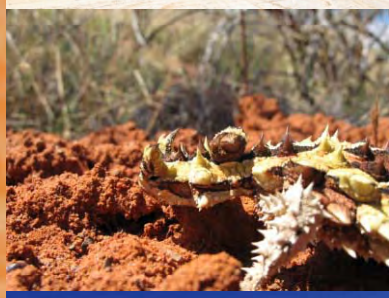
Tropicana Gold Project: Public Environmental Review

7. Environmental Impact Assessment and Management







INDEPENDENCE GROUP NL

360 environmental

7. ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

7.1. ASSESSMENT OVERVIEW

The Joint Venture has undertaken an impact assessment for the proposed Tropicana Gold Project (the Project) in accordance with the EPA Guide to EIA Environmental Principles, Factors and Objectives (EPA 2004b). This chapter specifically examines the potential impact of the Project (described in Chapter 2) on the existing environment (described in Chapter 6). Environmental Impact Assessments (EIAs) are iterative processes using information obtained during baseline studies to determine the environmental values likely to be impacted by the project. EIAs identify potential changes or improvement opportunities that can be incorporated to avoid or otherwise manage adverse environmental impacts to an acceptable level. As discussed in Chapter 3, the Joint Venture has adopted an adaptive management approach that has resulted in baseline information progressively influencing the design of the Project.

Chapter 5 introduced the management strategies (Appendix Series 3) that will be implemented over the life of the Project. This chapter describes the key environmental factors and potential environmental impacts that require management after the Project has been designed to prevent or limits these adverse effects. Chapter 7 also documents specific management measures adopted to ensure such impacts are avoided or otherwise mitigated. These measures are incorporated into high-level management actions that the Joint Venture will commit to over the life of the Project. These actions are referred to as the "Joint Venture Actions" and are outlined at the end of the discussion of each environmental factor. Residual impacts that cannot reasonably be avoided or mitigated through the management actions and measures described in this chapter will be the subject of specific commitments and offsets which are described in Chapter 13.

As discussed in Chapter 3, the main objective for the Joint Venture is to develop the Project so that it meets the environmental and social expectations of current and future stakeholders by preventing or limiting impacts on the environment. Table 7.1 provides examples of how the Joint Venture has responded to concerns raised by stakeholders and environmental information obtained during the Project's baseline surveys.

Table 7.1: Project Changes Based on Stakeholder Feedback and Environmental Knowledge

Design Change	Benefit
Location of the tailings storage facility	• Protect species of conservation interest • Reduce visual impact • Reduce clearing footprint • Improve rehabilitation outcomes
Design and location of the Infrastructure Corridor	• Protect species of conservation interest and heritage values • Reduce greenhouse footprint
Multi-purpose access route for the water supply pipeline, airstrip/ village access	• Reduce clearing
Incorporation of High Pressure Grinding Rolls into the crushing circuit	• Reduce energy consumption • Reduce greenhouse emission • Reduce transportation of material to site
Two stage thickening and processing water recycling	• Reduce water consumption • Reduce energy consumption for pumping • Reduce Greenhouse Emission • Reduce consumption of reagents
Village relocated	• Reduce noise and dust impact at village, and avoid impacts to heritage sites and species of conservation interest

Table 7.2 summarises the Joint Venture's evaluation of environmental factors relevant to the environmental assessment of the Project, and the significance of the factors in the assessment.

Table 7.2: Environmental Factors

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Physical Factors				
Soil Quality and Landform – Relevant to the Operational Area and Infrastructure Corridors				
To maintain the integrity, ecological functions and environmental values of the soil and landform.	• The main project area lies in a broad low valley of sand plain with two intersecting longitudinal dunes. The sand plain soils and vegetation are a ubiquitous central Australian land type. Directly to the west of the processing area is the edge of the main yellow/ orange dunefield. • The Project is described as being in the Southern Great Victoria Zone of the Sandy Desert Region (Tille 2006). • Aeolian sands and colluvium overlie a variably incised lateritic profile. The aeolian sands that form the basis for soils and regolith at the site form large areas of flat featureless plains and longitudinal dunes. • The dunes are generally orientated east west, however localised deviations from this trend indicate that the dunes were formed by westerly winds • The maximum height of the local environment is up to 385 mRL.	• Growth medium loss. • Potentially contaminated material placed on the outer surface of the waste landform. • Potentially Acid Forming or dispersive materials placed on the outer part of the waste landform. • Infrastructure interferes with surface flows.	• The waste landforms will contain overburden and processing waste within the tailings storage facility. The landform height has been designed not to exceed the 375 mRL and collectively cover 1,550 ha. The waste landforms will have a maximum slope angle of 15°, will form a continual slope (rather than benched), and will be covered with 10 m of non-acid forming and non dispersive material, the 1m of growth medium and rehabilitated. • The final pit void will be rendered safe by the installation of abandonment bund set back from the rim beyond the range of possible geotechnical instability. The pit void will be almost entirely surrounded by the waste landforms and will not be visible from outside the direct Resource Area.	• At closure, once built infrastructure has been removed, the land will be reshaped as required to blend into the surrounding landscape. Stockpiled growing medium will be re-spread according to the procedures to be developed and rehabilitated. • Further to discussions with stakeholders, the road, airstrip and village infrastructure may be retained or removed depending on the final land use options agreed as part of mine closure planning.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Surface Water – Relevant to all areas of the Project				
To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected.	• Annual rainfall is approximately 115 – 300 mm. • Surface drainage is a very minor feature in the majority of the Great Victoria Desert (Australian Resources Atlas 2008). The majority of the drainage catchments upstream of the site, and intersecting with the infrastructure corridors, are characterised by sandy soils, low relief, poorly defined drainage lines and areas with strong linear sand dunes with internal drainage. The climate is hot and dry for much of the year with potential evaporation greatly exceeding rainfall. • Two main local catchments are at the mine site – an eastern catchment and a western catchment. • Two broad, low relief drainage lines currently pass through the proposed operational area. • Drainage in the mine site catchments is from the southwest to the northeast, toward the southern reaches of the Lake Rason drainage system	Potential surface water impacts: • Clearing and disturbance increasing erosion risk. • Increased stormwater generation and modification to flow paths associated with disturbed, compacted or built areas • Modification of the existing drainage valley that runs through the site and diversion of stormwater flows from upslope around the west of the mine site. • Discharge of stormwater from the site with elevated levels of sediment or contaminants. • Increased salinity and sediment concentration of stormwater sourced from the road surface. • Overflow of tailings. • Wastewater management. • Dust suppression with hypersaline water. Potential impacts from the construction of an access road are: • Constriction of flows at cross-drainage structures causing downstream erosion and shadowing (e.g. reduced flows due to modification of flow paths) • Ponding upstream of the road, as a result of interruption of runoff flow paths, causing increased water logging or flooding.	• A permanent diversion channel will be installed to divert stormwater around the western side of the mine area. The channel will divert surface run-off from the dunes away from the processing area and TSF towards the Rason drainage area located NE of the mine. • Stormwater generated onsite retained through the creation of a gravity drainage network and storages. With regard to the access road: • Alignment will minimise impacts on major water features at crossings and avoid listed flora. • Minimising the footprint of the road corridor and construction facilities to minimise potential erosion. • Employ soil conservation techniques to prevent erosion and an increase in surface water turbidity such as drainage structures that detain water and reduce flow velocity before discharge, armouring erosion prone points and stabilising slopes during construction. • Use appropriately located and designed culverts or floodways to minimise disruption to natural flow paths, downstream runoff shadowing and upstream ponding. • Minimise salt contamination of downstream surface water by containing saline road construction and dust suppressing water on the road and adjacent table drains.	• During operations, the Joint Venture commits to minimising impacts of the new access roads on surface drainage. • The Project will be designed to prevent impacts on adjacent areas by preventing the discharge of potentially contaminated run-off • Upon closure runoff from the waste landforms will be permanently diverted into the pit void

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Groundwater – Relevant to the Operational Area and Water Supply Area				
Maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected.	• The water supply area is located in an outlier of the Officer Basin sediments within the proclaimed Goldfields Groundwater area. • Aquifer comprises a 250 m thick marine succession fine quartz sandstone, dolomitic siltstone and shale with an almost negligible recharge. Water level is ~ 120 m below surface. • Salinity between 40-80,000 mg/L. • Stygofauna sampling of the area has determined that the aquifer is not a suitable habitat.	• Water will be extracted from the Minigwal Trough for the purposes of mine water supply. Investigations indicate that no groundwater dependent ecosystems will be impacted by abstraction. • Clearing will be required for the pipeline and borefield infrastructure. • Seepage from the tailings storage facility may contaminate groundwater. • Waste water will be generated following the production of potable water. • Dewatering will form part of the open cut mine operation to remove water entering the pits from adjacent areas, generated as a result of rainfall and associated surface flow.	• Borefield and tailings pipeline will be located in bunds or buried and positioned to avoid sensitive environmental areas. • Sand dunes adjacent the dewatering operation will be monitored for water retention levels. • Sand dune vegetation (root zone and geology) profiled during excavations (construction). • Monitoring of groundwater levels, quantity and quality (including groundwater and recharge monitoring against modelling) in the Minigwal Trough. • Effluent associated with water treatment will be mixed into the processing feedwater.	• Predicted drawdowns will have no impact on groundwater dependent ecosystems as linkage between the surface and the deep aquifers is minimal (presence of clay layers). • The depth to groundwater over the impacted area is greater than the rooting depth of local vegetation. • The aquifer is sufficient to meet the Project's process water requirements without causing unacceptable environmental impacts.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Biophysical				
Vegetation and Flora – Relevant to all areas of the Project				
To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• The Project spans the Helms, Austin and Eucla Botanical Districts of the Eremaean Botanical Province • None of the observed vegetation units represent TECs. The ''Yellow sandplain communities of the Great Victoria Desert' is listed as a PEC by the DEC. • One Declared Rare Flora, *Conospermum toddii* was recorded in the Project area • 20 Priority Flora were recorded in the Project broader survey area which covered 230,000 ha. • 15 Priority Flora were recorded in the Project footprint which covered 3,440 ha. • Vegetation communities recorded within the Pinjin, TT Corridor and possibly the Operational Area may be the recently listed PEC 'Yellow sandplain communities of the Great Victoria Desert'.	• Up to 3,440 ha of native vegetation will be cleared. • Vegetation clearing will directly disturb vegetation units and Priority Flora species. • Alteration of surface water flows due to infrastructure may affect local water availability for some plant species. • Vehicle and earth movements could potentially introduce and/ or spread weed species. • Ignition sources resulting in increased fire frequency/ intensity may favour the establishment of weeds and prevent the regeneration of native vegetation, particularly fire-sensitive species, such as mulga. • Emissions such as hazardous materials and hydrocarbons, saline water, and dust may have physical effects on plants. • Introduced fauna.	• All disturbance areas have been subjected to environmental surveys and have been designed to minimise impacts to Priority flora species and avoid sensitive dunal systems. • Infrastructure has been designed to avoid impacts on all known populations of the DRF *C. toddii*. • Project will be progressively implemented to minimise unnecessary clearing. • Infrastructure located on previously cleared areas where practicable (including access roads). • Infrastructure designed to avoid ponding and alteration of water flows. • Flood mitigation measures will be installed in the Operational Area to prevent minesite flooding and release of potentially contaminated runoff. • Implement internal clearing procedure. • A list of conservation significant species will be kept up to date. • Cleared areas no longer required for use rehabilitated as soon as is practicable. • Undertake weed mapping through construction and operations. *continued next page*	• The progressive removal of 3,440 ha of native vegetation and the rehabilitation of 3, 040 ha approximately over the life of the Project. • No significant effect on regional flora and vegetation values, as the vegetation units recorded from the Project area occur more broadly in the region. • No TECs, Declared Rare Flora species or vegetation of high conservation significance will be affected by the Project. • Some locations of Priority Flora species will be disturbed by the Proposal. However, these species are not restricted to the Project locality and occur relatively broadly throughout the GVD.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
			• Weed inventory maintained. • Implement weed hygiene procedures for mining machinery entering/ leaving the Project area. • Management of fire will be undertaken for fires directly associated with the construction and operations of the Project • Fire management will focus primarily on the prevention and control of fires. • Implement dust management procedures. • Implement traffic controls to limit dust. • Implement a dust control strategies during high risk activities such as loading, transport and crushing. • Develop a monitor program to assess impacts of dust sensitive vegetation. • Implement feral fauna management. • Infrastructure design such as the Tailing Storage Facility to ensure containment of any runoff, to prevent uncontrolled discharge of tailings into the environment. • Implement spill response procedures.	

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Terrestrial Fauna – Relevant to all areas of the Project				
To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• The habitats within the Project support a range of fauna species, including several that are endemic to the region and/ or listed for protection under State and Federal conservation legislation. • Listed bird species observed in the survey area include the Australian Bustard (DEC Priority 4), Rainbow Bee-eater (EPBC Act - Migratory), Peregrine Falcon (WC Act – Schedule 1) and the Malleefowl (WC Act – Schedule 1, EPBC Act - Vulnerable). • Marsupial Moles (WC Act – Schedule 1), EPBC Act - Vulnerable) holes were recorded in all areas of proposed infrastructure of the Project. • One species of putative Short Range Endemic was found only in the Project footprint.	• Vegetation clearing will directly disturb terrestrial fauna habitat and may result in the loss of individual terrestrial fauna. • Activities associated with the Project such as increased movement of personnel and machinery use may result in changed fire regimes which pose a threat to species of conservation significance. Such impacts include immediate deaths of conservation interest fauna individuals and populations, loss of critical habitat loss of breeding habitat and habitat fragmentation. • The Project may potentially increase the incidence of feral animals in the area resulting in competition, predation and/ or habitat degradation. • Emissions such as environmentally hazardous materials and hydrocarbons, saline water, and dust may adversely alter fauna habitat. • Animals attracted to the tailings storage facility become trapped. • Death of animals attracted to the water of the tailings storage facility by cyanide-contaminated water.	• Avoidance of critical habitat to listed species. Disturbance to native vegetation will be minimised where possible and all areas requiring clearing will be clearly delineated. Cleared areas will be rehabilitated as soon as is practicable. Rehabilitation will include placing cleared vegetation and logs within the area, as these provide fauna refuge. Clearing will avoid the breeding season of conservation species at risk. • Management of fire directly associated with the construction and operations of the Project will focus primarily on the prevention and control of fires. • The Joint Venture will acquire knowledge of the fire sensitivity of listed fauna and how they respond to various fire regimes. • Implement management controls for invasive fauna. • Implement waste management process. • Design storage, handling and disposal facilities with appropriate bunding/ spill containment. • Implement the Tailings Environmental Management Strategy. *continued next page*	• The Project will result in the progressive loss of up to 3,440 ha of vegetation and subsequent revegetation of up to 3,040 ha over the life of the Project. • Loss of Marsupial Mole habitat due to clearing will displace individuals within the Project. The consequences of this impact are not considered to be significant to local populations within the Project footprint and in the region. • Conservation significant species such as the Malleefowl, Mulgara and Sandhill Dunnart may undergo a localised impact due to the removal of available habitat. The consequences of this impact will be minor, as populations of these taxa are expected to persist. • No fauna habitat of high conservation significance will be significantly affected by the Project. *continued next page*

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
			• Procedures for the management and disposal of hydrocarbons wastes and other environmentally hazardous substances will be implemented. • Manage facility in accordance the Cyanide Management Code. • Limit water storage on the tailings facility. • Waste landform design altered to prevent direct impacts on one putative Short Range Endemics.	• The Project will not conflict with the WC Act, as no terrestrial vertebrate species will cease to exist as a result of the Project. A broad scale fire is highly unlikely but may potentially cause widespread loss of fauna, including listed species, some of which may take years to recover. • Emissions will be reduced through infrastructure design and operation. Consequences to listed terrestrial fauna would be negligible and for the most part at the individual level. • Implementation of feral fauna management will negate any potential risks to listed species at a population level. • No lasting impacts on the potential putative Short Range Endemics restricted to the proposed footprint that will be impacted by the Project. • No animal deaths attributable to poor cyanide management.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Subterranean Fauna – Relevant to the Operational Area and the Water Supply Area				
To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• No Stygofauna species have been recorded. • A single Troglobitic Dipluran was located within the Operational Area (tailings storage facility area) and is currently restricted to the area. • A single Troglobitic centipede was located within the Operational Area (Resource Area) and is currently restricted to the area. • Seven Isopod specimens were collected from five sites, four of which were inside the Operational Area and one was outside.	• Changes to surface hydrology particularly in regards to sealing of recharge areas. • Mining will result in direct habitat loss and potentially the loss of some individuals. • Hydrocarbons spills and discharge of wastewater may degrade the subterranean environment by contaminating surface water and groundwater. • Seepage from the tailings storage facility may contaminate groundwater. • Vibration from blasting activities has the potential to cause changes to geological formations and may decrease (or increase) the habitat available to Troglofauna.	• It is unlikely that the Project will affect regional troglofauna populations as it is likely that troglofauna are utilising three widely distributed zones within the regolith profile. • It is highly unlikely that stygofauna occur either at the Water Supply Area or the Operational Area due to the salinity of the groundwater, historic marine and estuarine incursion in the area and the style of aquifer present (refer sections 6.2.11, 6.5.3 and 7.2.4 for further discussion). Over the life of the Project the Joint Venture may undertake further regional sampling if more suitable aquifers are identified within the region. • Implement land clearing control procedures. • Implement surface water management including diversion of stormwater and retention of site generated stormwater. • Implement pollution prevention controls for hydrocarbon/ chemical spills. • Implement a routine monitoring program of existing bores. • Spill response procedures developed and implemented. • Implementation of the TEMS. • The floor/ basin of the tailings storage facility will be lined to limit contaminated water release.	• The Project will result in a required area for pit voids of approximately 400 ha and a pit depth of 400 m. The impact is unavoidable and all Troglofauna occurring within this area will be impacted. • The contamination of groundwater from spills or seepage from the tailings storage facility represents a low risk to subterranean fauna.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Emissions Management				
Air Quality (Dust) – Relevant to the Operational Area and the Infrastructure Corridors				
To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting Statutory requirements and acceptable standards.	• Due to the remote and vegetated nature of the site, dust levels are essentially natural background levels. • Windblown dust is known to be an existing source of dust in the dry arid environment. • Low levels of fibrous minerals are present within the resource.	• Effects on vegetation can occur due to physical smothering of the leaf surface which results in reduced light transmissions and hence reduced photosynthesis and physical blocking of stomata through particle lodging resulting in a decrease in stomatal resistance. Dust may exacerbate secondary stress, such as drought, insects and pathogens. Effects of dust on natural communities may alter the competitive balance between species in a community. • The generation of dust from construction, earthworks, and traffic movements has the potential to influence local air quality, resulting in adverse impacts on human health, surrounding vegetation, fauna and ambient air quality.	• To prevent any lasting potential dust impact on listed flora the road route has been designed to avoid known populations. • Dust along operational roads will be suppressed by road watering and the periodic application of approved dust suppressing agents. • The maximum allowed level of dust concentration in the air varies depending on background levels and the levels of concern about the airborne material (determined on a risk assessment basis). 1000mg/m^3 of air, measured over 15 minutes is generally an acceptable level according to Dust Guidelines (DEP 1996). • Health risks from airborne dust containing fibrous materials will be either avoided or reduced by implementing dust control strategies such as dust suppression or collection.	• Dust levels maintained and measured to within acceptable health and safety limits.
Noise and Vibration – Relevant to the Operational Area				
To minimise impacts from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	• Noise and vibration levels are essentially, existing, natural background levels due to the remoteness of the location.	• Noise and vibration have the potential to disrupt the fauna behavior. • Vibration from blasting. • Noise from plant operation/ blasting comply with noise regulations.	• Ensure noise and vibration levels are minimised, and are measured to within acceptable standards.	• Noise and vibration levels will be maintained and measured to within acceptable limits.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Social Surroundings				
Indigenous Heritage – Relevant to all areas of the Project				
To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation i.e. the *Aboriginal Heritage Act 1972* and *Native Title Act 1993.*	• The nearest Indigenous communities are at Laverton and at Cosmo Newberry, which are both approximately 220 km away, at Coonana, which is approximately 225 km to the southwest, and at Tjuntjuntjarra, which is approximately 250 km to the east. The Project Operational Area is wholly within the area of the former Wongatha Native Title Claim (NTC reference WC 99/001). • No ethnographic sites previously reported. • 10 archaeological sites were discovered and recorded within the Operational Area. • Only 1 site has been found within the 60 km^2 of the central mining area, with another 9 sites in the estimated 230 km^2 of the remainder of the Operational Area. In addition, 12 sites were found within the 2 proposed road corridors. • No sites were found in the Water Supply Area or in the water pipeline corridor. • The most common archaeological sites are artefact scatters and quarries, with a small number of rock shelter sites.	• Unidentified heritage site(s) is/ are discovered or damaged as part of the works. • Known heritage site(s) impacted by work.	• Avoid and protect all known archaeological sites. • Implement the Heritage Management Strategy. • Ensure Joint Venture employees and contractors are aware of their obligations. • Management of the Indigenous archaeological heritage involves, in the first instance, avoiding any impact to these sites. The current layout and infrastructure planning has taken into account the location of the archaeological sites and been modified as required to achieve site avoidance. • Internal Clearing Permit System incorporated into heritage clearance. • Procedures incorporated into the Heritage Management Strategy for the management of previously unknown sites.	• Greater understanding of regional Indigenous heritage as a result of the Joint Venture's activities at the Project. • The Joint Venture complies with the *Aboriginal Heritage Act 1972* (WA), the *Heritage of Western Australia Act 1990* and all other relevant State and Federal Acts. • In the event that site disturbance is necessary or unavoidable, an application may be made for permission "to use the land" containing a heritage site, in accordance with Section 18 of the WA *Aboriginal Heritage Act 1972.*
European Heritage – Relevant to the Pinjin Infrastructure Corridor				
Ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• A desktop assessment of potential European heritage was undertaken for the Pinjin area which is the most likely disturbance area to have significance for European heritage. • No known site of significance will be impacted by the Project.	• Unidentified heritage site(s) is/ are discovered or damaged as part of the works.	• The current layout and infrastructure planning will not impact any heritage sites.	• Historical and cultural associations have been identified; the Joint Venture will comply with relevant legislation. • Sites identified in the future will be managed in accordance with legislative requirements.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Visual Amenity and Landscape – Relevant to the Operational Area				
To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable. To maintain the integrity, ecological functions and environmental values of landscapes and landforms.	• The GVD is dominated by longitudinal sand dunes with a predominant east-west orientation and ring dunes separated by interdune corridors (or swales) and sand plains • The landforms in the area surrounding the Project vary in height from 2 – 40 m.	• The Project creates a visual impact, whereby the waste landforms and/ or mining infrastructure do not blend in with the existing infrastructure. • Pit voids.	• The maximum height of the proposed Project will not exceed the height of the natural environment. The final waste landform will not project above the surrounding environment (i.e. 375 mRL) and hence will blend into the landscape at closure. The final shape of the waste landform will be gently sloped and blended to the surrounding landscape. • The outer slope of the constructed landform will be similar to the local area ~ 15˚. • The pit void will be surrounded by the waste landform and thus will not be visible beyond the mining area.	• The rehabilitated waste landforms blend as much as possible to the existing landscape. • Mining landform not visible outside the local area.
Recreation and Tourism – Relevant to all areas of the Project				
Ensure that existing and planned recreational uses in the area are not enhanced (to increase access) or compromised.	• Tourism is well-established in the Goldfields region and is fast developing. • The remoteness of the Project means that tourism opportunities are for serious campers and 4WDs. Recreational opportunities are centred on a genuine wilderness experience and therefore tourism infrastructure opportunities are minimal.	• Improved access routes can have a negative impact on adjacent nature reserves, by increased use. • Improved road access is likely to add regional benefit to the local tourism industry and open up opportunities to Indigenous enterprise and employment as well better access for other mineral explorers in the region.	• Access road will be managed as a private road • Authorised use of the road by other users will be controlled by an access agreement which will impose management obligations on the user. • Access decisions will need to involve consultation with key stakeholders. • Access agreement to be formally established with other potential road users.	• Tourism access to local reserves has not had a negative impact on the ecology of the region as a result of the Project. • Further to discussions with stakeholders, the road, airstrip and village infrastructure may be retained or removed depending on the final land use options agreed as part of mine closure planning. • Opportunities that result from the project are supported.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Public Safety – Relevant to all areas of the Project				
Ensure, as far as practicable, that the construction, operation and closure phases of the project do not compromise public safety.	• The remoteness of the region reduces the risk that the works pose a risk to public safety.	• Infrastructure provision or improvements particularly road, telecommunications and power. • The remoteness of the area, and the long travelling distance pose a health and safety risk that will require management.	• Education for staff and contractors as to the risk of remote driving and working in remote areas. • Notify key stakeholders of proposed construction activity and duration. • Install water tanks along the access road.	• All safety and Health legislation met. • Emergency response assistance to remote communities.
Socio-economic aspects – Relevant to all areas of the Project				
To ensure the community are informed about the project and are empowered and involved through all project phases. To ensure that the social and economic value of the region is not adversely impacted. Provide positive benefits for the region where practicable.	• The remoteness of the area provides opportunities for local employment.	• Environmental impacts associated with infrastructure installation. • Infrastructure provision or improvements particularly road, telecommunications and power. • Impacts of shifts and rosters. • Local businesses not supported as part of the Project.	• Work with local Indigenous groups and contractors to identify contracting and job opportunities for Indigenous people. • Extensive consultations have been undertaken to date. • Consultation with Forest Products Commission is ongoing regarding synergies in terms of Indigenous employment and environmental rehabilitation programs. • Use of local suppliers and labour where possible.	• Indigenous enterprise and employment programs result from the Project. • Contribution to local government authority areas in terms of financial support and participation. • Long-term infrastructure enhancement opportunities present if agreed with key stakeholders.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Other				
Decommissioning and Closure – Relevant to all areas of the Project				
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.	• At Closure some areas will already be under rehabilitation. • Decommissioning (demolition, salvage, prep for rehabilitation). • Rehabilitation of all outstanding areas. • A new phase of negotiation with Stakeholders towards relinquishment.	• Infrastructure not decommissioned. • Failure to achieve agreed Completion Criteria. • Loss of opportunity for other users.	• A life of mine Closure Strategy updated and refined as closure approaches. • Develop Rehabilitation Strategy and Completion Criteria. • Ongoing consultation with stakeholders via the Closure Consultation Committee.	• Satisfying agreed completion criteria. • Relinquishment of lease with no liability to the community.
Rehabilitation – Relevant to all areas of the Project				
Ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.	• Following disturbance for mining and support infrastructure rehabilitation will be required for approximately 3, 040 ha including the reconstructed landform such as the waste landform.	• Failure to achieve agreed Completion Criteria. • Loss of suitable grow medium. • Poor vegetation establishment. • Rehabilitation activities not compatible with intended land use.	• Rehabilitation Research Program to identify missing areas of knowledge and then undertaking focused research. • Develop Completion Criteria early to drive the rehabilitation effort. • Progressive rehabilitation where possible. • Construct landforms that are stable and support target ecosystems. • Rehabilitation Strategy premised on determining appropriate ecosystem, managing growing medium, revegetating, monitoring and remediation if required. • Ongoing consultation with key stakeholders via Closure Consultation Committee.	• Rehabilitated landform will blend into the adjacent landscape. • Landforms are safe, stable and non-polluting. • Revegetation establishment similar to the adjacent natural environment.

EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Matters of 'National Environmental Significance' (NES) – Relevant to all areas of the Project				
Note: in the absence of specific EPA or DEWHA objectives, The Project's objective is to avoid and/ or mitigate significant impacts to matters of NES.	Evidence of several NES species was recorded within the surveys of the Project: • Marsupial Mole (*Notoryctes typhlops* or *caurinus*) - listed as Endangered under the EPBC Act; • Malleefowl (*Leipoa ocellata*) - listed as Vulnerable under the EPBC Act; • *Conospermum toddii* (listed as Endangered); and, • The Rainbow Bee-eater (*Merops ornatus*) - listed as Migratory under the EPBC Act (sighted on 60 occasions).	• Loss of Declared Rare Flora. • Loss of threatened or migratory species.	• Implementation of the Threatened Species and Communities Management Strategy. • Avoid and protect Declared Rare Flora populations within the Project tenements. • Design infrastructure corridors to avoid EPBC listed species critical habitat • Manage dust to limit any indirect impacts on EPBC Listed species located adjacent to the Project. • Manage the tailings storage facility to prevent impacts on Listed species via the Tailings Environmental Management Strategy. • Work with key agencies to reduce non-Project processes on EPBC Listed species.	• No decline in Declared Rare Flora, threatened or migratory species as a result of the project. • Avoid *C. toddii* populations recorded in the survey area. • Localised removal of Marsupial Mole and Malleefowl habitat does not alter the status of the species. • No impact on migratory species as directly attributable to the Project.

7.2. DIRECT IMPACTS

7.2.1. Soil Quality and Landform

Management Objective

The objectives of the Tropicana Gold Project (the Project) for the management of soils and landforms are to maintain the integrity, ecological functions and environmental values of the soil and natural and reconstructed landforms.

Description of Factor

Landform

As described in Chapter 6 the Project is located in the GVD which is dominated by longitudinal sand dunes with a predominant east-west orientation and ring dunes separated by interdune corridors (or swales) and sand plains. These sandplains sit at an elevation of 350-500 m Australian Height Datum, dropping to less than 300 m in the south (Appendix 2.A1). Other landforms present are scarpland-breakaways and residuals of various forms (cuestas, mesas, buttes, stony hillocks and hills) (Tille 2006). The Project site is generally vegetated with a mixture of tree, shrub, and grass species. Vegetation appears to be a significant factor in the stability of the dunes. The dunes consist of loosely packed sand, whereas the swale areas are typically massive red earths (Appendix 2-B11).

Soil Description

The dominant soil colours of red and yellowish-orange was identified for the majority of samples of 'Quaternary sand' geological description (Appendix 2-B12). In terms of the physical characteristics, the major trends in regolith geology / lithology as determined by Outback Ecology (Appendix 2-B16) were:

- A dominant regolith profile lithologies included quaternary sands, quaternary sands underlain by calcrete or (suspected) laterite, and combinations of arenite topsoils or subsoils. Soil profiles at sites with arenite materials consisted either entirely of arenite, arenite over conglomerate rock or sand over arenite.
- Other regolith lithologies included;
    - quaternary sand over ferricrete
    - quaternary sand over (suspected) saprolitic clay
    - quaternary sand over sandstone
    - quaternary sand over tertiary sand
    - calcrete
    - calcrete over silcrete
    - laterite / lateritic duricrust
    - (suspected) sandstone or ferricrete.

Further descriptions for soil strength, pH, structural stability and soil chemical characteristics are discussed in detail in Appendices 2-B16, 2-B14 and 2-B18.

Applicable Standards and Guidelines

- Guidelines on the Safe Design and Operating Standards for Tailings Storage (DME 1999)
- The Strategic Framework for Tailings Management (DoIR 2003)
- Environmental Notes on Mining Waste Rock Dumps (DME 2001)
- Mine Void Water Issues in WA (WRC 2001)
- Landform Design for Rehabilitation (Environment Australia 1998)
- Guidance No.6 Rehabilitation of Terrestrial Ecosystems (EPA 2006)
- Guidance No.33 Environmental Guidance for Planning and Development (EPA 2008).

Potential Impacts

The potential impacts to soils and landforms resulting from the Project are:

- the creation of a permanent pit void/s;
- the construction of a waste landforms;
- physical presence of mine infrastructure; and,
- rehabilitation risks.

The management of these potential impacts is strongly associated with mine closure, therefore rehabilitation and mine closure are covered in detail in Chapter 10.

Pit Void

Potential Impacts

To access the resource, the open cut mining operation will create a permanent pit void. At its full extent the pit void will be 420 m deep and up to 400 ha in area. The pit walls will vary in steepness depending on the occurrence of the resource and the mining sequence.

At between 20 m and 50 m depth below the current surface, the pit void will intersect with a saline aquifer that is about 20 m to 30 m thick (Appendix 2-B17). The groundwater will mainly express from fractures and joints in the water bearing rock strata. At the cessation of mine operations, pit dewatering will discontinue and the pit will gradually fill to create a permanent saline lake. Modelling by Pennington Scott (Appendix 2-B17) suggests that the water in the pit void/s will stabilise at around 170 – 180 mbgl approximately 50 – 100 year after mining ceases.

Potential impacts to landforms resulting from the creation of a permanent pit void may result in:

- safety issues - geological stability and risk of pollution;
- landform modification may reduce the aesthetic value and visual quality of the area; and,
- public safety concerns.

Management Measures

The final pit void will be rendered safe by the installation of an abandonment bund set back from the rim beyond the range of possible geotechnical instability. The pit void will remain post operations. The pit void will be almost entirely surrounded by the waste landforms and will not be visible from beyond the actual minesite. During the life of the Project, consideration will be given to inpit dumping that does not compromise future economic opportunities such as underground mining or pit cutbacks.

Modelling by Soil Water Consultant (Appendix 2-B19) suggests the water quality in the void will remain at pH levels >7, with evaporative concentration of groundwater and alkalinity inputs from weathering of exposed NAF material being the primary drivers. Given the predicted alkalinity of the pit water it is not expected that metals will increase to problematic concentrations as the pH of the water will likely limit their solubility. It is also predicted that the pit water will likely become hypersaline after 50 years.

Waste Landforms

Potential Impacts

The waste landforms, containing overburden and surrounding tailings storage facility, will have a maximum height of 375 mRL and collectively cover up to 1,550 ha (including tailings storage facility). The waste landforms will surround the pit void. They will have a maximum slope angle of 15° and will form a continual slope (rather than be benched). The surface of the waste landforms will be covered with at least one metre of growing medium and vegetated with local plant species.

Potential impacts to soils and landforms resulting from the creation of a permanent waste landform may result in:

- potential release of acid run-off;
- potential release of metals;
- modified landscape that may reduce the aesthetic value and visual quality of the area; and,
- wind erosion of dune sand used during restoration activities of unvegetated soil or sand susceptible may not be revegetated.

Management Measures

Work by SRK and Soil Water Consultants (Appendices 2-B18 and 2-B19) has shown that the total volume of potentially acid forming waste (PAF) that will be mined is less than 15 % of the total volume of waste material. The buffering capacity of the non-acid forming (NAF) and acid neutralising waste far exceeds the potential acidity (total mass of acidity is only 1/50th of the total mass of readily available alkalinity). Therefore the potential for acid rock drainage is minimal. Co-dumping of PAF and NAF further reduces the risk of acid drainage, as does the addition of a 10 m capping of NAF material over the co-dumped waste at closure. The establishment of a vegetated cover over one metre of growth medium further reduces the risk by minimising the penetration of water to the NAF capping layer (Appendix 2-B13).

Appendix 2-B19 also contains information on the potential bioavailability of metals from the waste material. Leach tests of samples representing 92% of the total volume of waste material demonstrated that:

- under neutral conditions (i.e. simulating rainfall) there was a low release of metals, predominantly calcium, magnesium, sodium, barium, manganese strontium and boron); and,
- under acidic conditions (i.e. if acid was generated from the waste due to oxidation of PAF materials) release of metals increased, and additional metals could be released including cobalt, beryllium, cadmium, lead, molybdenum, nickel, tin and zinc.

As mentioned above, the risk of acid generation and release from the waste material is minimal, therefore the tests under neutral conditions are more likely to represent conditions for the Project. Capping of the co-dumped waste with the 10 m NAF layer and a one metre layer of growth medium will significantly reduce the ability of vegetation on the surface of the WML to access the released metals. Metal drainage from the WML is anticipated to have a very low risk of occurrence.

The landform heights and slopes are designed to create landforms that will ultimately blend into the surrounding landscape. The maximum height of the landforms will be 375 mRL. This will make the waste landform summits lower than surrounding high landscape and not visible outside the broad valley containing the Resource Area. The slopes are similar to the maximum angle of local dunes. Management of the waste landform is covered in more detail in Chapter 10.

