impacts and flooding.

The processing plant pad and its key infrastructure will be located above the 100 year flood level, using selected fill obtained from the mine pre-stripping activities. The processing plant will have a system of water drains to collect excess water and direct it to the raw water pond for further use. The raw water pond will be constructed from compacted mine waste, graded *in situ* and lined with HDPE to provide impermeable containment.

The inner slopes of the IWL embankments will be constructed with an average upstream (inner) slope of two horizontal: one vertical. Benches will be formed at 20m vertical increments on the inner slopes to assist in the control of tailings deposition. A vertical crushed rock filter zone will be constructed within the embankments to contain the fine tailings within the waste rock embankments.

The IWL has been designed to maintain a minimum distance of one kilometre between the Murchison River and the downstream toe of the embankment. The purpose of this offset is to minimise the obstruction of flow from the Murchison River following significant rainfall events. Flood hydrology studies have been undertaken to determine any potential impacts of the IWL on surface water flows for the Murchison River. These studies have determined that an offset distance of one kilometre from the Murchison River can be accommodated without significant impacts to the surface water flows.

The proposed IWL cells will encroach into the floodplain of the Murchison River. The IWL will be armoured to resist erosion from flood events and surface water flows resulting from rainfall events up to the Probable Maximum Precipitation. The surface cover, drainage lines and downstream toe of the embankments will be constructed from erosion-resistant hard rock waste. Embankment erosion will also be controlled by the formation of a concave downstream (outer) embankment profile. Both the ultimate height of the IWL and the slope angles are designed to reflect the surrounding ranges. In areas that may be exposed to frequent water action, oversize material (boulders >0.6m) will be used as rip-rap to armour the IWL. Drainage structures will be constructed within the cell walls to handle runoff from a 100 year rainfall event.

Surface water drains will be constructed around the perimeter of the IWL to assist in drainage and direct surface water flows around the facility. The drains will be designed to accommodate routine surface water flows up to the 2-year Average Return Interval (**ARI**) rainfall event. After larger rainfall events, it is envisaged that the drains will overtop and excess water will be accommodated as sheet flow around the IWL.

Rainfall, within the IWL cell, will runoff to decantation ponds and will be used in the processing circuit. Water which falls within the open pit will be pumped out to decantation ponds by a system of movable pipes and pumps and returned to the raw water pond to be reused in the processing circuit. There will be enough capacity in the tailing dam decantation ponds to retain all excess water. Discharge of excess water to the Murchison River or surrounding environment is not envisaged.

9.5.5 PREDICTED OUTCOME

The IWL has been designed to minimise any potential impacts on the Murchison River during flood events and will be armoured to prevent erosion. Bunding and drainage structures will be designed to manage runoff from sources of potential contamination or sedimentation, and to minimise scour and erosion. There will be no

discharge of water to the Murchison River or surrounding environment without prior approval.

Installation of the proposed gas pipeline along the Jack Hills to DBNGP services corridor may result in some minor, short-term impacts on surface water quality, namely associated with potential increased turbidity. These impacts will be temporary during the construction phase only and are not expected to have any significant impacts on surface water quality in the region.

Similarly, construction activities associated with the Jack Hills to Weld Range Services Corridor may result in some temporary impacts on surface water quality. This services corridor may support power lines and water supply and would include an unsealed access track. Infrastructure along the corridor will be designed to minimise impacts on surface water flows, including sheetflow, so as to reduce potential impacts on mulga vegetation.

9.6 GROUNDWATER

9.6.1 EPA OBJECTIVES

The EPA's objectives for water management are:

- To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that the quality of water emissions (surface, ground and marine) does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.

9.6.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to the assessment of impacts on groundwater include:

- *Rights in Water and Irrigation Act (1914)*;
- ARMCANZ/ANZECC (1995) *National Water Quality Management Strategy, Guidelines for Groundwater Protection*; and
- Government of Western Australia (2003) *State Water Quality Management Strategy, Implementation Plan: Status Report.*

9.6.3 POTENTIAL IMPACTS

There are two potential sources of water table drawdown impacts related to the Project: Firstly, from pit dewatering that will occur over part of the life of the mine; and secondly, from the operation of the production borefield to supply process and potable water to the Project. These have the potential to impact upon local environmental receptors, including:

- water supply to pastoral wells and bores; and
- groundwater dependent ecosystems (**GDE**) of the Murchison Palaeochannel valley and associated drainage lines which support:
  - » groundwater dependent vegetation; and
  - » calcrete aquifers containing an endemic stygofauna species.

The flowchart and discussion below provide a summary of potential impacts, their mitigation measures, monitoring and corrective actions.

9.6.3.1 PIT DEWATERING

Pit dewatering will result in the development of a cone of depression in the water level in a localised area. As detailed in Section 8.3.2, the Archaen greenstone belt formation and surrounding Archaen granitic rocks and gneisses are expected to form aquifers. Aquaterra (2010; Appendix B) completed groundwater analysis, and the theoretical, maximum distances of water level drawdown away from the edge of the mine pit for the greenstone and granite/gneiss aquifers are presented in Table 9.3.

Groundwater in the surrounding formations will drain towards the pit when the pit base drops below the 380 to 400 mAHD water level mark. Assessment of the above assumptions against the current mining proposal indicated the following:

- Year 0 to 8 of operation: very limited groundwater inflow from discrete fracture sets.
- Year 8 to 12 of operation: dewatering of fractured rock aquifer within the ore body, resulting in an increase in dewatering volumes.
- Year 12 to 33 of operation: continuous dewatering of the ore body and inflow from surrounding aquifers.

Groundwater studies indicate that peak groundwater flows will reach 125L/s when the pit reaches a depth of 50 to 100m below the surrounding plain (Aquaterra, 2010; Appendix B). Pit inflows during the first ten years of operation will be small, totalling less than 5L/s from a localised, shallow perched watertable aquifer. After ten years of operation the northern end of the mine will be advanced below the regional water level with increasing inflows predicted to peak at 125L/s after 15 years. As the groundwater levels in the vicinity of the mine fall to below the base of the pit the rates of inflow to the pit will drop to around 90-110L/s through to the end of the mine life.

Note: When considering the results of the modelling, these drawdown calculations presume homogenous aquifer condition and no not consider aquifer boundaries which will exist in nearly every hydrogeological system. Therefore these calculations provide a conservative upper estimate.

TABLE 9.3 THEORETICAL MAXIMUM DISTANCES OF WATER LEVEL DRAWDOWN AROUND THE MINE AT VARYING STATE OF THE OPERATION

Year of Operation	Base of pit in Section 3	Estimated extent of drawdown along the greenstone below aquifer (m)	Estimated extent of drawdown along the granitic rocks and gneisses (m)
5	530	0	0
10	400	0	0
15	290	2550	1150
20	220	3800	1700
25	180	4750	2100
30	160	5500	2450
33	160	5950	2650

The cone of depression is expected to form an elongated shape, with its large extent along the strike direction of the greenstone belt units, due to the structural controls on the permeability of regional aquifers.

Figure 9-1 shows the theoretical cone of depression.

The extent of the cone of depression within the greenstone belt aquifer and granitic rocks and gneisses at different stages of mining is provided in Table 9.4. This is further detailed in Aquaterra (2010) (Appendix B).

TABLE 9.4 THEORETICAL DEPTH OF DRAWDOWN

Fractured Greenstone Belt Aquifer														
Distance from the edge of pit (m)	0	10	25	50	100	250	500	1000	2000	3000	4000	5000	5900	Year of Operation
Drawdown (m)	100	46	36	29	23	16	11	6	2	0	0	0	0	15
	170	80	64	53	43	31	22	14	7	2	0	0	0	20
	210	100	80	67	55	40	30	20	11	6	2	0	0	25
	230	111	89	75	62	46	35	24	14	8	4	1	0	30
	230	112	90	76	63	47	35	25	15	9	5	2	0	33
Fractured Granite Rocks and Gneisses Aquifer														
Distance from the edge of pit (m)	0	10	25	50	100	250	500	1000	1500	2000	2500			Year of operation
Drawdown (m)	100	43	32	25	19	11	6	1	0	0	0			15
	170	75	58	47	36	24	15	6	1	0	0			20
	210	95	74	60	47	32	21	11	5	1	0			25
	230	105	82	67	53	37	25	14	7	3	0			30
	230	106	83	68	54	38	26	15	8	4	1			33

With regards to pit dewatering during the life of the project, the following assumptions have been made:

- The size of the drawdown cone from pit dewatering is estimated to extend up to 3.5 km laterally from strike at the centre of the mine and approximately 1.5 km laterally at the northern extremity of the depression cone (Figure 2-3, Aquaterra, 2010; Appendix B).
- The drawdown cone is steeply angled towards the centre of the pit, and no widespread geographic drawdown of the regional watertable is expected based upon preliminary modelling by Aquaterra (Figure 2-3, Aquaterra 2010; Appendix B).
- The exact nature of the hydrogeological boundary between the Mt Taylor Fractured rock aquifer and the Murchison Palaeochannel aquifer is unknown at this stage. If these aquifers show a hydrogeological connection there is potential to cause the drawdown depression to expand westwards into the Murchison Palaeochannel. However, this can be managed to ensure there are no significant impacts to GDEs, as detailed in Section 9.6.4.1.

Pit dewatering will result in groundwater drawdown, which may have detrimental effects on subterranean fauna, other groundwater users and the palaeochannel aquifer coinciding with the Murchison River (Aquaterra, 2010; Appendix B).

With the exception of groundwater bores operated by CRL, there are no other production bores within the theoretical cone of depression. Therefore, no detrimental impacts to other groundwater users are expected (Aquaterra, 2010).

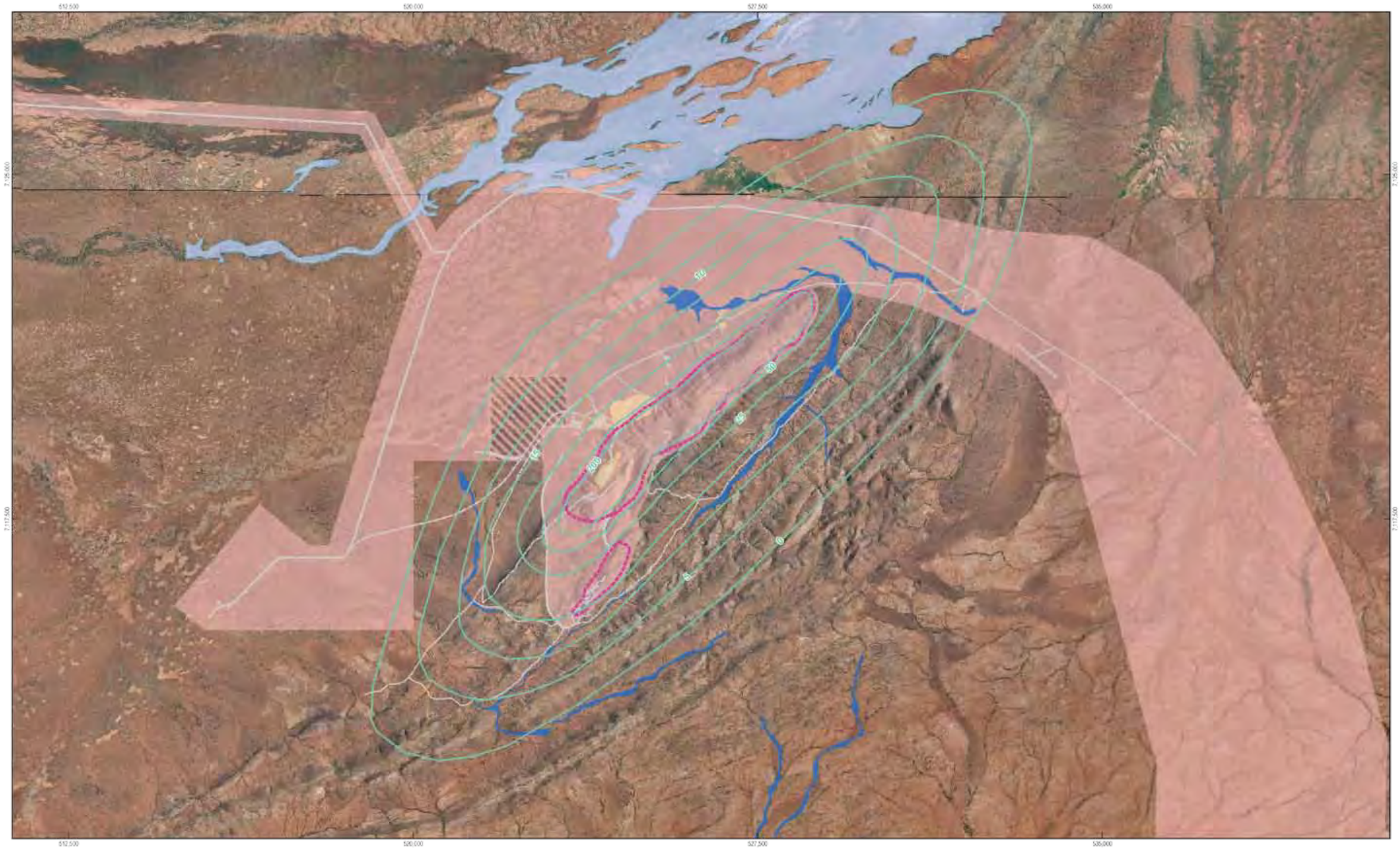
Piezometric pressure in the pit walls will be measured as part of the on-going mining operation and the drainage design will be developed to ensure pit wall stability.

Current modelling of the pit dewatering drawdown cone (Figure 2-3, Aquaterra 2010) shows a steeply angled cone of depression, rapidly reducing with increasing distance from the pit. There is expected to be minimal drawdown on the plains towards the Murchison Palaeochannel, with minimal impact to GDE vegetation or known stygofauna communities in the Murchison Palaeochannel and associated drainage lines.

Groundwater dependent plant species are situated immediately along the Murchison River channels and associated drainage lines and consist primarily of *Eucalyptus victrix*. Mapping and description of this vegetation has been undertaken. *E. victrix* has a very extensive range. If the species are not tolerant of the drawdown cone, then there is the potential for some trees in the local vicinity to be lost.

As shown in Figure 9-1, the theoretical groundwater drawdown cone has a limited impact on groundwater dependent vegetation associated with the Murchison Palaeochannel.

Groundwater dependent vegetation, specifically *E. victrix* has been shown in other areas (Cape Lambert Pilbara) to be able sustain drops in water levels of up to 4 m when dewatering occurs gradually. Therefore there is a degree of confidence that if mining operations were to ensure a drop in groundwater level of no more than 3.5 m below current levels in areas that support GDV and /or stygofauna communities, then the impacts would be insignificant.



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GHD House, 239 Adelaide Terrace Perth WA 6004 T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data Source: GHD: Groundwater Dependant Vegetation, Theoretical Groundwater Cone of Depression - 20100608; Landgate: Milleura 2005 Mosaic, Gould 2006 Mosaic; Crosslands Resources Ltd: Potential Impact Area, Existing & Proposed Site Roads & Tracks, Mine Expansion Pits - 20100521, Stage 1 Approved Areas - 20100112. Created by: kdrallu, sleo2

9.6.3.2 GROUNDWATER SUPPLY

Calcrete and Tertiary Palaeochannel Aquifers

In assessing the potential impacts on drawdown from the borefield, the following assumptions have been made:

- This Borefield will abstract water from the Murchison Palaeochannel.
- There is a possibility that the superficial calcrete aquifers are connected to the Murchison Palaeochannel in localised areas, and therefore water abstraction will be indirectly abstracted from the calcrete aquifer system as well.
- Production bores will have a localised drawdown depression, as well as a regional lowering of groundwater levels across the entire aquifer.
- Initial indications based upon previous drilling results from area 1A (Aquaterra 2009) suggest that calcrete aquifers are commonly 5 - 20 m in thickness, and often separated hydrologically from the deeper Murchison Palaeochannel aquifer by an aquitard in this area.

There are no major DoW-licensed groundwater users close to the three areas (1A to C) of calcrete and alluvial aquifer systems identified along the Murchison River as a potential future water supply to the mine (Aquaterra, 2009). Groundwater levels in these areas are generally shallow (i.e. 4 to 10m below surface).

Long term, large-scale abstraction from borefields tapping the calcrete and deeper-seated 'palaeo-channel' alluvial aquifer systems is likely to impact other existing users (e.g. domestic or stock bores) and GDEs (particularly stygofauna and riverine phreatophytic vegetation) within the zone of water level drawdown. Stygofauna are most prolific in 'fresh' calcrete aquifers but have also been found in other types of aquifers with salinity levels in excess of 30,000mg/L TDS (Aquaterra, 2009).

GDV species are situated immediately along the Murchison River channels and associated drainage lines and consist primarily of *Eucalyptus victrix*, which has a very extensive range. If the species are not tolerant of the drawdown cone, then there is the potential for some trees in the local vicinity to be lost.