The progressive rehabilitation program incorporating the Rehabilitation Research Program aims to establish suitable local vegetation communities that blend into the local landscape and provide similar ecological services (see Appendix 2-A5 for further information regarding rehabilitation options for the waste landforms).

Other Infrastructure

Potential Impacts

As the existing landscape at the proposed location of mine operations (such as the processing plant and workshops) is essentially flat, the existing landform will not be substantially reconfigured to accommodate the infrastructure. Other areas requiring clearing and developing will include the village, the Water Supply Area, aerodrome and infrastructure corridors. Infrastructure Corridors will be constructed as all-weather unsealed roads. The road corridors travel through a range of landscapes.

Management Measures

At closure, once the built infrastructure has been removed, the land will be reshaped as required to blend into the surrounding landscape. Stockpiled growing medium will be re-spread and revegetated with local species.

The water extraction borefield will be designed to accommodate bores and connecting infrastructure but all other land and vegetation within the borefield will be untouched.

The infrastructure corridors have been subjected to environmental surveys, this information has been incorporated into the corridor design and proposed route surveys. The proposed routes have taken into consideration a range of criteria including:

- avoiding listed flora species;
- avoiding heritage sites; and,
- avoiding sensitive dunal systems.

Soil Values and Rehabilitation

Potential Impacts

Due to the remote location, only a limited amount of knowledge is currently available about the regeneration strategies of flora found within the region, as consequence it not yet fully determined what will be technically feasible in a reconstructed landscape. An adaptive management approach will be used to build on current knowledge through information obtained during the construction/ operational phases on the viability of harvesting the soil stored seed bank, determine the typical rooting depths of key stone species and soil moisture levels through the soil profile. While the knowledge is being collected cleared vegetation and growing medium will be stockpiled for later use in rehabilitation. As new information become available new practices will be adopted to optimize the rehabilitation outcome for the project. This pattern of clearing, stockpiling and growing medium reuse will continue throughout the life of the Project.

Impacts related to rehabilitation include:

- failure to establish self-sustaining vegetative cover; and,
- rehabilitation falls short of agreed completion criteria.

Rehabilitation is discussed in more detail in Chapter 10 and Appendix 2-A5.

Management Measures

As noted, there are a number of unanswered questions regarding the values and use of growing medium in this desert environment. These questions are to be addressed in the Rehabilitation Research Strategy and the answers will inform the approach to handling growing medium. The research will centre on the following questions:

- Is there a soil seed bank or other biotic values at this site that can be utilised to improve rehabilitation outcomes?
- Are there methods for handling and storing topsoil/ soil stored seed bank that will preserve the biotic values and activate them when the soil is re-utilised?
- Can the deeper regolith be utilised as a growing medium?

This research will determine how much growing medium is required to establish a vegetative ecosystem compatible with the surrounding environment and the volume required to rehabilitate the waste landforms. To do this the Joint Venture will:

- develop procedures for characterising the topsoil and regolith into growing medium (i.e. material that forms a stable landform and will support vegetation) and material that is not suitable as growing medium;
- develop a growing medium material budget to ensure that sufficient growing medium is reserved for the areas requiring rehabilitation;
- develop procedures for segregating, stripping and stockpiling growing medium; and,
- develop procedures for reconstructing landforms and spreading growing medium in a way that will support local vegetation.

Rehabilitation management is covered in detail in Chapter 10 under Closure and Rehabilitation.

The Joint Venture Actions

Action 1: Create safe, stable landforms that blend into the existing environment. This requirement forms part of the Completion Criteria as outlined in the Conceptual Mine Closure and Rehabilitation Strategy.

Action 2: Manage growth media to maximise the return on rehabilitation efforts and take advantage of natural biotic values. The studies required to assist in meeting this action will be managed via the Project Rehabilitation Research Strategy.

Action 3: Investigate all options to limit the clearing to only the area absolutely necessary. Consideration will be given to inpit tailings and waste material dumping over the life of the Project taking into consideration mineral resource extraction and technical, economic and sustainability issues.

Action 4: Develop and Implement of a CEMS and OEMS.

7.2.2. Flora and Vegetation

Management Objectives

The objectives of the Project for the management of flora and vegetation are to:

- maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge;
- minimise the loss and adverse impacts to native vegetation; and,
- minimise impacts to Listed Flora species and species of conservation interest within the Project footprint.

Description of Factor

Listed Flora

Flora species currently classified as listed species identified within the Project footprint are presented in Chapter 6 for each area of the Project. Table 7.3 describes the listed species found within the Project footprint and number of locations likely to be affected by the Project. Figure 7.1 shows the listed species that will be impacted to some extent by the Project at the Operational Area. Figure 7.2a-m shows the listed species identified within the Pinjin survey corridor that are constraints to the final alignment of the Mine Access Road. Figure 7.3a-o shows the listed species identified within the TT Corridor that are constraints to the selection of the alignment for the fibre optic cable. Figure 7.4 (Minigwal Water Supply Area) and Figure 7.5 (Borefield pipeline) show the locations of listed flora that are constraints for the locations of bores the alignment of the pipeline, respectively.

One DRF and 20 Priority Flora were recorded within the 230,000 ha survey area for the Project.

In the context of statutory requirements, the most significant flora species present within the survey area is the DRF *Conospermum toddii*. *C. toddii* was recorded in the Operational Area and the Pinjin Infrastructure Corridor surveys, and is believed to occur in some of the vegetation communities found along the TT Corridor, however, it was not recorded within the Project impact footprint (refer Figures 7.1 and 7.2a-m). Due to the extensive representation of this taxon within the Queen Victoria Spring Nature Reserve, it may be deemed relatively secure.

Of the Priority Flora recorded in the Project survey, the taxa considered most vulnerable are the Priority 1 taxon *Dampiera eriantha*. However this species is not predicted to be impacted by the clearing for the Project. An assessment of the impacts on recorded Priority Flora has determined that 13 Priority Flora species are likely to be directly affected by the Project footprint (Table 7.3). For additional information on this assessment refer to the MBS Report in Appendix 2-F3). In earlier versions of the Project's layouts, clearing would have resulted in impacts to *Baeckea* sp. Sandstone and *Physopsis chrysotricha*, however because surveys have shown these species to be locally uncommon, the Joint Venture has altered the layout to avoid clearing impacts. As such the site access route within the Operational Area and the TT Corridor has been altered.

To determine population estimates and potential population impacts, MBS (Appendix 2-F3) undertook the following process to determine the percentage of each population impacted:

- All duplicates were removed.
- Points within 100 m were merged (defined as one population) and the sum of plant counts was taken for each point to provide the most accurate measure of plant numbers.
- The total number of plants occurring within the conceptual layout was divided by the sum of all plants recorded in the greater region and the Project surveyed areas to provide a percentage disturbance to known threatened species.

Three of the Priority Flora recorded within the Project survey area will have greater than 5% of the known populations (including the Regional Data) removed by the Project (Figure 7.1). These species are:

- *Acacia eremophila* var. *variabili*s (~ 5%);
- *Acacia eremophila* numerous nerved variant (~10%); and
- *Eucalyptus pimpiniana* (~9.5%).

One species *Dicrastylis cundeeleensis* appears to have an estimated 46.5% of its surveyed population located within the project footprint (Figure 7.1). This is likely to be an artefact of the surveys undertaken as the species has been recorded in four different vegetation communities within the Pinjin survey corridor and four communities within the operational survey area (Figures 7.1 and 7.2). Also this species was only described in 2007 after the Project flora surveys commenced which means that populations recorded in the initial phase of work many have been recorded as another species. This species was also only included on the DEC Priority list in 2008.

Daviesia purpurascens will be locally affected within the Operational Area where it has been determined that 94% of the local population is within the proposed operational footprint. However, on a regional scale, the impact is less than 5% of known populations.

Of the seven Priority Flora species recorded in the Minigwal Trough survey area (Table 7.3), the Project will only impact *Olearia arida* and *Dicrastylis nicholasii/ cundeeleensis* (Figure 7.4). Impacts to these species will be limited to less than 10% of the identified population within this area.

Table 7.3: Priority Flora Species Recorded in the Tropicana Gold Project Footprint

Species	DEC Priority Listing	Record in the Project Footprint (estimated % of population affected)[1]	Project Survey Populations (No. plants)[2]	Florabase Records (plants)
Baeckea sp. Great Victoria Desert	2	One location on Pinjin Three locations on the TT Corridor 14 locations in the Operational Area 4 locations in the Minigwal Borefield **(0.47%)**	125 (815,294)	7 (>250)
Dicrastylis nicholasii	2	Ten locations on the TT Corridor 121 locations Operational Area 14 locations in the Minigwal Borefield and 10 on Minigwal Pipeline route. **(0.7%)**	368 (8,791,146)	8 (unknown)
Grevillea secunda	2	Two locations on Pinjin Two locations on the TT Corridor One location in the Operational Area (**0.13%)**	17(82)	16 (>90)
Olearia arida	2	One location on the TT Corridor 34 locations in the Operational Area 4 locations on the Minigwal Pipeline. **(0.67%)**	127 (547,043)	7 (unknown)
Acacia eremophila numerous nerved variant	3	12 locations in the Operational Area **(11.72%)**	21 (731)	7 (unknown)
Acacia eremophila var. *variabilis*	3	1 location in the Operational Area **(4.9%)**	3 (45)	16 (unknown)

Species	DEC Priority Listing	Record in the Project Footprint (estimated % of population affected)[1]	Project Survey Populations (No. plants)[2]	Florabase Records (plants)
Dicrastylis cundeeleensis	3	Two locations on Pinjin Three locations on the TT Corridor 26 locations in the Operational Area One location in the Minigwal Borefield **(46.52%)**	81 (8,744)	11 (unknown)
Eucalyptus pimpiniana	3	Two locations on Pinjin **(9.53%)**	11 (554)	11 (>600)
Microcorys macredieana	3	Two locations on the TT Corridor Four locations in the Operational Area Two locations in the Minigwal Borefield **(0.39%)**	70 (45,576)	22 (unknown)
Micromyrtus stenocalyx	3	13 locations in the Operational Area **(0.02%)**	103 (2,118)	17 (>70)
Comesperma viscidulum	4	One location on Pinjin One location on the TT Corridor **(0.05%)**	9 (33)	9 (>30)
Daviesia purpurascens	4	One location on Pinjin Two locations on the TT Corridor 13 locations in the Operational Area One location in the Minigwal Borefield **(2.37%)**	39 (23,390)	51(>300)
Lepidobolus deserti	4	Two locations on Pinjin One location in Minigwal Borefield **(0.00%)**	99 (5,147)	19 (>100)
Caesia talinyka ms		Two locations in the Operational Area **(0.44%)**	61 (668)	-

1. Percentage of populations recorded by the Project surveys and Joint Venture commissioned regional surveys
2. Includes data from a threatened species surveys within Queen Victoria Spring, Plumridge Lakes and Neale Junction Nature Reserves commissioned by the Joint Venture
3. Analysis completed on behalf of the Joint Venture by MBS Environmental; refer to Appendix 2-F3 for complete report. (Data used in the MBS was derived from all baseline survey data, targeted threatened species survey data, Joint Venture GIS threatened species field data and Florabase/Naturemap informtation).

Vegetation

Communities of conservation interest are not federally or state listed, but are considered locally less common. Table 7.5 lists the maximum percentage of each vegetation community that may be cleared within the Operational Area if the Project reaches its maximum predicted extent. Table 7.6 lists the maximum percentage of each conservation interest vegetation community that occurs on the Pinjin and TT Corridor. No communities of conservation interest were recorded along the Borefield pipeline corridor, those occurring within the designated Minigwal Borefiled will not be impacted. Figure 7.1 shows the communities of conservation interest that will be impacted to some extent by the Project at the Operational Area. Figures 7.2, 7.3, 7.4 and 7.5 show the vegetation communities of conservation interest that are constraints in the final positioning of the Mine Access Road in the Pinjin Corridor, the fibre optic cable in the TT Corridor, bores within the Minigwal Borefield and the pipeline within the Borefield pipeline corridor, respectively.

At the Operational Area, the vegetation community that will be impacted to the greatest extent by clearing for the Project is “Mixed eucalypt woodlands over mixed open shrubs and *Triodia basedowii*” which will have 5.45% of its

total surveyed area removed Area which is considerably less than the level of 30% below which species loss is considered to accelerate exponentially at an ecosystem level (EPA 2000a). Communities of conservation interest at the Operational Area are primarily located on the dunes, particularly the extensive dune-fields locate to the west of the project footprint. The Joint Venture is minimizing impacts to dunes through the Project.

No TECs as defined by the EPBC Act or the DEC were observed in the Project survey area.

As described in section 6.6, The PEC 'Yellow sandplain communities of the Great Victoria Desert' appears to be present in some sections of the Pinjin Infrastructure Corridor and the TT Corridor. The DEC has identified mining activities as a potential threatening process to this PEC. Although large areas of this PEC appear to occur west of the TT Corridor and to the east and north of the Pinjin Infrastructure Corridor (Appendix 2-C5, F8), further details about the extent and location are still unknown, partly due to a lack of state-wide mapping of the PEC and the lack of a formal description of the community. The vegetation community that appears to be the most representative of the PEC as described in section 6.6 has not been observed in either of the Pinjn or the TT Corridor survey area but has been observed throughout the region (Appendix 2-C5).

There are six sections of the proposed Pinjin infrastructure corridor and two section of the TT Corridor that potentially intersect with the PEC. Impacts to the PEC on the TT Corridor are expected to be minimal as the clearing width for the installation of the proposed fibre optic cable will be restricted to a few metres along the length of the corridor.

To date, little information has been available regarding the plant assemblages of this PEC (J. Pryde, DEC, pers. comm.). Vegetation communities that the Joint Venture considers might represent the PEC are being considered as constraints to the alignment of infrastructure through the corridors (Figures 7.2 and 7.3). In order to determine the risk to any vegetation associated with the PEC, a conservative approach was taken by identifying the extent and type of communities found on yellow and yellow-orange sand in areas thought to be the PEC (Table 7.4). Of the vegetation communities found on yellow and yellow-orange sand dunes, approximately half of the area impacted is the E4 community (Table 7.4 and Appendix 2-C5) which is widespread throughout the region. The proposed corridor avoids the community S11 (Appendix 2-C1, 2-C2 and 2-C5).

Table 7.4: Summary of Direct Impact within Communities found on Yellow and Yellow-Orange Sand within the Potential PEC along the Pinjin Corridor

Vegetation Community	Yellow and yellow-orange sand within survey area (ha)	Yellow and yellow-orange sand within proposed corridor (ha)	Percentage impacted by proposed corridor
E4	1170.70	62.97	5.38
S5	771.62	32.34	4.19
S8	168.09	16.27	9.68
S9	204.83	12.17	5.94
S11	69.12	0.00	0.00
Total	2384.36	123.75	5.19

Six plant communities within the Pinjin survey corridor have been identified as of conservation interest; these were S11, E10, E11, S1, S4 and S9 (Figure 7.2). These communities were identified as being of importance, either because they supported a DRF species (S11) or other conservation interest species (S9), or because of their limited distribution within the Pinjin Infrastructure Corridor.

Six plant communities within the TT survey corridor have been identified as of conservation interest; these are E1B, E1C, E2B, END, T5B and T8A (Figure 7.3). These communities were identified as being important, either because they contain habitat suitable to support DRF species (E2D) or other conservation interest species, or because they have a limited distribution within the survey corridor (T5B).

Two plant communities (E5 & E6) within the Minigwal Trough survey area (including the pipeline corridor) have been classified as of conservation interest because they are the least common vegetation communities encountered (Figure 7.4 and 7.5); no impact is predicted to these two communities. None of these communities supported DRF species and as such are not considered regionally significant. Seven communities supported Priority species, and as such are considered to have local significance.

Table 7.5: Percentage of Each Vegetation Community that will Potentially be Cleared Within the Operational Area (Source: Appendix 2-F3)

Vegetation Unit	Surveyed Area (ha)	Area Impacted (ha)	Maximum % Cleared
Mixed eucalypt woodlands over mixed open shrubs and *Triodia basedowii*	30,823	2,331	7.56
Isolated *Acacia* spp. over open low shrubs and moderately dense tussock grasslands	12,678	194	1.53
Minor Clay Pan: Scattered *Acacia nyssophylla/ Grevillea sarissa* over open herbs and grasses	174	2.51	1.44
Dunes: Scattered E*. gongylocarpa* over mixed shrubs and *Triodia desertorum* or *T. basedowii*	6,009	72	0.15
Acacia aneura woodlands over grasses ± *Triodia basedowii*	28,089	274	0.73
Open to moderately dense *Acacia aneura* over *Aluta maisonneuvei* subsp. *auriculata/ Acacia ramulosa* var. *ramulosa* over *Eremophila forrestii* subsp. f*orrestii* over *Triodia basedowii*	19,661	185	0.94
Eucalyptus gongylocarpa/ E. youngiana/ E. concinna over open mixed shrubland over *Triodia desertorum*	1,425	2.74	0.19
Open to moderately dense *Casuarina pauper* woodland over open mixed shrubs and scattered soft grasses and/ or *Triodia scariosa*	4,992	4.28	0.09
Narrow drainage channel: Sparse *Acacia aneura* over sparse to open shrubs and moderately dense tussock grasses	243	0	Nil
Rocky breakaways and associated slopes: Open *Acacia quadrimarginea/ Dodonaea rigida* over sparse mixed shrubs over mixed soft grasses	221	0	Nil
Eucalyptus gongylocarpa over open shrubland over open *Dodonaea viscosa* subsp. *angustissima/ Eremophila platythamnos* subsp. *platythamnos* shrubland over *Triodia desertorum* or T*. basedowii*	15,428	0	Nil
White to grey brown clay pans: Dwarf halophytic shrublands of variable composition over sparse to dense herbs and grasses	265	0	Nil
Pale orange to orange clay pans: Low open to sparse scrub dominated by *Frankenia cinerea/ Atriplex vesicaria* over sparse cover of *Eragrostis pergracilis/ Aristida contorta*	427	0	Nil
Shallow depressions and areas fringing some claypans: Moderately dense *Melaleuca interioris* shrubland over sparse chenopods and soft grasses	66	0	Nil
Plains and gentle hill slopes at margins of saline complex: Sparse to open *Casuarina pauper* ± mallee Eucalypts over *Dodonaea viscosa* subsp. *angustissima/ Senna artemisioides* subsp. *petiolaris* over Chenopod species and soft grasses	1,281	0	Nil
Open mallee *Eucalyptus concinna* over sparse to open low shrubs over open *Triodia scariosa*	13,519	0	Nil
	135,367.50	3,065	

Note: % impacts in table 7.4 include solar thermal area no longer required by project. Actual impact will be less than presented due to the reduced area.

Table 7.6: Percentage of Each Conservation Significant Vegetation Community that will Potentially be Cleared within the Project

Vegetation Unit	Surveyed Area (ha)	Area Impacted (ha)	Maximum % Cleared
Pinjin Infrastructure Corridor (30 m Corridor width)			
S1: Tall open scrub of *Callistemon phoeniceus*. This community occurs on pink-brown clay adjacent to a seasonally wet area.	70.5	0.27	0.38
S4: Open heath of *Melaleuca hamata* over *Aluta maisonneuvei* subsp. *auriculata* with *Grevillea acuaria*. This community occurs on orange sandy clay in low lying seasonally wet areas.	6.7	0.93	14.0
S9: Low shrubland of *Leptosema chambersii, Baeckea* sp. Great Victoria Desert (P2), *Homalocalyx thryptomenoides, Enekbatus eremaeus, Cryptandra distigma* with mixed low shrubs and occasional emergent *Eucalyptus* spp. This community occurs on yellow-orange sandy loams on lower and mid slopes.	305.5	14.0	4.6
Tropicana-Transline Communications Corridor (5 m Corridor width)			
E1B: Sparse mixed *Eucalyptus youngiana/ Eucalyptus concinna* trees, over sparse to open *Acacia ligulata/ Grevillea juncifolia* subsp. *temulenta/ Acacia murrayana* tall shrubs, over open to moderately dense *Keraudrenia velutina* subsp. *elliptica/ Aluta maisonneuvei* subsp. *auriculata/ Acacia helmsiana/ Hannafordia bissillii* subsp. *bissillii/ Acacia sibina*, over sparse to open mixed *Triodia* spp. hummock grasses.	1609.17	3.1	0.19
E1C: Open *Eucalyptus gongylocarpa* mallees, over sparse *Acacia aneura/ Acacia ligulata/ Grevillea juncifolia* subsp. *temulenta* tall shrubs, over open to moderately dense *Bertya dimerostigma/ Acacia helmsiana/ Keraudrenia velutina* subsp. *elliptica* shrubs, over moderately dense *Triodia tomentosa* hummock grasses.	1604.8	4.3	0.27
E2B: Sparse *Eucalyptus gongylocarpa/ Eucalyptus youngiana* mallees, over open *Callitris preissii/ Thryptomene biseriata/ Acacia ligulata* tall shrubs, over open *Anthotroche pannosa/ Hakea francisiana/ Eremophila decipiens* subsp. *decipiens* shrubs, over scattered mixed *Triodia* spp. hummock grasses.	3267.8	6.7	0.21
E2D: Sparse to open *Eucalyptus trivalva/ Eucalyptus youngiana* mallees, over open *Callitris preissii/ Thryptomene biseriata/ Leptospermum fastigiatum* tall shrubs, over sparse *Anthotroche pannosa/ Microcorys macrediana/ Pityrodia loricata* shrubs, over scattered *Glischrocaryon aureum* herbs.	326.4	0.45	0.14
T5B: Open *Eucalyptus concinna/ Eucalyptus youngiana* mallees, over scattered *Acacia ligulata/ Acacia hemiteles* tall shrubs, over scattered *Scaevola spinescens/ Grevillea nematophylla/ Acacia rigens/ Grevillea acuaria*, over open to moderately dense *Triodia rigidissima* hummock grassland.	2633.2	7.0	0.27
T8A: Sparse *Eucalyptus youngiana* mallees, over scattered *Acacia ligulata* tall shrubs, over sparse *Grevillea acacioides/ Grevillea juncifolia* subsp. *temulenta/ Mirbelia seorsifolia/ Keraudrenia velutina* subsp. *elliptica* shrubs, over open to moderately dense *Triodia basedowii* hummock grassland.	3429.5	8.0	0.23

Applicable Guidelines and Legislation

Environmental Protection Authority Objective and Guidance

In most circumstances, including this assessment, the EPA applies the following objective in its assessment of proposals that may affect flora and vegetation:

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

EPA Position Statement No. 3 (EPA 2002b) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia. The Position Statement intends to provide the following outcomes:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and, therefore, the need to develop and implement best practice in terrestrial biological surveys; and,
- enable greater certainty for proponents in the formal environmental impact assessment process by defining the principles the EPA will use when assessing Proposals that may have an effect on biodiversity values.

In addition to the above requirements, EPA principles described in section 5.1 requires surveys undertaken as part of the formal EIA process to address guidelines produced by the EPA, in this case Guidance Statement No. 51 Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (EPA 2004c).

State Legislation

Native flora in Western Australia is protected at a State level under the WC Act. Under this Act, flora species listed as Declared Rare Flora (DRF) are afforded specific protection as threatened species. This Act is periodically reviewed and the current list of DRF is provided in the Western Australian Wildlife Conservation (Rare Flora) Notice 2008. Declared Rare Flora are defined as “taxa which have been adequately searched for and deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild”.

Ecological communities in Western Australia are also protected by the DEC and can be listed as ‘Threatened Ecological Communities’ (TEC’s) once they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee and are then endorsed by the Minister for Environment. TEC’s are listed under four categories; Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) (DEC 2008d).

Department of Environment and Conservation Priority Species and Ecological Communities

The Department of Environment and Conservation (DEC) maintains a list of Priority Flora taxa and Ecological Communities. Priority Flora taxa, which are considered poorly known, uncommon, or under threat, but for which there is insufficient justification based on known distribution and population sizes for inclusion on the DRF schedule. Priority Flora taxa are assigned to one of four Priority categories (Atkins 2006). Possible threatened ecological communities that do not meet the survey criteria mentioned above are added to the DEC’s Priority Ecological Community (PEC) Lists. PEC’s are listed under five categories based on survey criteria and current knowledge, Priority 1, 2, 3, 4 and 5 (Department of Environment and Conservation 2008).

Federal Legislation

Threatened flora species are protected at a National level under the Federal EPBC Act.

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of ‘national environmental significance’ (NES), to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources, and to promote the conservation of biodiversity.

The EPBC Act includes provisions to protect native species and communities (and in particular prevent the extinction, and promote the recovery, of threatened species). There are six parts to the EPBC Act covering species that are:

- extinct;
- extinct in the wild;
- critically endangered;
- endangered;
- vulnerable; and,
- conservation dependent.

The EPBC Act also provides for the identification and listing of Threatened Ecological Communities (TECs). This Act lists TEC's that are defined as Critically Endangered, Endangered or Vulnerable.

Potential Impacts

The potential impacts to flora and vegetation resulting from the Project are:

- clearing of native vegetation;
- introduction of weeds;
- fire;
- dust;
- salinisation of soil or vegetation death from saline water use;
- alteration to surface water flow and groundwater level;
- introduced fauna; and,
- emissions.

Indirect and direct impacts as discussed below can potentially occur throughout the Project life and may include the removal of individuals and partial loss of populations of species of Priority flora or of conservation significance. Figure 7.1 shows the flora and vegetation values potentially impacted in the Operational Area. Clearing impacts will be the principle impact to Priority Flora.

Clearing of Native Vegetation

Potential Impacts

Primary impacts to flora and vegetation proposed by the Project will result from vegetation clearing. Should the Project reach its maximum potential 3,440 ha of native vegetation would be removed. This represents 1.7% of the area that has been floristically mapped (230,000 ha) over the Operational Area (Figure 6.11), Bypass Road, Infrastructure Corridors (Figures 6.17 and 6.19), Water Supply Area and pipeline (Figures 6.21 and 6.23 respectively) and Power Supply.

Clearing of vegetation is an unavoidable impact associated with the development of any mining project. The clearing of native vegetation will directly disturb vegetation units and Priority Flora species as described previously.

Potential impacts resulting from the clearing of native vegetation and the development of infrastructure for the Project are the:

- unavoidable loss of individual conservation interest flora species;
- unavoidable loss of sections of various vegetation communities;
- loss and/ or degradation of sections of various habitats required for the survival of specific listed flora species;
- fragmentation of populations of conservation interest flora species and communities; and,
- alteration of local surface water flows.

Management Measures

The following management measures will be implemented or have been implemented by the Joint Venture to prevent or mitigate impacts of land and habitat disturbance on native flora populations:

- all disturbance areas have been mapped over a much larger area than the actual clearing requirements to enable an informed assessment of potential impacts;
- prevent unnecessary clearing of vegetation (including the access roads);
- No DRF (*Conospermum toddii*) population will be removed or impacted by the Project.
- All DRF population within 50 m of a disturbance area will be clearly delineated in the field.
- avoidance:
    - the Joint Venture will avoid community S11 (as it is known to support *C. toddii*) when aligning the mine access road within the Pinjin Infrastructure Corridor; and
    - clearing impacts from the development of the borefield and the water pipeline will avoid known locations of most Priority Flora recorded in the area. The exceptions to this are *Dicrastylis nicholasii* and *Olearia arida* populations. These species are ubiquitous within the survey area. The pipeline requires a 10 m clearing corridor and the area mapped is 100 m wide. Species of conservation significance will generally be avoided within this corridor. Regardless, impacts will be minimised by taking the path of least environmental impact and the Joint Venture will not clear more that 10% of the recorded population within the Water Supply Area and pipeline corridor infrastructure has been designed and located to avoid impacts on all known populations of DRF and potential habitats such as sand dune systems suitable for *Conospermum toddii*. The Joint Venture will avoid community S11 (as it is known to support *C. toddii*) when aligning the mine access road within the Pinjin Infrastructure Corridor;
- minimise:
    - Infrastructure has been designed and located to minimise clearing impacts on all known potential habitats of DRF such as sand dune systems suitable for *Conospermum toddii*;
    - Infrastructure areas will be designed and located to avoid known locations of Priority Flora and other flora species of conservation interest (i.e. *Baeckea* sp. Sandstone and *Physopsis chrysotricha*) where reasonably practical i.e. the corridors have been designed to avoid crossing over dunes which appear to be the preferred habitat of many of the Listed and conservation interest flora species. Borrow pits will be placed to minimise impacts to Priority flora;
    - Impacts to the preferred habitats of Priority Flora will be minimised;
    - Clearing impacts to vegetation communities believed to be associated with the PEC (such as S11 on the Pinjin Infrastructure Corridor and the yellow to yellow-orange sand dunes) will be minimised;

- obtaining an approval for all areas to be cleared and ensure that all facilities are located within the approved area;
- disturbance to native vegetation will be minimised where possible and all areas requiring clearing will be clearly delineated;
- a database of species and communities of conservation interest will be established for the region and maintained for duration of the Project;
- implementation of a Threatened Species and Communities Management Strategy (TS&CMS) (Appendix 3-E);
- implementation of the Construction Environmental Management Strategy (CEMS) and Operational Environmental Management Strategy (OEMS) (Appendices 3-B and 3-C respectively);
- to counterbalance any disturbance that may occur to conservation interest flora species, Joint Venture will establish a nursery to grow DRF and Priority species known to occur in the Project area for use in progressive rehabilitation where appropriate; and,
- cleared areas no longer required for use will be rehabilitated as soon as is practicable (refer section 7.2.7 and Chapter 10). Progressive rehabilitation will be conducted throughout the Project life with revegetation continued after mine closure (refer section 7.2.7 and Chapter 10).

Introduction of Weeds

Potential Impacts

At present the Project area has remarkably low levels of weed invasion, with only three taxa recorded, all of which were recorded at low frequency. However, increased vehicular traffic, combined with the introduction of machinery, earthworks and disturbance in the area, disposal of water and domestic operations, and increased human activities may introduce or provide an opportunity for additional species to become established unless weed hygiene procedures are implemented. The potential impacts of weeds are:

- competition for resources with native flora;
- degradation of critical habitats for native flora and fauna species;
- contribution to altered fire regimes resulting in altered habitats for native flora and fauna species; and,
- reduced success of rehabilitation.

Management Measures

Specific management actions have been identified to assist in minimising the potential sources of weed infestations and containing, controlling and/ or eradicating target weed species from the Project area.

The risk of introducing weed species will be minimised through the implementation of the following management measures:

- implementation of the CEMS and the OEMS (Appendices 3-B and 3-C respectively);
- undertake weed mapping and maintain a weed inventory;
- undertake regular site inspections to record any new observations of weed infestations or changes in weed distribution especially near known populations of DRF;
- staff inductions to include information on weed identification, reporting of weeds and procedures to prevent the spread of weeds;

- undertake weed hygiene throughout the life of the mine i.e. All machinery, vehicles and plant to be free of soil and vegetative matter upon arrival on site. An inspection of machinery/ vehicle/ plant will be conducted upon arrival on site to confirm this;
- minimising soil disturbance during clearing;
- weed control/ treatment program for 'High Priority' species;
- gravel and borrow material will be sourced locally, therefore free of *Phytophora* and weed propagules;
- domestic waste to be disposed of in the correct manner to prevent seed invasion from food waste products;
- following rehabilitation, areas will be monitored and treated for weed invasion if required; and,
- if required, weed control to be implemented in rehabilitation if required.

The CEMS and the OEMS outline the monitoring and reporting commitments relevant to weeds management.

Fire

Potential Impacts

Fires are a frequent occurrence in hummock grasslands in the semi-arid and arid zones of Australia. Although the native flora is adapted and in many instances dependent upon fire for activation of seed germination, too frequent or too hot bushfires can result in detrimental changes to the composition and diversity of the vegetation, causing local extinctions of vulnerable species.

Activities associated with the Project may result in an increased likelihood of accidental fire. Potential impacts on native flora and vegetation resulting from accidental fire comprise:

- immediate deaths of native flora and fauna individuals and populations;
- increased proliferation of weeds;
- altered vegetation structure;
- altered habitat unable to provide conditions for native flora species to recolonise; and,
- uncontrolled release of contaminated fire water.

Management Measures

Management of fire directly associated with the construction and operations of the Project will focus primarily on the prevention and control of fires. The risk of fire resulting directly from Project mining-related activities can be minimised by implementing management measures such as:

- implementation of the CEMS and OEMS (Appendices 3-B and 3-C respectively);
- ensure facilities comply with Local Government fire prevention requirements;
- open fires will only be allowed in designated area and no fires will be allowed during fire ban periods. Unauthorised fire use will be a dismissible offence;
- Emergency Response Team to be adequately equipped and trained in fire response;
- work that may start fires will not be conducted in fire risk areas on days deemed to have a high fire risk;
- a Fire Prevention and Control management strategy will be established in consultation with DEC and local authorities;
- correct storage and isolation of flammable liquids;

- implementation of safe smoking practices and appropriate disposal of cigarette butts;
- the Pinjin and TT Corridors will act as major fire breaks for the region, along with other minor roads created for the mine; and,
- prevention of unauthorised off-road driving by Project staff and contractors and limiting the use of petrol fuelled vehicles in uncleared areas.

The CEMS (Appendix 3-B) and the OEMS (Appendix 3-C) outline the monitoring and reporting commitments relevant to fire of the Joint Venture.

In addition, the Joint Venture will acquire knowledge of the fire sensitivity of listed flora species and vegetation communities and how listed species respond to various fire regimes. Little information is available at present due to the limited knowledge base for the region. Further information can be generated as part of the Biodiversity Trust (see section 13.1.3). This information will be incorporated into the Project Fire Prevention Control Strategies.

Dust

Potential Impacts

There is the potential to generate excessive amounts of dust while undertaking earthworks and leaving earthen surfaces unrehabilitated. Wheel generated dust from haul trucks and general traffic is predicted to be the greatest source of dust. Mining activities, material handling and wind entrainment of fine particles from the waste landform and tailings storage facility are other potential sources of dust.

The distance between the Pinjin Mine Access Road and conservation significant flora along the surveyed corridor is shown in Table 7.7. Impacts to *Conospermum toddii* are unlikely due to the distance of all likely populations being over 350 m from the road, and impacts to *Hibbertia* are also unlikely (all populations at least 400 m from the road). Some Priority species are located within 50 m of the proposed road alignment and therefore may be impacted by dust from the road. All species have locations at least 300 m from the alignment, a distance at which impacts from dust could be expected to be minimal.

Potential impacts of dust on conservation interest species and vegetation include:

- plant stress (as a result of the clogging of plant reducing photosynthesis and transpiration and making plants less attractive to pollinators) or chemical effects (altered soil chemistry). This is particularly prevalent along roads and tracks; and,
- alteration of habitat negatively impacting on conservation interest flora species.