Carnarvon - Byro Basin

The Carnarvon Basin artesian groundwater resources are located within the Gascoyne Groundwater Area, Zuytdorp/Ningaloo Groundwater Sub-Area. The allocation limit for these aquifer(s) is 30 GL and current understanding is that these resources are over allocated (pers. comm., K. Burton, November, 2009) but further applications for groundwater licences will be assessed by the DoW primarily by their potential impacts on existing users (DoW, 2007). On this basis, the allocation limits are likely to increase where it can be demonstrated by project proponents that the groundwater required can be sourced while satisfying these and other conditions. The Byro sub-basin is within the Gascoyne Groundwater Area, Talisker / Mia Mia Groundwater Sub-Area. The DoW Water Resource Licensing (**WRL**) system portrays an allocation limit of 10 000 000 kL (10 GL) for the sedimentary aquifer within this area of which 1.71 % has been allocated.

It is understood that the allocation limit is based on limited data and that groundwater availability may be significantly greater. In order for the spatial extent of the CRL potential borefield and pipeline to be feasible for the potentially large scale draw, the goals of the proposed investigation include:

- delineating more accurate aquifer storage; and
- assessing the possibility of utilising aquifer storage in these thick sequences.

Utilising storage is a process that may be supported by the regulator subject to the lack of a feasible alternative and minimal to no predicted impacts on the environment and other users.

Stygofauna will not be impacted as a result of use of the water from the Byro Basin as this is an artesian system. Extraction from this aquifer, which will not impact any perched aquifers above it due to the positive pressure excerted on them from the artesian system below.

9.6.3.3 GROUNDWATER CONTAMINATION

Waste characterisation indicates that there is a very low risk of acid drainage from the potential waste ores and beneficiation tailings for the Project, and a low risk of metalliferous drainage and elevated salinity from waste dump drainage (SGS Lakefield Oretest, 2009; Appendix C). This has been detailed in Section 9.8.

There is a minor risk of groundwater contamination associated with the use, transport, storage and disposal of hydrocarbons and chemicals during construction and mining activities. However no significant impacts on groundwater quality are anticipated.

9.6.4 MANAGEMENT AND MONITORING

9.6.4.1 PIT DEWATERING

The bulk of the dewatering will be undertaken via a number of bores located in and around the perimeter of the pit. Diffuse inflows from the walls will be directed to in-pit sumps for transfer to retention ponds where it will be used for dust suppression and the excess will be used in the process water circuit. The sumps will be excavated from areas of the pit floor. These areas will be advanced at least one bench below the current mining level.

The establishment of a series of specific monitoring bores will be established in consultation with hydrogeologists from Aquaterra and the Department of Water. These will enable the monitoring of water level trends at varying distances from the pit and allow CRL to determine if dewatering activities will have an affect upon the Murchison Palaeochannel aquifer. Bimonthly monitoring of these bores will encompass both water levels, and water chemistry, thus enabling emerging trends to be detected early prior to any critical issues arising. It is currently unknown if the water at depth is more saline than that encountered near the surface, however, if this is the case monitoring of electrical conductivity will allow early detection of any water flow from the Murchison Palaeochannel aquifer into the fractured rock aquifers leading into the mining pit.

CRL will also monitor rainfall to determine recharge rates of the surrounding aquifers. This will enable a holistic approach to be adopted and add to the development water abstraction modelling.

If a lowered water table trend is detected in two subsequent events that has the potential to impact upon any of the environmental trigger levels actions can be initiated at an early stage to counteract any impacts. CRL proposes to commence re-injection of water being pumped from the mining pit into bores situated between the mining area and the Murchison Palaeochannel Aquifer. This will serve to mitigate any localised impacts caused by pit dewatering.

9.6.4.2 GROUNDWATER SUPPLY

The Carnarvon Basin and Murchison River Palaeo-channel groundwater investigation (and potential development) will follow the Department of Water (**DoW**) groundwater licensing process to the H3 level of assessment described by DoW (2009). It will be conducted in close liaison with the DoW hydrogeologists to provide adequate controls leading to the most expeditious licensing process possible. A weather station incorporating rainfall sampling for isotope and chloride analysis will be established at Jack Hills. Investigation drilling as well as test production and monitoring bore construction followed by controlled test pumping and water sampling of completed bores will be undertaken. Subject to the confirmation that the main target areas have potential for large groundwater resources and high yielding bores, stygofauna sampling and age dating of water from bores will be undertaken and the complete data will be analysed and synthesised.

A numerical groundwater model will be developed in consultation with the DoW. This model will assist in estimating impacts associated with groundwater development. Predicted impacts will then be assessed against environmental and other criteria by the DoW and other relevant regulators. Subject to acceptance of predicted impacts and to successful resolution of land tenure issues, an allocation of water may be granted and the borefields will then constructed.

All groundwater abstraction bores will be licensed, and operated in accordance with the relevant Operating Strategy and Department of Water licence conditions. Monitoring requirements will likely include:

- monitoring of extraction volumes;
- monthly monitoring of groundwater levels; and
- quarterly groundwater quality analysis.

Plans for the CRL Carnarvon Basin (Byro sub-basin) investigation are set out in Global Groundwater, 2010 (Appendix B). This provides the hydrogeological setting based on available work, sets out nominal drilling sites and targets and details the full process to be followed. The investigation plan has been generated bearing in mind the state-wide requirements for hydrogeological reports (DoW, 2009), and with input from the Regional Hydrogeologist of the DoW Mid West Gascoyne Region.

Monitoring

Water drawdown at both a local and regional scale will be monitored through a series of specific monitoring bores established and managed by CRL in consultation with hydrogeologists from Aquaterra. These will incorporate all of the individual calcrete aquifers that may be affected by Borefield 1A, 1B, and 1C.

These will enable the monitoring of water level trends at varying distances from the pit and allow CRL to determine if dewatering activities will have an affect upon the Murchison Palaeochannel aquifer. Bimonthly monitoring of these bores will encompass both water levels and water chemistry, thus enabling emerging trends to be detected early prior to any critical issues arising.

Stygofauna communities present in the calcrete aquifers are able to sustain greater reductions in localised drawdown, as long as water levels remain several metres above the base of the calcrete aquifer. Given that calcrete aquifers are commonly 5 - 20 m in thickness, and often separated hydrologically from the deeper Murchison Palaeochannel aquifer by an aquitard in this area (Aquaterra 2009), meaning they are unlikely to be affected by indirect water abstraction from the palaeochannel.

Mitigation

If a lowered water table trend is detected in two subsequent events from any area of the monitoring bore network that has the potential to impact upon any of the environmental trigger levels, actions will be initiated at an early stage to counteract any impacts. This may be in the form of reduced abstraction rates from individual bores until local water levels increase sufficiently. Additional water will be obtained from the Byro Borefield to reduce the requirements for abstraction from the 1A, 1B, and 1C Borefield.

9.6.4.3 GROUNDWATER CONTAMINATION

Potential sources of groundwater contamination, such as hydrocarbons and chemicals, will be managed in accordance with CRLs existing management plans, relevant Australian Standards and legislation, as outlined in Section 9.7.

Potential management associated with any detection of acid drainage is provided in Section 9.8. CRL will monitor water quality and sediment to ensure early detection of any acid drainage, and will implement the remediation actions outlined in Section 9.8 if required.

9.6.5 PREDICTED OUTCOME

Pit dewatering may result in drawdown of groundwater levels up to 6 km from the mine pit within the fractured greenstone belt units, and 2.8 km within the surrounding granitic basement: this is a conservative estimate. No other groundwater users are expected to be impacted by the anticipated drawdown, however there is potential for impacts to subterranean fauna and groundwater dependent vegetation present in the area. Potential impacts to subterranean fauna within the drawdown zone are addressed in Section 9.4.

Numerical flow modelling of a 19,200 m^3/day capacity borefield tapping the palaeo-channel alluvial aquifer system in Area 1A along the Murchison River indicated maximum water level drawdown of 4 to 7m would occur near the production holes after 15 years of continuous abstraction. Water level drawdown of approximately 0.8m was predicted near the Murchison River (Aquaterra, 2009). Similar aquifer responses are anticipated for adjoining areas 1B and 1C. Long-term, large scale abstraction from the aquifer systems has the potential to impact other existing users and groundwater dependent ecosystems. The Byro sub-basin has the potential to alleviate these potential impacts.

CRL will continue to assess potential groundwater sources in consultation with the DoW. Following completion of groundwater investigations, CRL will apply for licences to abstract groundwater under Section 5C of the RIWI Act. All groundwater bores will be licensed and operated in accordance with the relevant DoW licence conditions and Groundwater Operating Strategy.

The Project is not expected to impact on groundwater quality. Waste characterisation indicates that there is a very low risk of acid drainage from potential waste ores and beneficiation tailings for the Project, and a low risk of metalliferous drainage and elevated salinity from waste dump drainage (SGS Lakefield Oretest, 2009). A flowchart showing the activities that potentially impact groundwater and the mitigation measures is provided at Figure 9-2.

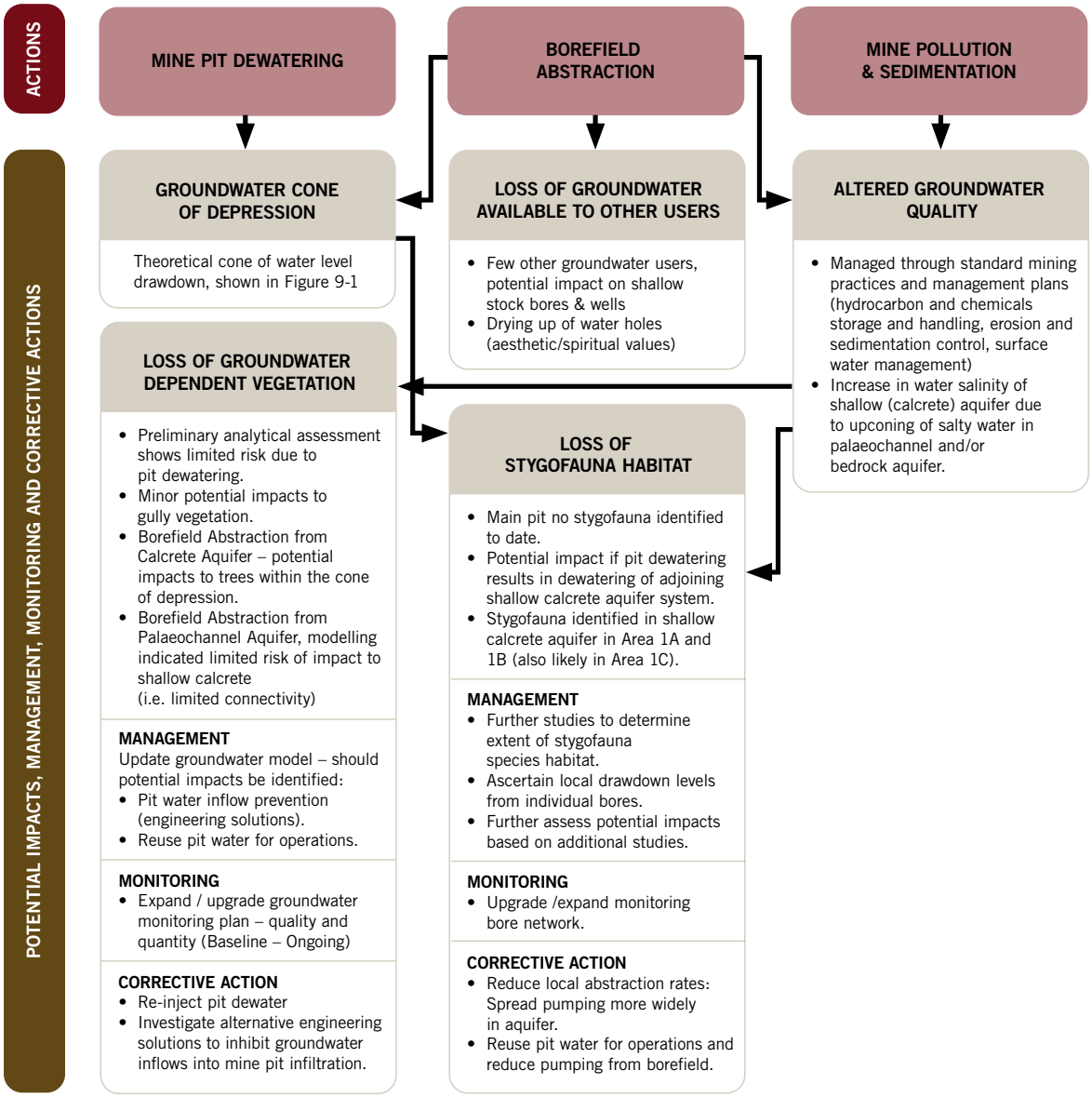

FIGURE 9-2 SUMMARY FLOWCHART OF POTENTIAL IMPACTS, MANAGEMENT ACTIONS AND MONITORING OF GROUNDWATER DRAWDOWN AND CONTAMINATION.

9.7 SOLID AND LIQUID WASTE

9.7.1 EPA OBJECTIVES

The EPA objectives relating to waste management are:

- To maintain the integrity, ecological function and values of the environment
- To ensure that emissions do not adversely affect the health, welfare and amenity of people and land uses.

9.7.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to waste management include:

- *Litter Regulations (1981*);
- E*nvironmental Protection (Controlled Waste) Regulations 2004*;
- Department of Environment (2005) *Review of Waste Classification and Waste Definitions 1996 (as amended)*; and
- *Health Act, 1911.*

9.7.3 POTENTIAL IMPACTS

9.7.3.1 SOLID WASTE

Solid wastes will be generated during the construction and operational phase. Waste streams will be generated in the form of:

- General domestic and office refuse;
- Hazardous wastes (e.g. oils, grease, lubricants);
- Industrial wastes (e.g. tyres, packaging, infrastructure and machinery components);
- Waste rock; and
- Tailings fines.

Incorrect disposal of waste materials has the potential to impact on the surrounding environment. Potential impacts include:

- contamination of soil, surface water or groundwater as a result of chemical, hydrocarbon or sewage spills;
- fire, resulting in the loss of vegetation and fauna;
- an increase in feral species populations resulting in increased competition with native fauna; and
- health impacts to humans and fauna.

9.7.3.2 LIQUID WASTE

Liquid tailings waste will be produced but will have no chemical input. Due to the high requirements for water during processing, tailings waste will be produced as a paste, rather than a liquid. Any liquid collecting in the tailings cells will be reused.

Liquid waste, comprising sewage and grey water, will be generated at the mine during construction and operational phases. The construction phase accommodation camp will be serviced by temporary treatment and disposal facilities. Permanent facilities will be established to service permanent site accommodation and ablutions during the operation phase. All treatment disposal facilities will comply with relevant public health requirements.

The septic tank sewage system and waste water treatment plant currently operational at the mine will be upgraded to cater for additional throughput. Grey water throughput is estimated to be in the order of 310L per

day per person. The throughput of grey water will significantly increase. The current waste water treatment plant discharges the treated water via a sprinkler system to an area of native vegetation. Expansion or relocation of these facilities will be designed and operated in compliance with the health regulations of the Department of Health and the Shire of Meekatharra.

9.7.4 MANAGEMENT AND MONITORING

9.7.4.1 SOLID WASTE

CRL has adopted the following approach to waste management for the Project:

- avoid waste creation;
- reduce waste generation at source;
- reuse and recycle; and
- treat and/or dispose.

Inert and putrescibles waste will be incorporated in a dedication section of the IWL, which will be developed and operated in accordance with the relevant licence conditions. Hazardous wastes will be disposed of off-site and will not pose an environmental hazard.

Other solid wastes will be recycled to the maximum extent realistically achievable, with any residual materials being disposed of either by integration within the waste rock containment area or to a dedicated landfill servicing the mine site. Recycling will be maximised and any residual waste material will be disposed of in accordance with relevant State and Local Government requirements.

9.7.4.2 LIQUID WASTE

Sewage from the accommodation village and other amenities will be treated in packaged treatment plants to Department of Health requirements and reticulated into landscaping irrigation.

Storage of waste oil on site will be in accordance with the *Dangerous Goods Safety Act 2004* and associated regulations. Oily waste materials (e.g. filters, rags and spill clean up materials) shall be segregated from general waste, contained and disposed of using a turbo burner, in accordance with the Environmental Protection (Controlled Waste) Regulations 2004.

9.7.4.3 TAILINGS AND WASTE ROCK

Golder Associates (2010) undertook geochemical testing on two tailings samples. Physical characterisation of tailings indicates that they are classified as silty sand with low plasticity (reflective of low clay content). The tailings are anticipated to have an approximate solids content of 65%.

The mineralogy of the tailings indicates it is predominantly composed of silicates, carbonates and oxides (XRD analysis indicates composition is 34.5% quartz, 19.5% magnesite, 0.4% calcite, 11.5% hematite, 14.2% talc, <5% antigorite, 1.2% corderite or amphibole, and 18.5% amorphous/unidentified). Generally, the mineralogy is dominated by the magnesium phases (magnesite, talc and antigorite).