Table 7.7: Cumulative number of populations of conservation significant flora and distance to the Pinjin Mine Access Road

		Distance from proposed road alignment (m)																	
Species	Status	10	20	30	40	50	60	70	80	90	100	150	200	250	300	350	400	450	500
Conospermum toddii	DRF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2
Hibbertia sp. nova	new	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Baeckea sp. Great Victoria Desert	P2	1	2	6	8	10	11	12	12	13	13	13	15	15	15	17	17	17	17
Dicrastylis nicholasii	P2	1	2	2	2	3	5	5	5	6	6	6	7	7	7	7	7	7	9
Grevillea secunda	P2	2	3	3	4	4	4	6	6	6	6	7	7	10	10	10	11	11	11
Olearia arida	P2	0	0	1	1	2	2	2	3	3	3	4	4	5	5	5	5	5	6
Thryptomene eremaea	P2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Dicrastylis cundeeleensis	P3	2	2	5	6	8	9	9	10	10	10	17	18	22	22	22	23	23	23
Eucalyptus pimpiniana	P3	1	4	5	5	6	6	6	9	9	9	11	12	12	12	12	14	14	14
Microcorys macredieana	P3	0	1	1	1	2	2	2	2	2	3	5	6	6	6	7	8	8	8
Micromyrtus stenocalyx	P3	0	0	1	4	5	6	6	6	6	6	8	10	11	11	12	12	12	12
Comesperma viscidulum	P4	1	1	3	4	4	6	6	6	6	6	9	9	10	10	10	11	14	14
Daviesia purpurascens	P4	1	2	5	7	7	7	9	11	13	13	16	19	20	21	22	23	26	27
Lepidobolus deserti	P4	1	2	2	4	6	6	8	10	10	11	14	16	17	17	18	19	22	22

Management Measures

Increased vehicle movements and mining operations have the potential to increase dust on the site. Dust management will include:

- implementation of the CEMS and OEMS (Appendices 3-B and 3-C respectively);
- minimise disturbance area to what is absolutely necessary by limiting clearing and progressively rehabilitating to limit windblown dust generation;
- land clearing and topsoil stripping will not be undertaken during periods of high wind;
- dust suppression techniques will be used on internal roads to minimise dust generation. The method and rate will be dependent upon location and climatic conditions at the time;
- minimise the number of roads required on site;
- limit road speeds near dust sensitive vegetation and ensure road speeds are manage to on other road to reduce dust generation and safety issues;
- village location will be positioned outside the National Environment Protection Measure for Ambient Air Quality 50ug/m^3 24-hour PM10 emission contour;
- implement a dust control strategy during high risk activities such as loading, transport and crushing;
- dust control strategies within the crushing area will achieve 80% effectiveness;

- develop a monitoring program to assess impacts on dust sensitive vegetation; and,
- surface stabilisation methods such as sealing, sheeting, shielding and chemical treatments, will be employed in areas where dust emission are likely to cause OSH issues.

The CEMS and the OEMS outline the monitoring and reporting commitments relevant to dust.

Saline Water

Potential Impacts

As the groundwater in the region is saline, damage to vegetation and flora may occur when groundwater is inappropriately used (such as overwatering of roads) or disposed off. Due to the scarcity of water in the semi-arid and arid zone, pit water is a convenient and economical source of water for gold processing for the Project. The saline nature of the local groundwater also makes it an effective binding agent which encourages a crust to form on the surface of roads and stockpile, which further helps to suppress dust (Bertuch and van Etten 2004).

Management Measures

The watering of haul roads is considered normal practice in Western Australia and is a convenient way to dispose of surplus water generated by the pits. Runoff of salty water from roads and the subsequent effects on soil will be carefully managed for example, by using appropriate drainage techniques. The Joint Venture will use equipment suitable to the task and water will be applied at an appropriate rate to minimise dust and to avoid runoff and saline scalds. As a contingency measure, drains will be installed adjacent to the roads to capture saline runoff, to prevent impact of adjacent vegetation.

Alteration to Surface Water Flow

Potential Impacts

The establishment of a mining project in any region may affect local surface water flows which if not managed can adversely affect some plant species or vegetation communities. This alteration can cause local drought conditions or cause water to be retained causing vegetation to become waterlogged, in either case the result can be vegetation death. Linear infrastructure, such as roads, above-ground pipes and the airstrip, are most likely to cause significant surface water impacts, if drainage controls are not properly installed.

The Joint Venture does not envisage that alteration to surface water flow will affect conservation significant flora species as they tend to occur in high infiltration areas (e.g. on dune crests, which are being avoided). It is possible that if roads and drainage structures are not appropriately designed and managed changes in surface flow associated can have negative impacts on mulga. The root systems of mulga are specially adapted to obtain water from the thin soil surface layer therefore alterations to surface water flow may impact water uptake of this species (Bertuch and van Etten 2004).

Management Measures

To prevent impacts associated with altered surface water flows the following management actions will be adopted:

- stormwater diversion drains will be installed within the Operational Area;
- diversion system installed across the Operational Area will separate clean and potentially dirty stormwater;
- potentially dirty stormwater from the Operational Area will be retained onsite through the creation of a gravity drainage network and storages;

- design infrastructure to avoid ponding and the alteration of water flows. Surface water dispersion systems will be incorporated into road corridors to prevent interference with surface flow critical for vegetation survival; and,
- water pipeline corridors will be designed not to interfere with surface water flow and to prevent infrastructure damage by surface flows.

Introduction of Introduced Fauna

Potential Impacts

Although feral species are already established in the region, the Project may potentially increase the incidence of feral animals in the area which may impact native flora species in the following ways:

- habitat degradation including compression of dunes, reducing the value of dunes as habitat;
- feral herbivorous species (rabbits, goats) grazing native flora species; and,
- grazing of rehabilitated areas.

Management Measures

To prevent impacts associated with introduced fauna the following management actions will be adopted:

- all waste materials (particularly putrescible waste) will be appropriately disposed of to prevent habitation by fauna;
- restricted access to potential food sources such as the landfill;
- support regional feral animal project undertaken by DEC or Department of Agriculture and Food;
- manage artificial water sources to prevent animal access; and,
- impacts to the existing environment due to the introduction of fauna can be managed by the implementation of the CEMS and the OEMS (Appendices 3-B and 3-C respectively).

Emissions

Potential Impacts

Development of the Project will require the use and production of materials that are potentially hazardous to the environment. These include:

- general and putrescible wastes and associated disposal facility;
- workshops, chemical storage areas and other dangerous goods (e.g. cyanide) or controlled wastes (e.g. waste oil);
- tailings and associated tailings storage facility; and,
- saline groundwater which has the potential to damage vegetation.

Potential impacts to native flora species include:

- habitat modification;
- rise in groundwater; and,
- contamination of surface water and groundwater.

Management Measures

Impacts to the native vegetation and flora resulting from the generation of waste, hazardous materials and contamination will be mitigated by:

- implementation of the CEMS and the OEMS (Appendices 3-B and 3-C respectively);
- implement a site recycling program to support WA's ZeroWaste WA policy;
- manage industrial waste in accordance with *Environmental Protection (Controlled Waste) Regulations 2004*;
- manage the site landfill in accordance with *Environmental Protection (Rural Landfill) Regulations 2002*;
- design infrastructure such as the tailings storage facility to ensure containment of any potentially contaminated runoff and to prevent uncontrolled discharge of tailings into the environment;
- the tailings storage facility will be designed and constructed to limit the potential release of seepage water through the installation of a basin liner, seepage recovery system and by recovering water at the plant prior to the releasing of the tailings into the tailings storage facility;
- surface runoff will flow to the retention pond, where any sediment will settle out prior to the water being used in the processing plant or for dust suppression;
- compliance with the International Cyanide Management Code; and,
- development and implementation of spill emergency response procedures.

The CEMS and the OEMS outline the monitoring and reporting commitments of the Joint Venture.

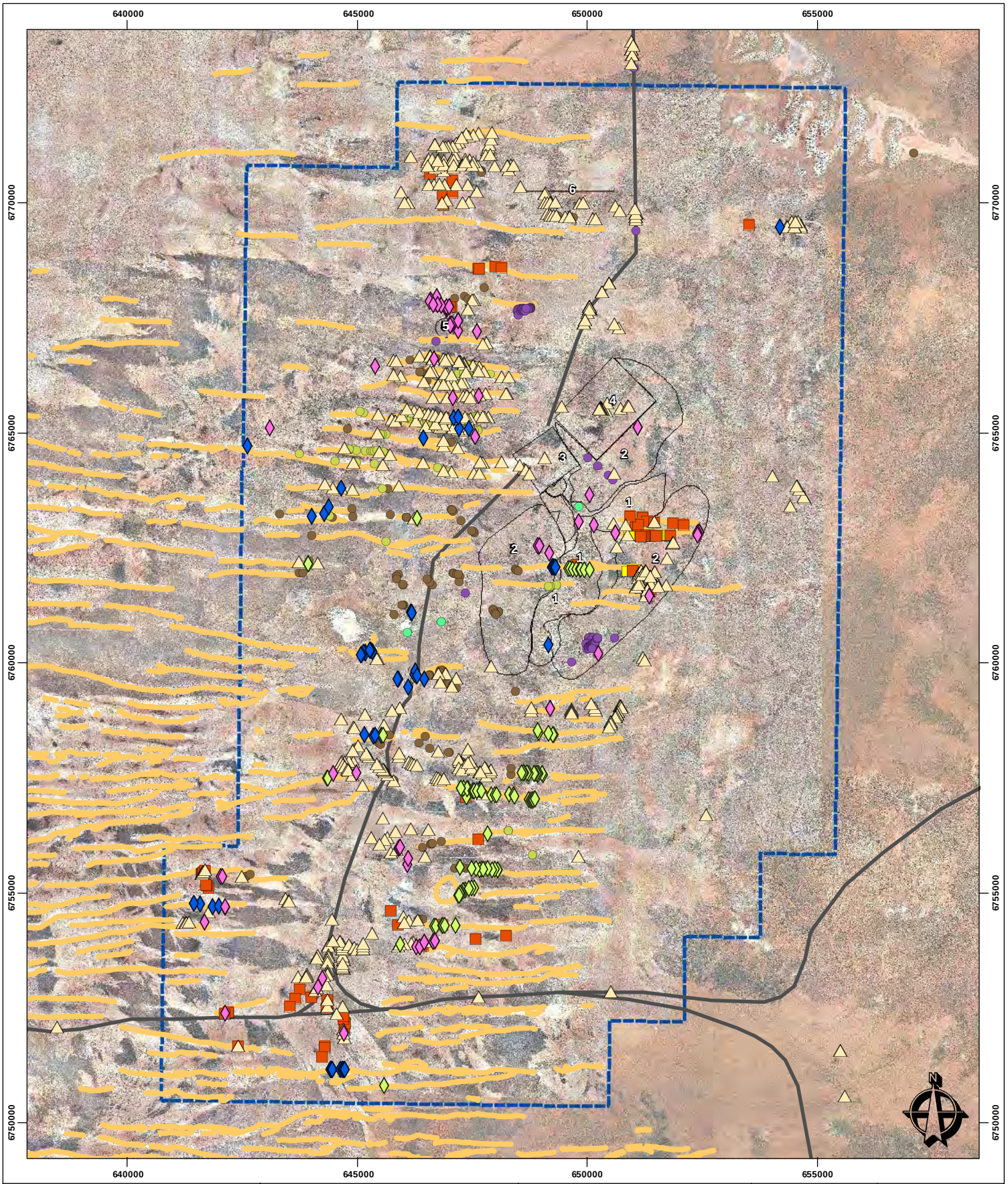
The Joint Venture Actions

Action 5: A Threatened Species and Communities Management Strategy (Appendix 3-E) will be finalised in consultation with the DEC prior to the commencement of ground disturbing activities. The Strategy has been developed for the management of Project identified threatened species and communities that are known, or predicted to occur, within the Project and the surrounding environment. The strategy identifies risks to threatened species and communities within the Project footprint, identifies the risks associated with the construction and operation of the Project and presents proposed mitigation and management techniques to minimise the impact of the Project on threatened species and communities. The Threatened Species and Communities Management Strategy will be implemented throughout the life of the project.

Action 6: The Joint Venture will undertake additional surveys and research to improve the knowledge of the distribution, abundance and biology of conservation interest taxa directly affected by the Project as part of the Biodiversity Trust Offset (section 13.1.3).

Action 7: The Joint Venture will construct and operate the tailings storage facility in accordance with the Tailings Environmental Management Strategy.

Action: Implement Joint Venture Action 4 as described in section 7.2.1.



Legend

Listed Flora

- *Acacia eremophila* numerous-nerved variant
- *Acacia eremophila* var. *variabilis*
- *Baeckea* sp. Great Victoria Desert
- *Caesia talingka* C. Tauss ms
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*
- *Olearia arida*

Sand Ridge (Threatened Flora and Fauna Habitat)

Conceptual Site Layout

1: Resource Area
2: Waste Material Landforms
3: Processing Area
4: Tailings Storage Facility
5: Village
6: Airstrip

Operational Area

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 500 1,000 2,000 3,000 4,000

Metres

1:110,000 @ A4

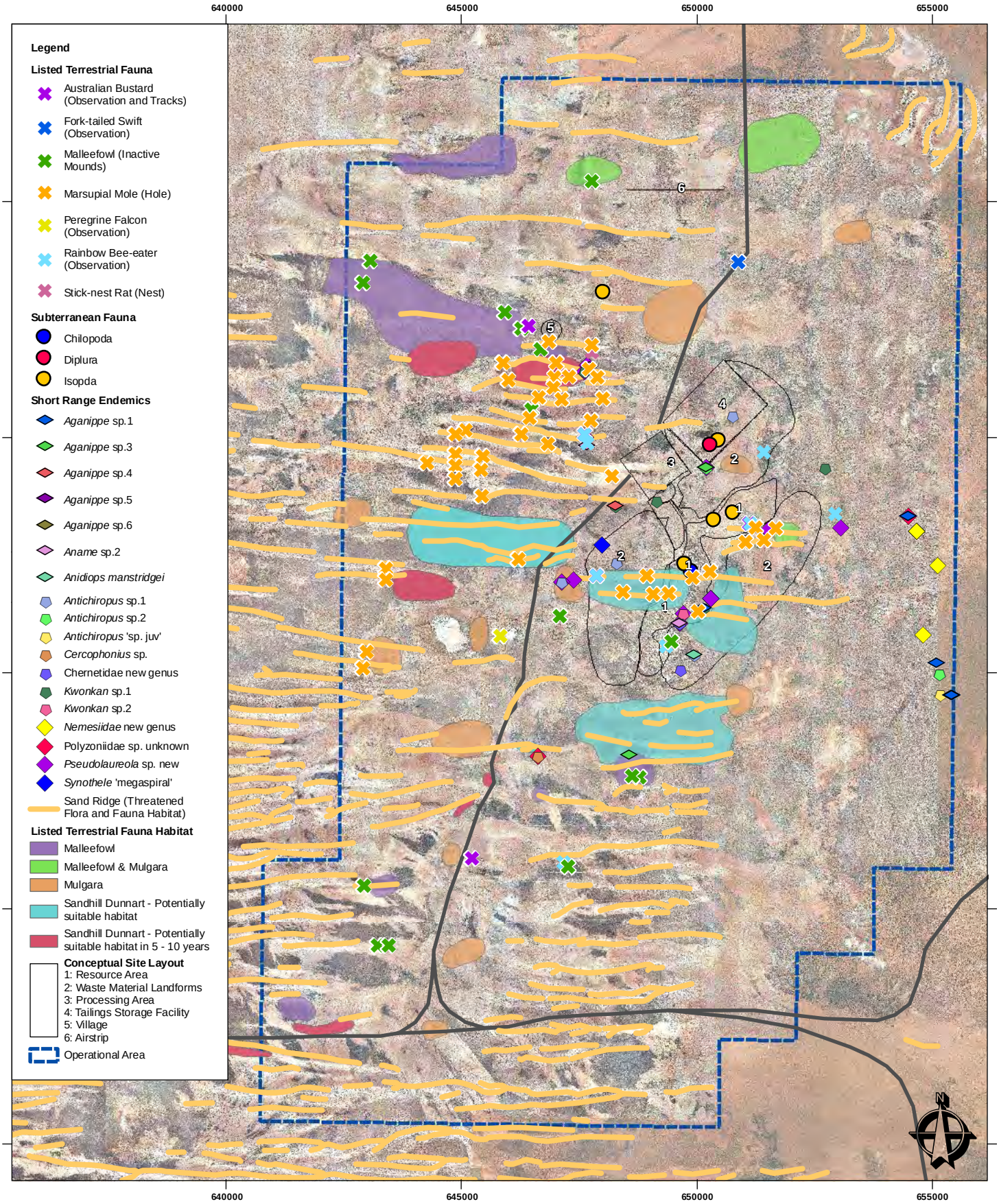
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING ID**
19.08.09	0	351-1.17a

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Operational Area Impact Map - Flora and Vegetation
Figure 7.1a



Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 500 1,000 2,000 3,000 4,000

Metres

1:110,000 @ A4

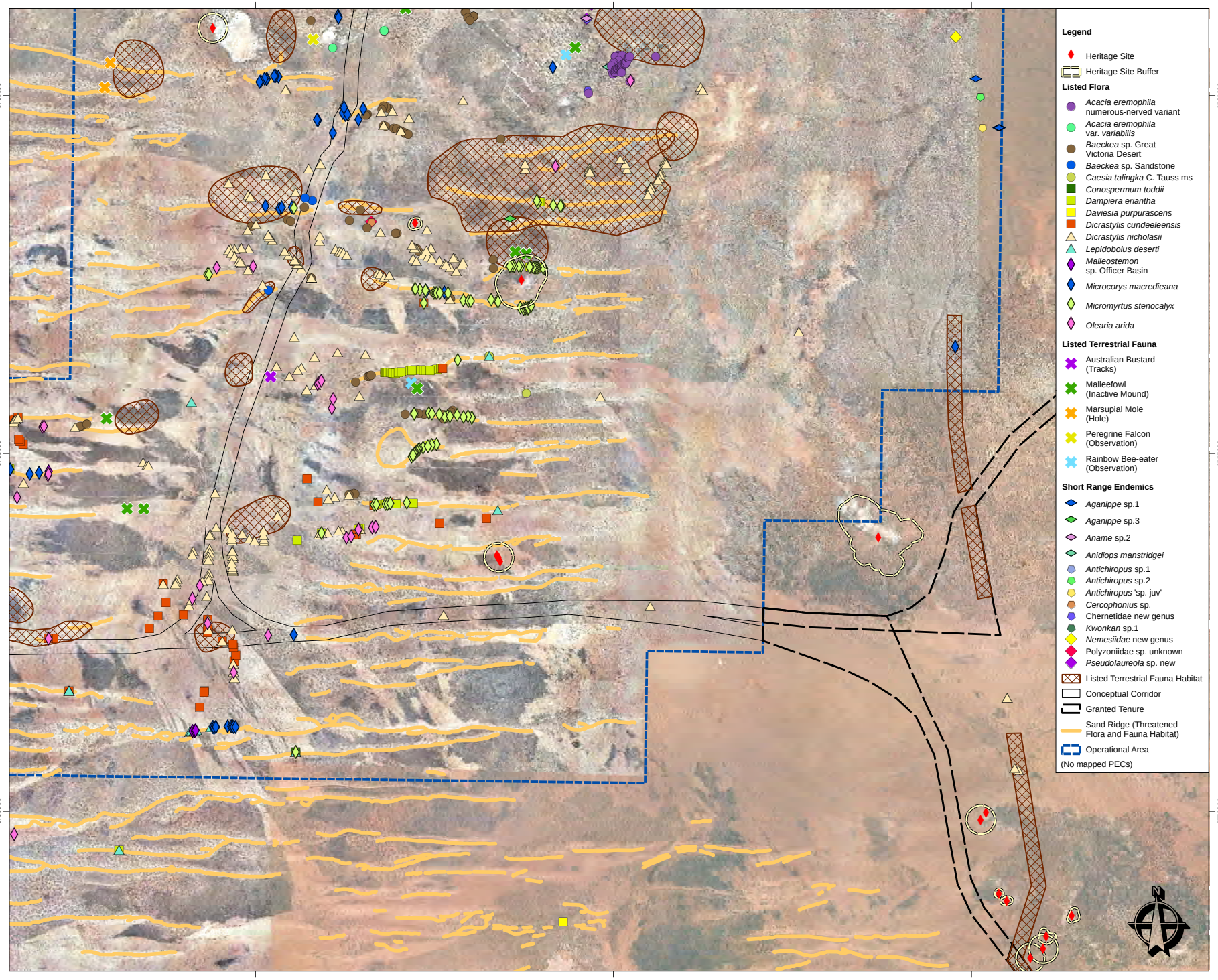
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING ID**
19.08.09	0	351-1.17b

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Operational Area Impact Map - Fauna (Terrestrial and Subterranean)
Figure 7.1b



Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

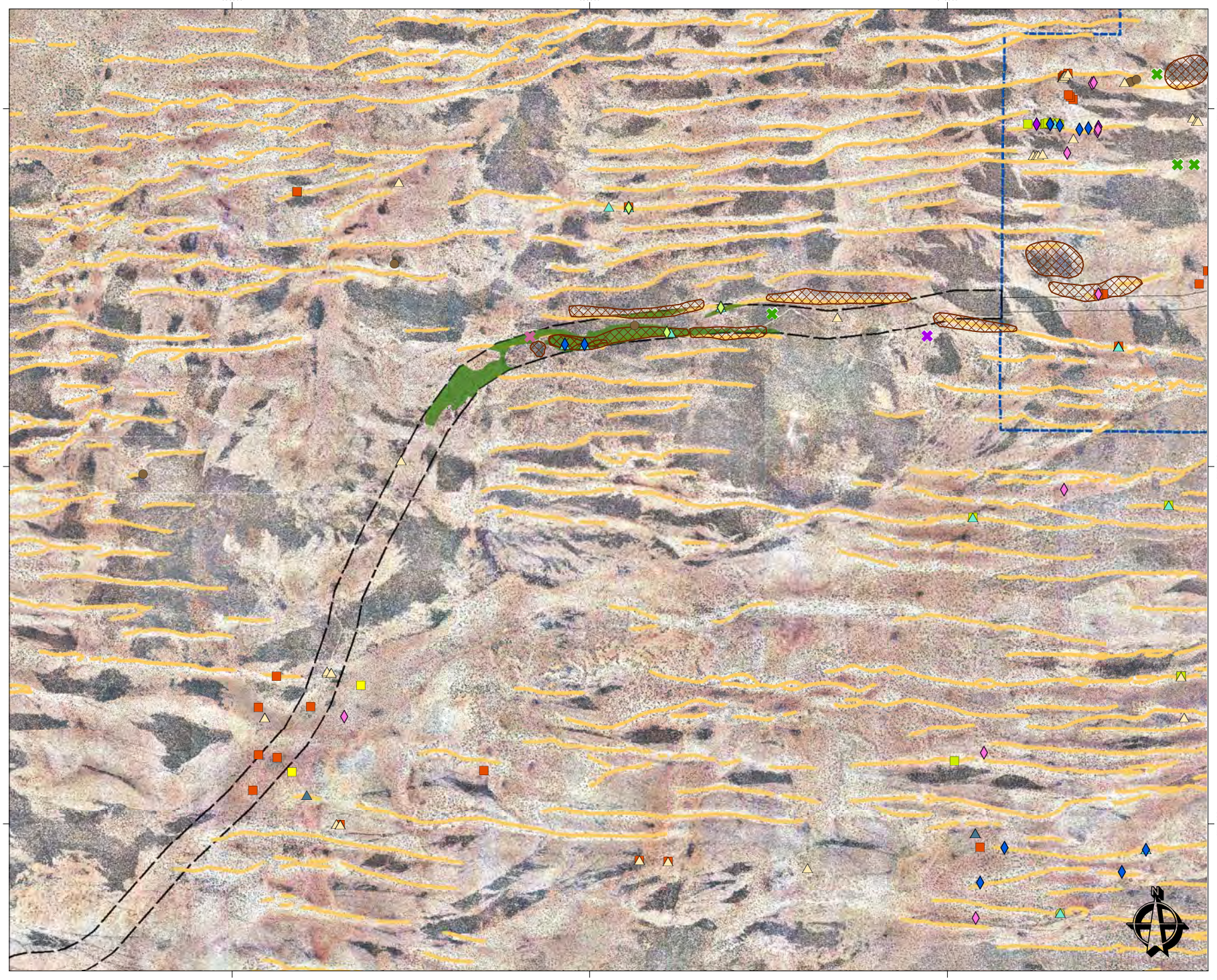
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
11.08.09	0	351-2.18a

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2a



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Caesia talingka* C. Tauss ms
- *Dampiera eriantha*
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Lepidobolus deserti*
- *Malleostemon* sp. Officer Basin
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*
- *Olearia arida*

Listed Terrestrial Fauna

- Australian Bustard (Observation)
- Malleefowl (Inactive Mound or Observation)
- Stick-nest Rat (Nest)

- Mapped PEC
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Conceptual Corridor
- Granted Tenure
- Operational Area

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18b

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2b

Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Conospermum toddii*
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Hibbertia* sp. nov
- *Isotropis canescens*
- *Lepidobolus deserti*
- *Microcorys macredieana*
- *Olearia arida*

Listed Terrestrial Fauna

- Carpet Python (south west subspecies)

- Sand Ridge (Threatened Flora and Fauna Habitat)
- Granted Tenure
- Mapped PEC

Existing Roads and Tracks

- Gravel Road
- Track
- Listed Terrestrial Fauna Habitat

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

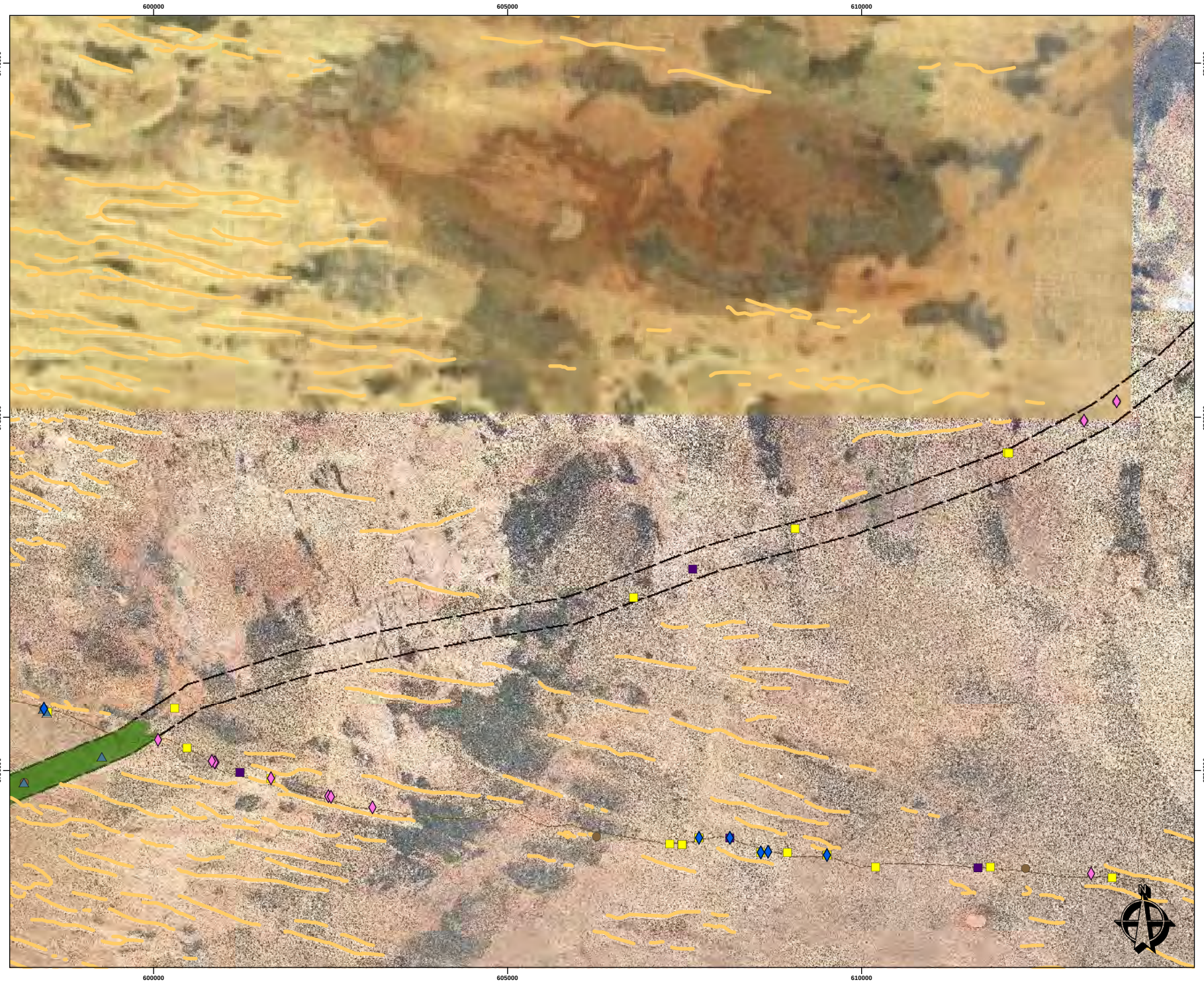
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18c

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2c



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Comesperma viscidulum*
- *Daviesia purpurascens*
- *Grevillea secunda*
- *Microcorys macredieana*
- *Olearia arida*

Sand Ridge (Threatened Flora and Fauna Habitat)

Mapped PEC

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna habitats or listed terrestrial fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

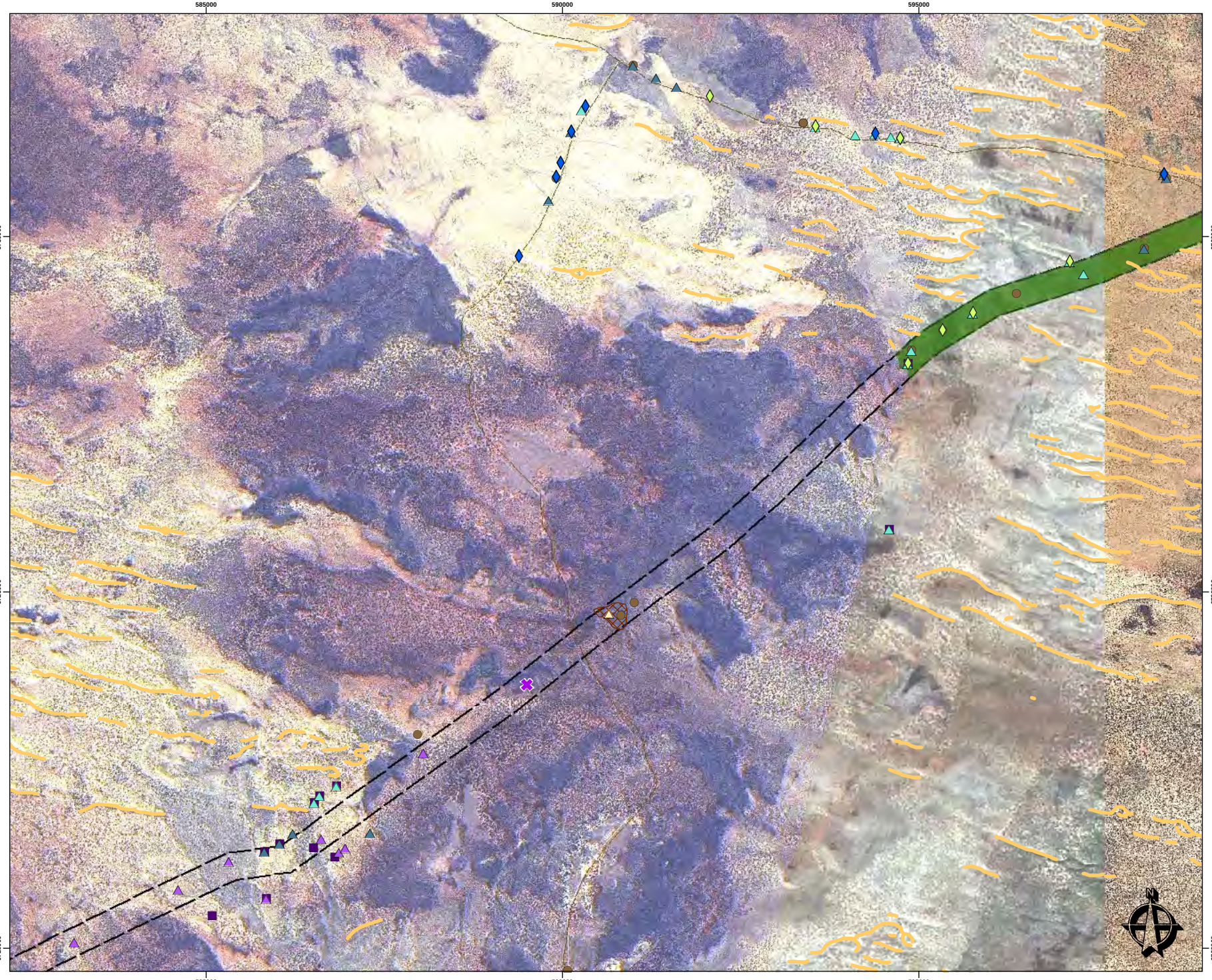
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18d

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2d



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Comesperma viscidulum*
- *Dicrastylis nicholasii*
- *Eucalyptus pimpiniana*
- *Grevillea secunda*
- *Lepidobolus deserti*
- *Microcorys macredieana*
- *Micromyrtus serrulata*
- *Micromyrtus stenocalyx*

Listed Terrestrial Fauna

- Australian Bustard (Footprints)

- Sand Ridge (Threatened Flora and Fauna Habitat)
- Listed Terrestrial Fauna Habitat
- MappedPEC
- Granted Tenure

Existing Roads and Tracks

- Gravel Road
- Track

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

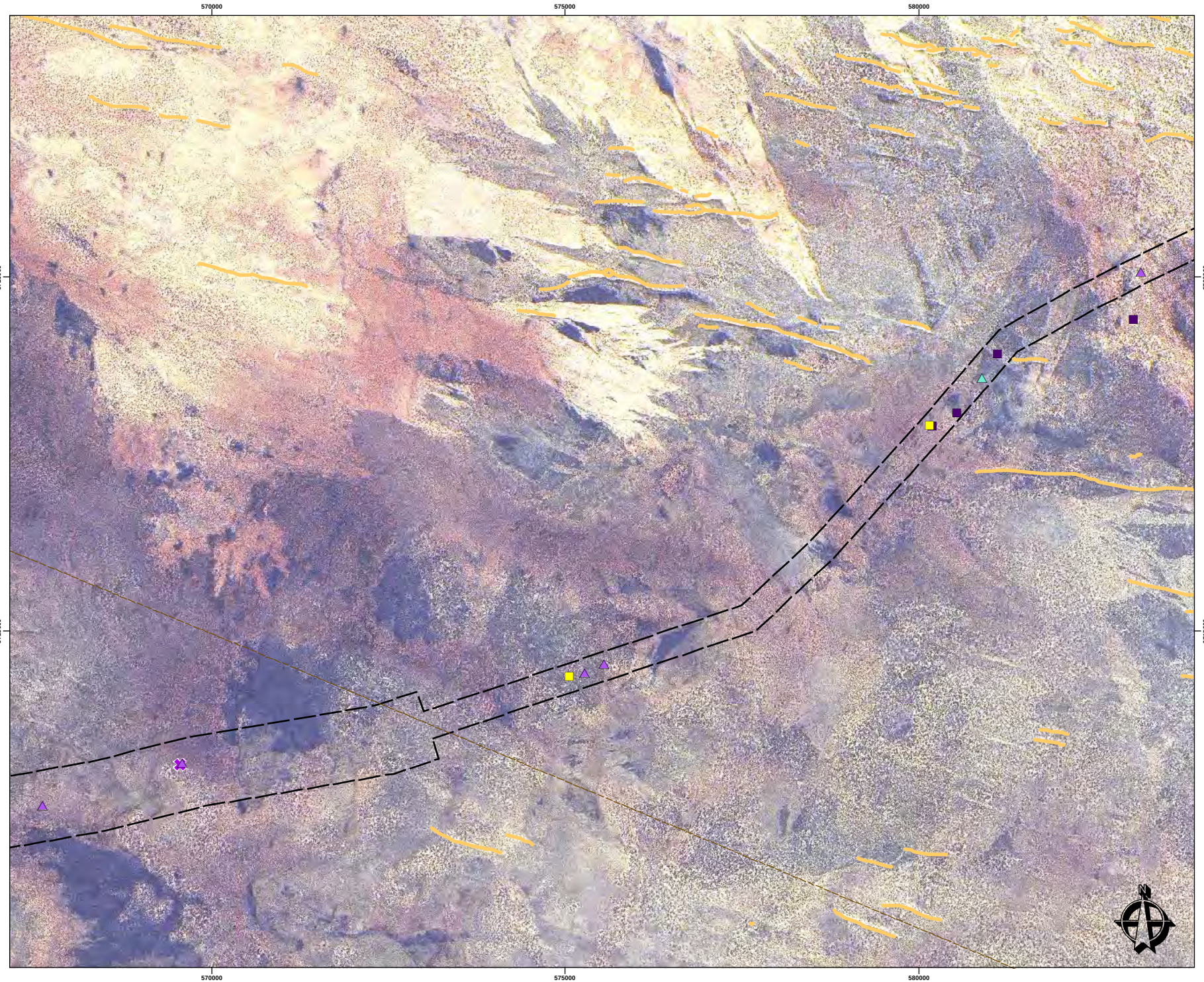
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18e