Laboratory analysis (geochemical) was conducted at ALS Laboratories, Perth. The results of these findings are summarised below:

- tailings solids were predominantly comprised of Fe, Mn and Al;
- soluble concentrations of Na, Mg, Ca and K were low, indicating that salinity is unlikely to be an issue;
- the total S concentrations were very low at 0.04%S, indicating acidity is unlikely to be an issue; and
- analysis of trace elements indicates that Ba, Cu, Ni, Sr, Th and Zn were present however, were below the average concentrations for basalts and shales and so do not appear to be enriched.

CRL propose to dispose of tailings in cells constructed from, and ultimately encapsulated by, waste rock, forming the IWL. Tailings will be deposited as slurry from multiple spigot locations around the perimeter of seven cells. Tailings deposition will only be active in one cell at a time, with each cell progressively constructed, filled, decommissioned and covered with waste rock. The potential for acid mine drainage is addressed in Section 9.8.

The IWL will be located to the north of the range, on flat land over areas of relatively degraded pastoral lease. The vegetation types on this land are widely represented in the local and regional area.

9.7.5 PREDICTED OUTCOMES

With the implementation of appropriate waste management practices, in accordance with the relevant standards and regulations, the generation and disposal of waste on-site is anticipated to have minimal impacts on the surrounding environment.

9.8 ACID AND METALLIFEROUS DRAINAGE

9.8.1 EPA'S OBJECTIVES

The EPA's objectives relating to acid and metalliferous drainage are:

- To ensure that land uses and activities that may emit or cause pollution are managed to maintain: the physical and biological environment and the natural processes that support life, and the health, welfare and amenity of people, and land uses.
- To ensure that pollutants emitted are as reasonably practicable, and comply with all statutory requirements and acceptable standards.

9.8.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to acid and metalliferous drainage include:

- DITR (2007) *Managing Acid and Metalliferous Drainage, Leading Practice Sustainable Development Program for the Mining Industry*.

9.8.3 POTENTIAL IMPACTS

Acid Rock Drainage (**ARD**) refers to the risks associated with the reaction of sulfide bearing minerals to air, water and microorganisms. Activities such as mining involve the excavation of rocks comprising sulfide minerals, and therefore have ARD risks. The drainage produced from ARD is generally acidic with significant concentrations of dissolved heavy metals.

The term Acid and Metalliferous Drainage (**AMD**) reflects the fact that not all problematic drainage relates to the oxidation of sulfides, as near-neutral but metalliferous drainage can be just as difficult to manage as acidic water. In addition to problems caused by the acidity and metalliferous content of AMD discharges, acid generation can be successfully neutralised by mineral assemblages only to result in a highly saline leachate (as a result of the neutralisation reactions).

AMD poses a potential significant risk to the operations of a mine. Once the AMD process has commenced, it is often difficult to stop. The process will continue to progress until oxygen, water, sulfide or the metalliferous source has been exacerbated.

SGS Lakefield Oretest (2009 and 2010) completed AMD studies for the Project (Appendix C). The studies determined that there is a very low risk of acid drainage from the potential waste ores and beneficiation tailings for the Project. There is also evidence to suggest a low risk of metalliferous drainage and elevated salinity from waste dump drainage. A few small fringe areas of 'Potentially Acid Forming – Low Capacity' and even less 'Potential Acid Forming' material were identified.

Overall there appears to be excess neutralising capacity to acid potential at a ratio of 8 to 1 in the waste ore and

10 to 1 in the process tailings. Quantitatively, there is approximately seven million tonnes of excess neutralising capacity in the waste ores and 24 million tonnes of excess in the process tailings. Further work is in progress to provide additional confidence and validation to the findings of the two studies.

The receiving environment with respect to any AMD discharges from the site includes:

- groundwater: levels depressed in the mine site area due to pumping, natural level thought to be approximately 4m bgl);
- surface waters: the Murchison River is 1km from the proposed storage facility; and
- adjacent flora and fauna habitat.

The surrounding environment is not considered to be sensitive to potential AMD impacts from the site due to:

- The climate is semi arid with significantly higher annual evaporation potential than precipitation. This will limit the potential for the generation of leachate in the long term because net infiltration rates though the storage facility is likely to be very low.
- The Murchison River is one kilometre from the site and thus represents a significant migration pathway for AMD discharges derived from the site.
- The groundwater down gradient from the proposed facility is unlikely to be used for extraction. Discharges from groundwater into the Murchison River provide a potential pathway for contaminant migration however the travel time is likely to be significant given the distance of the river, and the low hydraulic conductivity of hard rock geology.
- Surrounding flora and fauna are not likely to come into direct contact with AMD discharges as a result of the surface water management control measures planned. Therefore no pathway is thought to exist at this time linking these receptors with the site.

A risk management approach has been developed to address AMD and is detailed in the Acid Mine Drainage Management Strategy (Appendix A).

9.8.4 MANAGEMENT AND MONITORING

9.8.4.1 TREATMENT AND ONGOING TESTING

An Acid and Metalliferous Drainage Management Strategy (see Appendix A) has been prepared, that provides a framework for further analysis, risk based management strategies, treatments and monitoring.

The key AMD management elements include:

- Characterisation.
- Prediction.
- Prevention.
- Treatment.
- Monitoring.

Treatment can be chemical (blending/neutralisation), physical (containment), or a combination (blending and containment). The preferred treatment options for Jack Hills are:

- Based on the initial geochemical assessment, the tailings materials themselves may be an effective neutralisation agent due to their fine grain size and high carbonate content. As a result a potential treatment strategy would therefore be to blend and deposit Potential Acid Forming (**PAF**) materials with tailings and deposit them in the constructed cells. The viability of this strategy is dependant on the results of the additional AMD testing programme, which will indicate the suitability of the tailings materials for use as a blending agent for neutralisation.
- CRL will periodically test for PAF and metalliferous minerals within the pit areas throughout the extraction phase. If such materials are found in levels that risk the formation of acid mine drainage, they will be encapsulated within the waste dump lined with carbonate materials.

Waste material testing to-date has indicated some variability in the AMD characteristics of the material, however Net Acid Generating (**NAG**) tests indicate that a small portion (probably <10%) of the material has a slightly positive Net Acid Producing Potential (**NAPP**) and may therefore be PAF. This is thought to relate to marginal acidity generated from metal dissolution/speciation/precipitation reactions, but may also be reflective of the rate of dissolution of available acid consuming carbonate species. The AMD characteristics of the waste rock should be reviewed once the additional kinetic testing and geochemical block model has been completed to determine the level of risk posed by the small volumes of potentially PAF material.

If significant volumes of PAF materials are predicted to be produced at the site then consideration should be given to options to mitigate potential risks. On this site the following options are considered to be potentially viable:

- separation of the PAF and Non Acid Forming (**NAF**) waste streams for independent storage i.e. in PAF cells;
- blending of PAF and NAF waste streams on the basis of supporting geochemical testing that indicates the blended material will be NAF; and
- deposition of PAF waste rock materials within the tailings on the basis of supporting geochemical testing that indicates the tailings will provide adequate neutralisation capacity.

The AMD Strategy (Appendix A) provides a list of active and non-active treatment options for acidic or metalliferous leachate, should these be encountered. However, treatments are not likely to be required at the site given the low potential for acid generation, and low toxic metal content of the tailings materials.

9.8.4.2 MONITORING OF DRAINAGE

The AMD Strategy (Appendix A) provides an outline monitoring schedule for the site, based on guidance provided in Department of Industry, Tourism and Resources (**DITR**) (2007), and is in line with the methodology of International Network for Acid Prevention (**INAP**) (2008).

Monitoring will include:

- CRL will monitor water quality and sediment in the silt traps constructed at the toe of the IWL.
- If acid leachate is identified in the IWL traps, CRL will test for acid leachate in the groundwater below the IWL. This will involve monitoring in bores placed in natural drainage valleys immediately downstream of the dumps.

9.8.4.3 REMEDIATION

Trigger values will be established that are specific to the site, a decision rule for trigger values is provided in the AMD Strategy (Appendix A). As mentioned above, a set of potential treatment options are listed in the AMD Strategy, and should monitoring indicate that acidic and metalliferous drainage/materials have exceeded the site trigger value then remediation may be required.

Given the expected low AMD potential of the materials, a combination of the following treatment systems would be effective:

- re-circulation of minor acidic discharges back into tailings facilities;
- passive drains (possibly containing magnesite or limestone) used to line the seepage interception drains;
- provision for active dosing with (possibly site won magnesite based) neutralisation agent if highly acidic discharges are produced on site and require treatment;
- the geology of the ore body/waste rock comprises magnesite and so provides a significant resource of neutralising material, the use of site won material as a neutralising agent, or using the tailings themselves would be the most cost-effective and sustainable solution;

- If acid leachate is found beyond the levels acceptable for lowland rivers in low rainfall areas (ANZECC and ARMCANZ, 2000) in the silt traps at the toe of the IWL, these will be lined with carbonate rocks to neutralise the acid; and
- If acid leachate is found within the groundwater downstream of the IWL, beyond the levels acceptable for water quality release to waterways, dewatering bores will be installed and water pumped into carbonate rock-lined evaporation ponds on the IWL.

9.8.5 PREDICTED OUTCOMES

The AMD study completed for the Project indicates that waste rock is unlikely to generate acid, and leachates will contain negligible concentrations of contaminants. However, if such drainage does occur, management through encapsulation, pumping and neutralisation will minimise risk to the surrounding environment.

9.9 DANGEROUS AND HAZARDOUS SUBSTANCES

9.9.1 EPA OBJECTIVE

The EPA's objectives in relation to dangerous and hazardous substances are:

- to ensure that land uses and activities that may emit or cause pollution are managed to maintain: physical and biological environment and the natural processes that support life, the health, welfare and amenity of people and land uses; and
- to ensure that pollutants emitted are as reasonably practicable, and comply with all statutory requirements and acceptable standards.

9.9.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to dangerous and hazardous substances include:

- *Explosives and Dangerous Goods Act* 1961; and
- Explosives and Dangerous Goods (Explosives) Regulations 1963.

9.9.3 POTENTIAL IMPACTS

A hazardous material is one that poses a hazard to human health or the environment when improperly handled, stored or disposed of. During construction and operational phases of the mine, there is a risk of chemical or hydrocarbon release into the environment. Possible impacts associated with chemical or hydrocarbon release range from pollution of soil, surface water or groundwater to the explosion of chemicals. The greatest hazardous material on site, by volume, will be hydrocarbons (e.g. diesels, oils and grease) used in the operation of mining equipment. Other hazardous materials will be used in small quantities.

9.9.4 MANAGEMENT AND MONITORING

In order to minimise the potential for chemical or hydrocarbon release, CRL has developed specific management measures for the storage, transport, handling and disposal of dangerous and hazardous substances, which are outlined in the CEMP and OEMP. The following measures are form part of these plans and will be implemented throughout the Project life:

- all hazardous substances stored on site will be documented in a Hazardous Substances Register (EMS, 2009);
- absorbents will be kept on site for minor spills as a component of a Spill Kit. Staff will be trained on the use of the spill kits, including appropriate disposal of absorbents;
- all spills will be reported and investigated to identify corrective actions to reduce the likelihood of reoccurrence;
- contaminated runoff will be treated prior to discharge;

- an explosives magazine will be constructed and operated in accordance with the *Explosives and Dangerous Goods Act* 1961 and the Explosives and Dangerous Goods (Explosives) Regulations 1963;
- crushing activities will be conducted in areas where surface drainage can be captured to ensure overflows, spillages or leaks are contained;
- a Licence to Store Dangerous Goods will be obtained for the storage of all hazardous materials on site; and
- all explosives will be transported by road from Perth or Geraldton, and will be transported and stored in accordance with the *Mines Safety and Inspection Act 1994*, Mines Safety and Inspection Regulations 1995 and *Explosives and Dangerous Goods Act 1961*.

9.9.5 PREDICTED OUTCOME

Dangerous and hazardous substances will be stored, transported, handled and disposed of in accordance with CRL's Hydrocarbon and Hazardous Substance Management Work Instruction (EMS, 2009) to minimise the risk of contamination, explosion or fire. Should significant soil or water contamination occur at the site, CRL will liaise with the DEC to determine an appropriate course of action for remediation.

9.10 AIR QUALITY (DUST)

9.10.1 EPA OBJECTIVE

The EPA's objective for air quality is to ensure that air emissions to air do not adversely affect environmental values or the health, welfare and amenity of people and land users by meeting statutory requirements and acceptable standards.

9.10.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to air quality include:

- Occupational Safety Regulations (1996);
- Mines Safety and Inspection Regulations (1995); and
- EPA (2000) Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites.

9.10.3 POTENTIAL IMPACTS

Dust emissions are likely to be generated during construction, mining, ore processing and ore transporting activities. Other activities that will lead to dust generation include stripping and stockpiling of topsoil, waste rock and overburden. The generation of excessive dust can adversely affect:

- human health of the workforce, particularly respirable particulate matter;
- health of the surrounding vegetation and flora; and
- reduce the amenity of receptors.

An occupational exposure monitoring programme has been operating at the Project site since July 2009 and will continue throughout the Project. No significant exposures to airborne fibres have been identified. It is expected that silica will present the most significant occupational exposure risk over the life of the project. Further work is being undertaken to further define the extent of fibrous materials on site.

The nearest residence is Mileura station, located approximately 35 km south of the Project area. Given the lack of sensitive receptors in the vicinity, dust is unlikely to impact on amenity. However excessive dust can affect the respiration and transpiration of sensitive flora species leading to localised deaths.

CRL commenced a dust deposition monitoring program in January 2007. Based on the results of vegetation monitoring studies to-date, dust deposition is not considered to be a significant concern in regards to vegetation health (Cardno BSD, 2008).

Dust suppression techniques, such as water sprays, and addition of dust suppression agents (i.e. Soiltac), and covers on truck trailers are currently employed to minimise dust emissions associated with the Jack Hills Stage 1 mine. Dust deposition gauges are currently monitored on a monthly basis, and vegetation in permanent monitoring quadrats is monitored annually. There have been no impacts to the surrounding vegetation identified through this monitoring regime.

9.10.4 MANAGEMENT AND MONITORING

The management of dust for the Project area will be achieved through the implementation of the dust management actions. The existing dust monitoring program will be expanded to include monitoring of environmentally sensitive areas (e.g. *Triodia* communities). CRL will undertake vegetation health monitoring on a yearly basis for the first five years of mine operations, to monitor the impacts of dust deposition on sensitive vegetation, and identify the need for additional dust management measures. After five years, the vegetation health monitoring regime will be reported and reviewed.

Dust management actions have been developed to reduce dust from the largest contributing sources. At a minimum, these measures will include:

- use of dust suppression measures (i.e. dust suppressants such as Soiltac, ventilation extraction systems and water sprays) on crushing, screening and conveying transfer points on the three crushing units;
- water carts will be available for application of water or other dust suppressants to unsealed haul roads;
- enforcement of speed limits within the plant and stockpile areas (max. 20 km/hr) and on haul and exit roads (max. 40 km/hr);
- operation of water cannon on plant and product stockpiles and other exposed surfaces;
- use of dust extraction equipment on drilling rigs;
- all mobile equipment to be regularly inspected to ensure integrity of cabins and seals;
- mobile equipment to be operated with windows closed and air conditioners operating;
- field staff to work upwind of dust generating activities where practicable;
- timing of blasting operations to reduce dust through consideration of meteorological conditions (wind speed and direction), in accordance with the Blast Approval Form (EMS, 2009);
- clearing vegetation in a staged manner to reduce open, exposed areas;
- maintaining a buffer zone of vegetation or building bunds to act as a windbreaks to reduce wind speed;
- tarps covering all haulage trucks going to and leaving the mine site;
- undertaking daily inspections during dust prone conditions to visually assess dust generation;
- undertaking regular inspections of dust suppression equipment;
- undertaking progressive rehabilitation of mined areas to reduce the total exposed area; and
- minimising drop heights between loaders and trucks to reduce dust creation.

Asbestos management strategies will be addressed utilising the management actions outlined in the CEMP and OEMP, and in accordance with the DMP Management Of Asbestos In Mining Operations Guideline (2001).

Potential Fibrous Materials

All available information for each potential fibrous mineral (**PFM**) interval will be collated into an asbestiform mineral register; including mineral type, asbestiform nature, rock type, alteration structures, assays, magnetic susceptibility and Magnasat. It will then be possible to define the information required to identify different PFMs and potential risk factors for each fibre type in terms of location, change of finding the fibre and potential hazard. Given the potential for impact on worker health, and the perception of asbestos issues, the risk from asbestos minerals is considered moderate.

As the asbestiform minerals do not appear to be confined to a particular rock unity then the assumption is that any mining activities may intersect asbestiform minerals. The scale of mining activity or the amount of mineral moved does not affect the precautions of controls that should be put in place. Any activity that causes dust has the potential to produce airborne fibres.

A management and decontamination plan will be formalised as a greater understanding of localised potential for presence of asbestiform minerals is realised. This will include education, instruction and training for all personnel and particularly drillers. Operational procedures can include drilling test holes to check the models interpretation before conducting blast hole drilling (with hole lengths adjusted if necessary), wet drilling or in hole dust suppression, and drilling blast holes short of any expected contact and bulldozing down to the contact. Mitigation means include walk through 'water walls' for personnel, laundering work clothes at a specific facility, positive pressure in the cabs of all machinery (equipped with a magnahelic gauge) and issuing all personnel with P2 type respirators.

Any encountered asbestos will be buried in the IWL. Tailings will be kept wet until they are covered to mitigate any asbestiform fibres becoming airborne from the processing circuit.

9.10.5 PREDICTED OUTCOME

With the implementation of the proposed dust management measures, dust impacts on human receptors and vegetation are unlikely during construction and operation of the proposed Project.

9.11 GREENHOUSE GAS EMISSIONS

9.11.1 EPA OBJECTIVE

The EPA's objective for greenhouse gas emissions is to minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.

9.11.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to greenhouse gas emissions include:

- *National Greenhouse and Energy Reporting Act* 2007;
- National Greenhouse and Energy Reporting Guidelines 2008;
- National Pollution Inventory Guidelines 2009;
- Western Australian Greenhouse Task Force (2004) Western Australian Greenhouse Strategy; and
- EPA (2002) Guidance Statement No. 12: Minimising Greenhouse Gases.

9.11.3 POTENTIAL IMPACTS

A Carbon Emission Reduction Strategy has been conducted for the Project. The Project will generate greenhouse gases during construction and operation phases. The main greenhouse gas emission contributors are expected to be:

- land clearing;
- mobile engines required for material excavation, ore processing and waste/product movement;
- transportation;
- stationary engines;
- power generation; and
- the on-site landfill facility.

Estimated annual CO_2-e emissions of coal, diesel or natural gas for the Projects power generation requirements were compared (Table 9.3; Cardno, 2009b). Based on these calculations the power station will be fired by natural

gas supplied from the DBNGP, with diesel as a back-up power source. Natural gas produces nearly half the carbon dioxide per unit of energy delivered compared to coal due to its lower ratio of carbon to hydrogen (Cardno, 2009b). In addition, the transportation of coal and diesel to the mine would contribute very high levels of CO_2-e emissions.

TABLE 9.5 ESTIMATED CO_2-E EMISSIONS FOR THE PROJECT BASED ON COAL, DIESEL OR NATURAL GAS POWER GENERATION OPTIONS

	Coal Fired Power Station	Diesel Fired Power Station	Natural Gas Power Station
Estimated annual CO_2-e emissions	3,044,378 tonnes	2,314,278 tonnes	**1,738,586 tonnes**

9.11.4 MANAGEMENT AND MONITORING

CRL has developed a Carbon Emission Reduction Strategy to identify opportunities to reduce greenhouse gas emissions for the Project (Cardno, 2009b; Appendix D). A range of measures to minimise greenhouse gas emissions have been identified and will be further investigated to identify those which are feasible and will be implemented for the Project.

Clearing of vegetation for the Project will be minimised as far as reasonably practical. Areas not required for ongoing operations will be progressively rehabilitated.

9.11.5 PREDICTED OUTCOME

Power generation is likely to be the most significant source of greenhouse gas emissions associated with the Project. As such, CRL has committed to a gas-fired power station, with diesel-back up supply, which will result in significantly lower emissions than a coal-fired power station.

The anticipated greenhouse gas emissions and energy consumption associated with the Project will trigger an obligation for CRL to participate in the National Greenhouse and Energy Reporting process under the *National Greenhouse and Energy Reporting Act 2007*.

9.12 NOISE AND VIBRATION

9.12.1 EPA'S OBJECTIVE

The EPA's objective is to protect the amenity of the community from noise and vibration impacts associated with development or land use by ensuring that statutory requirements and acceptable standards are met.

9.12.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to noise and vibration include:

- *Environmental Protection (Noise) Regulations (1997)*; and
- EPA (2007) Draft Guidance Statement No. 8: Environmental Noise.

9.12.3 POTENTIAL IMPACT

The construction and operational phases of the Project will result in noise emissions and vibration, namely associated with blasting, operation of earth moving equipment, trucks and machinery, and crushing and screening. Other sources of noise include take-off and landing of aircraft and increased train activity along haulage routes associated with increased production. Once production commences, the mine will operated on a 24 hour basis, seven days per week. However, given the remote location of the Project, it is considered that adverse impacts to other land users are unlikely. The accommodation village is located approximately 18 km from the pit and 2 km from the airstrip. It is not anticipated that the accommodation village will experience significant noise disruptions during construction or operation of the mine or associated infrastructure.

CRL commissioned Phoenix Environmental Science (**Phoenix**) to investigate the effects of exploration drilling on *I. nigrum* for the Project, in March 2009 (Appendix F). The first phase of the study examined whether previous Reverse Circulation (**RC**) and diamond drilling programs have lead to the death or displacement of *I. nigrum* individuals or populations within the 200 m exclusion buffer zone imposed on CRL by the DEC. Results of the study confirmed that spider presence and absence was similar regardless of the distance from spider burrows to existing drill holes. Subsequently, the DEC has reduced their requirement for a 200m exclusion buffer by 50%, from 200m to 100m (Phoenix, 2009).

The second phase of the assessment involved observation of the biological response to drilling, using a vibration simulation device (**VSD**) to simulate an RC drill rig. In addition, noise levels created by the generator used to power the VSD, a light vehicle, a diamond drill rig, a rock breaker, excavator and a blast were measured for comparison. The results found that of all the equipment tested, the RC drill rig is likely to be the noisiest, and would have the greatest potential to impact *I. nigrum* (Phoenix, 2009).

Vibrations from exploration activities were found to have no immediate or short term effects on the survival of *I. nigrum*. Phoenix (2009) recommended a 25-50 m exclusion buffer be applied around burrows until it is established whether or not there are any long term effects on *I. nigrum* from drilling operations. Based on this recommendation, the DEC then reduced their requirement for a 100m exclusion buffer to 25 m (Phoenix, 2009).

9.12.4 MANAGEMENT AND MONITORING

Construction work will be carried out in accordance with the AS 2436-1981: Guide to noise control on construction, maintenance and demolition sites. The following management and mitigation measures shall be implemented during the operations phase of the Project:

- all operations shall be conducted in compliance with the *Mines Safety and Inspection Act 1994* and Regulations;
- all machinery and equipment shall be maintained in accordance with manufacturers' specifications and relevant standards;
- designated speed limits shall be implemented;
- the use of appropriate personal protective equipment shall be enforced to reduce any noise impacts on the workforce;
- blasting activities shall be designed to comply with standards and minimise noise projection; and
- any required blasting activities shall be limited to day light hours in accordance with the *Mines Safety and Inspection Regulations 1995.*

Based on the findings of the targeted research program undertaken by Phoenix (2009), a 25 m exclusion buffer will be maintained around *I. nigrum* burrows which will not be directly impacted by the Project, until it is established whether there are any long term effects on *I. nigrum* from mine activities causing vibration. A long term monitoring program (developed in consultation with the DEC) will continue to be implemented for a period of five years.

9.12.5 PREDICTED OUTCOME

With the exception of the mine accommodation village, there are no sensitive receivers in the vicinity of the Project mine. Noise levels associated with the operation of the mine will be managed to ensure compliance with assigned noise levels at all noise sensitive premises.

Research undertaken by Phoenix into the potential impacts of vibrations on *I. nigrum* indicates that there are no immediate or short tem effects from vibrations on the survival of this species. A 25 m exclusion buffer will be maintained around all *I. nigrum* burrows that are not within the proposed Project footprint. CRL will develop a monitoring program in consultation with the DEC to identify any long-term effects on *I. nigrum* resulting from vibrations.

9.13 VISUAL AMENITY

9.13.1 EPA OBJECTIVE

The EPA's objective is to ensure that visual amenity is considered and measures are adopted to reduce adverse visual impacts on the surrounding environment as low as reasonably practicable.

9.13.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to visual amenity include:

- WAPC (2007) Visual Landscape Planning in Western Australia.

9.13.3 POTENTIAL IMPACT

Contextually, the proposed mine operation is comparatively remote, and there is no close public access available by virtue of roads or tracks within a distance of approximately 6 km. Beringarra-Cue Road passes some 20 km+ to the south west of the proposed mine operation, and completely out of sight on the southern side of Jack Hills ranges. Similarly, the extension eastward of the Beringarra-Pindar Road on the northern side of the Murchison River is some 12 km+ away from the proposed mining operation. While other tracks exist, these two roads are the principal publicly accessible viewing opportunities for regional traffic and travellers.

The consequence of the proposed mine operation is that it will result in visual 'features in the landscape', in the form of mine workings (mine excavation and mine pit), mine support and associated structures, and the extensive IWL which will gradually form into a pronounced 'waste mound' rising above the flat plain. There will also be intermittent visually noticeable dust generated by transport and mine workings, in combination with windy weather.

In considering the degree of 'visual impact' that will result, the following is first emphasized. The notion of 'visual impact' is a human construct, and largely a matter of the degree to which human (i.e. community) values towards the existing landscape of the locality/region are influenced or affected, either positively or negatively. Change in or to the landscape may occur, but as to whether it is a positive or negative impact depends to a high degree on how this impacts upon 'human perception'. Hence, the related aspect of 'visibility' is critical.

While local change to the landscape is inevitable in the form of partial removal of a ridge and creation of permanent change in the local topography and terrain (notwithstanding mine closure and decommissioning intentions and plans), the assessment concludes that this will not be highly 'visible' – that is, there is in reality and practice, a low likelihood that the mine operations and the visual elements involved will be observable by anyone other than the mine employees themselves, and very low numbers of local pastoralists and other miscellaneous travellers passing close the mine workings.

The impact on the wider regional landscape is similarly not likely to be significant, though the reasons involve further explanation. It is accepted that in the 'wide-open landscape' typical of the Meekatharra Plateau Landscape, where long distance panoramas to the sky-line are dominant, two factors militate against visibility.

First, from any point where human beings may exist to view the landscape (i.e. predominantly roads and tracks) long range visual accessibility is usually interrupted or prevented by foreground vegetation and micro-relief (i.e. low ridges).

Second, those roads and tracks where visibility might be possible are at sufficient distances such that clear observation of 'specific landscape elements' within the landscape (i.e. mine related structures, mine tracks or benches, vertical cuts associate with the mine void, etc) become difficult to discern. This is related to the notion of 'visual distance bands', which are explained as follows:

Distance away from the subject site is also a critical factor in assessing visual impact. The effect of distance on ability to discern detail of specific landscape elements, as well as the contribution of surrounding 'visual noise' in the wider vista or view is critical. In summary, the greater the distance and the wider the view/vista or panorama, the less a given visual element will dominate, or be intrusive. The generally accepted distance bands affecting visibility are as follows:

- Immediate Foreground (0 to 500 m): where details of colour, texture and structures are evident. Immediate foreground visual access in this case will be extremely limited.
- Mid-ground (up to 4 km): where some detail can be seen, but where increasingly colour and texture variation is seen as grouped into mass elements (e.g. groups of trees). Visible details progressively decline.
- Middle Distance (up to 7 km): although perception of colour and texture variation is limited, the essential elements are identifiable (i.e. vegetation stands, vegetation texture, dominant colour hues, dramatic features, transition zone and intrusive elements).
- Background (from 7 to 16 km): in which all detail recedes or fades, and visibility is dominated by landscape form and lines, rather than colour or texture. Additionally, land use and constructed elements are decreasingly visible or discernable.
- Far Distance (beyond 16 km): landscape detail and structures are not seen, or very difficult to discern.

In the case of the proposed Project, visible distance would at best be in excess of seven kilometres, and more likely much greater than that. From the above it will be apparent that ability to actually see and discern the proposed mine, even if there was 'visual accessibility' would be difficult.

The long distance visibility is likely to mostly apply to vantage points obtainable from other ridge features (i.e. pronounced elevated terrain from where observation and views are possible). This mainly applies to other portions of the Jack Hills ridge landscape feature. However, as far as is known, the greater Jack Hills ridge landscape is largely 'inaccessible', that is there are no obvious publicly accessible vehicle access routes, and there are no known plans to open up the landscape to visitors or travellers.

9.13.4 MANAGEMENT AND MONITORING

CRL propose to mitigate the visual impact by:

- planning and design of the pit profiles, waste and tailings facilities to conform with the landforms of the ranges;
- undertaken progressive rehabilitation using local-provenance species;
- in line with the requirements outlined in the Decommissioning and Closure Management Plan:
  - » internal roads and other access track will be decommissioned and rehabilitated;
  - » infrastructure, equipment and waste material will be removed from the Project area;
- light overspill associated with the construction and operation phases will be managed in accordance with the Australian Standards, AS 4282-1997: Control of the Obtrusive Effects of Outdoor Living (AS 1997); and
- light overspill impacts will be mitigated through downward-directed lights, shrouding and the use of "Bug Yellow' lighting to limit the attraction of flying insects to areas that are permanently lit.

9.13.5 PREDICTED OUTCOME

The visual impact appraisal completed for the Project indicates that the proposed Jack Hills mine operation will have low visual impact consequences, and will not impact upon any significant number of stakeholders or community, either local or regional.

9.14 INDIGENOUS HERITAGE

9.14.1 EPA OBJECTIVE

The EPA's objective for indigenous heritage is to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

9.14.2 RELEVANT LEGISLATION AND STANDARDS

The key legislation and standards relevant to indigenous heritage include:

- *Aboriginal Heritage Act* 1972; and
- EPA (2004) Guidance Statement No. 41: Assessment of Aboriginal Heritage.

9.14.3 POTENTIAL IMPACT

The Project will directly impact on two registered heritage sites, Site # 2413 and Site # 25560. CRL will consult with the Wajarri Yamatji people and develop a management strategy to address the heritage issues and if required obtain approval under Section 18 of the *Aboriginal Heritage Act 1972* prior to any disturbance of any heritage sites. There is also potential for previously unrecorded sites to be impacted during construction or operational phases of the Project.

9.14.4 MANAGEMENT AND MONITORING

Heritage surveys have been carried out over all existing disturbances associated with the Jack Hills Stage 1 mine and exploration drilling programs, and have identified areas that are registered or have some significance to the Wajarri Yamatji people. Some of these areas are highly sensitive and relate to watercourses or places of spiritual significance. Aboriginal heritage surveys and clearances will be required for all Project footprint areas, and are currently being planned and agreed upon with the respective Aboriginal people.

The Wajarri Yamatji Native Title Party has been informed of CRL's intent to expand the Jack Hills mining operations. Discussions have commenced with the Malgana Shark Bay Peoples and the Wajarri Yamatji people in relation to the proposed gas pipeline and service corridor routes and the management of heritage issues.

A Cultural Heritage Management Plan has been prepared and implemented in partnership with the Wajarri Yamatji people. CRL has an existing mining agreement with the Wajarri Yamatji Native Title Party. This agreement outlines CRL's obligations and responsibilities including:

- Aboriginal Heritage Protocol;
- royalty payments;
- compensation payments;
- environmental protection;
- Aboriginal employment;
- Aboriginal contracting opportunities;
- cultural awareness training; and
- induction training.

The Aboriginal Heritage Protocol incorporated in the Mining Agreement outlines the processes required when undertaking Low Impact and Ground Disturbing Mining Operations within our mining, exploration and miscellaneous tenements. Some of the key processes highlighted within this protocol are:

- works program request;
- costs and methodology of survey;
- survey teams;
- reports of surveys; and
- land access processes.

9.14.5 PREDICTED OUTCOME

CRL is committed to the preservation of culturally significant sites and the protection of Aboriginal heritage wherever possible. CRL will continue to consult and reinforce our relationship with the Native Title groups and address any heritage issues with the intent to negotiate mutually agreed and acceptable outcomes for all parties.

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10. ENVIRONMENTAL MANAGEMENT COMMITMENTS

CRL commits to implement and operate the Project in accordance with the following environmental commitments.

10.1 ENVIRONMENTAL MANAGEMENT SYSTEM

CRL aims to conduct its business in an efficient and environmentally responsible manner, meeting the expectation of its community, shareholders and relevant government agencies. CRL recognises that environmental responsibilities go beyond those required under statutory requirements and include social obligations, leadership in sustainable development and climate change and conserving biodiversity (CRL, 2009). As such, CRL has developed the Environmental Management System (**EMS**) to meet the AS/NZS ISO 14001 (2004) Environmental Management Systems standard.

The EMS applies to all aspects of the exploration, development, construction, operation and closure phases of Stage 1 and the Project. It is to be implemented by all personnel working for and on behalf of CRL's for the duration of the Project.

The overarching elements of the corporate EMS include:

- environmental policy;
- planning;
- implementation and operation;
- checking and corrective actions; and
- management review and continual improvement.

Each element is discussed further in the sections below.

10.1.1 ENVIRONMENTAL POLICY

CRL management is committed to managing its activities in an environmentally responsible manner and the management of environmental risks. Individual members of management have embraced environmental responsibilities associated with their role and authorities in the company. CRL commitment is reflected in their corporate Environmental Policy outlined below.