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2e



Legend

Listed Flora

- *Comesperma viscidulum*
- *Daviesia purpurascens*
- *Eucalyptus pimpiniana*
- *Lepidobolus deserti*

Listed Terrestrial Fauna

- Australian Bustard (Footprints)
- Rainbow Bee-eater (Observation)
- Sand Ridge (Threatened Flora and Fauna Habitat)

Existing Roads and Tracks

- Gravel Road
- Track
- Granted Tenure

(No heritage sites, listed terrestrial fauna habitats or potential PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

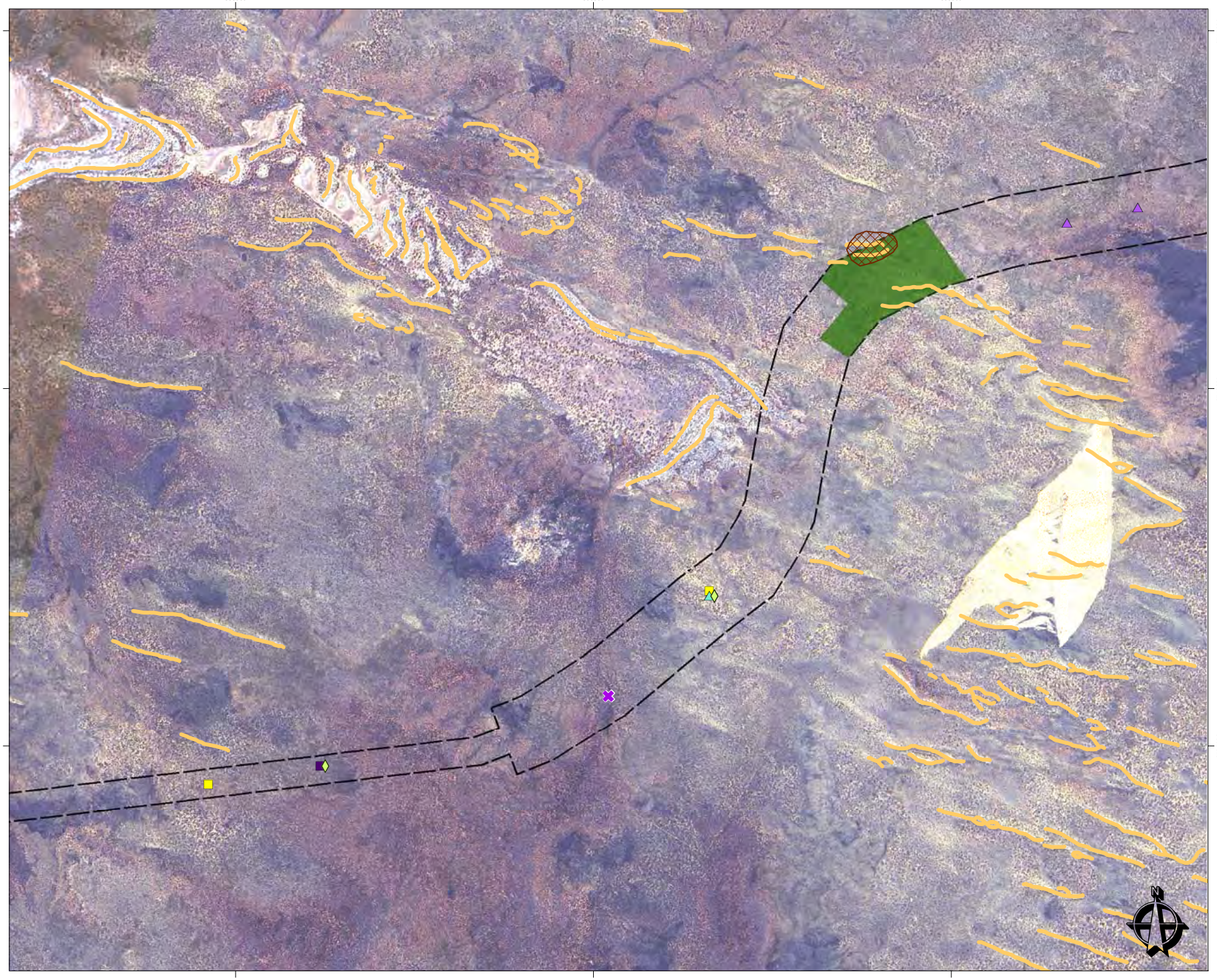
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18f

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2f



Legend

Listed Flora

- *Comesperma viscidulum*
- *Daviesia purpurascens*
- *Eucalyptus pimpiniana*
- *Lepidobolus deserti*
- *Micromyrtus stenocalyx*

Listed Terrestrial Fauna

- Australian Bustard (Footprints)
- Malleefowl (Footprints)
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Mapped PEC
- Granted Tenure

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

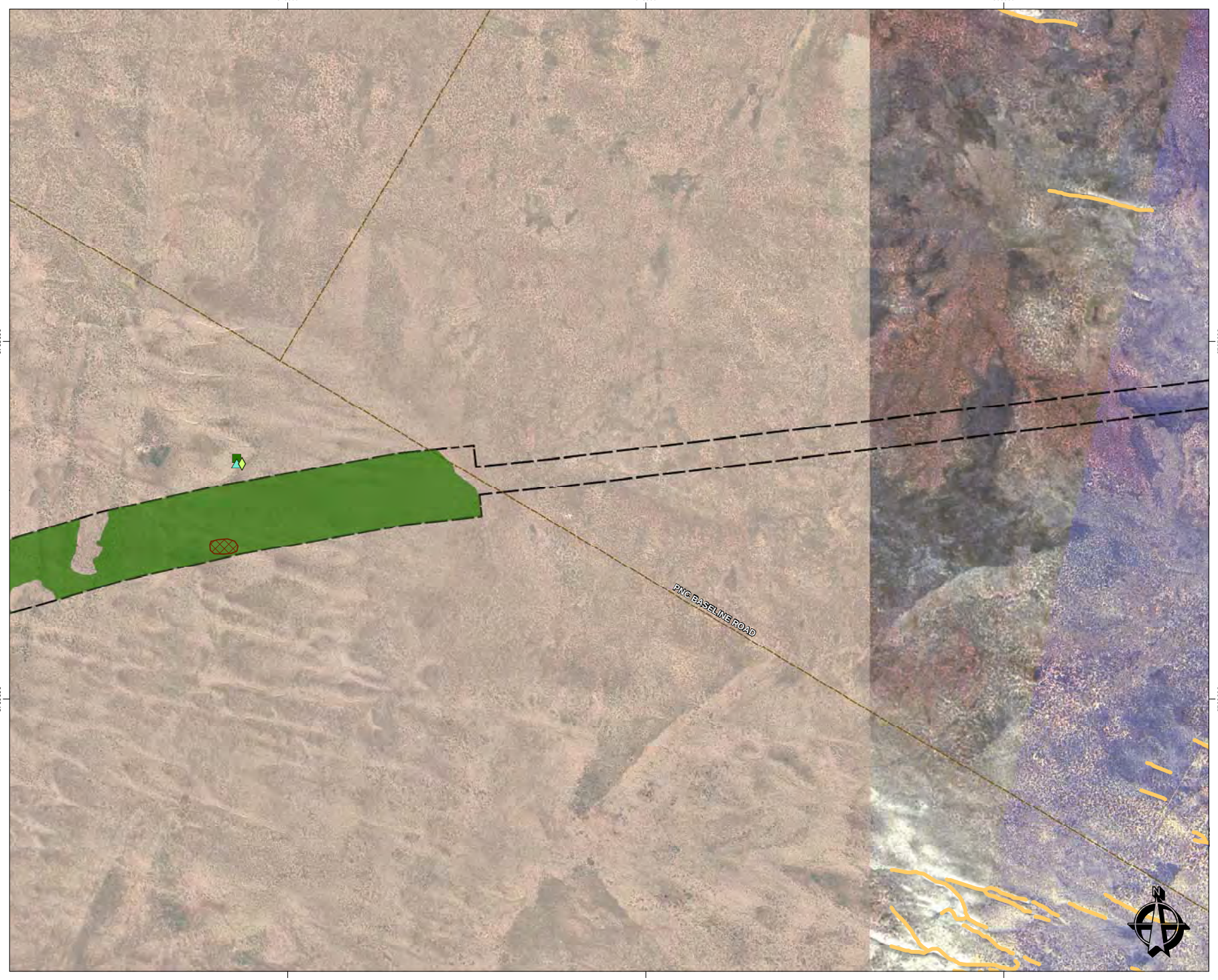
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18g

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2g



Legend

Listed Flora

- *Conospermum toddii*
- *Lepidobolus deserti*
- *Micromyrtus stenocalyx*

Sand Ridge (Threatened Flora and Fauna Habitat)

Listed Terrestrial Fauna Habitat

Mapped PEC

Existing Roads and Tracks

Gravel Road

Track

Granted Tenure

(No heritage sites or listed fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18h

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2h

Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Grevillea secunda*
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*

Listed Terrestrial Fauna Habitat

Sand Ridge (Threatened Flora and Fauna Habitat)

Mapped PEC

Granted Tenure

(No heritage sites or listed terrestrial fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18i

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2i

Legend

Listed Flora

- *Eucalyptus pimpiniana*
- *Lepidobolus deserti*

Listed Terrestrial Fauna

- Australian Bustard (Observation, Nest & Egg)

- Sand Ridge (Threatened Flora and Fauna Habitat)
- Mapped PEC
- Granted Tenure

(No heritage sites or listed terrestrial fauna habitats)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

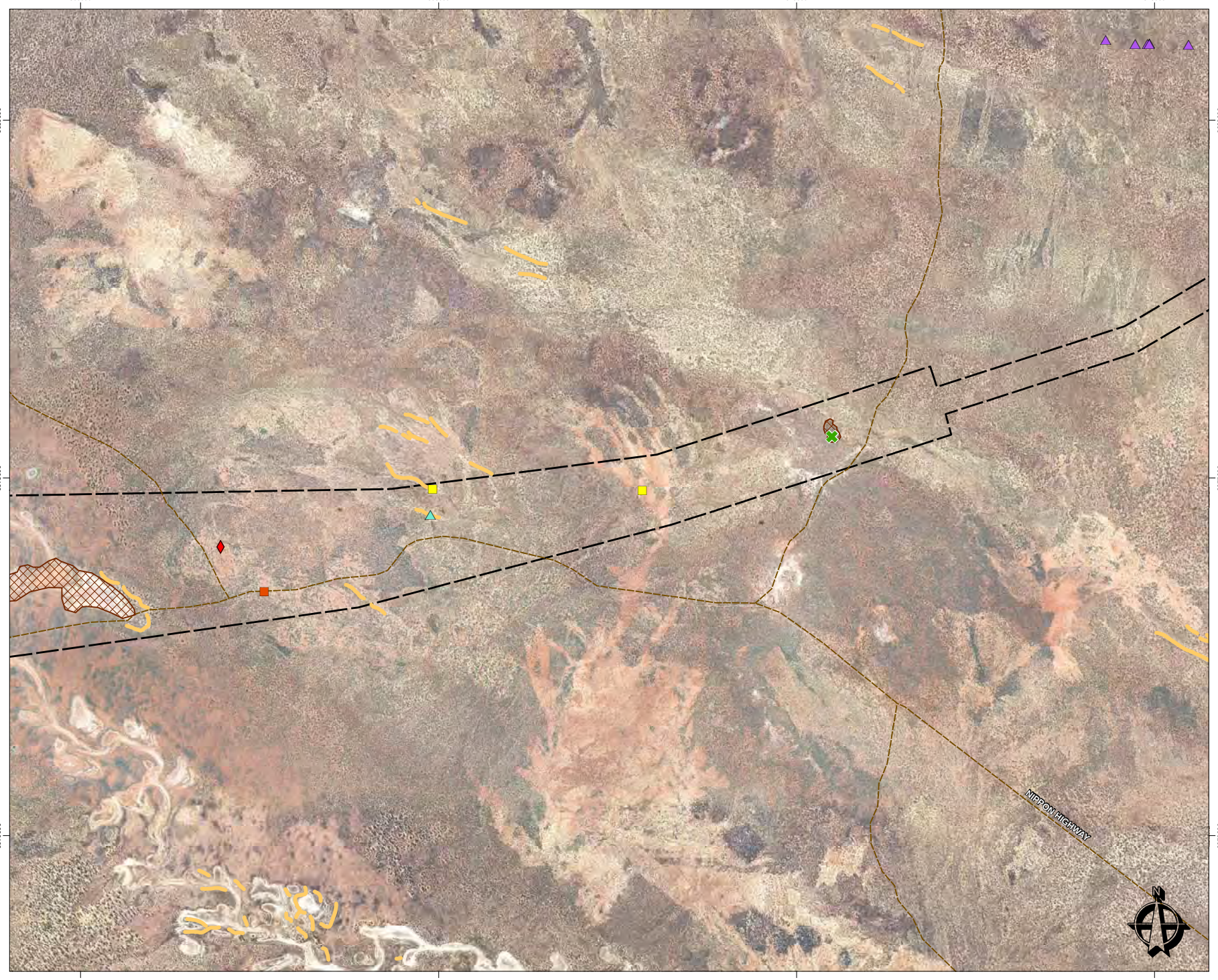
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18j

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2j



Legend

Listed Flora

- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Eucalyptus pimpiniana*
- *Lepidobolus deserti*
- *Thryptomene eremaea*

Listed Terrestrial Fauna

- Malleefowl (Active & Inactive Mounds)
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Listed Terrestrial Fauna Habitat

Existing Roads and Tracks

- Gravel Road
- Track
- Granted Tenure

(No heritage sites or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18k

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2k

Legend

Heritage Site

Listed Flora

Micromyrtus serrulata

Thryptomene eremaea

Listed Terrestrial Fauna

Malleefowl (Observation)

Rainbow Bee-eater (Observation)

Listed Terrestrial Fauna Habitat

A3 community with a high density of conservation-significant flora species

Existing Roads and Tracks

Gravel Road

Track

Granted Tenure

(No sand ridges)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

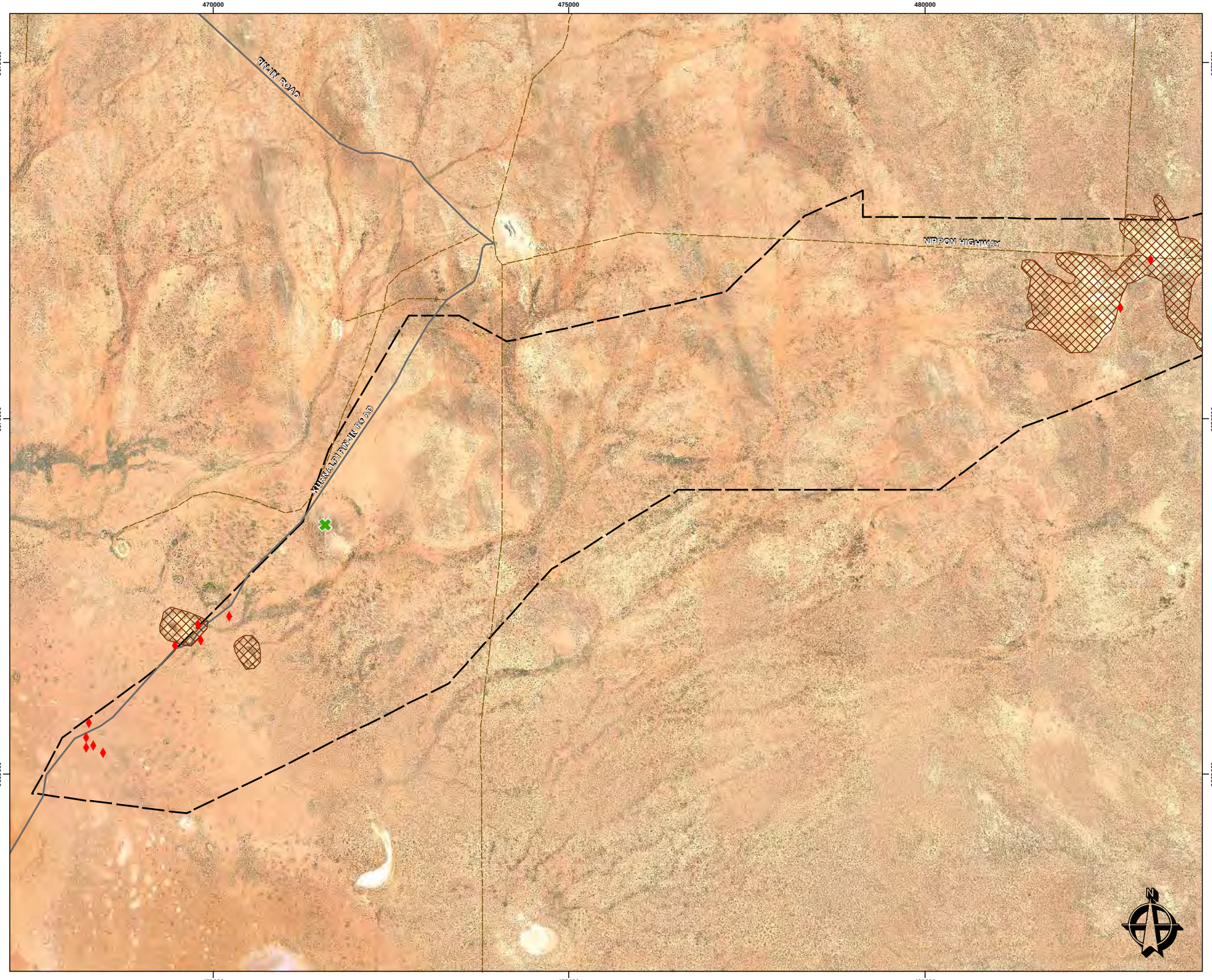
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18l

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2l



Legend

- Heritage Site

Listed Terrestrial Fauna

- Malleefowl (Inactive Mound)
- Listed Terrestrial Fauna Habitat

Existing Roads and Tracks

- Gravel Road
- Track
- Granted Tenure

(No listed flora, sand ridges or potential PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM LANDGATE 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.18m

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Pinjin Infrastructure Corridor and Public Bypass Constraints Map
Figure 7.2m

Legend

- Heritage Site
- Heritage Site Buffer

Listed Flora

- *Daviesia purpurascens*
- *Dicrastylis nicholasii*
- *Microcorys macredieana*
- *Olearia arida*

Listed Terrestrial Fauna Habitat

- Mulgara
- Regent Parrots Tree
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Conceptual Corridor
- Granted Tenure
- Operational Area

(No mapped PECs or listed fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19a

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3a

Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Conospermum toddii*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Microcorys macredieana*
- *Olearia arida*

Listed Terrestrial Fauna

- Malleefowl (Inactive Mound)
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Mapped PEC
- Granted Tenure

Existing Roads and Tracks

- Gravel Road
- Track

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19b

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3b

Legend

- Heritage Site
- Heritage Site Buffer

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Microcorys macredieana*
- *Olearia arida*

Listed Terrestrial Fauna

- Malleefowl (Tracks & Inactive Mound)

Listed Terrestrial Fauna Habitat

- Malleefowl
- Mulgara
- Regent Parrots Tree
- Marsupial Mole
- Listed Terrestrial Fauna Habitat
- Granted Tenure
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Mapped PEC

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

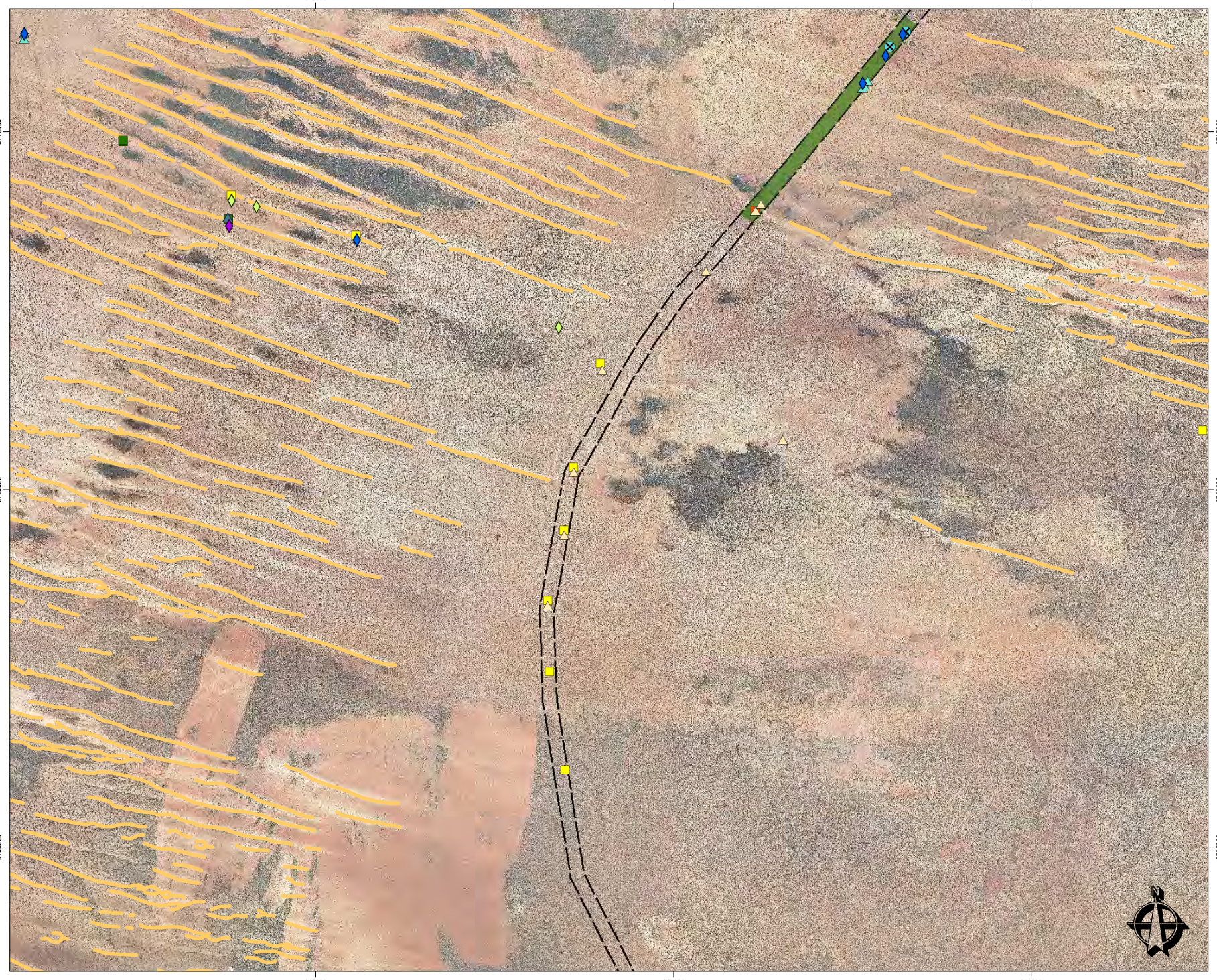
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19c

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3c



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Conospermum toddii*
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Lepidobolus deserti*
- *Malleostemon* sp. Officer Basin
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*

Listed Terrestrial Fauna Habitat

- Regent Parrots Tree
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Mapped PEC
- Granted Tenure

(No heritage sites or listed terrestrial fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

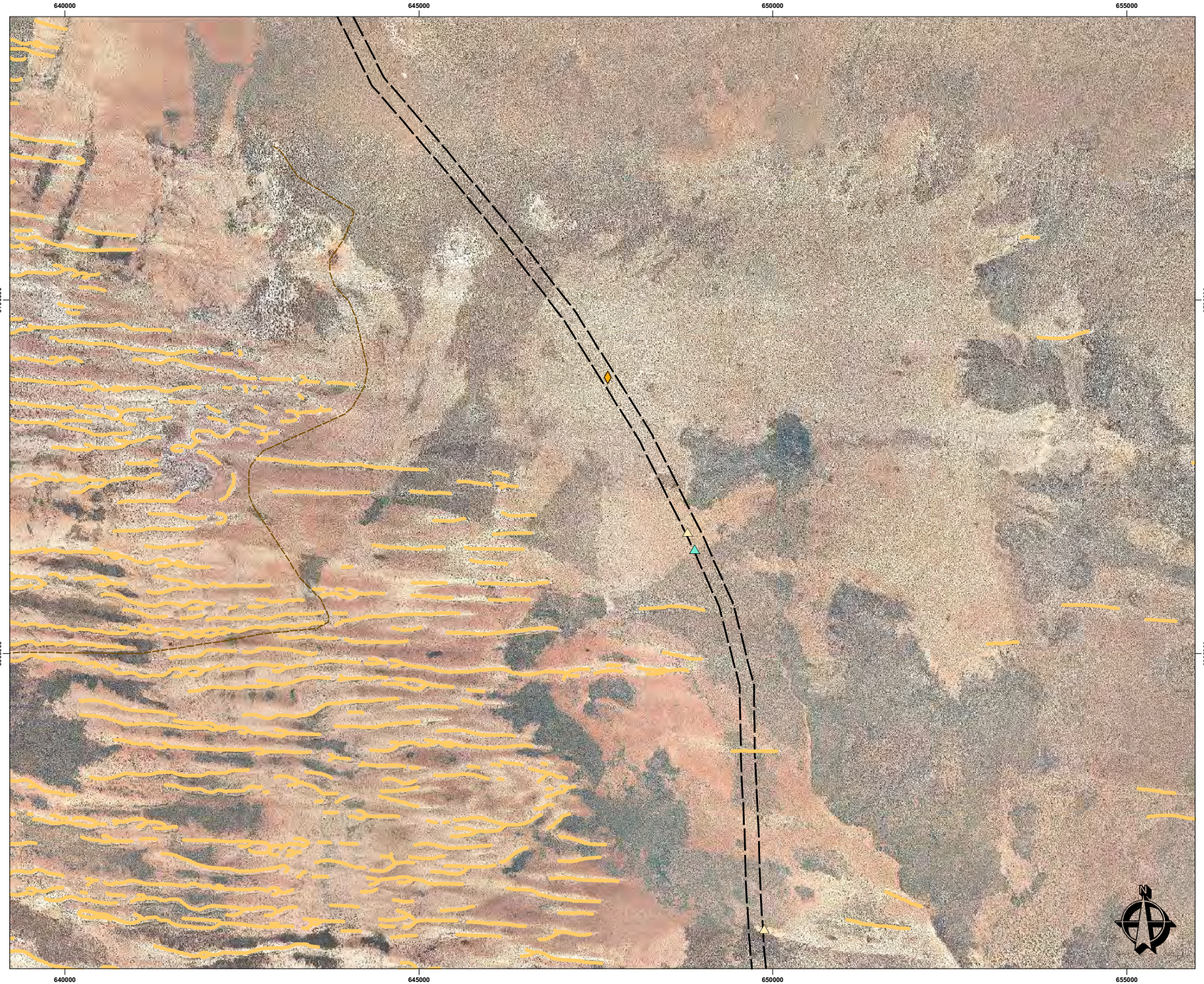
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19d

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3d



Legend

Listed Flora

- *Dicrastylis nicholasii*
- *Lepidobolus deserti*
- *Physopsis chrysotricha*

Sand Ridge (Threatened Flora and Fauna Habitat)

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

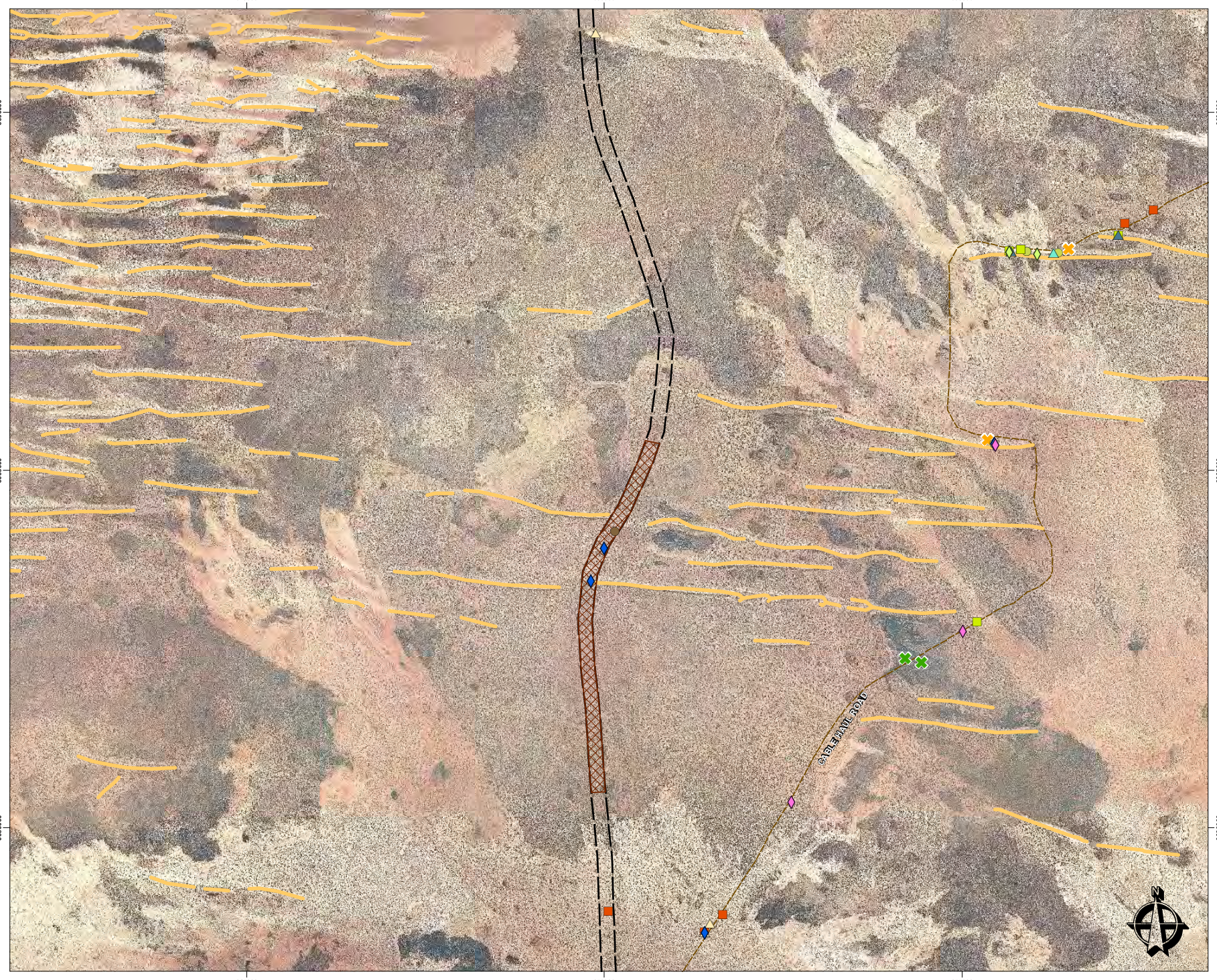
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19e

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3e



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Caesia talingka* C. Tauss ms
- *Dampiera eriantha*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Lepidobolus deserti*
- *Malleostemon* sp. Officer Basin
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*
- *Olearia arida*

Listed Terrestrial Fauna

- Malleefowl (Inactive Mound)
- Marsupial Mole (Holes)
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Granted Tenure

Existing Roads and Tracks

- Gravel Road
- Track

(No heritage sites or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

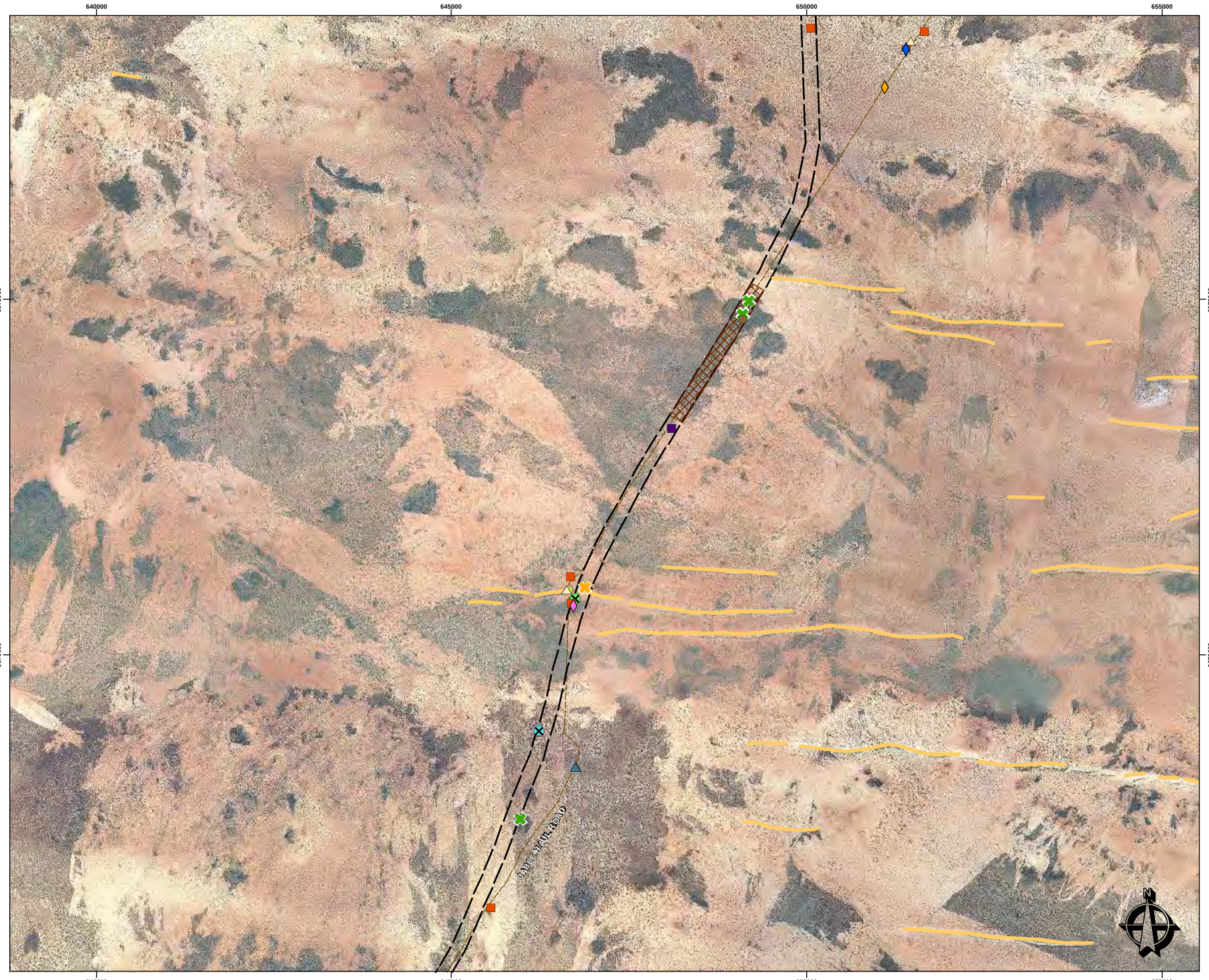
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19f

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3f



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Caesia talingka* C. Tauss ms
- *Comesperma viscidulum*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Microcorys macredieana*
- *Olearia arida*
- *Physopsis chrysotricha*

Listed Terrestrial Fauna

- Malleefowl (Inactive Mound)
- Marsupial Mole (Holes)