CROSSLANDS RESOURCES LTD

Environmental Policy

Crosslands Resources Ltd (Crosslands) is the second largest exporter of iron ore from Western Australia's fast developing mid-west region, and an emerging mining industry leader. Crosslands is committed to protecting the surrounding environment in areas where the company is conducting exploration and mining related activities during design, planning, operation and decommissioning phases.

Crosslands vision is:
"To be the mid-west's leading iron ore supplier, building value for employees, communities and shareholders."

Our activities will be planned and conducted to reduce our environmental footprint to protect the natural environment, our heritage, and preserve biodiversity for the benefit of current and future generations.

We are committed to:

- Comply with all applicable legal and other requirements which relate to our environmental management.
- Establish and maintain environmental objectives and targets based on the prevention of pollution.
- Maintain an Environmental Management System to provide standards and processes to 1) manage our environmental risks, 2) achieve our environmental objectives and targets, and 3) ensure continual improvement in our environmental performance.
- Provide our employees and contractors with the necessary training to ensure they recognise the potential impact of their activities and to achieve a culture of responsible environmental management.
- Avoid, and where this is not possible, minimise adverse environmental impact.
- Minimise waste disposal through waste avoidance, recycling, and resource recovery.
- Establish and maintain a framework for reviewing our environmental objectives and targets and monitoring our environmental performance through audit and self-regulation.
- Regularly report on our environmental performance while working closely with government and other related industries.
- Communicate this policy and our environmental management commitments to all employees and contractors and make this policy available to the public on our website.
- Make appropriate resources available to implement this policy.

Our Environmental Responsibilities
Environmental leadership and adherence to the Crosslands Environmental Policy is the responsibility of all Crosslands employees and contractors. The Chief Executive Officer and Senior Management are accountable to the Stakeholders for the development and implementation of this policy through the Environmental Management System.

Andrew Caruso
CHIEF EXECUTIVE OFFICER
Crosslands Resources Ltd

Review Date: 4 May 2010 Version 4.0

10.1.2 PLANNING

The environmental risk assessment approach CRL has adopted in the EMS involves the systematic identification of environmental aspects of its activities which have the potential to impact the environment. The risk assessment takes into consideration the potential for pollution, inability to achieve targets and non-compliance with legal or other requirements. Significant risks are addressed through the setting of objectives and targets, and the implementation of Environmental Management Plans (**EMP**s) (CRL, 2009).

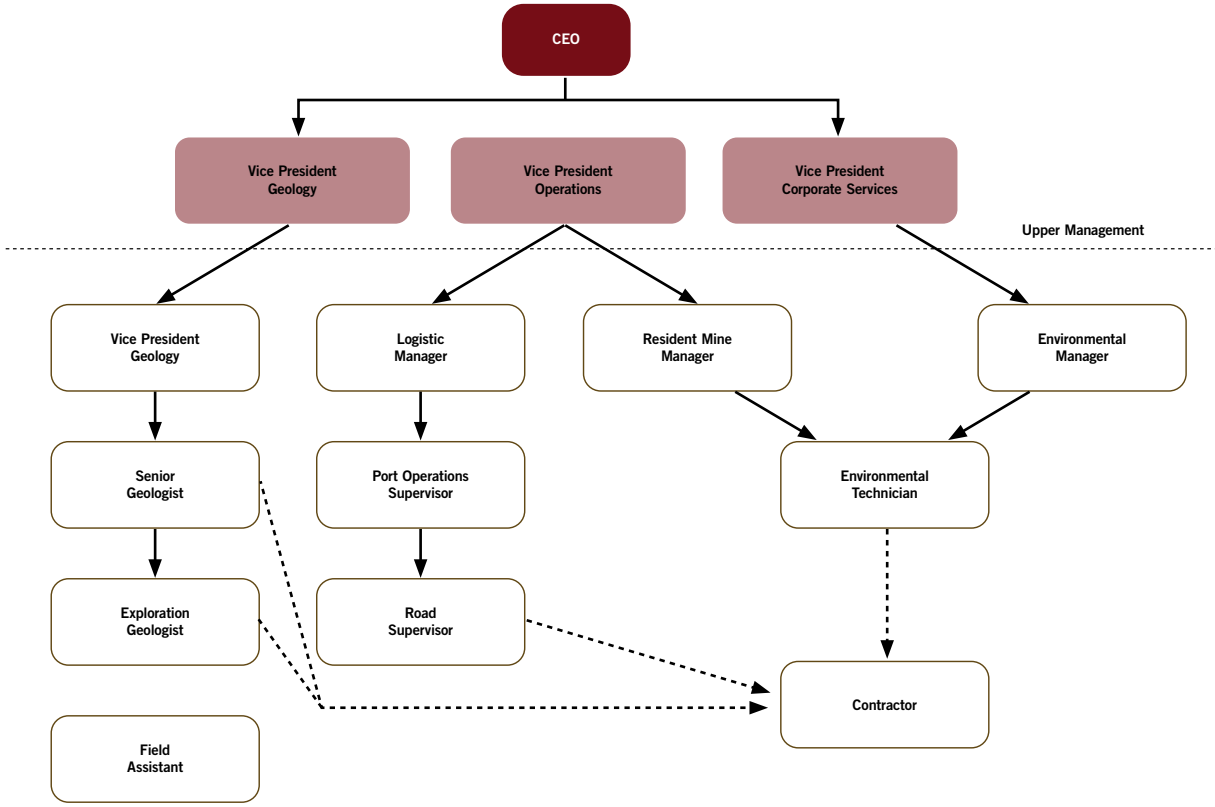
Effective planning also ensures that CRL is aware of and is addressing its on-going legal obligations, and that intended environmental outcomes are achieved in the most efficient manner.

10.1.3 IMPLEMENTATION AND OPERATION

The practical procedures within the EMS (work instructions and standard operating procedures) will help

ensure compliance with obligations and environmental performance criteria. The roles and responsibilities for environmental management shall be clearly defined in these procedures. Implementation begins at induction and shall continue through ongoing training for the life of the Project. Environmental objectives and each employee's obligations for environmental management will be clearly communicated to all staff and contractors. Figure 10-1 below outlines CRL management structure and its responsibilities for effective management and application of environmental management.

FIGURE 10-1 CRL MANAGEMENT STRUCTURE



10.1.4 CHECKING AND CORRECTIVE ACTIONS

Periodic auditing and regular inspection is a necessary step to assess and ensure compliance with environmental management objectives. It is also an effective mechanism for dealing with non-compliance, incidents and reporting. CRL undertakes regular internal and external auditing of its procedures and outcomes, and will continue this through the operation and decommissioning of the Project.

10.1.5 MANAGEMENT REVIEW AND CONTINUAL IMPROVEMENT

Review of performance results will help ensure continual improvement in levels of compliance. The cyclical nature of the EMS facilitates continual improvement in environmental performance, and provides the mechanism for managing significant risks, achieving targets and complying with legal and other requirements.

CRL currently undertake an Annual Environmental Review (**AER**) for the Stage 1 mining operations, which considers the compliance reporting requirements of both the Department of Mines and Petroleum (**DMP**) and DEC.

The AER objectives are:

- presentation of major mining operations and activities for the Jack Hills mining operation from the previous year and the proposed works for the following year;
- presentation of all environmental management and rehabilitation activities for the reporting year and the proposed developments and activities for the following year;

- illustration that the operators of the Jack Hills mine site have set up procedures and audit processes to monitor operations at the site;
- presentation of all compliance obligations of the Jack Hills mine site, and the processes employed to meet these compliances;
- presentation of an active statement on the effectiveness of any previously undertaken action employed to rectify non-compliances;
- presentation of environmental hazards detected throughout the reporting year;
- presentation of environmental incidents that have occurred and how these incidents were managed;
- presentation of clear and concise information on all environmental activities undertaken at the Jack Hills site as part of the DMP collection of data on the extent of mining in WA and the environmental management standards being achieved; and
- appraisal, assessment and listing of compliances against Ministerial Conditions as listed in Ministerial Statement No. 727.

CRL continually strives to improve its level of environmental performance as well as concentrating on the needs of stakeholders and traditional owners in the area. CRL prepares annual compliance reports as per legislative requirements, but also views this as a management tool to review and improve its environmental operations and encourages input from regulatory authorities to further improve site operations. CRL is keen to build on these processes and aims to continually improve compliance ratings for the mine and associated operations.

10.2 ENVIRONMENTAL MANAGEMENT PLANS

The primary tools for the implementation of the EMS are the environmental and other management plans. CRL have developed environmental management plans (**EMPs**) to address and control the development of the most significant environmental aspects of Stage 1 and the proposed Project. The EMPs are maintained in the EMS such that they are subject to the cyclic nature of planning, implementation, review and improvement.

Under CRL's EMS (2009), key environmental factors are managed under specific environmental management plans (EMPs), required by Ministerial Statement (**MS**) 727. Some plans have been developed that are not a requirement of MS 727. The current EMPs within CRL's EMS include:

- Construction EMP
- Cue Camp EMP
- Cue-Beringarra Road EMP
- Dust Management Plan
- Exploration EMP
- Fauna Management Plan
- Fire Management Plan
- Geraldton Port EMP
- Heritage Management Plan
- Ore Transfer and Transport EMP
- Water Operating Strategy
- Land Management Plan
- Vegetation Management Plan

These plans will be revised to meet the requirements of the Project. Some will become defunct (Stage 1 Construction EMP), others will be revised and new management plans will be developed.

In particular CRL has developed the following overarching EMP's and management strategies (Appendix A) for the Project:

- Construction EMP;
- Operations EMP;
- Decommissioning and Closure Management Plan;
- Acid and Metalliferous Drainage Management Strategy
- Completion Criteria and Key Performance Indicators for Revegetation at the Crosslands Resources Jack Hills Operation; and
- Rehabilitation Strategy.

Specific management activities conducted by CRL that contribute to biodiversity conservation in the mid-west region include:

- Feral goat and cat control programs;
- Noxious weed control (i.e. Ruby Dock) along Cue-Beringarra Road; and
- Weed monitoring and control around the mine site.

These management activities will continue during the life of the Project.

10.3 STUDIES

Under the existing MS 727, CRL has contributed to biodiversity knowledge in the region as follows:

- Extensive survey and data analysis has been conducted to better understand the vegetation communities at Jack Hills and surrounding ranges, specific to *Triodia melvillei* communities.
- Surveys of Priority flora species, found to occur within the Jack Hills ranges, have been conducted to find additional populations.
- Fauna surveys of vertebrates and invertebrates, including short range endemics, stygofauna and troglofauna have been conducted at Jack Hills and surrounding areas.
- Assessment of the impacts of vibration, from exploration drilling and other mining related activities, on *Idiosoma nigrum* (to be submitted to a journal, currently in preparation).
- Determination of completion criteria for rehabilitation (based on methodology that won Minara Resources a Golden Gecko Award).

CRL will itself continue, and also promote others, to undertake further studies to expand biodiversity knowledge of the Mid West Banded Ironstone Formations and in particular the Jack Hills ranges. CRL's further studies will include:

- Implement a long-term *Idiosoma nigrum* spider monitoring program. Phoenix Environmental are currently conducting this program.
- Conduct regional searches for *Idiosoma nigrum*, in collaboration with the DEC and Sinosteel, on conservation lands in the mid-west region. Brad Durrant (DEC) is the project lead for this program.
- Continue a priority flora and priority ecological community research program. G&G Environmental are currently conducting this program.
- Provide monetary and intellectual support for a research project, in collaboration with other members of Geraldton Iron Ore Alliance (**GIOA**) and DEC, to assess the impacts of goat grazing on vegetation in the mid-west region. Murdoch University has been chosen to manage this research program. Lara Jefferson has been nominated by GIOA to sit on the Student Supervisory Panel.
- CRL has funded a Masters project to measure the physiological effects of dust on vegetation at Jack Hills, identify an indicator species and trigger levels. CRL has been monitoring dust deposition around the current mining activities. This information will provide a baseline dataset which will value-add to the research program.

10.4 SUMMARY

CRL's environmental management commitments are summarised in the following Table 10.1

TABLE 10.1 ENVIRONMENTAL MANAGEMENT COMMITMENTS AND THE IMPLEMENTATION ACTIONS REQUIRED TO MEET THE OBJECTIVES, AND TIMING AND CONSULTATION.

No.	Commitment	Objective	Action	Timing	Consultation
1	Implement the CRL Environmental Management System (EMS) based on ISO 14001: 2004	To gain ISO14001 EMS accreditation within five years of starting Project operations.	CRL to ensure resources for Environmental advisor (reporting to the Environmental Manager) and supporting roles, to specifically manage the implementation of the EMS, documentation and review processes. Implement environmental risk based approach to all aspects of CRL's activities in relation to the Project. CRL EMS to be externally audited every three years.	All phases	External ISO 14001 EMS auditor
2	Environmental considerations are included during the design and engineering phase of the project	To ensure that CRL's environmental policy is implemented during the design and planning stages.	Implement the Carbon Reduction Emissions Strategy (Appendix D) to ensure considerations of sustainable design and engineering of infrastructure. Ensure that noise, air quality, mosquitoes and other human health factors are considered. Develop and implement Vegetation Monitoring Strategy to ensure baseline data is collected prior to Project activities. Ensure obstructions to surface water flow is minimised by linear infrastructure in the design and engineering phase. Implement the long term *Idiosoma nigrum* monitoring program. Update the AMD assessment to reflect the most current resource block model. Ensure on-going stakeholder consultation, especially with the Wadjarri Yamatji and Malgana Shark Bay Native Title Groups, and adjacent station owners. Develop and review CRL EMS Management Plans, Work Instructions, Forms and Registers. Learn from other mining operations that have demonstrated 'excellence' in environmental management initiatives. Implement the Decommissioning and Closure Management Plan.	Planning	DEC DoH DMP DIA DoW Station owners Native Title Groups

No.	Commitment	Objective	Action	Timing	Consultation
3	The surrounding environment is protected through environmental management practices during the construction phase.	To achieve a high level of environmental management during the construction phase of the Project.	Implement the Construction Environmental Management Plan. Implement the Decommissioning and Closure Management Plan. Ensure a training matrix is established and implemented for all personnel working as employees or contractors on-site.	Construction phase	DMP DEC DIA DoW DoH Shires Pastoralists Native Title Groups
4	The surrounding environment is protected through environmental management practices during the operations phase.	To demonstrate a high level of environmental management throughout the life of mine. To be an industry leader in environmental management. To win a Golden Gecko award for environmental 'excellence' To have an 'environmental' culture at all of CRL's Project facilities. To continue to learn and understand the ecological processes of the surrounding environment.	Implement the Operation Environmental Management Plan. Implement the Decommissioning and Closure Management Plan. Place emphasis on individual's responsibilities for their actions in relation to environment through environmental awareness training. Internal audit system to be implemented at all departmental levels. Instill a culture of risk assessment from Job Safety and Environmental Analysis at the task level, through to technical risk, and through to business risk levels. Environmental awareness training to be on-going and regular. Review and improve the EMS, EMP's and associated documentation on an on-going basis. Benchmark against companies that have demonstrated environmental management excellence. Select CRL personnel to have at least one Key Performance Indicator (KPI) based on environmental performance. Support of at least one research program of flora or fauna of the local surrounding environment and one regional research program. Present environmental management initiatives and research outcomes at industry and scientific conferences. Ensure transparency of environmental lessons learnt with regulators and other stakeholders.	End of Construction and during the life of mine period	DMP DEC DIA DoW DoH Shires Pastoralists Native Title Groups

No.	Commitment	Objective	Action	Timing	Consultation
5	Planning for decommissioning and closure will occur during every phase of the project through preparation and continued review of a Decommissioning and Closure Management Plan.	To ensure that CRL is prepared in terms of financial, environmental, and social provisioning for closure at any point in time.	Prepare and Implement the Decommissioning and Closure Management Plan. Review and update the DCMP regularly. Consult regularly with stakeholders. Ensure financial provisioning is addressed on a six monthly basis. Progressive rehabilitation will be implemented where possible. Rehabilitation planning, resourcing (e.g. seed sourcing, topsoil storage) and research will be on-going.	All phases	DMP DEC DIA DoW DoH Shires Pastoralists Native Title Groups
6	Environmental awareness training will be on-going.	To ensure CRL personnel and contractors are aware of the surrounding environment in which they are working, understand the environmental objectives and targets, comply with the EMS, and relevant environmental Acts.	All personnel working for CRL will undergo an environmental induction. A monthly newsletter will be distributed with an environmental update, an environmental topic will be raised at least once per week at all toolbox meetings. on-site, posters to be displayed on at least three information boards, and three external specialty workshops to be held per annum to select groups. Internal workshops run by the environmental department will be held every four months to select groups.	All phases	
7	Conduct internal and external auditing of CRL's environmental management effectiveness.	To ensure that the EMS is being implemented through a review and checking process.	Self auditing will occur at different levels: Audit of CRL's activities using a self check list; Audit of CRL's environmental management record keeping; and Audit of CRL's EMS implementation and effectiveness. Annual external audits will consist of a site audit for annual environmental reporting, and an audit of EMS ISO 14001 implementation to gain accreditation.	All phases	DMP DEC DoW OEPA

No.	Commitment	Objective	Action	Timing	Consultation
8	Review and continually improve CRL's environmental management and ensure compliance with environmental laws and licenses.	Review and continual improvement, as a component of CRL's EMS, of environmental management to ensure objectives and targets are being met. To achieve a high level of compliance with environmental licence and regulatory conditions.	Environmental incidences will be recorded and addressed as they arise, and management actions implemented to reduce the risk of re-occurrence. Annual environmental performance reviews will be conducted and reported to address compliance, and determine actions for improvement. The Annual Environmental Report will be submitted no later than the 30th of January of each year.	Annually	DMP DEC DoW OEPA
9	Communicate CRL's environmental performance to stakeholders and the community.	To effectively communicate environmental performance and respond to complaints in a timely manner.	Implement the Community Consultation Management Plan.	All phases	DMP DEC DIA DoW DoH Shires Pastoralists Native Title Groups Community

No.	Commitment	Objective	Action	Timing	Consultation
10	The Groundwater, respective groundwater dependent ecosystems (GDE's) and other users are not impacted significantly by CRL's activities.	To conduct sufficient investigation to ensure abstraction volumes and rates do not significantly impact GDE's, pastoral bores, or water storage. To ensure monitoring bores are sampled regularly to identify impacts to groundwater quality and quantity. To ensure monitoring identifies AMD issues and mitigation measures are implemented within short time frames. To ensure hydrocarbon management and containment measures are of a high standard.	Develop and implement a Groundwater Operating Strategy, which will detail a monitoring plan showing monitoring bores, sampling frequency and methodology, reporting, audit and review. Hydrocarbon and hazardous chemicals management is described in the CEMP and OEMP, and will be implemented. Develop and implement an AMD monitoring program.	All phases	DoW Pastoralists and other tenement holders Native Title Groups Shires DEC DMP
11	Ensure surface water is considered.	To prevent impacts to the environment as a result of obstruction of natural surface water flow.	The design and engineering of infrastructure will take into account natural surface water flows and creek lines. A monitoring program for erosion, flooding and shadowing will be developed and implemented. Develop and implement an AMD monitoring program. Develop and implement a Surface Water Management Plan.	All phases	Pastoralists Shires DEC

No.	Commitment	Objective	Action	Timing	Consultation
12	Protect and prevent impacts to flora and vegetation outside of the approved footprint and in the immediate vicinity of the Project's activities.	To have a net benefit to the surrounding flora and vegetation as a result of the Project's activities.	Implement a feral fauna control program as detailed in the fauna management component of the CEMP and OEMP. Collaborate with pastoralists to control feral goats. Support a research program to determine the effects of feral goat grazing on vegetation to better inform land managers of grazing pressures. Control noxious weeds within CRL's mining activities. Educate local Shires of noxious weeds and control measures. Implement the following plans: Construction EMP; and Operation EMP.	All phases	Shires Pastoralists DEC DMP
13	Protect and prevent impacts to fauna and fauna habitat in the immediate vicinity of the Project's activities.	To have a net benefit to the surrounding native fauna and fauna habitat as a result of the Project's activities.	Implement a feral fauna control program as detailed in the CEMP/OEMP. Implement long term monitoring of *Idiosoma nigrum* in the immediate vicinity of Project's activities. Actions as per Item 10 to improve and protect habitat. Restoration of degraded high value areas affected by CRL. Rehabilitation activities to consider fauna habitat (e.g. rock overhang areas for bats)	All phases	Landowners DEC DMP

No.	Commitment	Objective	Action	Timing	Consultation
14	Reduce atmospheric pollutants where possible	To minimise greenhouse gaseous, and particulate emissions into the atmosphere as a result of the Projects activities.	Implement Carbon Reduction Strategy. Implement dust management actions. Implement vegetation monitoring. Develop and implement asbestos and dust awareness training, and monitoring program. Annual National Pollutants Inventory reporting. Annual National Greenhouse and Energy Reporting Scheme (NGERS) reporting. Participation in the Energy Efficiency Opportunities program. Meet specific measurable targets annually to continue to find ways to reduce emissions.	All phases.	DoH DEC DMP
15	Reduce noise and vibration where possible	To minimise noise and vibration from Project activities.	Implement long term monitoring of *Idiosoma nigrum* in the immediate vicinity of the Project's activities. The accommodation village is to be located at a distance from mining activities. Meet noise regulations for plant and equipment.	All phases.	DMP DoH DEC Landowners
16	Reduce liquid and solid pollutants, where possible.	To minimise domestic and industrial waste generation, recycle where possible and manage waste in accordance with guidelines.	Implement the land management actions. Implement a recycling program. Identify and meet specific measurable targets annually to continue to find ways to reduce or recycle domestic and industrial waste. Monitor and report on the effectiveness of waste facilities including waste water treatment plant, wash down facility, hydrocarbon storage facility, landfills, and recycling activities, including water. Develop and implement an AMD monitoring program. Environmental awareness training to include spill response and emergency response. Emergency Response Team to be trained to effectively contain and manage major spills or waste emissions.	All phases	DEC DMP

No.	Commitment	Objective	Action	Timing	Consultation
17	Minimise impacts to Aboriginal Heritage values through positive associations and collaboration with the Native Title Groups.	To have a positive relationship with the Aboriginal people of the area, respect their values and promote their culture.	Implement the heritage management actions. On-going consultation with the Native Title Groups. Continue the Aboriginal employment opportunities program. Cultural awareness presentations for employees.	All phases	DIA Native Title Groups

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11. ENVIRONMENTAL OFFSETS

11.1 ENVIRONMENTAL CONTEXT

CRL appreciates that as with any proposal, it is important for the Project to be considered within the broader local, regional and State environmental context. As part of the DEC's strategic review of the banded iron formation ranges of the mid-west and Goldfields, a study titled 'Flora and Vegetation of the Banded Ironstone Formations of the Yilgarn Craton' was undertaken. The strategic review was undertaken to provide an additional level of information to government to allow for a more strategic approach to resource utilization and biodiversity conservation decision making. Consequently there is now a good source of comparative information on the biogeography of the flora and vegetation of the mid-west banded iron formation ranges.

The Review indicates a predisposition towards allowing development over the Jack Hills area where substantial iron ore resources are identified and are required to sustain a long term mining industry, while also providing for an adequate level of conservation of their biodiversity values.

The Review indicates that, based on the current floristic information at the time of the Review, the Jack Hills and Weld Range have fewer environmental obstacles and should be able to proceed to development with minimal constraints. The EPA has expressed hope for the State to set aside a representative conservation area in the Jack Hills Range. However, most of the Jack Hills Range is under mining or exploration tenements.

11.2 CRL'S OBJECTIVE

CRL's objective is to implement the Project in a way which meets the environmental, social and economic expectations of the Project's stakeholders.

The Project will provide environmental, social and economic benefits for the area through employment, infrastructure and flow-on effects to the non-mining sector. Environmental benefits will include:

- participation in the DEC – Geraldton Iron Ore Alliance partnership to add value to regional environmental management initiatives;
- on-going local management of feral fauna; and
- increased knowledge of local environmental values through on-going surveys and research initiatives.

These and other environmental benefits arising from the Project are addressed in this Chapter as part of the Project's offsets package.

11.3 OFFSETS PRINCIPLES

11.3.1 OFFSET GUIDELINES

The role of environmental offsets is guided by the EPA's:

- Environmental Offsets Position Statement No. 9, January 2006 (EPA 2006) – which provides overarching guidance and a consistent policy approach on the matter (page 2); and
- Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) Environmental Offsets – Biodiversity No. 19 September 2008 (EPA 2008) – which sets out the EPA's advice on when offsets are considered to be appropriate as part of the EIA process for proposals and how proponents should address offsets, (collectively the **Offset Guidelines**).

These Offset Guidelines provide the primarily guidance for formulating offset packages.

11.3.2 INTENTION

In summary, environmental offsets:

- aim to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a

positive environmental gain, with an aspirational goal of achieving a 'net environmental benefit';

- represent a 'last line of defense' for the environment, only being used when all other options to avoid and mitigate environmental impacts have been considered and exhausted; and
- should be included, where appropriate, as part of approvals for environmentally acceptable projects to maintain and wherever possible enhance the State's environment, (EPA 2006 Foreword page i).

11.3.3 TYPES

Broadly there are two types of offsets:

1. Direct offsets are at least one activity selected to help counterbalance the environmental impact, with the aim of achieving no environmental difference, e.g. restoration (offsite, namely not including restoration and rehabilitation of land directly affected by the proposal), rehabilitation (offsite), re-establishment, sequestration. However, direct offsets may not be possible to achieve in every circumstance. Where native vegetation is outside the conservation estate and is subject to threatening processes, its acquisition and inclusion into the conservation estate may be considered a direct offset because of its security of tenure, purpose and management.
2. Contributing offsets are selected complementary activities (as necessary) which, with the direct offset, meet the EPA's offset principles; e.g. protection mechanisms; management; education; research; removal of threats; or other activities having a proven environmental benefit; or contributions to an approved 'bank', credit trading scheme or trust fund (as deemed appropriate by the EPA).

11.3.4 PRINCIPLES

The policies, decisions and advice of the EPA will be guided by the following principles (EPA, 2006):

A. Environmental offsets should only be considered after all other reasonable attempts to mitigate adverse impacts have been exhausted.

B. An environmental offset package should address both direct offsets and contributing offsets.

C. Environmental offsets should ideally be 'like for like or better'.

D. Positive environmental offset ratios should apply where risk of failure is apparent.

E. Environmental offsets must entail a robust and consistent assessment process.

F. Environmental offsets must meet all statutory requirements.

G. Environmental offsets must be clearly defined, transparent and enforceable.

H. Environmental offset must ensure a long lasting benefit.

11.3.5 DECISION-MAKING PROCESS

The EPA have developed a decision-making process for using environmental offsets (EPA, 2006), which CRL will follow to finalise an offsets package for the Project.

11.4 PROJECT OFFSETS

CRL recognises that the Project will have some residual impacts that cannot be avoided, minimised, rectified or reduced by its management measures. CRL will use the Offsets Guidelines and develop and action a number of environmental offsets to address these impacts, to be drawn from those identified in Table 11-1.

11.4.1 PROPOSAL

The Project proposal is outlined in Section 5.

11.4.2 KEY ENVIRONMENTAL FACTORS AND IMPACTS

The key environmental factors and impacts and the mitigation measures to avoid, minimise, rectify and reduce

those environmental impacts are outlined in Section 9. These build on CRL's practices with Stage 1 and will be continue to be implemented, reviewed and updated as appropriate to ensure environmental impacts are mitigated to the extent reasonably practicable.

11.4.3 RESIDUAL IMPACTS

Having reviewed the residual impacts from implementation of the Project, CRL concludes that the critical unavoidable impacts necessitating the development of an offset are:

- The upland *Triodia* community, a component of the Priority 1 Ecological Community "Jack Hills Vegetation Complexes", specifically will be directly impacted (approximately 76%) by the Project. All species within this community are well represented in other community types. However, the specific composition of species that defines the community will be impacted. Similar communities also exist in other ranges in the mid-west region. Additional research is required to determine how similar they are to the Jack Hills upland *Triodia* community.
- Twelve Priority flora species have been found in the Jack Hills Project area. Nine of these species will be impacted by the Project.
- The SRE *Idiosoma nigrum* population at Jack Hills is the largest most northerly population of this species. While only 18% of this species will be impacted, it is not found extensively in conservation areas and is under threat from mining related activities and feral goats. Large numbers of the species have been found by mining companies in the mid-west region. It is becoming more evident that reducing the conservation status of this species should be considered. CRL is working in collaboration with Sinosteel and the DEC to determine if this is the case.

11.4.4 INDICATIVE PROJECT

CRL's intention in this draft PER is to present an indication of the types of possible offsets. CRL will then actively engage with relevant stakeholders to develop its offsets package. A final package will then be developed, which will meet the EPA's Principle G that offsets are clearly defined, transparent and enforceable. CRL intends to remain flexible and adaptive in planning the Project's offsets to allow the most effective possible management of residual environmental impacts. Indicative Project offsets that may be appropriate are presented in Table 11.1.

CRL appreciates that the EPA and DEC's offsets focus has been primarily on direct offsets to achieve a 'like for like or better' offset. An appropriate direct offset would be to take steps to assist inclusion of a component of the Jack Hills Range in the conservation estate. However, as stated previously, most of the range is under mining or exploration tenements. Similar vegetation communities exist in surrounding ranges and this may be worth investigating. Figure 8-9 shows conservation estate in the mid-west region. Most of the pastoral land in the area is also degraded as a result of grazing pressures. A restoration program of such areas, with a focus on sustainability, may also be worthwhile investigating. CRL intends to continue exploring opportunities for direct offsets for inclusion in the final PER. CRL is also committed to assisting a range of contributing offsets targeted to the particular environmental factors impacted by the Project.

CRL considers that the Project's residual environmental impacts can be best addressed through a focus on a range of contributing offsets targeted to the particular environmental factors impacted by the Project. The residual impacts largely relate to biodiversity matters affected by incomplete species knowledge, which therefore show apparently limited distribution. These matters would most effectively be addressed through programs focused on improving knowledge. CLR is exploring opportunities to provide support for these programs through a structure involving relevant stakeholders to achieve the most targeted outcomes.

TABLE 11.1 INDICATIVE PROJECT OFFSETS

Targeted residual impacts	Offsets	Further consultation required
Conservation significant vegetation communities	CRL will, if available and reasonable, take steps to assist inclusion of land in the conservation estate of comparably representative environmental values.	Selecting the appropriate land and determining the appropriate management measures will require further consultation with the relevant stakeholders.
	Conduct research and additional surveys to determine degree of similarity of regional *Triodia melvillei* communities.	DEC
	Contribute to research to determine the definition and practical measurement of Priority Ecological Communities (PEC) in the mid-west region.	DEC, Curtin University of Technology
Conservation significant flora	Restoration and rehabilitation of degraded areas outside the Project area.	Selecting the appropriate areas and determining the appropriate management measures will require further consultation with the relevant stakeholders.
	Explore and contribute to sustainable agriculture initiatives to have overall net environmental benefit while also providing economic benefit. Initiatives may include: • feral goat control and reduction of grazing pressures; • restoration of riparian and other high value areas; • fencing; • diversification of land use; • investigate economic use of native species products; and • collaborative programs with the Aboriginal people.	Northern Agricultural Catchment Council, Department of Agriculture, Caring for Our Country Pastoralists
	Participation in the DEC – Geraldton Iron Ore Alliance partnership to value-add to regional environmental initiatives, including support for research on the effects of feral goat grazing on native vegetation in the mid-west region.	GIOA membership, Murdoch University
	Support for increased knowledge of local or regional environmental values through on-going surveys and research initiatives, including: • *Acacia sp.* Jack Hills taxonomic studies; and • Study of the effects of dust on vegetation in the mid-west region.	DEC, various universities

Targeted residual impacts	Offsets	Further consultation required
Native fauna	Support for on-going management of feral fauna.	
	Idiosoma nigrum taxonomic, translocation and ecological studies.	WA Museum, DEC
Native flora and fauna	Support for on-going local weed and pathogen management.	Department of Agriculture and DEC
	Education of local Shires and communities on noxious weeds and effective management strategies.	DEC and local Shires
	Support for on-going local fire management programs.	DEC and FESA
	Support and promote a TAFE course for EMS development and education of small, local contractors to promote high standards of environmental management in the region.	TAFE (Geraldton) and DEC
	Scholarship program for Aboriginal student to complete environmental studies and apprenticeship.	Curtin University of Technology, TAFE (Geraldton), Yamitji Land and Sea Council, Yamitji Wajarri Native Title Party

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12. SOCIAL IMPACT AND MANAGEMENT COMMITMENTS

12.1 STAKEHOLDER CONSULTATION AND LIAISON

CRL's approach to stakeholder consultation and liaison is set out in Section 13.

12.2 SOCIAL IMPACT ASSESSMENT

A Social Impact Assessment (**SIA**) has been conducted for the Project (Environment Resource Management; ERM 2009). The SIA examined the existing social and economic setting within the Shire of Meekatharra and Shire of Cue and identified potential positive and negative impacts associated with the Project and outlined a range of mitigation measures. The assessment focused on the communities of Cue and Meekatharra as these are the two Shires in closest proximity to the Jack Hills mine.

Potential positive social impacts associated with the Project include:

- regional employment opportunities, in both construction and operational phases (up to 2,000 positions are predicted during peak periods and 1,350 during operations for the lifetime of the project);
- regional opportunities for existing and new business to develop in support of supplying goods and services where feasible throughout operations and construction;
- construction and upgrading of local infrastructure, particularly roads; and
- on-going community investment to promote long term sustainable development in the region.