Listed Terrestrial Fauna Habitat

- Regent Parrots Tree
- Marsupial Mole
- Listed Terrestrial Fauna Habitat
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Granted Tenure

Existing Roads and Tracks

- Gravel Road
- Track

(No heritage sites or mapped PECS)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

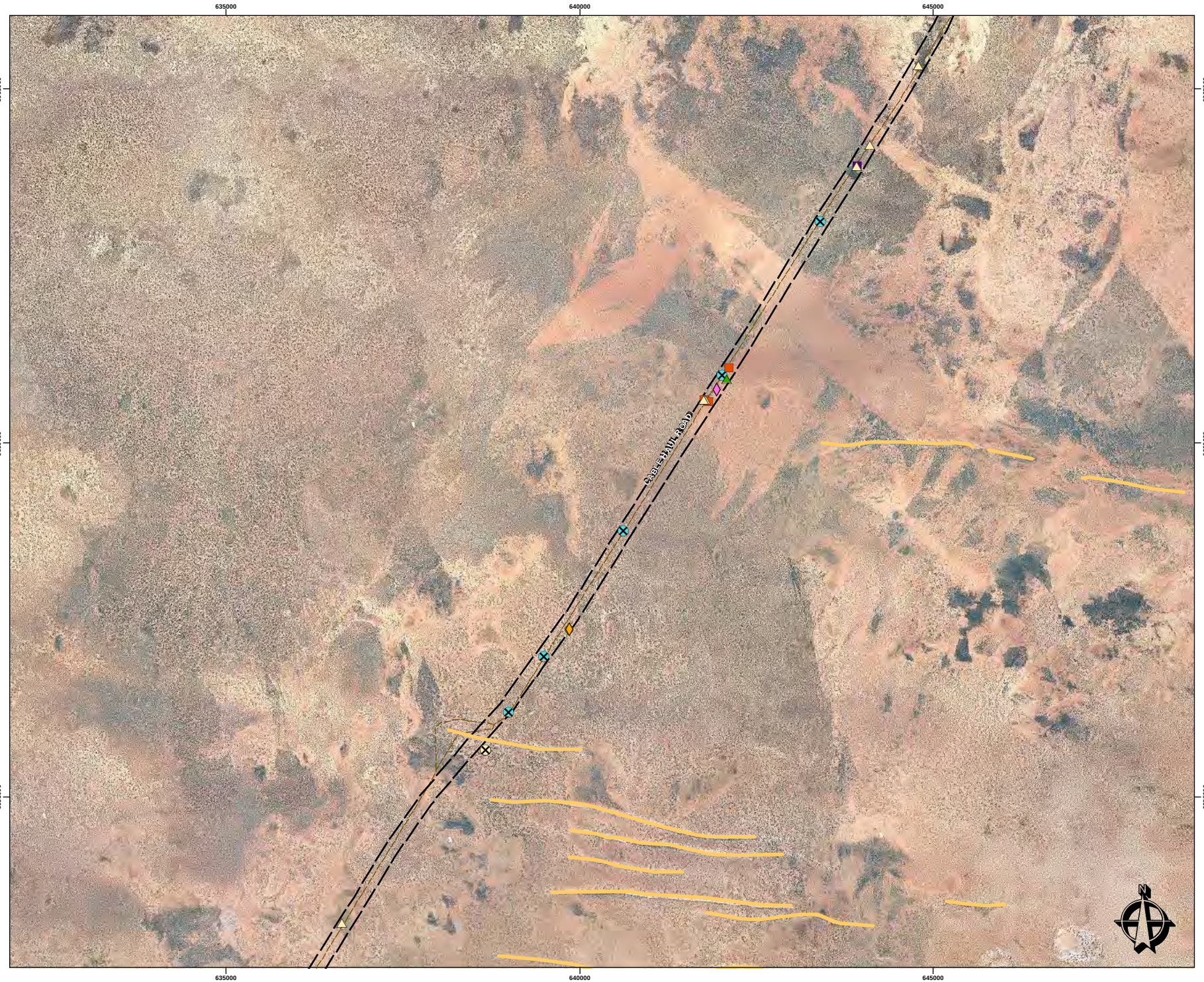
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19g

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3g



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Comesperma viscidulum*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Isotropis canescens*
- *Olearia arida*
- *Physopsis chrysotricha*

Listed Terrestrial Fauna Habitat

- Regent Parrots Tree
- Sandhill Dunnart
- Marsupial Mole
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Granted Tenure

Existing Roads and Tracks

- Gravel Road
- Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

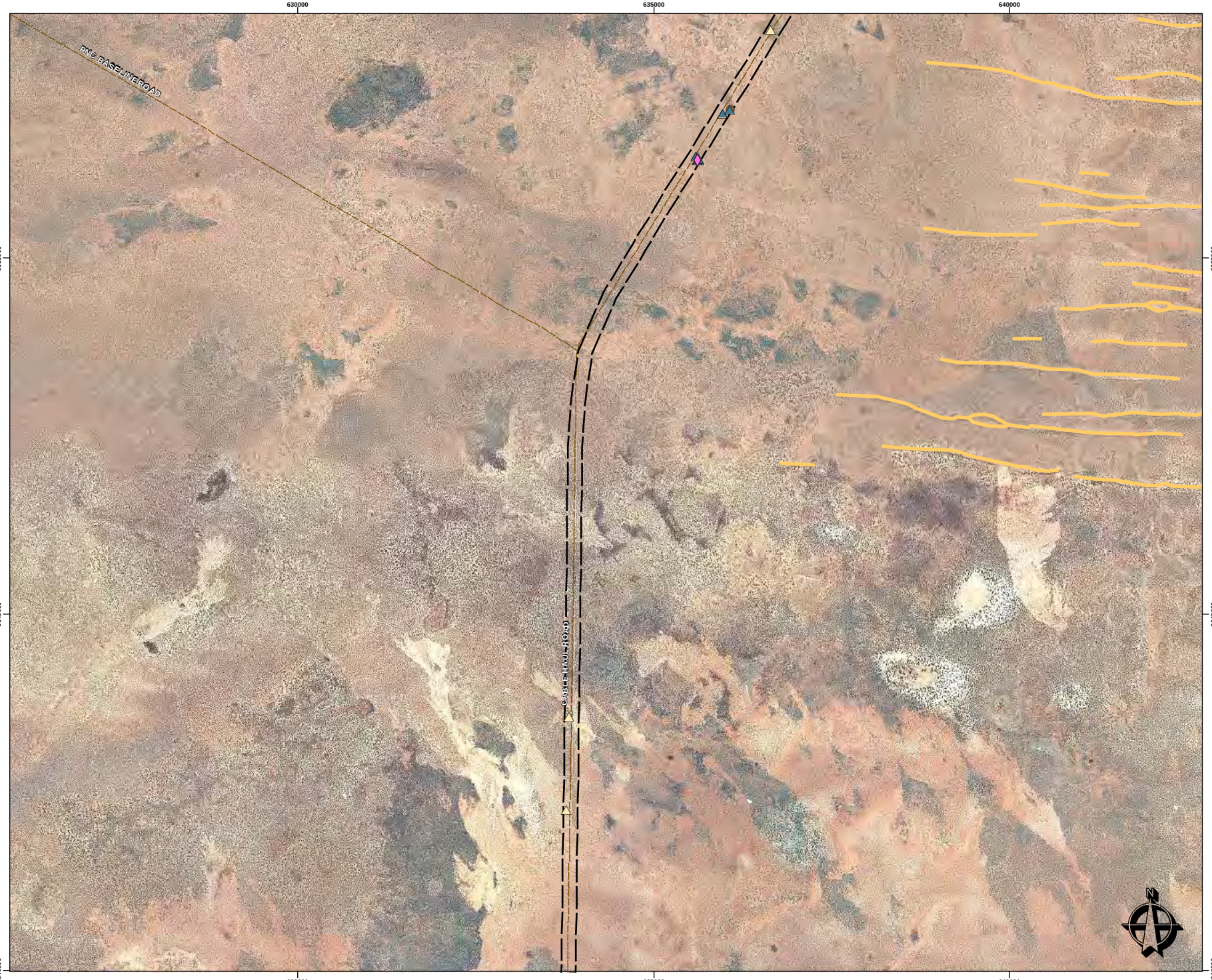
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19h

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3h



Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Olearia arida*

Sand Ridge (Threatened Flora and Fauna Habitat)

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECS)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19i

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3i

Legend

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Dicrastylis nicholasii*
- *Grevillea secunda*

Sand Ridge (Threatened Flora and Fauna Habitat)

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19j

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3j

Legend

Listed Flora

- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Olearia arida*

Sand Ridge (Threatened Flora and Fauna Habitat)

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

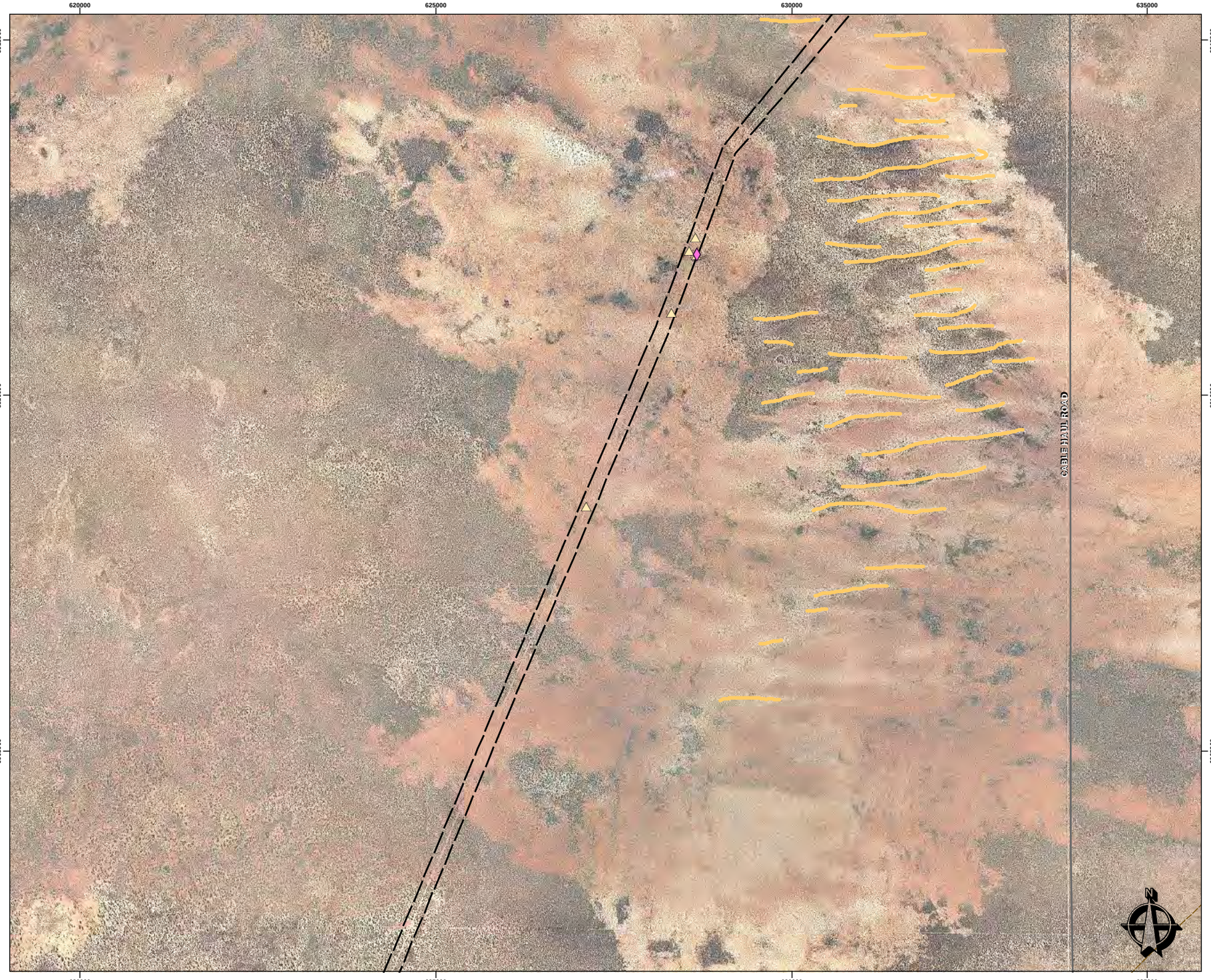
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19k

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3k



Legend

Listed Flora

- *Dicrastylis nicholasii*
- *Olearia arida*

Sand Ridge (Threatened Flora and Fauna Habitat)

Granted Tenure

Existing Roads and Tracks

Gravel Road

Track

(No heritage sites, listed terrestrial fauna, threatened fauna habitats or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

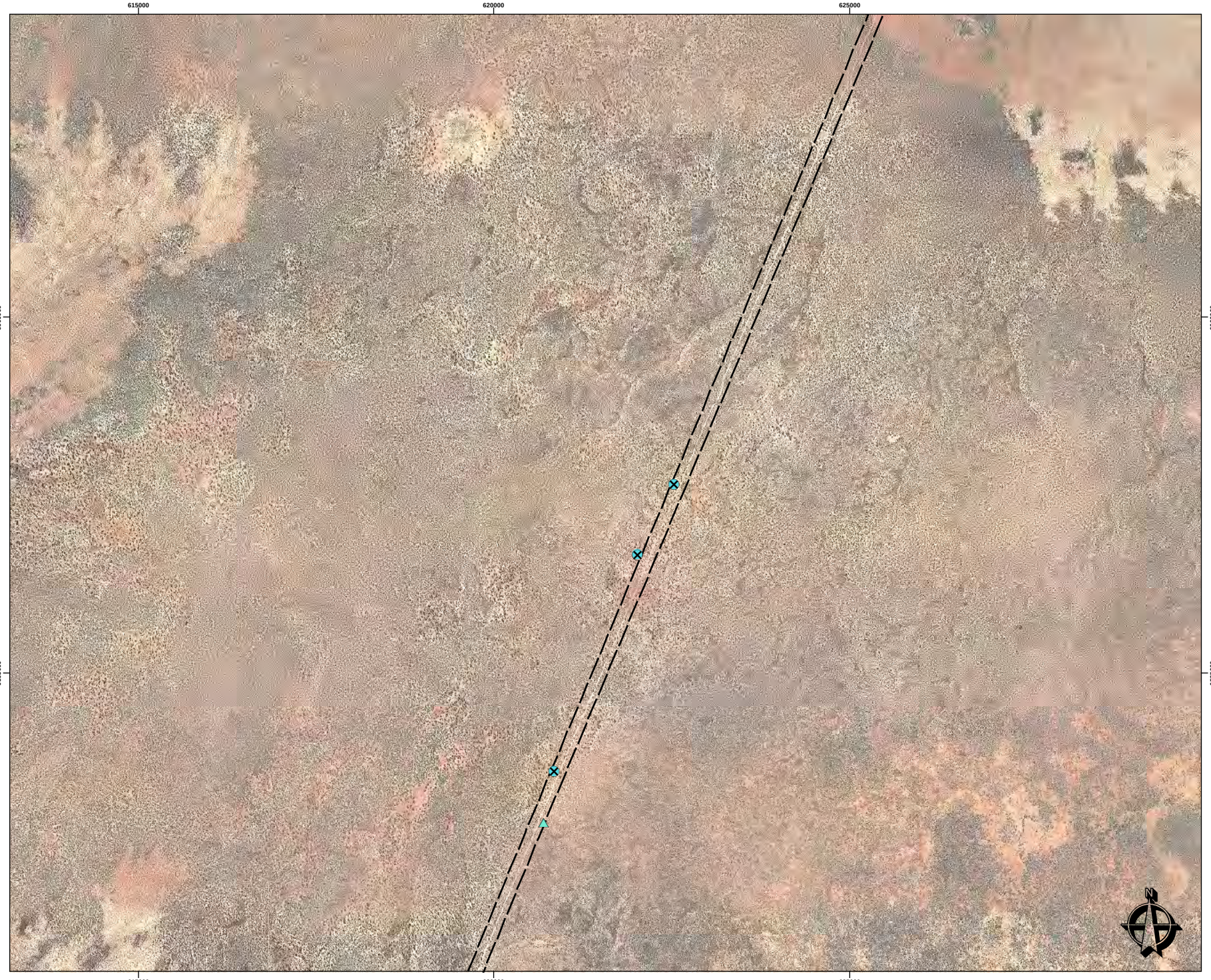
Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION	
100%	MGA ZONE 51	
HORIZONTAL DATUM	**HEIGHT DATUM**	
GDA 94	N/A	
CREATED BY	**CHECKED BY**	**APPROVED**
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19l

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3l



Legend

Listed Flora

Lepidobolus deserti

Listed Terrestrial Fauna Habitat

Regent Parrots Tree

Granted Tenure

(No heritage sites, listed terrestrial fauna, sand ridges or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

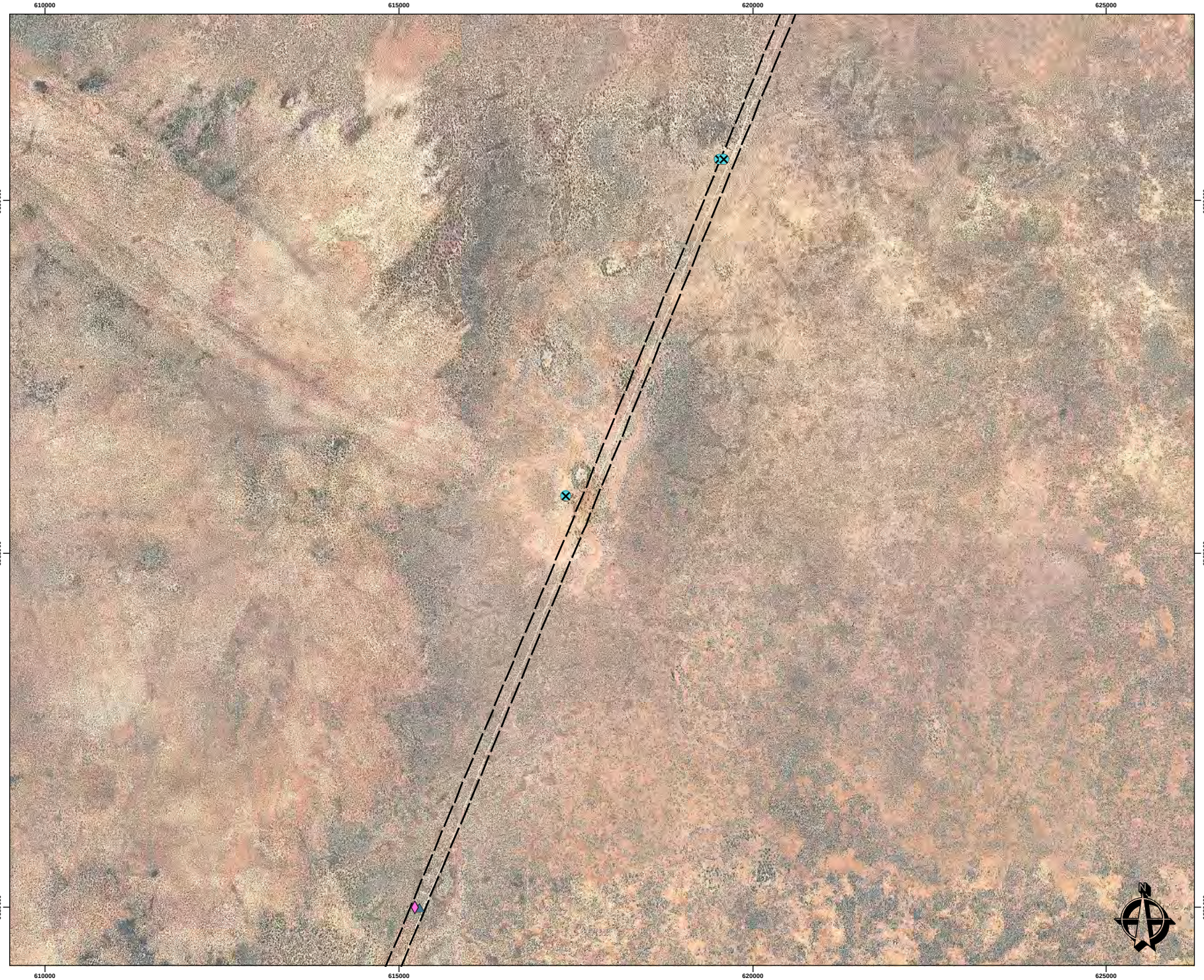
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19m

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3m



Legend

Listed Flora

Grevillea secunda

Olearia arida

Listed Terrestrial Fauna Habitat

Regent Parrots Tree

Granted Tenure

(No heritage sites, listed terrestrial fauna, sand ridges or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19n

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3n

Legend

Listed Flora

- *Grevillea secunda*
- *Olearia arida*
- Granted Tenure

(No heritage sites, listed terrestrial fauna, listed terrestrial fauna habitats, sand ridges or mapped PECs)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.25 0.5 1 1.5 2

Kilometers

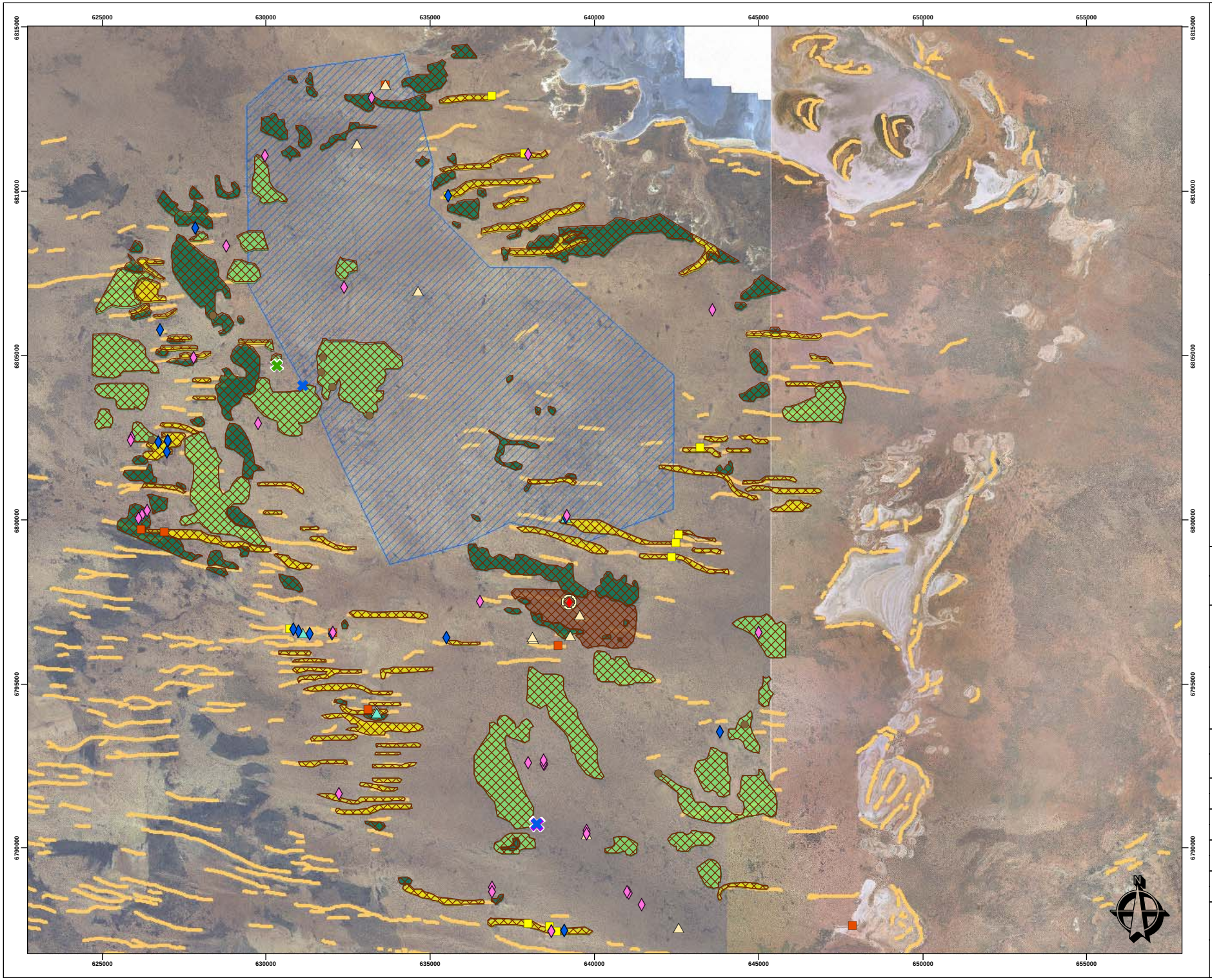
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
18.08.09	0	351-2.19o

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
TTC Constraints Map
Figure 7.3o



Legend

- Heritage Site
- Heritage Site Buffer

Listed Flora

- *Baeckea* sp. Great Victoria Desert
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Lepidobolus deserti*
- *Microcorys macredieana*
- *Olearia arida*

Listed Terrestrial Fauna

- Australian Bustard (Tracks)
- Fork-tailed Swift (Observation)
- Malleefowl (Active and inactive mounds)
- Listed Terrestrial Fauna Habitat

Locally Restricted Vegetation Communities

- Clay Pan
- Eucalypt Woodland
- Mulga Woodland
- Sand Dune
- Proposed Borefield Area
- Sand Ridge (Threatened Flora and Fauna Habitat)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 0.5 1 2 3 4 5
Kilometers

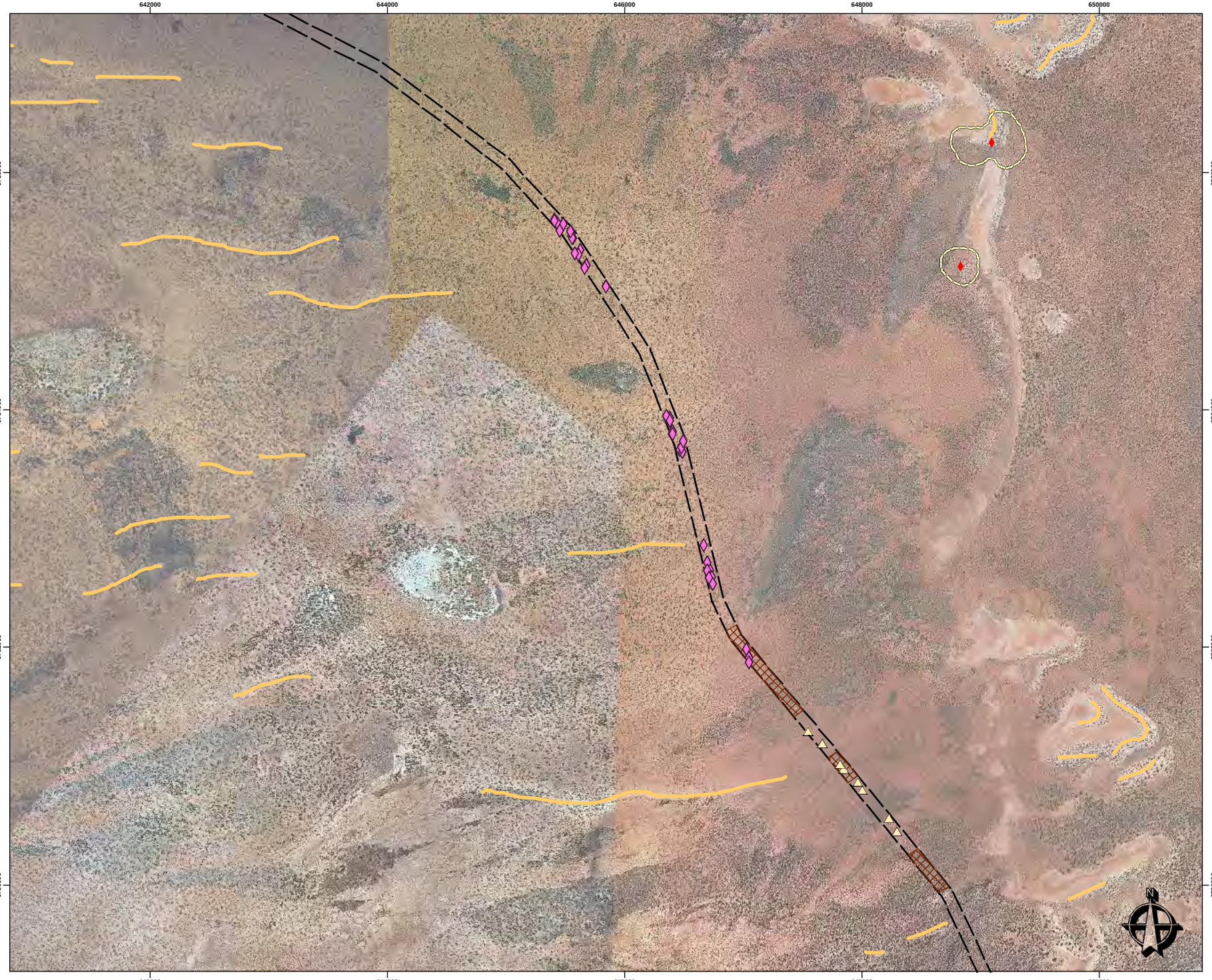
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
19.08.09	0	351-2.20

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Minigwal Trough Water Supply Area
Constraints Map
Figure 7.4



Legend

- Heritage Site
- Heritage Site Buffer

Listed Flora

- *Dicrastylis nicholasii*
- *Olearia arida*
- Sand Ridge (Threatened Flora and Fauna Habitat)
- Threatened Terrestrial Fauna Habitat
- Infrastructure Corridor Survey Area

(No listed terrestrial fauna)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 250 500 1,000 1,500

Metres

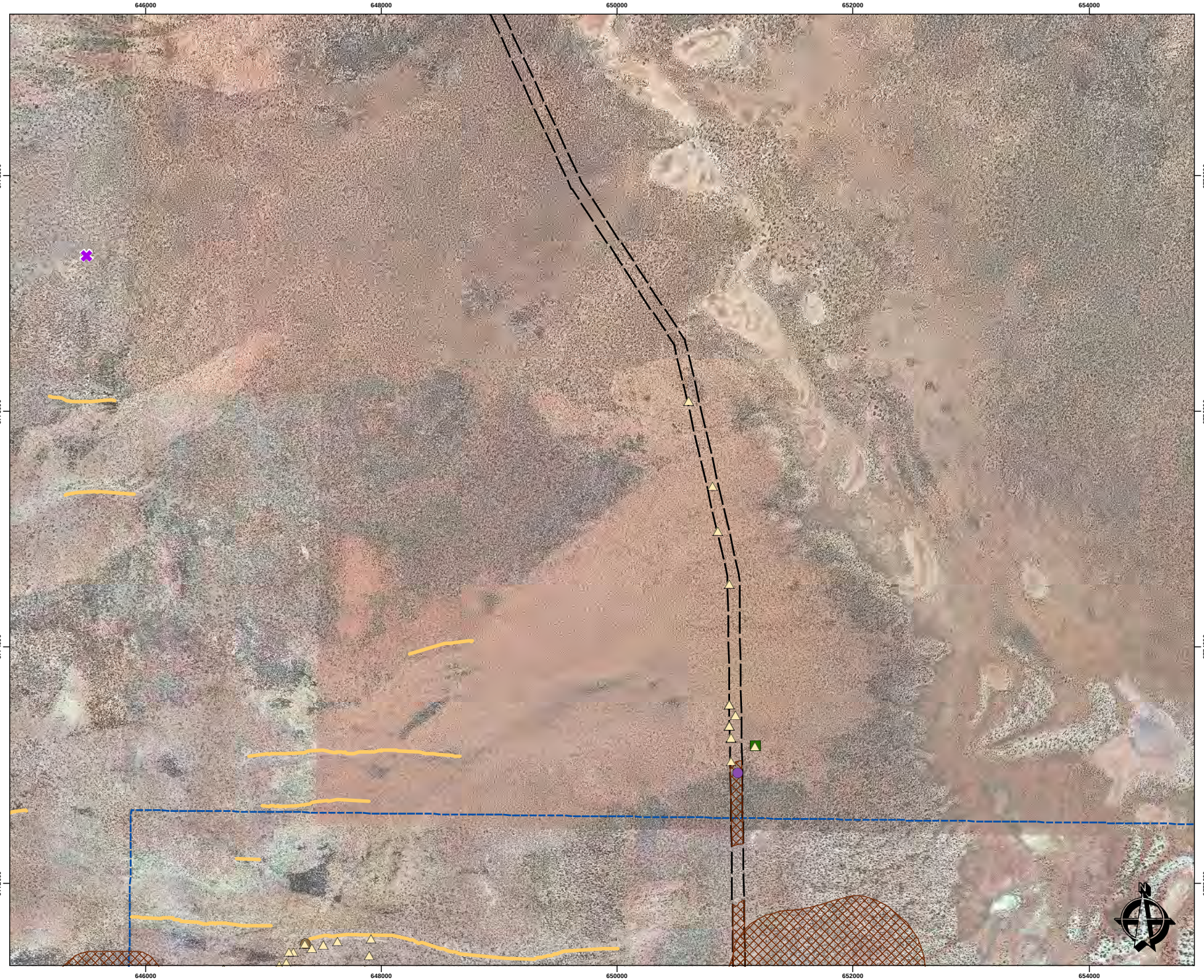
LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
19.08.09	0	351-2.21a

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Borefield Pipeline Constraints Map
Figure 7.5a



Legend

Listed Flora

- *Acacia eremophila* numerous-nerved variant
- *Baeckea* sp. Great Victoria Desert
- *Conospermum toddii*
- *Dicrastylis nicholasii*

Listed Terrestrial Fauna

- Australian Bustard (Observation)

- Sand Ridge (Threatened Flora and Fauna Habitat)
- Threatened Terrestrial Fauna Habitat
- Indicative Infrastructure Corridor (100m Width)
- Operational Area Boundary

(No heritage sites)

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLD ASHANTI 2008

SCALE

0 250 500 1,000 1,500

Meters

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
19.08.09	0	351-2.21b

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Borefield Pipeline Constraints Map
Figure 7.5b

7.2.3. Terrestrial Fauna (including Short Range Endemics)

Management Objectives

The objectives of the Joint Venture for the management of fauna are:

- to maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge;
- avoid Project impacts to listed fauna species and species of conservation interest; and,
- avoid known critical fauna habitat.

Description of Factor

Listed Fauna and Other Fauna of Conservation Interest

Evidence of listed terrestrial fauna species recorded during the Project surveys were discussed in Chapter 6. Figure 7.1b demonstrates those fauna values potentially impacted within the Operational Area. Figures 7.2-7.5 illustrate the locations of listed species recorded within the Project survey areas. The likelihood of impacts to listed species as a result of the Project footprint is discussed below:

- Marsupial Mole - *Notoryctes typhlops* and *Notoryctes caurinus* (both forms listed as Endangered – EPBC and Schedule 1 – WC Act)

  Any disturbance by the Joint Venture on or in close proximity to dune systems could potentially impact the Marsupial Mole. Traces of Marsupial Moles (mole holes) have been found on all surveyed sand dunes and some sandy flat areas within and around the Operational Area, and the species is likely to occur in most of the dune systems within this area (refer to Figure 6.15 in Chapter 6). Evidence of the Marsupial Mole was identified in sand dune/ plain sections along infrastructure corridors and Marsupial Mole habitat was also identified in the Water Supply Area. The results of a regional survey commissioned by the Joint Venture has determined that the species is widespread in the GVD and probably more common than previous records suggest (Appendix 2-F2). A survey of the Western Australian section of the GVD indicated that mole hole abundance was similar to that recorded in the South Australia GVD and suggested that more than 30 km of recognisable moleholes per hectare occurs on the crests and slopes of the dunefields surveyed (Benshemesh and Schulz 2008).

- Malleefowl - *Leipoa ocellata* (Vulnerable – EPBC Act and Schedule 1 – WC Act)

  The likelihood of Malleefowl occurring in the Operational Area is moderate even though the majority of suitable habitat has been burnt within the last 10 years, thus lowering its suitability as habitat. All mounds recorded have been classified as inactive/ historical (Appendices 2-B5 and 2-F4). As the habitat matures over the next decade and becomes increasingly suitable, the likelihood of Malleefowl occurring in the Operational Area will increase accordingly (Appendix 2-B5). Signs of Malleefowl in the form of mounds were identified in the Operational Area (Figure 7.1), individual sightings, nest mounds and tracks Pinjin Infrastructure Corridor (Figure 7.2), mounds and fresh tracks in the TT Corridor (Figure 7.3) and tracks in the Water Supply Area. Due to the low level of impact in the infrastructure corridors, such as the relatively small areas of vegetation that will be cleared, the construction of the infrastructure corridors will not significantly impact Malleefowl habitat.

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

  Several individuals were recorded in the Operational Area survey, both as sighted individuals and as identifiable tracks (refer to Figure 6.15 in Chapter 6). A nest and egg was recorded close to the Pinjin Infrastructure Corridor (Figure 7.2j) and tracks were recorded along the TT Corridor (Figure 7.3) and within the Minigwal Trough survey area (Figure 7.4). Due to the limited amount of clearing of preferred habitat required by the Project and the large areas of suitable habitat in the surrounding region, there is expected to be little impact on this species.

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

  This species is a common bird in WA, and due to its ability to travel large distances and its diverse habitat preferences, this species is unlikely to be significantly impacted by the Project.

- Stick Nest Rat - *Leporillus sp.* (Extinct – EPBC Act and Schedule 2 – WC Act)

  As discussed in section 6.2.8 evidence of this species in the form of abandoned nest where located within the Operational Area. This species is presumed extinct in the area therefore it is highly unlikely to be impacted by the Project.

- Mulgara - *Dasycercus blythi* (Priority 4-DEC)

  A possible inactive burrow of *Dasycercus blythi* was observed in the Operational Area and along the Pinjin Infrastructure Corridor. *D. blythi* is mainly known from sandy dunes or sand plain country with a cover of spinifex, therefore impacts to individuals may occur if suitable habitat is located within the Project footprint.

  The Operational Area contained significant amounts of hummock grasslands that were considered to be suitable Mulgara habitat within the Operational Area (Figure 7.1). However, the habitat was mostly patchy and the percentage ground cover and maturity of the habitat was highly variable. No Mulgara burrows or other signs of recent presence were identified in transects searched. These areas contained clumped grass and shrublands that were at a suitable age structure and cover for Mulgara habitation.

- Peregrine Falcon - *Falco peregrinus* (Schedule 4 – WC Act)

  One individual was opportunistically sighted in the vicinity of the Operational Area (Figure 6.15). Due to the widespread distribution of this species in Australia and the extent of suitable habitat outside of the Project footprint, as well as the apparent lack of a suitable breeding location within the surveyed area, the impacts of the Project on the species are expected to be negligible.

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

  Fifteen individuals were sighted in the Operational Area (Figure 6.15). Fork-tailed Swift rarely land, living almost exclusively in the air and feeding entirely on aerial insects (Simpson and Day 2004). This species was recorded in high numbers. Fork-tailed Swifts are not expected to be significantly impacted by the Project.

- Wood Sandpiper - *Tringa glareola* (Migratory - EPBC Act)

  This species was sighted at small lake north of Lake Rebecca. The Wood Sandpiper is typical of well-watered regions, particularly coastal plains and plains about lower courses of larger rivers (Simpson and Day 2004). Wood Sandpipers are not thought to be impacted by the Project.

- Common Greenshank - *Tringa nebularia* (Migratory - EPBC Act)

  The Common Greenshank was sighted at small lake north of Lake Rebecca. The species is typical of well-watered regions; casual or vagrant on west-coast islands and in the arid east (Simpson and Day 2004). The Common Greenshank are not thought to be impacted by the Project.

- Crested Bellbird - *Oreoica gutturalis* (Priority 4 – DEC).

  The Crested Bellbird was sighted along the Pinjin Infrastructure Corridor (Figure 7.2). The species occurs from semi-arid coastlines to the arid Australia interior. The Crested Bellbird is not thought to be impacted by the Project.

Species that were not recorded in the surveys but may be potentially impacted by the Project are discussed below:

- Sandhill Dunnart - *Sminthopsis psammophila* (Endangered – EPBC Act and Schedule 1 – WC Act)

  Although this species is known to occur in the region, it was not recorded in the surveys. Areas of suitable habitat for the Sandhill Dunnart were identified in the Operational Area and both infrastructure corridors (Figures 7.1, 7.2 and 7.3). This species is found in a variety of sandy habitats, usually with sand dunes and an understorey of *Triodia* spp. hummock grassland. Overstorey vegetation in the Great Victoria Desert is generally low, open *Eucalyptus* and *Callitris* woodlands (Van Dyke and Strahan 2008).

- Night Parrot - *Pezoporus occidentalis* (Endangered – EPBC Act, Critically Endangered – WC Act).

  The lack of confirmed sightings of the Night Parrot through most of its former distribution indicates that it is unlikely to occur in the Project footprint; however suitable habitat is present along the Pinjin Infrastructure Corridor. Species inhabits spinifex and/ or chenopod shrublands, especially close to water (Appendix 2-C6).

Fauna of Conservation Interest

- *Pseudantechinus* sp

  The recorded location of the *Pseudantechinus* sp. is approximately one kilometre from the proposed TT alignment (fibre optic cable), for this reason no direct impact from the Project is anticipated for this species.

- Short Range Endemics

  Given their potential to be restricted at small spatial scales, Short Range Endemic species are generally at greater risk of changes in conservation status, local population or taxon extinctions than other, more widely distributed taxa (EPA 2009).

  Following modification to the proposed waste landforms only one putative Short Range Endemic invertebrate will be fully impacted by the Project, based on current information on its single sampling location. This species is *Kwonkan* sp. 2. Distribution of habitat preferred by *Kwonkan* sp. 2 suggests that the species is not restricted to the operational footprint and therefore is not likely to be fully impacted by the Project (section 6.2.10) (Appendix 2-B4a).

Vertebrate Fauna Habitat

As discussed in Chapter 6, habitats significant to vertebrate fauna were recognised throughout the Project survey area, some of which may be considered to be 'island refugia' in that they are limited in area, or are not well represented in the area.

The main disturbance footprint for the Project is at the Operational Area. Large portions of the footprint have been burnt within the previous 5 to 10 years and consequently the quality of habitat is less than that of the surrounding areas (Appendix 2-B5).

Though the major proportion of the fauna habitat located within the operational and infrastructure areas will be removed, large areas of similar habitat, with almost identical characteristic (type and assemblage), have been recorded in the surrounding region (Appendix 2-B5). The Great Victoria Desert region is also one of the few remaining areas that has had limited disturbances from human activities such as pastoralism and mining resulting in large areas of relatively pristine habitat. As such, the regional impact of the proposed Project will be limited in terms of faunal habitats (Appendix 2-B5).

The region surrounding the TT Corridor is generally undisturbed and combined with the limited level of clearing required along the corridor, no fauna habitat types are expected to be significantly impacted by the development of the infrastructure corridor (Appendix 2-C1). Localised impacts are expected due to clearing activities but these are expected to be minimal.

Ninox Wildlife Consulting assessed the significance of 'island refugia' and emphasised the importance of remnant, reasonably long unburnt areas of varying vegetation, geology and soils. Along the Pinjin Infrastructure Corridor, a considerable area has been seriously burnt or is recovering from fairly recent burns, particularly the yellow sandplains, thus the area could be quite depleted of fauna (Appendix 2-C6). The remnant unburnt vegetation areas are the sources from which the burnt areas will be re-populated (Appendix 2-C6). The rate of recovery of fauna would be dependent on the rate of recovery of vegetation and ecological aspects and processes including shelter, prey species including invertebrates, flowering and seeding (Appendix 2-C6). Management will be taken to minimise further loss of mature vegetation or recovering vegetation particularly on the yellow sandplains that are vulnerable to wildfire.

Priority Ecological Community

Potential impacts to the 'Yellow sandplain communities of the Great Victoria Desert' PEC were discussed previously in section 7.2.2.

Applicable Guidelines and Legislation

Environmental Protection Authority Objective and Guidance

In most circumstances, including this assessment, the EPA applies the following objective in its assessment of proposals that may affect terrestrial fauna:

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

EPA Position Statement No. 3 (EPA 2002b) discusses the principles the EPA would apply when assessing Proposals that may have an effect on biodiversity values in Western Australia. The Position Statement intends to provide the following outcomes:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and, therefore, the need to develop and implement best practice in terrestrial biological surveys; and,
- enable greater certainty for proponents in the Environmental Impact Assessment process by defining the principles the EPA will use when assessing Proposals that may have an effect on biodiversity values.

In addition to considering the EPA principles described in section 5.3, the EPA requires that surveys undertaken as part of the EIA process address relevant guidelines, in this case Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004d) and Guidance Statement No. 20 Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment (EPA 2009) which was in draft form only at the time of the initial surveys, but has now been finalised.

State Legislation

Native fauna in Western Australia are protected at a State level under the *Wildlife Conservation Act 1950* (WC Act). The WC Act allows for the special protection of rare and threatened species. The list is periodically reviewed and the current list of protected fauna can be viewed on DEC's website.

Currently in Western Australia, rare or threatened species are defined under the Act according to the following schedules:

- Schedule 1: A native species that is rare, or likely to become extinct, is declared to be fauna that is in need of special protection.
- Schedule 2: A native species that is presumed to be extinct is declared to be fauna that is in need of special protection.
- Schedule 3: Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds, and birds in danger of extinction, are declared to be fauna that is in need of special protection.
- Schedule 4: A native species that is in need of special protection, otherwise than for the reasons specified in Schedules 1, 2 and 3.

Department of Environment and Conservation Priority Species

The DEC (Nature Conservation Division) maintains a list of Priority Fauna taxa categorised from Priority One to Five. Priority Fauna are considered to be poorly known and/ or under threat, but for which there is insufficient data to justify listing as specially protected under the WC Act. It is expected that the potential impacts of a proposal to these Priority listed species should be managed such that the species do not meet the IUCN criteria for threatened species as a result of the proposal.

Federal Legislation

Fauna are protected at a Federal level under the EPBC Act. The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of NES, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources and to promote the conservation of biodiversity.

The EPBC Act includes provisions to protect native species (and in particular prevent the extinction and promote the recovery of threatened species) and to ensure the conservation of migratory species. There are six categories of protected species under the EPBC Act covering species that are:

- extinct;
- extinct in the wild;
- critically endangered;
- endangered;
- vulnerable; and,
- conservation dependent.

International Agreements

Australia has entered into international agreements for the protection of migratory birds. These agreements are between Japan-Australia (JAMBA), China-Australia (CAMBA) and the Republic of Korea-Australia (ROKAMBA).

Potential Impacts

The potential impacts to terrestrial fauna resulting from the Project are:

- clearing of native vegetation;
- impacts to fauna habitat;
- fauna entrapment;
- fire;
- introduced fauna;
- introduction and/or spread of weeds and soil pathogens;
- changes to surface water hydrology; and,
- emissions to air/ land/ water.

Clearing of Native Vegetation

Potential Impacts

Clearing of significant areas of vegetation is an unavoidable impact of the establishment of a new operation. The Project could result in the clearing of up to 3,440 ha as previously discussed.

The most significant threat to terrestrial fauna (including Short Range Endemics) is the clearing and consequent loss of critical habitat because many of the species of conservation significance potentially impacted by the Project have specific habitat requirements. Clearing and associated impacts (e.g. compaction) can also result in the fragmentation of previously connected areas of habitat. Potential impacts resulting from the clearing of native vegetation and development of infrastructure for the Project are:

- loss of individuals of conservation interest fauna species;
- a localised reduction in biodiversity and ecological function;

- loss and degradation of habitats essential to the survival of native fauna species such as:
    - The Marsupial Mole may undergo a localised impact due to the clearing of habitat and earthworks. However due to the large areas of sand dunes located in the region, direct impacts from the Project to the regional populations of Marsupial Mole are expected to be insignificant.
    - The clearing of Malleefowl nesting mounds that may be reused in the future is a potential threat. Clearing of any patches of dense vegetation may potentially impact Malleefowl (if still present) by reducing the amount of suitable habitat within the Project area. Loss of thick stands of mallee/ mulga could potentially reduce the amount of available habitat for this species.
    - The clearing of hummock grasslands (e.g. *Triodia* spp.) grasslands and shrublands with medium to dense cover on sandy soils may remove the future potential habitat for the Mulgara.
    - Disturbance of dune systems, particularly areas supporting large spinifex clumps may reduce the area of suitable habitat available to the highly restricted Sandhill Dunnart.
    - The clearing of dense low vegetation including spinifex and/ or chenopod shrublands, especially close to water, may potentially impact the ground dwelling Night Parrot.
    - Clearing of habitat used by Short Range Endemics. Due to their highly restrictive and/or specialised habitat utilisation, and general lack of knowledge; and,
    - Clearing impacts on the potential PEC.
- fragmentation of populations of native fauna species;
- changed fire regimes;
- introduction of feral animals;
- displacement of local fauna into surrounding areas where they may face competition from established individuals; and,
- alteration of local surface water flows resulting in critical habitat impacts and resulting alteration of fauna habitat.

Management Measures

Development of management strategies has focused firstly on avoiding impacts to fauna habitat through site selection and secondly on managing and mitigating unavoidable impacts. The following measures will be implemented to manage and mitigate impacts to terrestrial fauna associated with the clearing of native vegetation:

- avoidance of critical fauna habitat;
    - Impacts to listed species will be minimised by avoiding critical habitat. The proposed layout has been designed taking into consideration threatened fauna data and critical habitat information obtained during the baseline surveys undertaken as part of the EIA process.
    - Targeted surveys for Marsupial Mole holes/ habitat and other fauna habitats of particular conservation interest species were undertaken to assist in the determination of the Project layout. The proposed Operational Area and infrastructure corridors avoid disturbance to continuous sand dunes where the Marsupial Mole may occur. Such habitat occurs west of the Resource Area and will not be impacted by the project (Figure 7.1). Clearing within the Resource Area will remove localised Marsupial Mole habitat. Lack of consideration of habitat connectivity in the placing of linear infrastructure (e.g. the access road) also has the potential to impact the populations (see section 7.2.10 and Figure 7.12 for further details).
    - The Project will also avoid most known nesting habitat of the Malleefowl such as mallee thickets and patches of old thick spinifex that form small discrete habitats. One mound located within the

Operational Area footprint will be removed (Figure 7.1). Clearing will not be undertaken during the Malleefowl nesting period (usually August to December).

- Although the Sandhill Dunnart and Mulgara were not recorded during the surveys, suitable habitat for this species was located. It is possible that under the right conditions Sandhill Dunnarts may migrate into the Project area (provided suitable unburnt habitat is available). For this reason, routing of infrastructure corridors will occur away from habitat suitable for this species where practicable.
- The proposed layout of the waste landform has been modified to prevent impacts on the restricted Aganippe sp. 4 (Figure 7.6). A habitat assessment for *Kwonkan* sp. 2 has suggested that its habitat does extend outside of the Project footprint, however individuals are yet to be sampled.

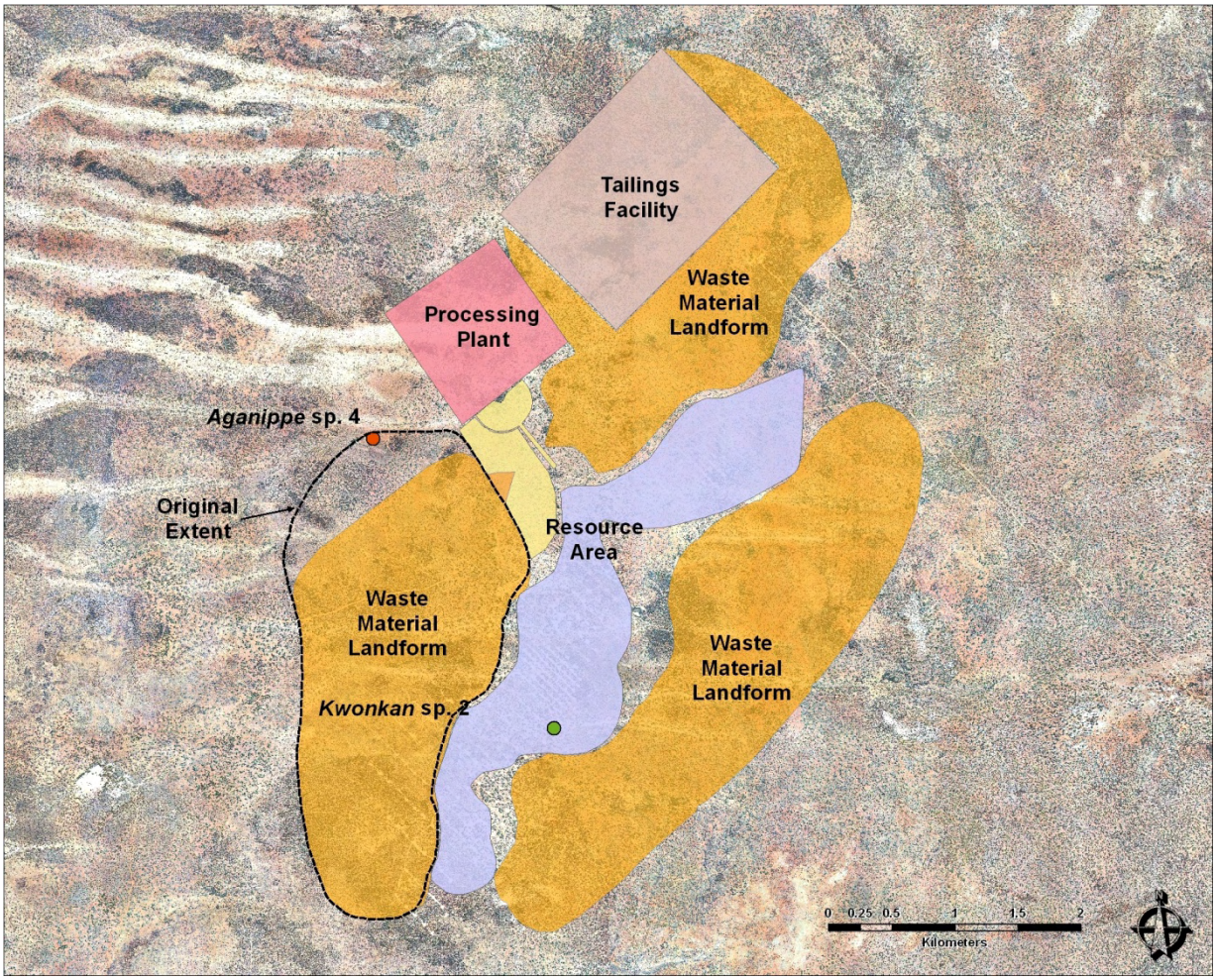
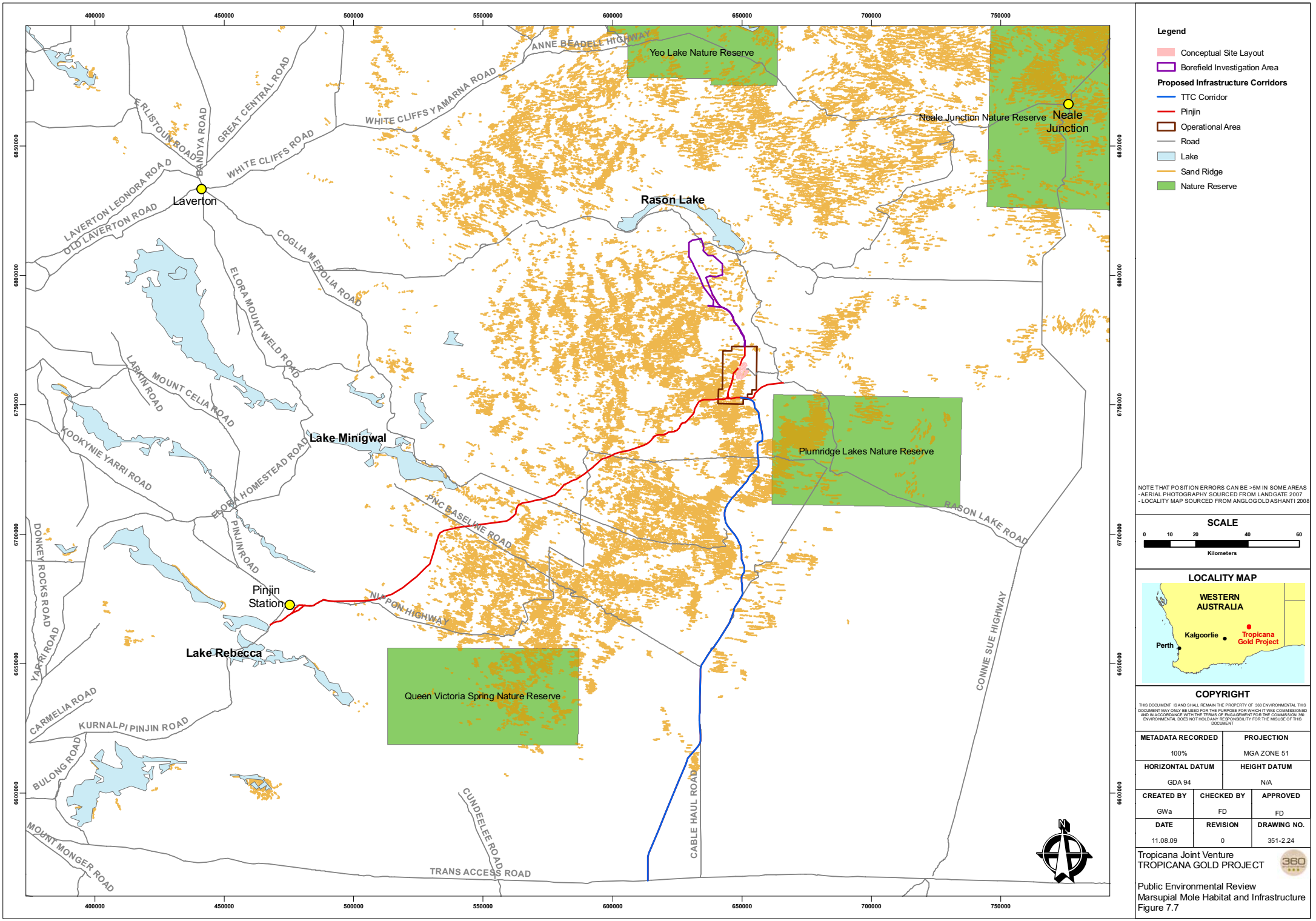


Figure 7.6: Modified Waste Landform

- implementation of the CEMS, OEMS and Threatened Species and Communities Management Strategy (TSCMS), (Appendices 3-B, 3-C and 3-E);
- clearing will avoid the breeding season of all conservation species at risk (for further detail see Appendix 3-E);
- All areas to be cleared will be approved under this PER (including borrow pits, quarry and other areas that are yet to be physically located. The clearing footprint of these areas has been included in the overall footprint for the Project and these items will be located to avoid known locations of listed or conservation significant fauna, and will also be located to minimise impacts to areas of their preferred habitat);
- disturbance to native vegetation minimised where possible and all areas requiring clearing will be clearly delineated;

- clearing is planned to retain habitat corridors where practicable. For example, the Joint Venture has aimed to place all infrastructure corridors so as to minimise disruption to prime habitat for the Marsupial Mole (i.e. avoid impacts to sand dunes; Figure 7.7). The preferential placement of the Mine Access Road in the interdunal areas achieves this aim. An additional concern was that infrastructure corridors may lead to fragmentation affects through compaction of substrate. However, as interdunal (compacted) areas are rarely used by Marsupial Moles (Appendix 2-B5 and Appendix 2-F5), except for surface crossings (pers. comm. J. Benshemesh July 2008) compaction of interdunes due to the road is unlikely to have a significant impact on the ability of Marsupial Moles to move through the landscape;
- clearing programs designed to occur over a period of time to allow movement of individuals away from clearing activities;
- a conservation interest species and community database will be established for the region and maintained for duration of the Project;
- cleared areas will be rehabilitated as soon as is practicable. Rehabilitation will include placing cleared vegetation (all sizes) within the area, as these provide fauna refuge. Following rehabilitation, areas will be monitored and, if necessary, treated for weed invasion;
- disturbance to possible Malleefowl and Sandhill Dunnart habitats minimised where practicable such as mulga stands which have been unburnt for greater than five years. Areas of spinifex which have been unburnt for approximately eight to 38 years, and have the potential to provide habitat for Sandhill Dunnarts and Mulgara will be protected where possible;
- trenches will be inspected and cleared of animals, for specific details of trench fauna management refer to CEMS and OEMS; and,
- based on the results of the targeted Mulgara survey, it is not anticipated that the species will be impacted by clearing. Although it is unlikely that populations of Mulgara will colonise the Project footprint if there is a substantial delay between the PER approval and ground disturbance (over approximately five years) a reassessment for the Mulgara and associated habitat will be undertaken.



METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	FD	FD
DATE	**REVISION**	**DRAWING NO.**
11.08.09	0	351-2.24

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Marsupial Mole Habitat and Infrastructure
Figure 7.7

Fire

Potential Impacts

Activities associated with the Project, such as increased movement of personnel and machinery use may result in changed fire regimes which pose a significant threat to species of conservation significance.

The Project Operational Area is located in a large area of native vegetation that has been subject to few impacts from human activities (e.g. lack of pastoralism, agriculture and forestry). The main degradation of habitat in the region occurs from frequent and widespread fires. spinifex grasslands are most susceptible to fire, and large areas within the Operational Area have been burnt in the past five years.

Potential impacts on conservation interest species resulting from accidental fire include:

- immediate deaths of conservation interest fauna individuals and populations;
- loss of critical habitat;
- loss of breeding habitat;
- habitat fragmentation in the area;
- loss of existing 'islands' of unburnt vegetation which provide refuge and habitat for conservation interest fauna species;
- alter abundance and composition of invertebrate and small vertebrate prey, which could be indirectly detrimental to the Marsupial Mole and other carnivorous or insectivorous species;
- increased proliferation of weeds;
- altered vegetation structure; and,
- loss of critical habitat such as spinifex for fauna species reliant on long unburnt vegetation, or mosaic/ patch style burning for example:
    - Mulgara maintain a semi-permanent home within spinifex, the burning of the spinifex, whether by natural or man-made fire, poses a threat to the Mulgara;
    - the Sandhill Dunnart is spinifex dependent; fire potentially reduces the variability of spinifex age at a local scale, thus reduces the availability and suitability of habitat for the Sandhill Dunnart;
    - as Short Range Endemic Species are restricted to small spatial scales they are considerably vulnerable to alteration to habitat due to changed fire regimes; and,
    - the Great Desert Skink is dependent on regeneration vegetation therefore changed fire regimes is the species' most significant threat.

Management Measures

Management of fire directly associated with the construction and operations of the Project will focus primarily on the prevention and control of fires. Standard fire management practices are outlined in the management section of Flora and Vegetation (section 7.2.2).

In addition, the Project will acquire knowledge of the fire sensitivity of listed fauna species and how listed fauna species respond to various fire regimes. Information is currently available relating to the fire sensitivity of some species in the area (e.g. Sandhill Dunnarts prefer spinifex habitat that has remained unburnt for several decades and Malleefowl are sensitive to habitat changes resulting from a too-short inter-fire period). Further information can be generated as part of the Biodiversity Trust (see section 13.1.3).

Introduced Fauna

Potential Impacts

Several feral species are already established in the region, however the Project may potentially increase the incidence of feral animals in the area. Introduced mammals such as the house mouse, European fox, wild dog and feral cat potentially pose a threat to all threatened species in the Project footprint.

Dingo (*Canis lupus dingo*), European fox or cat prints were observed on most sand dunes investigated.

The attraction of feral fauna to the area may impact conservation interest fauna and flora by:

- competing with listed species leading to their displacement of fauna from adjacent habitats;
- direct predation on listed species increasing the mortality of fauna. The Sandhill Dunnart, Mulgara, Malleefowl, Marsupial Mole and Woma Python are highly susceptible to predation. Remains of the Marsupial Mole have previously been recorded in the scats of feral cats, wild dogs and European foxes; and,
- habitat degradation including compression of dunes and trampling by species including camels or feral goats (*Capra hircus*). This may adversely affect the habitat of threatened fauna or their local movement and dispersal. Compaction of substrate from camels may adversely affect the availability of invertebrate prey. As the majority of the species of interest are insectivorous this may impact on food availability.

Management Measures

The risk of introducing feral fauna species to site will be mitigated in the following ways:

- pets will be not permitted on site;
- good housekeeping and rubbish disposal practice will be implemented (refer to CEMS and OEMS);
- barriers will be installed around water and waste storage facilities;
- site stormwater management to avoid ponding of water away from designated areas;
- maintenance of taps and other water infrastructure to prevent leaks; and,
- site personnel will be discouraged from feeding wildlife, both native and feral species.

Introduction and/or Spread of Weeds

Potential Impacts

Increased vehicular traffic, combined with the introduction of machinery, earthworks and disturbance in the area, disposal of water and domestic operations, and increased human activities may introduce or provide an opportunity for additional weed species to become established. The introduction of weeds and soil pathogens to the area may contribute to the degradation of critical habitats for native fauna species, in particular Short Range Endemics.

Management Measures

Specific management actions have been identified to assist in minimising the potential sources of weed infestations and containing, controlling and/ or eradicating target weed species from the Project area are detailed in section 7.2.2 (Flora and Vegetation).

Changes to Surface Water Hydrology

Potential Impacts

Changed hydrology, such as altered flow regimes may affect local vegetation on which the fauna, particularly Short Range Endemics are reliant.

Management Measures

Management measures will include:

- implementation of the CEMS and OEMS (Appendices 3-B and 3-C respectively);
- land clearing control procedures;
- disturbance to native vegetation will be minimised where possible and all areas requiring clearing will be clearly delineated; and
- the implementation of the surface water management as described in detail in section 7.2.5. Surface water management has two components that will address the potential impacts on surface drainage, they are:
  - diversion of stormwater from above the site
  - retention of site generated stormwater onsite through the creation of a gravity drainage network and storages.

Emissions to Air/ Land/ Water

Potential Impacts

The construction and operation of the Project will require activities such as the use and production of materials that may generate or release potentially hazardous emissions to the environment which may, in turn, impact upon a native species. These include:

- general and putrescibles wastes and associated disposal facility;
- workshops, chemical storage areas and other dangerous goods (e.g. - cyanide) or controlled waste (e.g. waste oil);
- tailings and associated tailings storage facility;
- waste landforms;
- generation of dust (particularly for Short Range Endemics); and,
- light, noise and vibration.

These impacts are discussed in detail in the TSCMS (Appendix 3-E).

Management Measures

Management measures complementing the flora and vegetation protection measures (section 7.2.2) have been developed to minimise the risk of emissions impacting on terrestrial fauna and include:

- establish and implement waste management processes that includes monitoring of life of product requirements including supplier removal;

- make available receptacles for rubbish disposal. Rubbish bins are to include a lid which is to be kept closed to prevent scavenging by animals;
- staff and contractors to be informed of appropriate rubbish disposal practices in on-site environmental awareness training;
- include fauna-rubbish interactions in environmental incident reporting;
- design storage, handling and disposal facilities with appropriate bunding/ spill containment;
- locate storage and handling facilities away from environmentally sensitive areas;
- establish and implement hydrocarbon storage, handling and use procedures and process;
- establish and implement Emergency Response Procedures (ERP) for hydrocarbon spills, including strategies for environmentally sensitive areas;
- ensure compliance with the International Cyanide Management Code;
- implement the Tailings Environmental Management Strategy (Appendix 3-G);
- implement standard procedures to prevent the disposal or accidental spill of waste hydrocarbons and other environmentally hazardous substances will be implemented. These procedures are fully described in the CEMS, OEMS and the TSCMS; and,
- adopt an appropriate dust management strategy including dust suppression and the monitoring of impacts.

The Joint Venture Actions

Action: Implement Joint Venture Action 4 as described in section 7.2.1 and Actions 5, 6 and 7 and 7.2.2.

7.2.4. Subterranean Fauna

Management Objectives

The objectives of the Joint Venture for the management of subterranean fauna are to:

- maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels;
- avoid Project impacts to subterranean fauna species; and
- improve knowledge of regional subterranean fauna in order to improve management.

Description of Factor

During the baseline surveys three types of troglofauna were identified (taxa observed where Isopoda (slater), Diplura (dipluran), Chilopoda (centipede)); two of these (dipluran and centipede) have been observed only within the operational footprint (Figure 7.1). The slater has been located both inside and outside the footprint – it will be partially impacted by the project (Figure 7.1). Based on known sampling locations of the dipluran and centipede it appears that these species will be fully impacted by the Project. The Joint Venture has conducted a review of the regolith around the Operational Area and has found that the habitat types potentially supporting troglofauna are wide spread outside of the footprint. Therefore the impact to the species is more likely to be partial rather than complete habitat removal (section 6.2.11; Appendix 2-B20).

There is an apparent lack of suitable stygofauna habitat within the proposed Project footprint (Appendix 2-B2 and 2-D5). For specific details on the field surveys refer to sections 6.2.11 and 6.5.3.

Applicable Guidelines and Legislation

Environmental Protection Authority Objective and Guidance

In most circumstances, including this assessment, the EPA applies the following objective in its assessment of Proposals that may affect subterranean fauna:

> "*To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystems levels through the avoidance or management of adverse impacts and improvements in knowledge".*

EPA Guidance Statement No. 54 (EPA 2003) provides guidance on the information the EPA will consider when assessing proposals where subterranean fauna is a relevant factor. This guidance statement specifically addresses the conservation of Stygofauna in groundwater systems and Troglofauna in subterranean caves and airspaces. It provides guidance on the information that the EPA will consider when assessing proposals where the protection of Stygofauna or Troglofauna is a relevant environmental factor. The draft EPA Guidance Statement No. 54a (EPA 2007a) has been developed as a technical appendix to EPA Guidance Statement No. 54 and provides guidance on sampling for subterranean fauna, including sampling effort, sampling design and ongoing monitoring.

State Legislation

In Western Australia, rare or endangered species are protected by the Wildlife Conservation (Specifically Protected Fauna) Notice 2008, under the WC Act 1950. Schedules 1 and 4 in this notice are relevant to this assessment, providing a listing of those species specially protected under the Act. See section 7.2.3 for further details.

Department of Environment and Conservation Priority Species

The DEC (Nature Conservation Division) maintains a list of Priority Fauna taxa categorised from Priority One to Five. Priority Fauna are considered to be poorly known and/ or under threat, but for which there is insufficient data to justify listing as specially protected under the WC Act. It is expected that the potential impacts of a proposal to these Priority listed species should be managed such that the species do not meet the IUCN criteria for threatened species as a result of the proposal.

Federal Legislation

Native fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). See section 7.2.3 for further details.

Potential Impacts

Subterranean ecosystems and the fauna they support may face significant risks from mining practices, specifically the ore extraction process which directly removes the habitat and dependent species (*ecologia* 2009b).

Potential impacts to subterranean fauna include:

- direct habitat removal;
- substrate or surface water (penetrating into habitat) contamination;
- surface water hydrology;
- groundwater drawdown and dewatering;
- groundwater rise;
- clearing of native vegetation; and,
- vibration.

This section focuses only on the potential impacts to troglofauna as no stygofauna species have been identified to date.

Direct/ Indirect Habitat Removal

Potential Impacts

The ore extraction process involves the direct removal of subterranean habitat and potentially, the loss of dependent species. Physical alterations of the environment may include changes to the temperature, humidity, availability of organic matter and interruption to the food chain by exposing voids to atmospheric oxygen, water content and pollutants (Appendix 2-B3).