Potential negative social impacts include:

- additional heavy transport vehicles on main roads, including the Great Northern Highway, during the construction phase (i.e. from 2011 to 2014), causing traffic delays, noise and dust generation and possibly increasing the likelihood of road traffic accidents;
- a transition from trucking ore to using rail to transport ore from the mine to the port will result in the loss of employment for approximately 170 truck drivers. In addition, the closure of CRL's Cuddingwarra stockpile facility and camp may have an economic impact on the town of Cue;
- potential for increased demands on general health infrastructure and emergency services leading to increased wait times to access services in local communities; and
- cumulative impacts on local community facilities and services as a result of the numerous extractive industry projects developing in the area.

12.3 ECONOMIC BENEFITS

The Project will result in substantial regional and State benefits, including:

- investment of capital into Western Australia's regional and state economies;
- major port and rail infrastructure construction in the mid-west region;
- positive contribution to Indigenous training and business opportunities in the mid-west region;
- increasing demands for goods and services creating business and employment opportunities;
- additional Commonwealth and State Government revenues through collection of additional
- royalties, taxation and other charges; and
- increased export value of Western Australian iron ore to international customers.

From an economic standpoint the Project will provide both direct and indirect employment opportunities in the mid-west region, as well as substantial investment in infrastructure.

12.4 MANAGEMENT

CRL is committed, as part of a social assessment program, to engage with service providers, especially education, accommodation, and health services, in order to afford these organisations the opportunity to prepare for any impacts associated with the proposed development.

CRL is committed to working cooperatively with the Traditional Owners (the Wajarri Yamatji Native Title Party) and their representatives (Yamatji Land and Sea Council), particularly in respect of Aboriginal heritage protection (addressed further in Section 8.8.1 and 9.14).

CRL is committed to making a positive contribution to Indigenous training and business opportunities in the mid-west region. The following mitigation measures are proposed to offset potential negative impacts identified for the project.

12.4.1 EMPLOYMENT AND LOCAL ECONOMY

- Feedback from recent stakeholder consultation sessions indicated there is a real need for coordination of efforts by industry and government to ensure development planning in the Mid West is integrated. The sharing in advance of workforce and project requirements and schedules will greatly assist stakeholders in the necessary planning required to support projects of this scale.
- When setting workforce salaries aim to benchmark them within the average bracket of similar skill sets within the Mid West. It is recommended to coordinate with other mining companies, e.g. via the GIOA, to avoid setting extravagant salaries that local service providers are unable to meet in order to compete for workers.
- Advertise locally for employment and contracting opportunities whenever possible and consider partnerships with TAFE and other local organisation in terms of preparing and planning for local training and capacity building to enable local businesses to service the mine. Where feasible, maximise local contracts to support the operations and where required seek to assist in capacity building smaller enterprises in order to meet the needs of the mine.
- Provide opportunities for training/re-training and apprenticeships in construction or mining. This will be available for some of the local and regional population interested in developing skills in these areas.

12.4.2 CONSTRUCTION AND OPERATIONS ISSUES

- Update existing management procedures relating to operations' traffic management to ensure that consideration is given to additional construction traffic and to reduce impacts on local traffic. This should occur in consultation with relevant agencies such as the Cue Shire Council, Meekatharra Shire Council and Main Roads WA.
- Update existing management procedures relating to fatigue management, taking into account the number of driving hours undertaken by drivers that are associated with the Project construction works.
- Although noise is considered a minor impact due to the remote nature of the Project, update existing noise management procedures to incorporate expanded construction and operations activities, particularly in relation to transport through communities such as Meekatharra and Cue.
- Update existing dust management procedures to incorporate additional dust, expected to be generated from construction and operations activities related to the expansion.

12.4.3 COMMUNITY INVESTMENT

- Seek to collaborate and coordinate efforts with other mines in the region to effectively identify and support the local communities' needs.
- Identify opportunities to strengthen community life such as through the potential provision of water stand pipes to outstations.

13. STAKEHOLDER CONSULTATION

13.1 STAKEHOLDER CONSULTATION PROGRAM

The aim of the program is to build a long-term positive relationship between CRL and the Project stakeholders including State and Local governments and the local communities of the mid-west region.

In promoting CRLs' case for the development of the Project the company must formally and informally engage a range of stakeholders. This engagement will also support the on-going activities that the company is undertaking to meet its statutory and regulatory requirements through the approvals process.

The main objectives are to build good relationships with stakeholders associated with the mid west region and minimise the risks and issues associated with the Project.

A wide range of stakeholders have been identified for the Project, comprising individuals and organisations from stakeholder groups such as government, industry and the local community. Regular consultation with the Project's identified stakeholders will continue throughout the project's lifespan, ensuring that queries and concerns raised are addressed.

Figure 13-1 illustrates the three step engagement process (identify the issues, identify the stakeholder and engage the stakeholder) conducted by CRL as part of the Project.

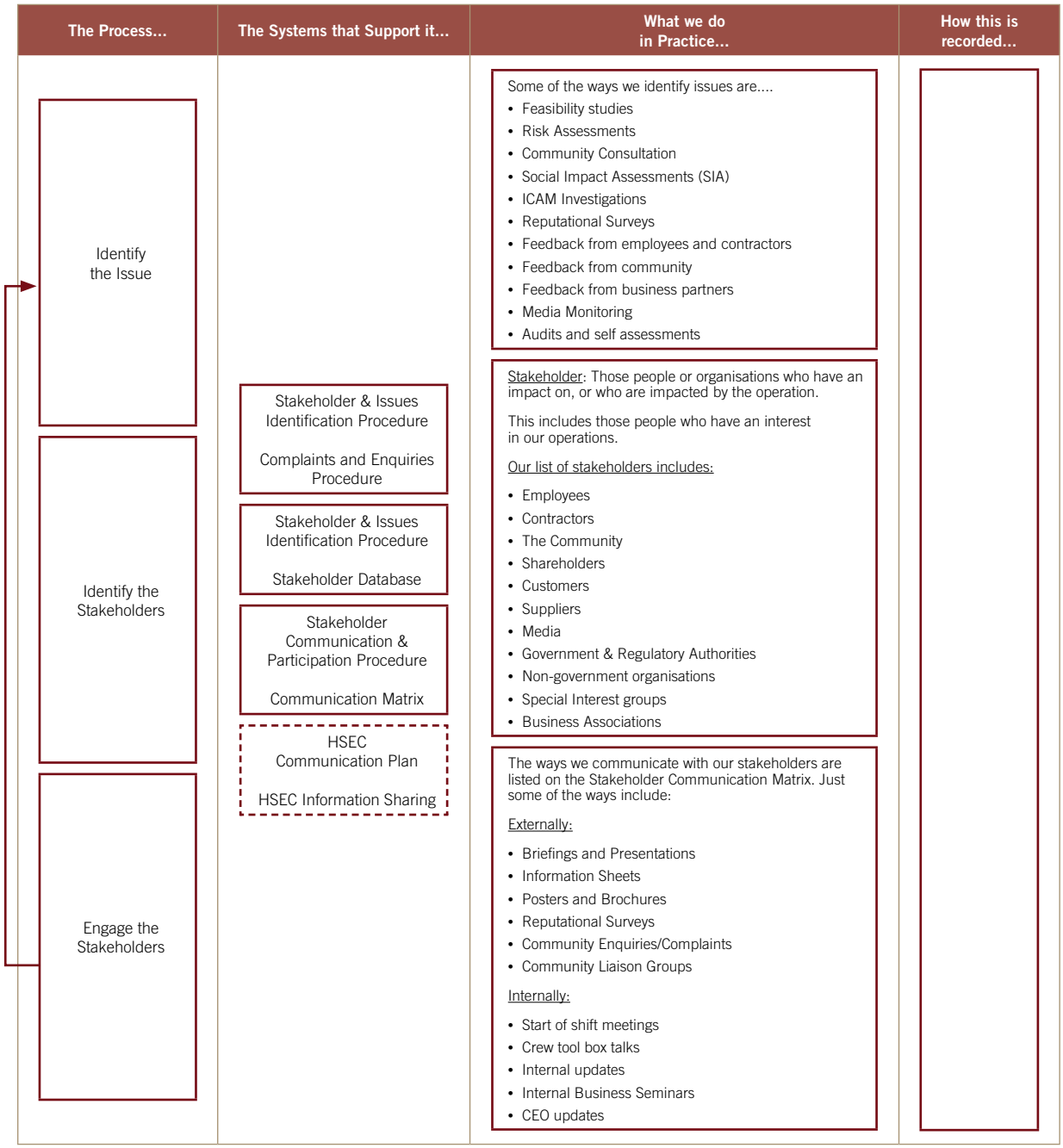

FIGURE 13-1 SUMMARY OF STAKEHOLDER ENGAGEMENT PROCESS

13.2 RELEVANT STAKEHOLDERS IDENTIFIED

Stakeholders for the Project are those people or organisations who have an impact on, or who are impacted by the operation. This includes those with an interest, and not necessarily financial, in the operations. Company-wide stakeholders may be at the international, national, state or local (regional/community) level.

The purpose of the stakeholder and issues identification procedure is to develop an understanding of the social, economic, cultural, political and/or organisational context of the Project to support: effective stakeholder engagement and social risk management; and, to respond to community concerns and issues management.

Stakeholder and issues identification is: on-going, relating to stakeholders with whom the operation maintains a continuous relationship; or, project or initiative based, relating to specific CRL projects or initiatives which impact specific stakeholder groups.

Typically, four steps are used in the stakeholder and issues identifications and analysis process.

- identify stakeholders and issues;
- assess stakeholder salience;
- record in database; and
- develop stakeholder engagement strategy.

The key stakeholders for the Project include WA State and Local Government, local communities, Indigenous People and Groups, landholders, business and industry groups, as well as, CRL employees.

13.2.1 WA STATE GOVERNMENT

The WA Government, and in particular Premier Colin Barnett, has been promoting the mid-west region of the State as a key driver for economic development. The focus industry is the emerging iron ore sector however to date the industry, in the mid-west, does not have sufficient infrastructure to support its proposed growth. The Premier's favoured development project, the proposed Oakajee Port north of Geraldton, is planned to proceed only if there is sufficient iron ore production from the region available to be exported through the port. The Premier has recently been vocal in support of the iron ore industry in the mid-west - a positive sign for the industry and for CRL's Project.

On a regular basis relevant CRL staff meet with State government departments (ministerial, officer and operational) to ensure they are fully informed of the proposed activities associated with the Project. The main decision making authorities (DMAs) for approvals include the:

- Department of Water;
- Department of Environment and Conservation;
- Department of Mines and Petroleum; and
- Department of Indigenous Affairs.

13.2.2 LOCAL GOVERNMENT

During Stage 1 operations, CRL has maintained good relationships with the Shires of Meekatharra, Murchison, Cue, Mt Magnet, Yalgoo, Mullewa and the City of Geraldton-Greenough as these Shires were affected by either the company's operating mine site, haulage operations or exporting activities.

Meekatharra and Murchison Shires, as well as, the Shire of Cue will continue to be consulted during the move from current to future operations as these are likely to be the more directly affected stakeholders. The City of Geraldton-Greenough will also be consulted on a regular basis, and provided with updates.

13.2.3 LOCAL COMMUNITIES

As mentioned above, Stage 1 operations have seen relationships built with the local Shires surrounding the Jack Hills mine and haulage route to ensure project activities were communicated and issues discussed and resolved where applicable. With the Project and shift to rail, community consultation will be required as changes occur to ensure these relationships are maintained and that future issues are addressed. In 2010 and beyond, due to the footprint of the Project the Shires of Murchison and Meekatharra will remain important as will the relationship with the City of Geraldton-Greenough and Shire of Chapman Valley (where the Oakajee Port will be located).

13.2.4 INDIGENOUS PEOPLE AND GROUPS

CRL holds regular meetings with the project's native title groups and the Yamatji Land and Sea Council (**YLSC**). CRL also undertake regular Heritage Surveys of the project site with the Traditional Owners. No land disturbance will occur without the appropriate Heritage clearances. Engagement to date has been undertaken with:

- Ngoonooru Wadjari Group;
- Wajarri Elders;
- Wajarri Yamatji Native Title Applicants;
- Wajarri Yamatji Native Title Working Group; and
- The Malgana Shark Bay People.

During the Project (both construction and operations), CRL will continue to work with the Wajarri Yamatji People to identify possible business and economic development opportunities.

During Stage 1 CRL provided assistance to an Aboriginal owned organisation to establish a heritage consultation business which CRL has utilised the services of on several occasions with successful outcomes. This business is now a highly successful operation and CRL are committed to continue to look for opportunities such as this for local Indigenous people and organisations to benefit from the presence of the mine, in particular via long term sustainable employment.

13.2.5 LANDHOLDERS

The three groups of landholders to be considered with relation to the Project, are divided into the following areas:

- in the immediate vicinity of the mine site;
- borefields;
- along the Jack Hills to DBNGP services corridor; and
- along the Jack Hills to Weld Range services corridor.

Land access permissions, complaints handling, and general consultation will form the base of ongoing communication with these groups. Land access policies and procedures are already in place and will continue to be followed to ensure relationships with these groups are maintained.

13.2.6 BUSINESS AND INDUSTRY

The Geraldton Iron Ore Alliance (GIOA), formed in 2005, was established by a group of companies with iron ore deposits in the Geraldton/Mid-west area of Western Australia. In addition to CRL, other members include:

- Asia Iron Holdings Limited;
- Gindalbie Metals Limited;
- Golden West Resources Limited; and
- Sinosteel Midwest Corporation Limited.

Sub-committees of the GIOA include environment, heritage, and human resources, which promote the sharing of information to improve practices relating to environment, indigenous heritage and community. In relation to community, member companies have adopted policies and practices designed to foster sound and balanced community relations. These policies include:

- the provision of timely information about company plans and projects;
- entering into consultations with relevant indigenous organisations, environment and community groups at the earliest opportunity to resolve matters of mutual importance; and
- actively liaising with Federal, State and Local Governments to ensure the industry is not only complying with the appropriate legislative requirements, but also operating in a way that is supported by Governments at both an elected and administrative level.

In relation to environment, member companies have adopted a range of policies to ensure sound environmental practice. These include:

- Implementing environmental management and quality of work standards that are maintained as strict operating procedures, regardless of the location of operations.
- Adhering to all relevant Government laws and regulations for the protection of the environment.
- Conducting exploration activities with due regard to the protection of wildlife, flora and sites of natural, cultural and historical significance.
- Ensuring that any damage to vegetation, land surface or man-made improvements that may occur as a result of the mining activities will be minimised and rehabilitated without undue delay.

This sub-committee have developed the GIOA Sustainability Principles and Minor Works in Banded Iron Formations – Key Principles. Currently the GIOA is supporting a research program to determine the effects of feral goat grazing on native vegetation.

A number of other businesses and industry have and will continue to be considered as part of the Project's consultation program such as Oakajee Port and Rail (**OP+R**) and Geraldton Port Authority (**GPA**).

13.2.7 MEDIA

Community newspapers throughout the mid-west and regional publications are used as a forum for updating community members with bi-monthly advertorials. As with Stage 1, they will continue to be informed regarding CRL's plans and activities.

13.2.8 EMPLOYEES

Employees and contractors are considered an important asset by CRL. An internal monthly update is sent to all staff to inform them of progress across all business units of the company. Internal business seminars are held on a monthly basis to educate staff in an interactive environment to enable a further understanding of all facets of the company. A quarterly roadshow presentation delivered by the CEO and members of senior management is also conducted at all CRL sites to deliver key company milestone information and messages.

Table 13.1 summarises the key stakeholders consulted to date as part of the Project.