Management Measures

The three Troglobitic species observed within the proposed Operational footprint (one recorded outside of the footprint as well) are thought to occupy one (or more) of three distinct habitat types as discussed in section 6.2.11. These habitats are not restricted to the Project footprint, thus while it is likely that the Project will remove the local populations of Troglofauna it is unlikely that the Project will have a significant impact on the regional populations.

The Joint Venture will continue to sample and investigate the distribution of the three troglobitic species observed and will minimise the Project footprint wherever possible.

Clearing of Native Vegetation

Potential Impacts

The clearing of native vegetation or surface sealing may alter the physical environment of Troglofauna in the following ways:

- reduction in organic inputs to subterranean ecosystems due to vegetation clearing. Clearing of vegetation beyond the mine footprint therefore has the potential to reduce nutrient influx to the underlying habitats;
- changes to groundwater either by increasing or decreasing (further covered below).

Management Measures

Management measures will include:

- implementation of the CEMS and OEMS (Appendices 3-B and 3-C respectively);
- obtaining an approval for all areas to be cleared; and,
- disturbance to native vegetation will be minimised where possible and all areas requiring clearing will be clearly delineated.

Changes to Surface Water Hydrology

Potential Impacts

The periodic surface water input and recharge during rainfall events determines the humidity of the subterranean habitat. Alteration to surface hydrology could therefore affect the underlying habitats. Increases in surface erosion could also lead to sedimentation of microhabitat space utilised by troglofauna.

Management Measures

Management measures will include:

- implementation of the CEMS and OEMS (Appendices 3-B and 3-C respectively);
- land clearing control procedures (to minimise the reduction of organic carbon influx from surface sources);
- disturbance to native vegetation will be minimised where possible and all areas requiring clearing will be clearly delineated; and
- surface water will be managed by:
  - diversion of stormwater from above the site
  - retention of site generated stormwater onsite through the creation of a gravity drainage network and storages.

Groundwater Drawdown/ Rise

Potential Impacts

Dewatering will accompany pit development as the proposed pits extend below the water table. Groundwater drawdown by abstraction within the Minigwal Trough, dewatering at the Operational Area, and other aquifer impacts may affect subterranean fauna. Alteration in groundwater levels either as a rise or a lowering of levels can potentially have both direct and indirect impacts on subterranean fauna.

Management Measures

Modelling of the pit dewatering drawdown cone indicates that a drawdown effect on the adjacent area will be up to 50 m within 1 km of the Resource Area which is located predominately under the proposed waste landforms. At the 4 km distance the drawdown cone is likely to be less than 1. The Joint Venture will monitor the drawdown effect over the life of the Project and in the event that the actual drawdown cone extents significantly outside the proposed operational area a contingency plan will be developed.

Groundwater and Surface Water Contamination

Potential Impacts

The potential exists for the subterranean environment to be degraded by spills of hydrocarbons and other chemicals. Hydrocarbons (including diesel) and other chemicals will be routinely used during mining, presenting both operational (for example, refueling) and storage risks. Spills of environmentally harmful substances may degrade the subterranean environment by contaminating surface water and groundwater (for example, chemical pollutant spills, unlined landfills and direct discharge of waste or different water quality). These risks are applicable to all Troglofauna that occur in the Project footprint.

Seepage from the tailings storage facility presents a risk to subterranean fauna as it may lead to contamination of surface water, groundwater and subterranean substrate. Two species have been recorded in the tailings storage facility area, a single specimen form the order Diplura and an Isopod (Figure 7.1).

Management Measures

Management measures for the prevention of groundwater and surface water contamination will include:

- implementation of pollution prevention controls for hydrocarbon/ chemical spills;
- implementation of a routine monitoring program for the duration of the Project in order to detect any potential pollution to the aquifers surrounding the Operational Area;
- ensure the Project has an appropriate a spill response procedure;
- implement the TSFEMS (Appendix 3-G);
- design of the tailings storage facility to include:
    - permanent and secure containment of all solid waste materials;
    - seepage from the tailings storage facility will be minimised by the use of liners and the underdrainage network; and,
    - limit the amount of free water stored on the facility by removing it as quickly as possible for use in the plant.

Vibration

Potential Impacts

Vibration from blasting activities has the potential to cause changes to geological formations and may decrease the habitat available to Troglofauna in close proximity to the mining area. Vibration from mining activities has the potential to collapse cavity features within geological formations.

Management Measures

The risks are difficult to quantify and equally difficult to mitigate. Vibration limits will be managed within industry standards as outlined in the CEMS and OEMS documents.

The Joint Venture Actions

Action: Implement Joint Venture Action 4 as described in section 7.2.1 and Actions 5, 6 and 7 as described in section 7.2.2.

7.2.5. Surface Water

Management Objective

The objectives of the Project for the management of surface water are to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

Applicable Standards and Guidelines

- EPA Guidance No. 33 Environmental Guidance for Planning and Development (EPA 2005); and,
- Water Quality Protection Guidelines No.6 Mine Stormwater (WRC 2000).

Description of Factor

Surface drainage is a very minor feature in the majority of the Great Victoria Desert (Australian Resources Atlas 2008). The majority of the drainage catchment is upstream of the Operational Area and the infrastructure corridors, and is characterised by sandy soils, low relief, poorly defined drainage lines and areas with strong linear sand dunes with internal drainage. With the high infiltration of sandy soil types and the arid climate, surface flow is an atypical state. Stormwater typically infiltrates soon after a rainfall event. When surface flow occurs, the flow events are highly variable in size and timing, and are generally as a result of tropical cyclones or excyclonic rain barring depression. The potential impacts are discussed as relevant to the each of the areas proposed to be developed.

Operational Area

There are two main local catchments adjacent to the main Operational Area, an eastern catchment (known as Catchment A) and a western catchment (known as Catchment B). Two broad, low relief drainage lines currently pass through the proposed operational area. Drainage is from the southwest to the northeast, toward the southern reaches of the Lake Rason system.

The majority of the resource and infrastructure areas are located mainly in Catchment A, on the western slopes of the north-easterly trending ridgeline and in the valley to the west. Parts of the eastern waste landform are located in Catchment B and the access road to the existing airstrip crosses the Catchment B valley.

Infrastructure Corridors

The proposed access route for the Project will be via the Pinjin Infrastructure Corridor; requires the construction of some 220 km of new road. This includes the upgrading of three ephemeral waterway crossings, Lake Minigwal, Lake Rebecca and Ponton Creek. The impact of disruption of sheetflows on mulga (*Acacia aneura*) is possible and has been discussed at length by Bertuch and van Etten (2004) and summarised in section 7.2.2.

Operational Area

Potential Impacts

Surface water impacts associated with the Operational Area are:

- increased stormwater generation and modification to flow paths;
- modification of the existing drainage valley that runs through the site and diversion of stormwater flows from upslope around the west of the main Operational Area; and,
- discharge of stormwater from the site with elevated levels of sediment, salt or contaminants.

Management Measures

A surface water management concept has been developed based on the conceptual site layout (Figure 7.8).This conceptual plan may be modified as the final design is further defined at a more detailed level. The concept has two components that will manage the potential impacts on surface drainage, they are:

- diversion of stormwater from above the site – A diversion channel will be established to divert stormwater around the western side of the Operational Area. The channel will be cut on the western side of the processing area to divert surface water flows that away from the processing area and tailings storage facility; and,
- retention of site generated stormwater onsite through the creation of a gravity drainage network and storages. The concept aims to separate potentially contaminated water from clean water areas. The run-off capture will either be used or allowed to evaporate. The storages will be sited, as much as possible, within the future waste landform footprint to avoid any extra clearing. Upon closure, runoff from the waste landforms will be permanently diverted into the pit void.

Infrastructure Corridors

Potential Impacts

Surface water impacts associated with the construction of linear infrastructure (such as the access road) are:

- constriction of flows at cross-drainage structures causing downstream erosion and shadowing (i.e. reduced flows due to upslope modification of flow paths);
- ponding upstream of the infrastructure, as a result of interruption of runoff flow paths, causing increased water logging or flooding;
- clearing and disturbance increasing erosion risk;
- increased salinity and sediment concentration of stormwater sourced from the disturbed areas; and;
- unplanned release of hypersaline water to the environment due to pipeline failure or leak.

Management Measures

To minimise the impacts of the infrastructure corridors on surface drainage the following management measures have been or will be implemented (Appendix 2-B8 and 2-C3):

- the proposed corridor alignments have been selected based on a range of criteria including minimising drainage crossing of major water features. Infrastructure corridors avoid listed flora species that might be affected by changes in drainage patterns;
- the footprint of the road corridor and construction areas has been minimised to reduce potential erosion;
- soil conservation techniques will be incorporated in the design to prevent erosion and an increase in surface water turbidity such as drainage structure that detain water and reduce flow velocity before discharge, armouring erosion prone points and stabilising slopes during construction;
- appropriately located and designed culverts or floodways to minimise disruption to natural flow paths, downstream runoff shadowing and upstream ponding (Figure 7.9). Minimise salt contamination of downstream surface water by containing saline road construction and dust suppressing water on the road and adjacent table drains; and,
- pipelines will be either bunded or buried and fitted with telemetry. The containment system will be selected taking into consideration the potential impacts on surface water sheet flows and potential damage to the pipeline.

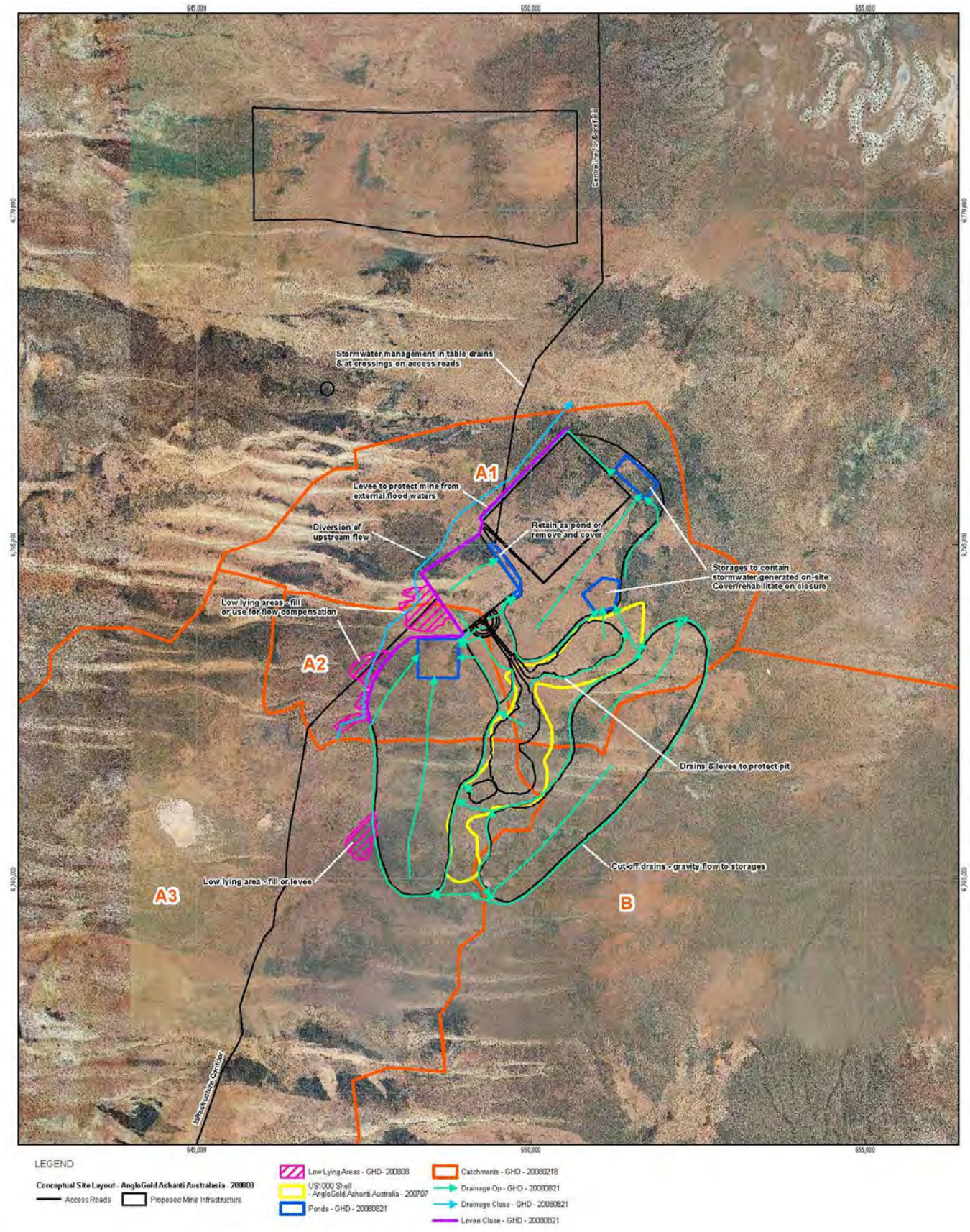


Figure 7.8: Conceptual Project Operational Area Surface Water Management Strategy (Source: Appendix 2-B8)

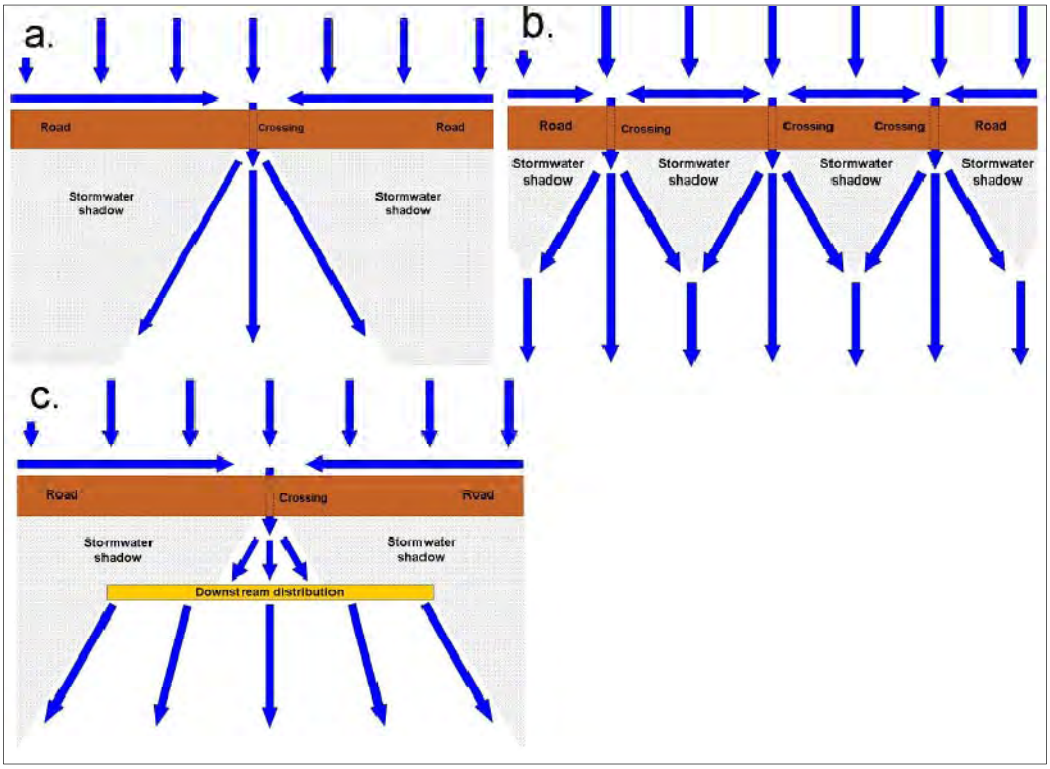


Figure 7.9: Possible Surface Water Flow Paths Downstream From a Road (Appendix 2-C3)

Diagrams b and c of Figure 7.9 illustrate how stormwater shadow, which can impact vegetation particularly mulga stands, which rely on sheet flow, can be lessened when compared to the standard approach in diagram a (Appendix 2-C3).

The Joint Venture Actions

Action 8: Where natural surface flows cannot remain, and where water is diverted around the Operational Area and infrastructure corridors, discharge will to be to local aquifers where possible. This philosophy is incorporated into the design.

Action 9: Take measures to ensure that all surface water flows from potentially contaminated areas are contained.

Action: Implement Joint Venture Action 4 as described in section 7.2.1 and Action 7 as described in section 7.2.2.

7.2.6. Groundwater

The Joint Venture's key water management considerations associated with water abstraction for the Project area, sustainable water abstraction from the Minigwal Trough, dewatering to facilitate operations and the disposal of dewatering water. This section summarises the impact and management associated with these aspects.

Objectives

The objectives for the management of groundwater abstraction associated with the Project are to:

- sustainably abstract groundwater from the borefield to facilitate mining operations; and,
- minimise the loss and adverse impacts to native vegetation associated with groundwater abstraction (dewatering and water supply).

Description of Factor

Direct impacts to groundwater can be expected at both the Water Supply Area (drawdown due to abstraction to supply the Project) and at the Operational Area (drawdown from dewatering to enable mining below the water table). The Joint Venture aims to minimise significant impacts through appropriate planning and management techniques. To minimise environmental impacts and/ risks, likely ecosystem responses to drawdown in both areas needs to be understood. Figures 7.10 and 7.11 describe the positioning of the water table in relation to the surface and geological features of the Operational Area.

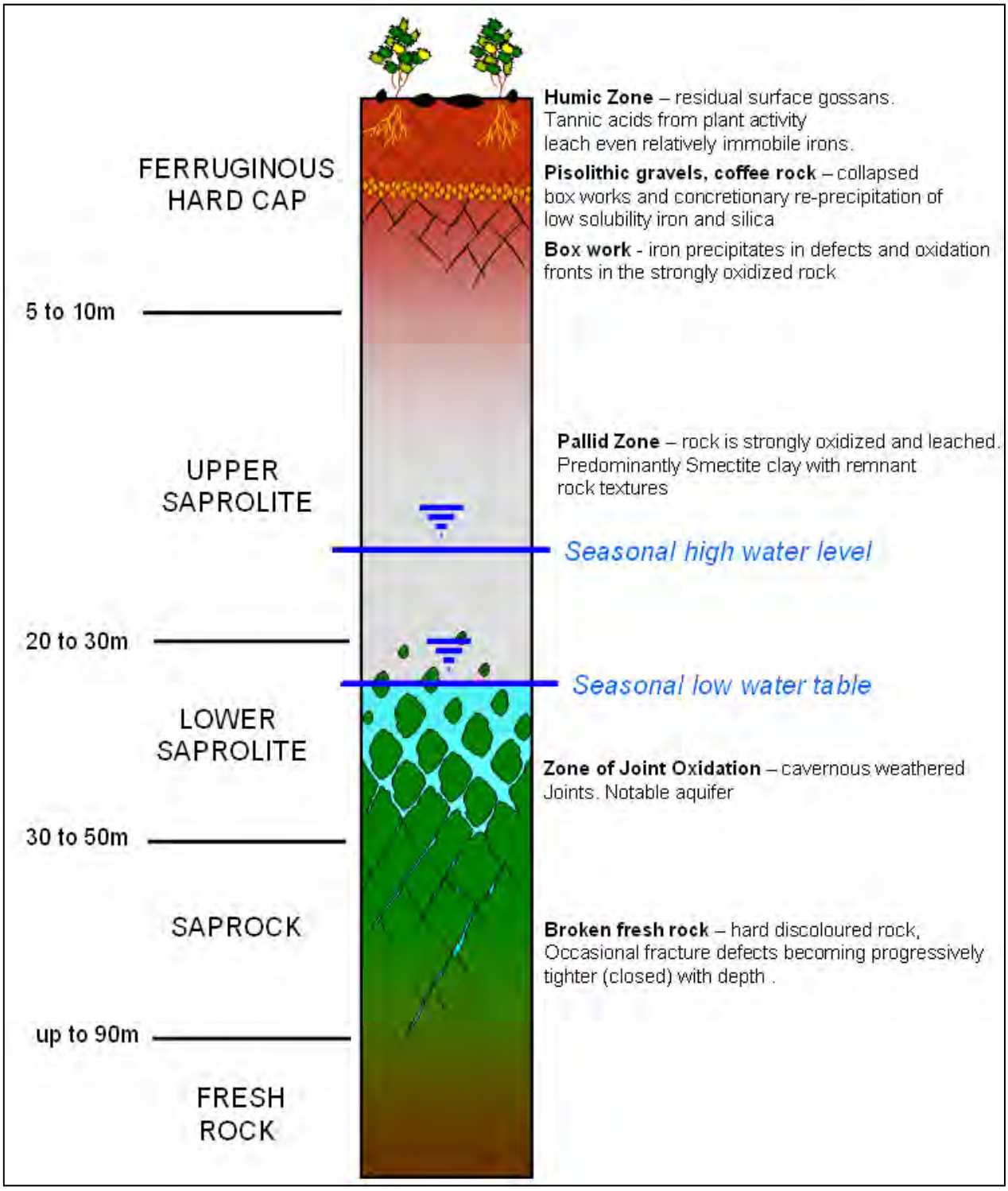


Figure 7.10: Water Table at the Operational Area and Laterite Profile

(Source: Appendix 2-B17)

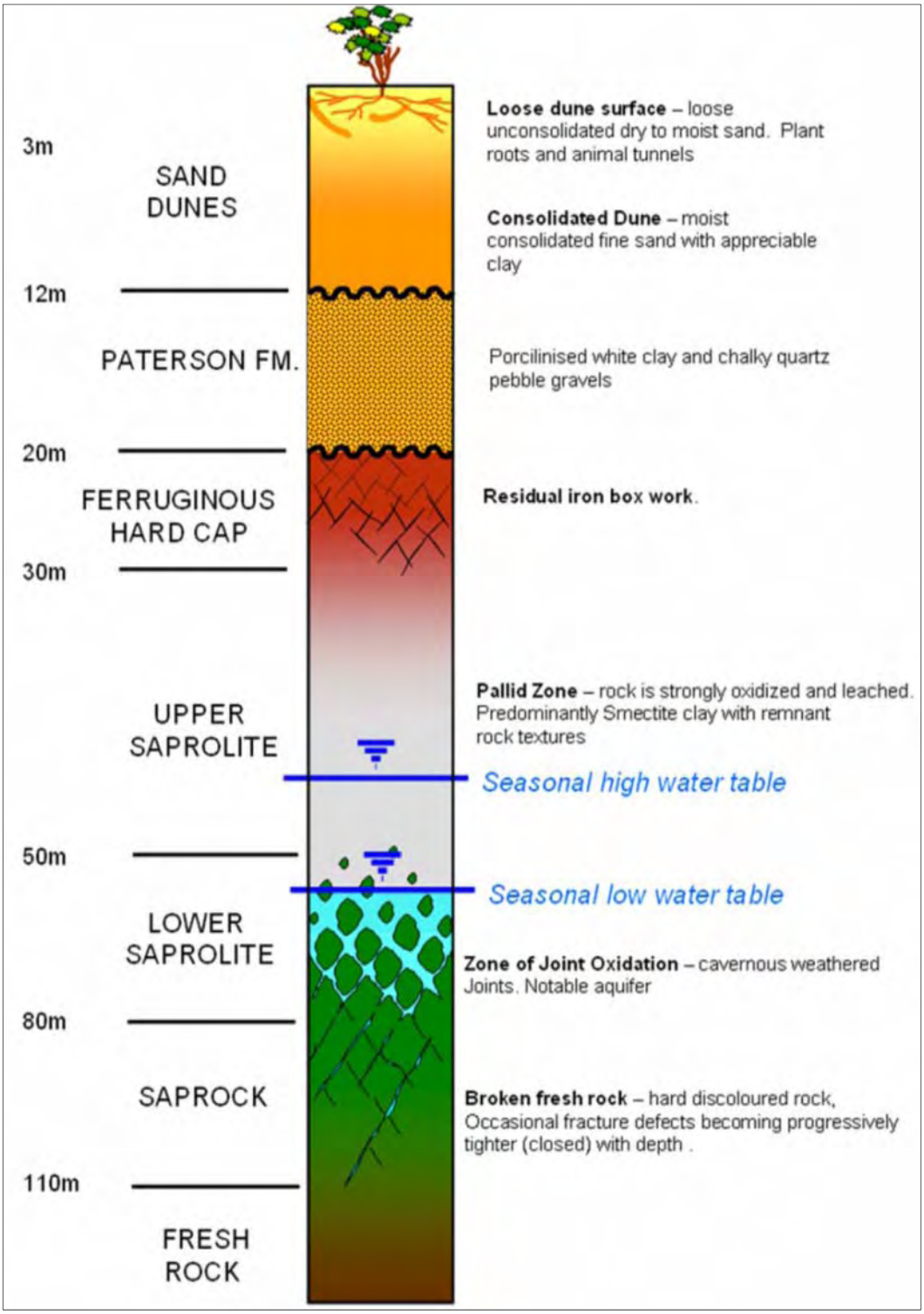


Figure 7.11: Water Table at the Operational Area and Laterite Profile Through Sand Dunes

(Source: Appendix 2-B17)

Further, and in order to demonstrate environmental due diligence (monitoring and reporting) environmental management practices will also be required. Appendix 2-B17 contains a detailed analysis of dewatering considerations associated with the Operational Area. Seepage and management of tailings storage facility is also discussed in Appendix 2-B15. Appendix 2-D4 contains data and analysis of impacts associated with the production borefield at the Minigwal Trough Water Supply Area.

The Project has been designed with water efficiency as a key priority due to the lack of available water in close proximity to the Operational Area. Dewatering water from the Operational Area will either be used for mining related activities or directed into the processing plant, thus eliminating the need to discharge dewater directly to the environment. This has efficiency benefits in terms of decreasing the required abstraction from the Water Supply Area, and decreasing the volume of water required to be pumped from the borefield (reducing the requirement for energy).

Project Water Supply

The Project will require the harvest of groundwater to supply the process and mine operations. It is estimated the Project will require up to14 ML/day based on 7 Mtpa processing plant, ideally having salinity levels less than 100,000 mg/L.

The main water consumer at the Operational Area will be the processing plant. However, water will be required for other purposes such as dust suppression, potable water and village. Indicative borefield design suggests that up to 40 production bores will be required, and as indicated in section 2 will be located 40 to 60 km northwest of the Operational Area. Figures 6.21 and 6.22 show the proposed borefield area and pipeline alignment overlain with vegetation mapping for the area. Section 7.2.2 discusses the vegetation impacts from clearing associated with the borefield and the pipeline route.

Dewatering at the Operational Area

Dewatering will form part of the open cut mine operation and will consist of the following phases (Appendix 2-B17):

- Phase 1 dewatering will take place through construction of four 100 m deep out-of-pit dewatering production bores. The bores will commence pumping prior to pit excavation and during excavation above the water table. These out-of-pit bores will serve the dual purpose of reducing pressure heads around the pit, while providing water supply for dust suppression during the initial phases of construction and mining; and,
- Phase 2 will involve in-pit sumps, as the pit progresses horizontal seep wells may be required to assist the drying of the walls.

The mine dewatering activities and tailings storage facility water management, has been the subject of a numerical groundwater model constructed using the FEFLOW finite element code. The model results indicate pit influx to be incorporated into the dewatering infrastructure design will consist of:

- long term average groundwater influx of 1600 kL/day;
- potential variability in flows which could consist of:
    - up to 1000 kL in one-off flows from perched alluviual/ colluvial systems;
    - 327 ML from rainfall accessions during a 100 year ARI storm event;
    - up to 100 kL/day additional flow following an episodic recharge event, receding over a period of a few weeks; and,
    - up to 333 kL/day extra from tailings leakage recirculation if faults provide preferential flow path between tailings storage facility and the pits.

Water Disposal to the Surrounding Environment

All water generated via the dewatering operations will be used in the process water and the Joint Venture anticipates that there will be no need to discharge mine water to the surrounding environment. Cut-off drains and

channels will concentrate runoff locally from rainfall events. Flows generated on-site will be intercepted, impounded and disposed of via evaporation and infiltration.

Tailings Storage Facility

The Tailings Storage Facility will be a two-cell paddock storage facility, integrated into the waste landform. If not managed appropriately, the facility could have the potential to impact groundwater.

Groundwater Dependent Ecosystems

The depth to groundwater over the impacted area is greater than the rooting depth of local vegetation. The water table depth is 17 - 35 m between dunes and 45 - 55 m under sand dunes. The only potential groundwater dependent vegetation in the Project vicinity is halophytic vegetation in the low-lying area of the Rason paleodrainage. While this vegetation relies mainly on fresher run-on surface flow and through flows in the Paterson Formation for its water requirement, it possibly uses saline moisture from the underlying Upper Saprolite in dry periods.

Applicable Guidelines and Legislation

EPA Objective and Guidance

The EPA objective is to maintain or improve the quality of water resources to ensure that existing and potential uses, including ecosystem maintenance are protected (EPA 1993). Both State and Federal Governments have endorsed the National Strategy for Conservation of Australia's Biological Diversity and the National Strategy for Ecologically Sustainable Development which are designed to 'protect biological diversity and maintain essential ecological processes and life support systems'.

State Legislation

The Department of Water (DoW) regulates the use of water in Western Australia under the *Rights in Water and Irrigation Act 1914* (WA) (RIWI Act). Under the RIWI Act, a 26d License to Construct Wells, and a 5c License to Take Water and Manage its Use is required.

The Project activities fall within the Goldfields Groundwater Management Area. Well licenses are required, to construct or alter any artesian well, and non-artesian wells in proclaimed areas (land covered by the Act). However, a Section 26D well license does not, on its own, give the right to take water. A 5C License will be required to abstract water from the Minigwal Trough Water Supply Area.

Potential Impacts

It is recognised that the environment is a legitimate water user and therefore groundwater extraction and management is a key consideration for the Project. The potential impacts to groundwater resulting from the Project are:

- unsustainable abstraction of water;
- excessive dewatering drawdowns outside of the project area;
- indirect effect on shallow/ superficial aquifers;
- contamination of groundwater through poor management of the tailings storage facility and chemicals;
- alteration to Groundwater Dependent Ecosystems (GDE);
- alteration to lakes, surface water drainage and tributaries;

- groundwater intrusion/ aquifer modifications;
- clearing of native vegetation for borefield and pipeline route (refer section 7.2.2); and,
- impacts on Troglofauna habitats (refer section 7.2.3).

Project Water Supply

Potential Impacts

An appraisal of the potential environmental and social issues arising from the borefield development and operation indicates that:

- there are no other groundwater users within 80 km of the borefield. Since borefield depressurisation will not extend beyond 5 km from the borefield, other water users will not be affected;
- the lake hydrology is overwhelmingly driven by seasonal rainfall accessions and through flows in the overlying Paterson Formation. The sandstone is separated from the lake by a confining shale;
- even in the unlikely event that depressurisation of the sandstone extends beneath the lake, the impact on the hydrology of the lake and any lake ecosystems would be negligible; and,
- the saline groundwater quality (more than 40,000 mg/L) and very tight interstitial pore spaces (less than 45 micron) are not conducive to Stygofauna. Sampling of the aquifer undertaken in 2008 did not identify the presence of any Stygofauna.

The water investigations to date indicate that, while the permeability of the sandstone in the Minigwal Trough may be poor relative to other basin aquifers in Western Australia, the aquifer is sufficient to meet the Project process water requirements.

Management Measures

Management strategies are focused around minimising land clearing for the pipeline route, access track and borefield. Well construction management methods, including waste management (disposal of construction and bore development materials), hygiene management including weed control, fire management and Indigenous heritage management will form part of standard construction and operational procedures. The CEMS details the construction requirements associated with the water supply for the Project (Appendix 3-B).

Prior to operations field tests will be undertaken to verify the predicted aquifer storage parameters and a refinement of the potential borefield impacts. From the data gathered agreed sustainability initiatives specific to recharge and recovery will be agreed with the DoW and will form part of the OEMS for the borefield (Appendix 3-C). The OEMS contains a water quality monitoring and management section which details the operational requirements for the borefield, which includes:

- operational strategy for borefield (volumes, rates, quality);
- monitoring, reporting and adaptive management responses (refer contingency section);
- disposal of desalination reject water; and,
- rehabilitation management associated with decommissioning will form part of the Mine Closure and Rehabilitation Management Strategy. This will include close out and reporting requirements.

Following completion of the Project, the Joint Venture will cease abstraction from the borefield and monitor the aquifer recovery for a period of up to 10 years or until it recovers to more than 80% of its capacity or until another user takes control of the borefield. Water levels in all production bores will be monitored at monthly intervals during the first year of recovery, then at quarterly intervals until year three (3), then annually until year 10. The

aquifer would then be returned to the State. The Joint Venture will cap and lock all production bores and will remove and rehabilitate all other associated borefield infrastructure and ground disturbance to the satisfaction of relevant authorities. The Mine Closure and Rehabilitation Management Strategy describes the Project mine closure requirements which will apply to the borefield and pipeline infrastructure at the completion of the works.

Dewatering Drawdowns

Potential Impacts

Particle tracking analysis reports indicate that groundwater migration to the pit is sourced from an area of about 1 km around the void, with flow paths extended up to 4 km to the southwest of the main Resource Area. Recharge over drawdown area is only 12 ML/year, less than 2% of the pit influx, indicating that the bulk of groundwater influx is derived from a decline in aquifer storage.

A numerical groundwater model of the Operational Area has been developed to simulate abstraction rates and changes to groundwater levels and flowpaths associated with the mine dewatering and TSF management. Modeling impacts of pit dewatering on groundwater levels and resulting flowlines were determined by the groundwater model using a 15 year model scenario representing the cessation of mining. The modelling predicts that a drawdown cone of up 50 m is likely to occur within a 1 km radius of the void, 10 m within about 1.5 km, and result in a drawdown cone of up to 1 m over a distance of about 4 km to the south and southwest (Figure 7.12). To the east of the void drawdowns are constrained by the boundary of the aquifer. The tailings storage facility is located to the north and drawdowns in this area will be influenced by the release of water from the facility and 1 m drawdown radius extends 1-1.5 km.

The water table is located approximately 20-30 m below surface and the quality of the water is saline to hyper-saline. The effect of the mine dewatering on regional flowpaths is to preferentially draw greater flow from the southwest toward the mine. The salinity of groundwater drawn toward the void will likely be in the range of 10,000-40,000 mg/L, similar to the existing salinity in the area. There should therefore be no significant change in the existing groundwater quality during mining (Appendix 2-B17).

The Cenozoic deposits have poor connection to the Lower Saprolite and are not intersected by the void and are therefore not considered significant for dewatering. Seasonal through flow in the Cenozoic deposits, is, however significant for interception of any potential seepage from the tailings storage facility, and is considered further below (also refer Groundwater Box Profile in Figure 6.7). While there are no significant water bodies or aquifers in the vicinity that could contribute extra flow to the pit through fault-driven short-circuiting of the aquifer, there is the potential for faulting to provide a greater connection between tailings storage facility and the pit.

Groundwater recharge over the Fraser Range is likely to be extremely low due to the low rainfall rates over the Great Victoria Desert region, and probably averages less than a few millimetres per year. Recharge, when it does occur, is likely to follow rare extreme rainfall and flood events associated with tropical depressions (usually ex-cyclones) that pass over the region. Most groundwater recharge is to the Quaternary sand and Paterson Formation. Under natural conditions the rate of recharge via downward leakage through the clayey colluvium and upper saprolite clayey aquitard will be low.