TABLE 13.1 LIST OF STAKEHOLDERS

Stakeholder	Organisation
Government - State	Member for Geraldton,
	Member for Nedlands
	Member for Agriculture Region
	Member for Mining and Pastoral Region
	Member for Agricultural Region, Parliament Secretary to Minister for Regional Development
	WA Local Government Association, Murchison Zone
	Department of Indigenous Affairs
	Department of Education and Training
	Department of Mines and Petroleum
	Department of Environment and Conservation
	Department of Water
	Department of State Development
	Department of Industry and Resources
	Main Roads Western Australia
	Geraldton Port Authority
	Geraldton Police Station
Opposition Govt - State	Leader of the Opposition
	Deputy Leader of the Opposition
	Opposition Spokesman on Local Government
Government - Federal	Federal Member for O'Connor
Government - Local	Shire of Greenough Geraldton
	Shire of Cue
	Shire of Meekatharra
	Shire of Murchison
	Shire of Yalgoo
	Shire of Mt Magnet
	Shire of Mullewa
	Shire of Sandstone
	Shire of Shark Bay
	Shire of Northampton
	Shire of Chapman Valley

Stakeholder	Organisation
Landholders	Mileura Station
	Beringarra Station
	Judal Station
	Moorarie Station
	Belele Station
	Glenburgh Station
	Byro Station
	Ballythunna Station
	Carey Downs Station
	Callytharra Springs
	Talisker Station
	Curbur Station
	Mt Narryer Station
	Jingimarra Station
	Killara Station
Community	Education- mid-west primary, secondary and tertiary
	Arts and culture groups
	Drummond Cove Progress Association
	Service groups
	Multi-cultural groups
	Youth and sporting
	Environmental groups

Stakeholder	Organisation
Media	Geraldton Guardian
	Midwest Times
	ABC Radio
	GWN
	WIN
	Yamaji News
	Midwest Aboriginal Media Association (Radio MAMA)
	Mid west community newsletters
	Valley Vibes
	Cue Dryblower
	Golden Prospect
	Mt Magnet Leader
	Northampton News
	Yalgoo Bulldust
	Mullewa Mail
	Murchison Monologue
Business/Industry	Mid West Chamber of Commerce and Industry
	Chamber of Minerals and Energy
	Training and employment providers e.g. West Coast TAFE
	Square Kilometre Array
	Geraldton Iron Ore Alliance
Indigenous	Yamatji Land and Sea Council (YLSC)
	Algoonouru Wajarri
	Mullewa Wadjarri Group
	Naaguja People
	Ngoonooru Wadjarri
	Wadjarri Yamatji Native Title Applicants
	Midwest Mining and Aboriginal Economic Development Partnership
Employees	Ex-employees
	Current
	Potential

13.3 STAKEHOLDER ENGAGEMENT PROCESS

To date stakeholders have been engaged using a number of different techniques, including:

- participation in community open days and community events;
- Community Liaison Group meetings in the mid-west with predominantly community members;
- Community Liaison Group meetings in Geraldton-Greenough with predominantly local government agencies;
- stakeholder meetings (one on one and group);
- presentations and stakeholder briefings;
- community sundowners;
- correspondence – via email, letters and telephone;
- media relations – releases, advertising and regular community updates;
- direct mail via targeted mail out; and
- information resources – displays, fact sheets and website.

CRL has utilised throughout Stage 1 a number of tools to assist in the engagement process and will continue to do so throughout the Project. These include published community updates, staff internal updates, introduction and information letters, website updates, illustrative figures and maps of the project area, presentations, information leaflets, newspaper adverts and non technical summary reports.

All the consultation activities have been documented and recorded as part of CRL's ongoing stakeholder engagement process. Where issues have been raised, a log has been opened where the issue has been documented. Responsibility is assigned to investigate and address the issue, with actions to respond to the person/organisation that raised the issue on next steps. Table 13.2 summarises the key issues discussed with stakeholders in association with the Project.

TABLE 13.2 ISSUES RAISED AND TOPICS DISCUSSED DURING THE PROJECT STAKEHOLDER CONSULTATION PROCESS.

State Government Agencies	Consultation topics and Issues
Department of Environment and Conservation (DEC) – Perth office	• Discussion of priority flora surveys (especially *Acacia* sp. Jack Hills); • *Idiosoma nigrum* survey methodology; • Vibration effects from drilling on *Idiosoma nigrum* research program; • Overview of water requirements and the level of consultation required; • Discussions regarding Project activities, potential impacts to the environment, surveys and management, environmental scoping requirements; and • Ongoing Project consultation regarding vegetation and flora, short range endemics including *Idiosoma nigrum*, stygofauna and troglofauna.
Department of Environment and Conservation (DEC) – Geraldton office	• Environmental impact assessment updates; • PEC communities in relation to the Murchison Palaeochannel system; • Conservation managed lands in the mid-west region; • EMS and CRL's environmental risk assessment approach; • Issues related to waste management; and • Site visit.

Department of Water (DoW) - Perth	• Availability of water for the Project; • Methodology and approach to finding a water source; • Update on consultant assessment for borefields; • Discussion of applications for water exploration in selected land tenements; and • Monitoring requirements and regulations.
Department of Water (DoW) - Geraldton	• Ongoing discussions regarding water requirements; • Water exploration licenses and conditions; • As per DoW Perth consultation.
Department of Mines and Petroleum (DMP)	• Current operations update; • Project update; • Program of Works for drilling programs; • Environmental impact assessments; • Future environmental activities and rehabilitation; • Aspects of the *Mining Act 1978;* and • Integrated Waste Landform: landform stability.
Environmental Protection Authority (EPA)	• Discussion regarding exclusions from referral and environmental scoping document and PER submission date; • Ongoing updates regarding project conditions; • *Idiosoma nigrum* surveys and results; • Briefing on spinifex communities; • Briefing on heritage.
Environmental Protection Authority - Service Unit (EPASU)	• Discussion regarding exclusions from referral and environmental scoping document; • Site visit; • EPA Bulletin 1220 for Stage 1 and issues raised.
Office of Minister for Transport	• Project description presentation.
Department of State Development (DSD)	• CRL Project update; • Processes and timeline for approvals; • Environmental impact assessment status; • Water requirements; • Social impact assessment outcomes.
Department of Indigenous Affairs (DIA)	• Briefing of Project activities; • Discussion of heritage and native title issues.
Department of Premier and Cabinet (DPC)	• Project briefing, key project conditions for discussion of potential issues with project and climate change issues.

Department of Commerce	• Discussion regarding interaction with SKA; • Extraction of water and potential synergies in terms of power, water, gas etc.
Department of Health	• Project description; • Discussion around health impact assessment for the Project.
Liberal Stakeholders	• Discussions regarding Mid West Iron Ore industry and CRL plans and developments.
Landholders	**Consultation topics and Issues**
Beringarra Station	• Project update; • Surface water management; • Feral goat control; • Gas pipeline route.
Judal Station	• Project update; • Feral goat control; • Station boundaries; • Impacts on livelihood.
Mileura Station	• Project update; • Airstrip maintenance; • Fencing.
Jingimarra Station	• Project update; • CRL background and proposed activities.
Mt Wittenoom Station	• Project update; • CRL background and proposed activities.
Milly Milly Station	• Land access; • Gas pipeline route.
Byro Station	• Land access; • Gas pipeline route.
Ballythunna Station	• Land access; • Gas pipeline route.
Mungullah Community	• Gas pipeline route.
Mt Gould Station	• Land access.
Mt Padbury Station	• Land access.
Beebyn Station	• Land access.
Sherwood Station	• Land access.
Killara Station	• Land access.

Indigenous Groups	Consultation topics and Issues
Yamatji Land and Sea Council (YLSC)	• Site for induction to the YLSC group for mining industries, streamlining communications between CRL and OP+R. Discussions on access to Mt Hale and Weld Range.
Algoonouru Wajarri	• Discussion regarding heritage survey for Mount Hale, exploration track and drill holes.
Corser & Corser Lawyers-Mullewa Wadjari Group	• Overview of company structure and proposed geotechnical drilling areas.
Naaguja People	• Discussions regarding Cross Cultural Course.
Ngoonooru Wadjari	• Discussion about earthmoving team during construction phase, discussion of future access to Mt Hale and monitoring measures for drilling program, update of the Project and discussion regarding reducing registered site zone of Mt Hale.
Caring for our Country	• Discussed sustainable environmental rehabilitation using traditional owners/ Indigenous groups.
Wadjari Yamatji Native Title Applicants	• Heritage clearance request.
Business/Industry	**Consultation topics and Issues**
GPA (Geraldton Port Authority)	• Discussion regarding potential hazard caused by spillages of material on crossover platform and steps and dust control discussions.
Mining and Civil Australia (MACA)	• Discussion regarding Indigenous Employment Strategy.
Wildflower Society WA	• Project description and Project update.
Midwest Mining Developments Conference, Fremantle	• Project description and Project update.
Mining the Mid West Conference, Perth	• Project description and Project update.
Midwest Resources Forum, Geraldton	• Project description and Project update.

CRL Liaison Groups

The CRL Liaison Group was formed in 2006 to update community members and other interested parties on progress in CRL mining operations; in addition to identify emerging community concerns and to gather feedback on CRL. The group now meets three times a year in Geraldton (after an initial bi-monthly meeting in the early stages of the Jack Hills project)

Members of the group include:

- Department of Education and Training;
- Mid West Gascoyne Area Consultative Committee;
- Department for Planning and Infrastructure;
- Mid West Development Commission;
- Department of Water;
- Midwest Chamber of Commerce and Industry;
- Department of Indigenous Affairs;
- Shire of Chapman Valley;
- Geraldton Personnel;
- Main Roads WA;
- Drummond Cove Progress Association;
- Batavia Regional Organisation of Councils;
- Shire of Yalgoo;
- City of Geraldton-Greenough;
- Department of Environment and Conservation; and
- Yamaji Land and Sea Council.

The CRL Liaison Group meetings have continued to be the primary forum for dissemination of information and feedback from community. One of the key outcomes from these meetings was the identification of the need for a community based and focused version to allow a true representation from the mid-west hinterlands. As a result in 2009 a community arm of the meeting, the Midwest Community Liaison Group was formed and has since met in Mt Magnet, Yalgoo and Mullewa with Shire and Community representatives invited from Meekatharra, Cue, Mt Magnet, Yalgoo, Mullewa and Geraldton-Greenough.

Action Plan

Further consultation is planned and will continue as the Project moves through the approvals process and into further planning, construction and operations.

The key aims of CRL's consultation process include:

- Sharing information to create awareness and a greater understanding with the community and stakeholders about the Jack Hills expansion and its impacts;
- Address any community issues raised through the consultation process to ensure support for the expansion project and continued support for current operations; and
- Maintaining the open and two-way communication established through the Stage 1 consultation program.

CRL has and will continue to disseminate information via:

- Liaison groups (both Geraldton-Greenough and mid-west based);
- Face-to-face meetings and briefings with relevant stakeholders and on request;
- Via print, information mail outs, factsheets, newsletters, published community updates; and
- Via email and web updates.

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14. CONCLUSION

The proposed Project, described in Section 5, will have a net benefit to the surrounding environment at a local and regional scale. This document has identified the significant environmental factors, potential impacts and management actions. Direct impacts to the environment have been described and will be offset through the development of an offsets package.

CRL will comply with the identified relevant legislation, guidelines and standards in Section 3. CRL has demonstrated compliance with Ministerial Statement No. 727 conditions as well as other environmental licence conditions, laws and regulations for the three year period of current mining operations at Jack Hills (Section 4).

CRL has conducted feasibility studies for the Project in a sustainable manner, with considerations of economic, social, and environmental issues. This is summarised in Section 6. CRL have addressed the EPA's six principles of sustainability in the development and implementation of the Project in Section 7.

CRL has commissioned extensive surveys to understand the existing environment over a four year period (Section 8), conducted an environmental impact assessment and identified key environmental factors that require measuring, monitoring and management (Section 9).

CRL's comprehensive EMS is of international standard and will continue to be implemented and continually improved throughout the life of the Project. The EMS and associated Management Plans provide the actions required to prevent and mitigate potential impacts to the health, welfare and amenity of the surrounding environment, as detailed in Section 10.

The development of an offsets package will ensure that implementation of the Project will have a net benefit on the environment to the satisfaction of the relevant stakeholders. The offsets strategy and indicative offsets are detailed in Section 11.

A social impact assessment has been described in Section 12, which identifies potential negative and positive social and economic impacts to the community and associated management commitments.

CRL has an on-going stakeholder consultation program, as detailed in Section 13. CRL intends to continue to work closely with the EPA, DoW, DEC, DMP, DIA and DoH to ensure a high level of environmental management and determine an appropriate offsets package to ensure that there will be a net benefit to the environment as a result of the Project.

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16. GLOSSARY

%	Percentage
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AER	Annual Environmental Review
AMD	Acid and Metalliferous Drainage
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARD	Acid Rock Drainage
ARI	Average Return Interval
ASS	Acid Sulphate Soil
BFO	Beneficiation Feed Ore
BIF	Banded Iron Formation
BOM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CRL	Crosslands Resources Limited
CS5	Compressor Station 56
DBNGP	Dampier Bunbury Natural Gas Pipeline
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and the Arts
DIA	Department of Indigenous Affairs
DITR	Department of Transport, Tourism and Resources
DMAs	Decision Making Authorities
DMP	Department of Mines and Petroleum
DoW	Department of Water
DPI	Department of Planning and Infrastructure
DRF	Declared Rare Flora
DSO	Direct Shipping Ore
EMP's	Environmental Management Plans
EMS	Environmental Management System
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESAs	Environmentally Sensitive Areas
ESD	Environmental Scoping Document
FM	Fibrous Mineral
FY	Financial Year
g	gram
GIOA	Geraldton Iron Ore Alliance
ha	hectare
HDPE	High Density Polyethylene

IBRA	Interim Biogeographical Regionalism for Australia
INAP	International Network for Acid Prevention
IWL	Integrated Waste Landform
JAMB	Japan-Australia Migratory Bird Agreement
km	kilometre
KPI	Key Performance Indicator
LGA	Local Government Authority
LPG	Liquified Petroleum Gas
m	metre
m²	Square metre
MBS	Martinick Bosch Sell
MCA	Minerals Council of Australia
MIM	Massive Iron Mineralisation
MOU	Memorandum of Understanding
MS	Ministerial Statement
Mtpa	Million tonnes per annum
NAF	Non Acid Forming
NAG	Net Acid Generating
NAPP	Net Acid Producing Potential
NES	National Environmental Significance
OP+R	Oakajee Port and Rail
PAF	Potential Acid Forming
PEC	Priority Ecological Community
PER	Public Environmental Review
PFM	Possible Fibrous Mineral
PS	Pit Shell
RAP	Radio Astronomy Park
RC	Reverse Circulation
RoKAMBA	Republic of Korea and Australia Migratory Birds Agreement
ROM	Run-Of-Mine
SC	Silty Sand
SIA	Social Impact Assessment
SKA	Square Kilometre Array
SOP's	Standard Operating Procedures
SRE	Short-range endemics
TEC	Threatened Ecological Community
VSD	Vibration Simulation Device
WAM	Western Australian Museum
WRL	Water Resource Licensing
YLSC	Yamatji Land and Sea Council

17. APPENDICES

APPENDIX A: ENVIRONMENTAL MANAGEMENT PLANS AND STRATEGIES

1. Construction EMP
2. Operations EMP
3. Decommissioning and Closure EMP
4. Acid and Metalliferous Drainage Management Strategy
5. G&G Environmental (2009) – Completion Criteria and Key Performance Indicators for Revegetation at the Crosslands Resources Jack Hills Operation
6. Landloch (2009) – Rehabilitation Strategy

APPENDIX B: SURFACE AND GROUNDWATER ASSESSMENTS

1. Golder Associates (2009b) - Preliminary Surface Water Assessment (Mine Site).
2. Golder Associates (2010) – Surface Water Assessment (Services Corridors).
3. Aquaterra (2010) – Jack Hills Stage 2 Groundwater Management, Groundwater Pre-Feasibility Study.
4. Aquaterra (2009) – Jack Hills Stage 2 Water Supply Investigation.
5. Global Groundwater (2010) – Byro Sub-Basin Hydrogeological Appraisal and Planned Exploration Program for Crosslands Resources Ltd.

APPENDIX C: ACID AND METALLIFEROUS DRAINAGE ASSESSMENTS

1. SGS Lakefield Oretest (2009) – Acid and Metalliferous Drainage Study
2. SGS Lakefield Oretest (2010) – Addendum to Acid and Metalliferous Drainage Study

APPENDIX D: AIR QUALITY ASSESSMENTS

1. Cardno BSD (2009b) – Carbon Reduction Emission Assessment
2. Cardno BSD (2008) – Assessment of Dust Deposition from Operations

APPENDIX E: ASBESTOS REVIEW

1. Golder Associates (2009a) – Review of Asbestos Extent at Jack Hills Deposit, WA

APPENDIX F: BASELINE FLORA, VEGETATION AND FAUNA ASSESSMENTS

1. Ecologia (2009a) – Jack Hills Stage 2 Flora and Vegetation Assessment
2. Ecologia (2009b) – Jack Hills Expansion Project Vertebrate Fauna Assessment
3. Ecologia (2009c) – Jack Hills Mine Expansion Short Range Endemic (SRE) Invertebrate Report
4. Ecologia (2009d) – Jack Hills Mine Expansion – The Shield-back Spider *Idiosoma nigrum* Targeted Survey.
5. Ecologia (2009f) – Troglofauna Assessment of Jack Hills Mine Expansion
6. GHD (2009a) - Jack Hills to DBNGP Gas Pipe Route – Flora and Fauna Study
7. GHD (2009b) - Jack Hills to Weld Range Service Corridor – Ecological Survey
8. GHD (2009c) – Triodia Surveys
9. GHD (2009d) – Associated Infrastructure Areas – Ecological Survey
10. GHD (2009e) *Idiosoma nigrum* Targeted Survey
11. GHD (2009f) – Jack Hills Stage 2 Expansion Project Troglofauna Survey Phase 3 and 4
12. GHD (2009g) – Stage 2 Expansion Regional Stygofauna Survey
13. GHD (2010) – Jack Hills Expansion Project Troglofauna Survey Phase 5 and 6
14. Mattiske (2010) – Review of Differences in Communities on the Jack Hills Project Area
15. Phoenix Environmental Science (2009) – Assessment of the Effect of Exploration Drilling on the Survival of *Idiosoma nigrum* (Idiopidae) at Jack Hills

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