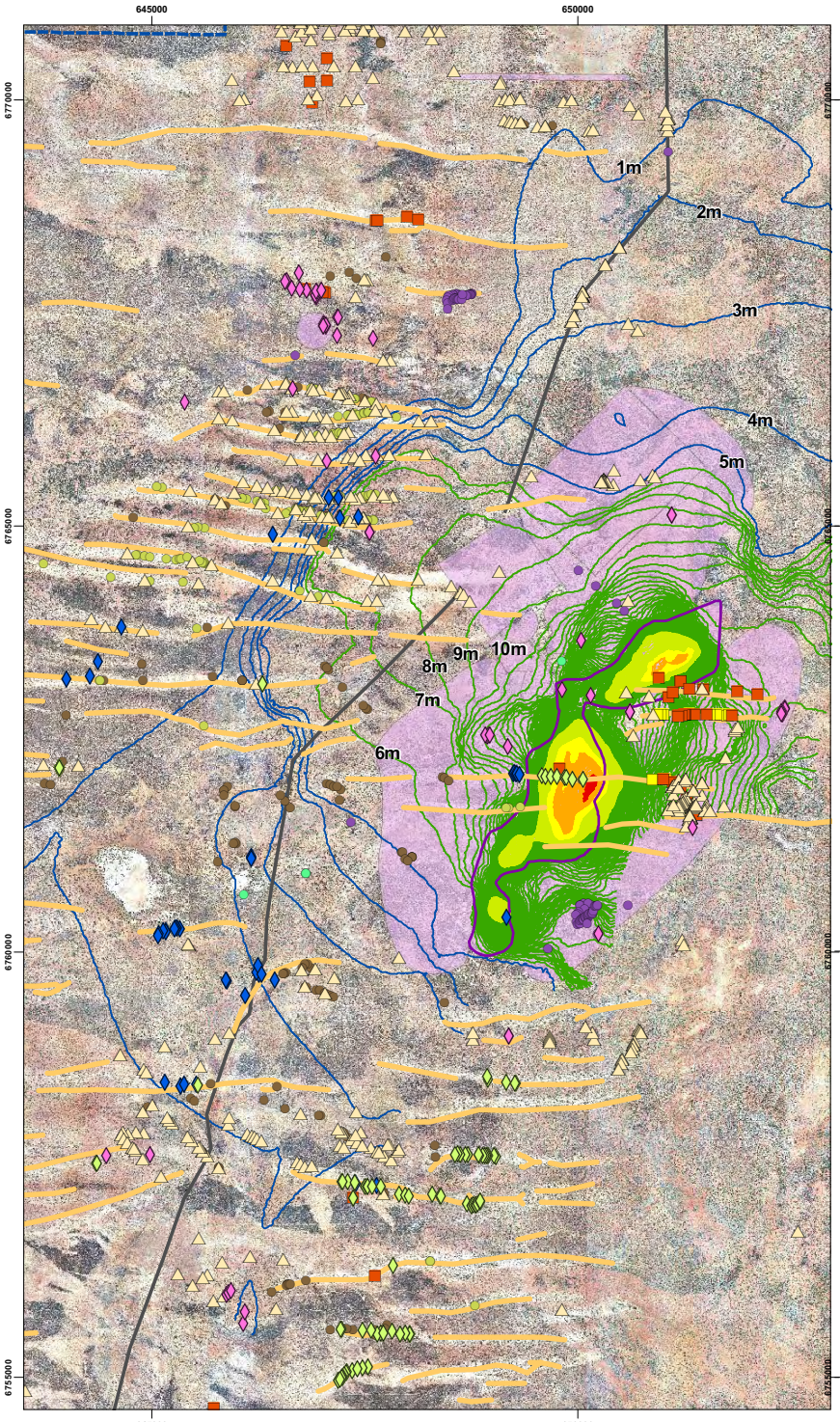
Long-term average rainfall recharge has been roughly calibrated over the model area in steady state model analyses to reproduce the water level gradient mapped from the Joint Venture's 40 piezometers. The best correspondence was found to be recharge of 0.5 mm/year, equivalent to about 0.2% of annual rainfall, evenly distributed over the model area. This corresponds well with the recharge rate estimated from the chlorinity analysis described in the Operational Area Groundwater Assessment (Appendix 2-B17).

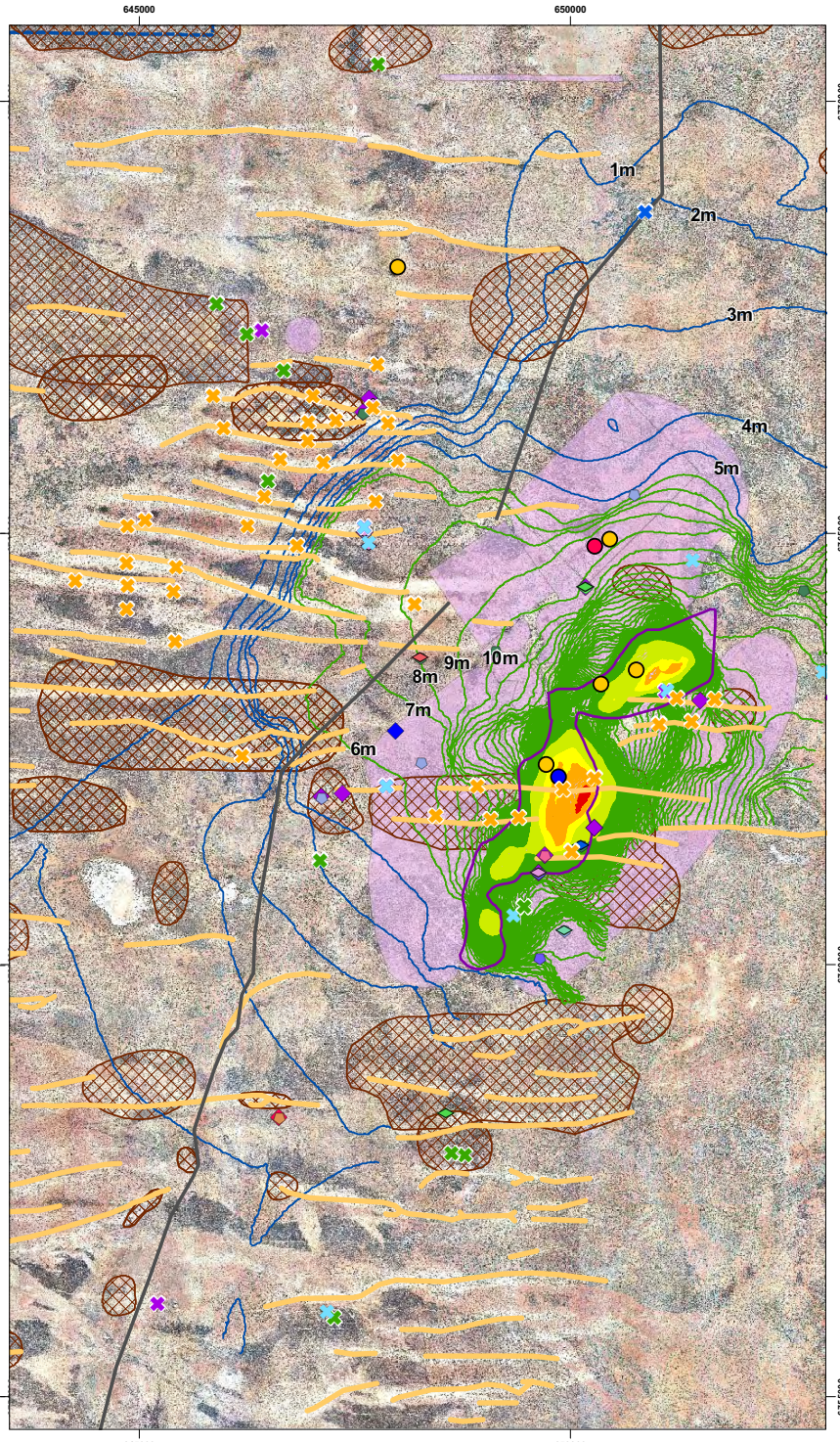
There are no large water bodies likely to be intersected by the proposed project and therefore the potential for catastrophic influx into the pit is not considered to be a risk (Appendix 2-B17).

Management Measures

During the clearing phase of the Project opportunities will arise to understand the moisture profile of the sand dune within the Resource Area. To gather this information trenches will be excavated in the dune allowing for the collection of soil and moisture data. The root profiles for key tree and shrub species will also be photographed and recorded (vertical slice model). The vegetation and dune moisture levels will be monitored in the immediate vicinity of the mining area for the first five years of the project to demonstrate that the dewatering activities are not having an impact on the dunes water retention abilities compared with dunes away from the active mining area (or as per those recorded during the construction profiling).

Observation bores will be installed across the site to monitoring the effects of dewatering on the water levels outside the mining area.





Legend

Listed Flora

- *Acacia eremophila numerous-nerved variant*
- *Acacia eremophila var. variabilis*
- *Baeckea sp. Great Victoria Desert*
- *Caesia talingka C. Tauss ms*
- *Daviesia purpurascens*
- *Dicrastylis cundeeleensis*
- *Dicrastylis nicholasii*
- *Grevillea secunda*
- *Microcorys macredieana*
- *Micromyrtus stenocalyx*
- *Olearia arida*
- Sand Ridge (Threatened Flora and Fauna Habitat)

Listed Terrestrial Fauna

- Australian Bustard (Observation and Tracks)
- Fork-tailed Swift (Observation)
- Malleefowl (Inactive Mounds)
- Marsupial Mole (Hole)
- Peregrine Falcon (Observation)
- Rainbow Bee-eater (Observation)
- Stick-nest Rat (Nest)
- Listed Terrestrial Fauna Habitat

Short Range Endemics

- *Aganippe sp.1*
- *Aganippe sp.3*
- *Aganippe sp.4*
- *Aganippe sp.5*
- *Aganippe sp.6*
- *Aname sp.2*
- *Anidiops manstridgei*
- *Antichiropus sp.1*
- *Antichiropus sp.2*
- *Antichiropus 'sp. juv'*
- *Cercophonius sp.*
- Chemetidae new genus
- *Kwonkan sp.1*
- *Kwonkan sp.2*
- *Nemesiidae* new genus
- Polyzoniidae sp. unknown
- *Pseudolaureola sp. new*
- *Synothele* 'megaspiral'

Subterranean Fauna

- Chilopoda
- Diplura
- Isopda
- Proposed Infrastructure Corridor
- Resource Area

Drawdown Contour (1m Increments)

- 1 - 5
- 6 - 80
- 81 - 160
- 161 - 240
- 241 - 320
- 321 - 400
- Operational Area
- Conceptual Site Layout

Imagery is a composite of aerial and satellite photography

NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- AERIAL PHOTOGRAPHY SOURCED FROM LANDGATE 2007
- LOCALITY MAP SOURCED FROM ANGLOGOLDASHANTI 2008

SCALE

0 0.5 1 2 3 4

Kilometers

LOCALITY MAP

METADATA RECORDED	PROJECTION
100%	MGA ZONE 51
HORIZONTAL DATUM	**HEIGHT DATUM**
GDA 94	N/A

CREATED BY	CHECKED BY	APPROVED
GWa	BP	FD
DATE	**REVISION**	**DRAWING NO.**
19.08.09	0	351-2.0.23

Tropicana Joint Venture
TROPICANA GOLD PROJECT

Public Environmental Review
Operational Area Drawdown Contours Impacts
Figure 7.12

Tailings Storage Facility

Potential Impacts

Drainage management within the tailings storage facility has been modeled by Knight Piesold using SEEPW (Appendix 2-B15). Under a worst case scenario where faulting provides a direct, high permeability connection between the tailings storage facility and the pit, the maximum influx that could occur is the entire tailings storage facility leakage volume of 1000 kL/day. This would increase the long-term pit influx by about 333 kL/day or 20% of the baseline.

Seepage rates under normal operating conditions with the proposed liner and under drainage system are estimated to be below the guideline limit of 1 kL/ha/day as set by the DoW. Seepage from the facility is not considered a significant issue. The Tailings Storage Facility is located in close proximity to a higher permeability sub-surface drainage zone (HPS drainage zone) and the open pit. The open pit will be dewatered to facilitate mining and water in the HPS drainage zone will be utilised as a water resource for the operation. It is therefore anticipated that both of these features will influence the direction and rate of seepage from the Tailings Storage Facility.

Seepage from the Tailings Storage Facility could result in a change to the groundwater in two ways:

- elevation in groundwater table beneath and/or adjacent to the facility, or,
- alteration in water quality.

Depending on the rate of seepage and management strategies implemented elevations in water table can result in localised impacts of vegetation through water logging or changes in water quality via salinisation or pH changes. The changes in water quality occur as the rising water level mobilise salts or trigger redox reactions which result in the generation or acid or mobilise metals.

Management Measures

The Tailings Storage Facility will be lined with a combination of HDPE and compacted clay liner. A tailings underdrainage system will direct water to a sump where it will then be pumped to the supernatant pond, then central decant, before being returned to the plant. The design includes a tailings storage facility seepage recovery system consisting of interception bores in the alluvial/ colluvial deposits both up-gradient (south) and down-gradient (north) of the tailings storage facility. The system will be implemented if other seepage management systems such as underdrainage and facility liner fail.

The management of the Tailings Storage Facility is provided in more detail in the Tailings Environmental Management Strategy (Appendix 3-G).

Groundwater Dependent Ecosystems

Potential Impacts

Depressurisation impacts should not extend to the Rason paleodrainage where the only potential for vegetation to access groundwater from the saprolite aquifer exists. These drawdowns should therefore have no impacts on groundwater dependent ecosystems as linkage between surface and deep aquifers is minimal (due to the presence of clay layers).

The groundwater simulation modelling shows that discernible groundwater depressurisation impacts in the Lower Saprolite over the life of the Water Supply Area do not extend to the Rason paleodrainage. In the unlikely event that pressure heads that drive upward groundwater seepage are lowered, these minor drawdowns will likely be

substantially dampened by the overlying Upper Saprolite aquitard and are unlikely to have significant impacts on the Rason hydrology.

Management

Observation bores will be installed in the Cenozoic deposits around the Rason drainage to monitor pressure changes over the life of the Project.

The Joint Venture Actions

Action 10: The CEMS and the OEMS includes management of water supply and dewatering operations. Monitoring of groundwater levels, quantity and quality (including groundwater and recharge monitoring against modelling) will be taken through the operations. Should the results deviate from the projected modelling or results of the field tests then the borefield operational strategy will be modified accordingly to ensure the aquifer is managed appropriately.

Action 11: The water supply and dewatering operational requirements will be implemented throughout the life of the project and are defined in the OEMS.

Action 12: The Mine Closure and Rehabilitation Management Strategy describe the Project mine closure requirements which will apply to the borefield and pipeline infrastructure at the completion of the works. Following completion of the Project, the Joint Venture will cease abstraction from the borefield and monitor the aquifer recovery for a period of 10 years or until it recovers to more than 80% of its capacity or until another user takes control of the borefield. Water levels in all production bores will be monitored at monthly intervals during the first year of recovery, then at quarterly intervals until year three, then annually until year ten.

Action: Implement Joint Venture Action 4 as described in section 7.2.1 and Action 7 as described in section 7.2.2.

7.2.7. Emissions

Management Objectives

The management objectives of the Project for emissions are:

- to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting Statutory requirements and acceptable standards;
- to minimise impacts from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards; and,
- to minimise emissions to levels as low as practicable on an ongoing basis and consider offsets to further reduce cumulative emissions.

Description of Factor

Emissions considered here include dust, noise and vibration, light and products resulting from the combustion of fossil fuels (e.g. at the power station and from the mining fleet) including volatile organic compounds (VOCs) and respirable particles small enough to avoid being filtered from inhaled air by the nose and throat. For monitoring purposes, particulate matter with an aerodynamic diameter of less than 10 micrometers (PM_{10}) is generally considered to have the potential to cause negative health effects.

Due to the remote nature of the site nearest community 220 km away potential impacts of emissions, with the exception of Greenhouse Gas emissions, were evaluated in terms of potential impacts on the receiving environment (flora and fauna) and the Project workforce.

Atmospheric dispersion modelling was carried out by Heggies (Appendix 2-B10) to determine the potential impact, in terms of air quality, of pollutants generated by extractive operations and diesel combustion. The pollutant concentrations measured were:

- particulate matter less than 10 microns across (PM_{10});
- nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO); and,
- volatile organic compounds (VOC) (benzene, toluene, xylene).

Applicable Standards and Guidelines

- *Mine Safety and Inspection Act 1994*;
- Australian Standard AS 3580.8.9.6 PM10 High Volume Sampler With Size Selective Inlets – Gravimetric Method;
- Australian Standard AS2724.3 Determination of TSP;
- Australian Standard AS2922 Ambient Air – Guide for the Siting of Sampling Units;
- *Environmental Protection (Noise) Regulations 1997* (Western Australia);
- *Environmental Protection (Unauthorised Discharges) Regulations 1997* (Western Australia);

- Environment Australia. 2000. Best Practice Environmental Management in Mining Series – Cleaner Production;
- Environment Australia. 1998. Best Practice Environmental Management in Mining Series – Dust Control;
- Environment Australia. 1998. Best Practice Environmental Management in Mining Series – Noise Vibration and Airblast Control;
- Environment Australia. 2002. Best Practice Environmental Management in Mining Series – Non Dust Atmospheric Emissions from Minerals Processing;
- Guidance No.12, Guidance Statement for Minimising Greenhouse Gas Emissions (EPA 2002c);
- EPA 2007. Draft Guidance No.8, Environmental Noise;
- EPA 2002. Guidance No.12, Guidance Statement for Minimising Greenhouse Gas Emissions;
- EPA Victoria. 2007. Protocol for Environmental Management State Environment Protection Policy (Air Quality Management) Mining and Extractive Industries, 2007
- National Environment Protection Council. 2003. National Environment Protection (Ambient Air Quality) Measure;
- National Environment Protection Council. 2004. National Environment Protection (Air Toxics) Measure;
- NSW DECC. 2005. Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation, New South Wales;
- QLD EPA. 1997. Environmental Protection Policy (Air); and,
- World Health Organisation. 2006. Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global Update 2005.

Airborne Pollutants

Potential Impacts

The results indicated that the concentrations of the pollutants previously listed would satisfy all applicable air quality assessment criteria and that the emissions would not adversely impact upon the biological integrity of threaten flora and fauna populations situated adjacent to the Operational Area (Appendix 2-B10).

The presence of fibrous minerals, including actinolite, observed in diamond drilling cores may impact the health of workers onsite if appropriate management measures are not applied.

Management Measures

The proposed layout and its associated emissions has been shown by Heggies (Appendix 2-B10) to not have a no significant impact on threatened flora and fauna populations located due west of the processing plant and no impact at the preferred village site.

The Joint Venture will establish and implement Emergency Response Procedures (ERP) for the occurrence of an unplanned gaseous emission.

Dust

Potential Impacts

Dust generation can influence the air quality, resulting in adverse impacts on human health, surrounding vegetation, fauna and ambient air quality. Health risks from airborne dust containing silica and fibrous materials can result in adverse impacts on human health.

The existing air quality in the vicinity of the Operational Area is associated with that of a rural arid environment. The generation of dust during the construction phase may result from the following activities: vegetation clearing, topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, etc (Appendix 2-B10). The relatively short-term nature of site construction activities means that the potential for dust generation varies depending on the level of activity, the specific operations, and the prevailing meteorological conditions (Appendix 2-B10).

In contrast the activities associated with the operational phase of the Project are relatively steady or follow a discernible annual cycle (Appendix 2-B10). The operational phase of the Project contains the majority of activities that are likely to occur during the construction phase plus operations related to the extraction, transportation and processing of ore (Appendix 2-B10).

Primary sources of particulate matter at the Project were the movement of haulage trucks, the processing area and wind erosion from exposed areas (Appendix 2-B10). It is considered that these three key components should be the focus of management strategies for the reduction of particulate matter generation from onsite operations (Appendix 2-B10).

Model predictions conducted by Heggies (Appendix 2-B10) demonstrated that the predicted mean monthly incremental dust deposition associated with the Project during the operational phase does not represent a significant impact to the preferred northern camp. No significant impacts are likely for the dunes to the west of Operational Area where the highest concentration of identified conservation significant flora populations occur (Appendix 2-B10).

Management Measures

Health risks from airborne dust will be managed in accordance with the *Mine Safety Act 1978* and will focus predominantly on silica and fibrous minerals when required. Health risks from airborne dust will be either avoided or reduced by adopting effective dust control strategies such as chemical additives, dust extraction systems and water suppression.

Ongoing dust suppression measures will be adopted to abate known dust lift-off areas. This will be partially achieved by undertaking progressive rehabilitation, limiting clearing and exposed areas to what are absolutely necessary and applying dust suppression techniques such as watering down.

Dust generated along the access routes by vehicles may be largely unavoidable. To prevent any potential dust impact on listed flora the road route has been designed to avoid known populations. Dust along operational roads within the Operational Area will be suppressed by road watering and the periodic application of approved dust suppressing agents.

Potential dust impacts on the conservation interest vegetation located to the west of the plant will be monitored and if impacts are identified control measure will be upgraded.

Management of human health risks from airborne dust containing fibrous materials originating from the waste material may include avoidance or reduction strategies such as capping, restriction of access, wet crushing,

remote operation and sealed cabins. In the event that it cannot be managed to an acceptable level, personnel protective equipment requirements will be adopted.

Noise and Vibration

Potential Impacts

Noise and vibration pollution may disrupt fauna species, or even alter community structure due to the neophobic (fear) response of wildlife to new stimuli. Over time most species will either habituate to the noise and vibration events associated with mining operations, or move to a suitable distance away from the source so that the noise or vibration event is no longer disturbing. Due to the large areas of relatively undisturbed habitat in the region, movement of some individuals away from noise sources will not cause significant impacts.

Management Measures

Noise reduction measures will be incorporated into the construction program where applicable in accordance with *Occupational Safety and Health Regulations 1996*, Regulation No 3.45 to 3.47, *Environmental Protection (Noise) Regulations 1997*, Regulation 13 and section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites. Construction activity is planned to be carried out on the basis of a 24 hour day and a 7 day week in the Operational Area to meet the proposed construction schedule for project completion. As the distance to the nearest neighbour is over 200 km away this is unlikely to be an amenity issue.

The main construction and operational activities that will generate noise and vibration are earthworks, drilling and blasting. The CEMS (Appendix 3-B) documents the mitigation measures that will be implemented to minimise impacts from noise and vibration. The Project will meet the requirements of Australian Standard 2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites". Noise and vibration reduction techniques may include sound insulation where required, silencers/ mufflers, smart reversing alarms, noise barriers for plant and equipment, vibration suppression controls, blast shielding, or vibration monitoring equipment. The Joint Venture will be required to meet (and verify) that noise and vibrations from site activities (e.g. blasting) do not exceed the criteria expressed in the specifications.

Light

Potential Impacts

Light pollution may disrupt fauna species, or potentially alter community structure due to the response of wildlife to new stimuli. Light sources may disorientate and/ or attract fauna species to areas of the mine infrastructure that may provide suitable microhabitats. Insects disorientated or attracted to light sources may attract insectivorous species and thus increase the frequency of fauna-human interactions in these locations.

Management Measures

Light reduction and minimisation techniques will be considered during the detailed design phase and controls will be incorporated.

The Joint Venture Actions

Action 13: Implement appropriate management and monitoring strategies to ensure the generation of emissions associated with the construction and operation of the Project has minimal impact on the surrounding environment and to the human health of workers onsite.

Action: Implement Joint Venture Action 4 as described in section 7.2.1.

7.2.8. Mining Waste and Potential Contaminants

Management Objectives

The objectives for the Project with respect to mining waste and potential contamination are:

- to ensure that any potentially contaminating activities associated with the operation are suitably managed such that they do not adversely affect environmental values or the health, welfare and amenity of people and land uses in the vicinity of the Project; and,
- to develop a good understanding of soils/ mining wastes and the physical Project environment such that any potential contamination impacts on the surrounding environment or human health are understood and mitigated through appropriate management strategies.

Specifically in relation to the issue of contamination, the Joint Venture has adopted a number of strategies throughout the life of the mine to minimise the risk of any potential contamination generated from the proposed operations on the surrounding environment. Key strategies are summarised in the sections below.

Applicable Standards and Guidelines

Western Australia

- Department of the Environment and Conservation (2003) Assessment Levels for Soil, Sediment and Water Guideline;
- *Contaminated Sites Act 2003*;
- Government of Western Australia (2000) Water Quality Protection Guideline No. 5. Mining and Mineral Processing. Minesite Water Quality Monitoring; and,
- Australian Institute of Mining and Metallurgy (2001) Average abundance of selected minor elements in the earth's crust. Field Geologists Manual. 4th Edition.

International

- Australian Centre for Mining Environmental Research (2003). Guide to the Application of the ANZECC/ ARMCANZ Water Quality Guidelines in the Minerals Industry;
- ANZECC/ ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and,
- Although the Ecotoxicity Ecological Soil Screening Levels of the United States Environmental Protection Agency (2005) have no legal authority in Australia, the EcoSSLs described within have been used to assist the Joint Venture in determining Project-specific trigger values.

Potential Impacts

A contamination assessment undertaken by 360 Environmental (Appendix 2-B1) (taking into consideration data obtain by SRK (Appendix 2-B18) and Landloch (Appendix 2-B14)) and Soil Water (Bioavailability Assessment - Appendix 2-B19) identified a number of potential sources of contamination associated with the proposed Project activities. These are discussed in the following sections.

Tailings Storage Facility

Potential Impacts

If poorly managed, tailings storage facilities can impact the natural environment. Impacts typically associated with a poorly managed facility include:

- release of saline water;
- release of cyanide contaminated water;
- release of water containing heavy metal;
- contamination of groundwater; and,
- ferrolysis.

These impacts can have a direct effect on the water users or groundwater dependent ecosystem (e.g. altering the quantity or quality of groundwater) or indirect effects on the surface environment manifested as vegetation stress or death due to changes in groundwater level and/ or quality.

Management Measures

The basin of the tailings storage facility will be lined with a combination of HDPE and low permeability clay to minimise seepage to the underlying substrate and groundwater. Seepage rates under normal operating conditions are estimated to be below guideline limits as set by the DoW, from an engineered soil lined facility should not exceed 1 kL/ha/day (Appendix 2-B15). Seepage rates during extreme wet conditions continue to remain below the guideline (Water Quality Protection Note WQPN 27, February 2006) seepage rates (Appendix 2-B15). The basin liner and underdrainage system for the facility have been optimised to make best use of naturally occurring materials on the site (refer to section 2.6.1 for liner specifics).

In addition, fencing will be erected around the tailings storage facility to keep animals out, and water birds will be monitored and discouraged to enter or remain in the area. The fencing will be adjusted as the waste landform grows to surround the tailings storage facility.

A comprehensive monitoring program will be developed to monitor for potential problems during the operation of the mine. The monitoring will include survey pins to check embankment movements, piezometers in the embankment and monitoring bores downstream of the embankment. The piezometers and bores will be monitored monthly for water levels and quarterly for water quality.

In the event that seepage is identified as an issue a seepage recovery strategy will be implemented. This strategy is discussed in the Tailings Environmental Management Strategy (refer to Appendix 3G).

Cyanide Management

The tailings storage facility will be managed to meet the requirement of the International Cyanide Management Code. As part of the code the tailings storage facility will be monitored for levels of Weak Acid Dissociable Cyanide (WAD cyanide; a form of cyanide that can be environmentally harmful once dissociated) to ensure that wildlife is protected. The Tailings Environmental Management Strategy (Appendix 3G) incorporates cyanide monitoring procedures and management strategies to meet the requirements of the International Cyanide Management Code. The preferred management option is to actively control cyanide levels at the CIL circuit to maintain residual WAD cyanide in tailings bleed water at an acceptable level. However, should monitoring in the first year of operation demonstrate that this is not possible, then an alternative method will be evaluated and implemented to meet the required standards.

If required, the cyanide destruction facility will be designed to reduce WAD cyanide in the tailings bleed water. The intention would be to treat only sufficient bleed water to ensure that the total standing bleed water at the tailings storage facility is below the target of 50 mg/L.

Closure and Rehabilitation

When the mining void is ultimately decommissioned, the tailings storage facility will be rehabilitated. The exact rehabilitation strategy is yet to be determined but the facility will be covered with a capillary break and growth medium. The capillary break will be used to prevent saline water rising up to the growth medium to avoid negative impacts to vegetation establishment. The outer western slope of the facility will be battered down to blend into the adjacent final waste landform.

Waste Landform

Potential Impacts

The key potential impact for the waste landform is the generation of acid rock drainage, release of heavy metals, and the release of sediments in surface runoff into the environment. Work undertaken by SRK (Appendix 2-B18) indicates that a quantity of waste material has the ability to generate acid. If not managed appropriately, this could result in an impact on the receiving environment. The impacts could include:

- acidification of the substrate;
- acidification and metal contamination of groundwater;
- release of dispersive materials;
- release of fibrous materials; and,
- failure of rehabilitation activities.

Surface run-off generated by major storm or cyclonic events may carry sediments from the waste landform and/ or permeate into the potentially acid forming waste, potentially impacting flora, fauna and the rehabilitation program if not managed appropriately (Appendices 2-B11 and 2-B13).

Management Measures

The waste landform will be managed to ensure that no potentially acid forming material is placed within the outer 10 m of the final landform. As detailed Chapter 10 the strategy for preventing acid formation and migration will be to co-dump with non-acid forming waste. The dilution and potential neutralisation of potentially acid forming waste by mixing it using a co-dumping procedure is intended to avoid the creation of a cell of waste that could be potentially harmful if exposed.

During operation, surface water run-off from the landforms will be managed via the site internal drainage system that directs potentially contaminated surface run-off to central points for recovery or evaporation. Run-off in the collection point will be tested following significant rain events to determine if management strategies are working. Monitoring bores will be installed across site to determine if the operation is affecting the local groundwater supply. Dispersive materials will be buried.

At closure, a toe drain will be installed to contain any run-off generated from the rehabilitated waste landform. This drain will divert run-off to the pit void.

Hydrocarbons and Dangerous Goods Spills

Potential Impacts

Spills of hydrocarbons and other chemicals may occur over the life of the project; these can result in localised areas of contamination. Potential contaminants associated with a typical gold mining operation include the following compounds:

- hydrocarbon (such as total petroleum hydrocarbons, benzene, toluene, polycyclic aromatic hydrocarbon, volatile and semi-volatile organic compounds);
- explosives;
- cyanide; and,
- di-iso butyl ketone.

Possible sources of hydrocarbon and other chemical contamination include:

- hydrocarbon storage areas;
- spills during refueling;
- hydraulic equipment failure and spills;
- poor housekeeping;
- waste management in workshops;
- chemical storage areas;
- hydrocarbon remediation facility; and,
- general plant and equipment leaks and spills.

Hydrocarbon/ chemical contamination may directly impact on flora and fauna in the vicinity or down-gradient of the spill.

Management Measures

In order to address the issue of chemical/ hydrocarbon spills, the Joint Venture has proposed to design, construction and implement hydrocarbon and chemical storage facilities that will contain any spills that may occur within the storage and refueling area (AS1940; AS3780; AS4452). The facilities will be designed to meet the Australian Standards and WA DEC and FESA requirements. In the event that a spill occurs outside a containment area, the Joint Venture will establish an onsite hydrocarbon remediation facility (HRF) for the Project. The HRF is to be utilised for the remediation of hydrocarbon contaminated soils generated during operations. The detailed design of the facility is not yet completed. The facility will be designed and constructed in accordance with relevant legislation including the Bioremediation of hydrocarbon-contaminated soils in Western Australia – Contaminated Sites Management Series (DoE 2004). In addition, the following procedures will be implemented:

- all chemicals utilised on site will be stored in accordance with the appropriate Australian Standards and other relevant regulations;
- all pipelines containing environmentally hazardous substance (including chemical hypersaline water and tailings) will be either bunded or buried in the case of hypersaline pipelines;
- compulsory spill reporting;
- spill emergency response procedure; and,
- revegetation of any areas damaged by a spill or leak following decontamination.

Putrescible and Industrial Waste

Potential Impacts

The Project will result in the generation of waste including putrescible, industrial waste and recyclables, some of which will have the potential to cause contamination to both the surface substrate and underlying groundwater. The potential contaminants of concern depend on the type of waste disposed; however, as a minimum, nutrients, metals and hydrocarbon may be potential contaminants of concern.

Management Measures

In order to minimise the impact of putrescibles and industrial waste generated from the operation of Project, the Joint Venture have proposed the following management strategies:

- implement a site recycling program to support the ZeroWasteWA policy;
- manage industrial waste in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004*; and,
- manage the site landfill in accordance with the *Environmental Protection (Rural Landfill) Regulations 2002*.

Fibrous Minerals

Potential Impacts

The presence of fibrous minerals, including actinolite, observed in diamond drilling cores may impact the health of workers onsite if appropriate management measures are not applied.

Management Measures

Health risks from airborne dust containing fibrous materials will be managed in accordance with the *Mine Safety and Inspection Act 1994*.

Management of human health risks from airborne dust containing fibrous materials originating from the waste material may include avoidance or reduction strategies such as capping, restriction of access, wet crushing, remote operation and sealed cabins. In the event that it cannot be managed to an acceptable level, personnel protective equipment requirements will be adopted.

Sewage Ponds

Potential Impacts

The village and associated amenities will be required to house up to 700 personnel at any one time during the Construction and Operational phases of the Project. If not managed appropriately, sewage could be a major health and environmental issue.

Management Measures

- Ensure sewage management facilities, septic tanks and / or leach drains are inspected regularly and meet the relevant requirements of all management authorities (Local Council, Department of Health, and DEC).
- Facilities will be managed in a manner that complies with legislative conditions, prevents pollution and preserves the amenity of the area.

The Joint Venture Actions

Action 14: Implement appropriate management and monitoring strategies to ensure the generation of any potential contamination associated with the operation of the Project has minimal impact on the surrounding environment and to the human health of workers onsite.

Action: Implement Joint Venture Action 4 as described in section 7.2.1 and Action 7 as described in section 7.2.2.

7.2.9. Visual Amenity

Management Objective

The management objectives of the Project with respect to visual amenity is to ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.

Applicable Standards

- EPA Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2008);
- WA Planning Commission Statement of Planning Policy No.2, Environment and Natural Resource Policy; (WAPC, 2003) and,
- WA Planning Commission Visual Landscape Planning in Western Australia Manual. Nov 2007 (WAPC, 2007).

Potential impacts

The impact of the Project on visual amenity is minimal due to the remoteness of the site. Potential post mining impacts on the visual amenity of the site are:

- the creation of a permanent pit void(s);
- the creation of Waste Material Landforms;
- the rehabilitation of all other mine infrastructure areas (depending on negotiated final land uses) and,
- power station stacks.

Management Measures

The permanent pit voids will be surrounded by the waste landforms and will not be visible beyond the mining area, nor will they be visible from any Nature Reserve.

The landform heights and slopes are designed to create landforms that will ultimately blend into the surrounding landscape. The maximum height of 375 mRL (average height 35 m) will make the waste landform summits lower than surrounding high points and not visible outside the broad valley containing the waste landforms. The slopes are similar to the maximum angle of local dunes.

The Progressive Rehabilitation Program aims to re-establish suitable local vegetation communities to blend into the local landscape. Revegetation will be undertaken on the waste landforms and on all other rehabilitated mine infrastructure areas.

Joint Venture Actions

Action: Implement Joint Venture Actions 1 as described in section 7.2.1

7.2.10. Matters of National Environmental Significance

Management Objectives

The objectives of the Project for the management of matters of 'national environmental significance' (NES) are:

- to maintain the abundance, diversity, geographic distribution and productivity of all species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge; and,
- avoid Project impacts to matters of NES where practical.

Applicable Guidelines and Legislation

Flora and fauna are protected at a Federal level under EPBC Act.

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of NES, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources, and to promote the conservation of biodiversity.

The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and to ensure the conservation of migratory species. There are six parts to the EPBC Act covering species that are:

- extinct;
- extinct in the wild;
- critically endangered;
- endangered;
- vulnerable; and,
- conservation dependent.

In addition to the principles outlined in Section 4a of the Act, Section 3a requires proponents and decision making authorities to take into consideration the principles of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

Potential Impacts to Matters of NES

Potential sources of impact to terrestrial and subterranean species were identified in sections 7.2.2, 7.2.3 and 7.2.4. In summary, the key potential sources of impact to matters of NES from the Project include:

- clearing of native vegetation (up to 3,440 ha). The long-term land disturbance associated with the Project will potentially decrease available habitat in the immediate area and may increase the potential for loss or displacement of EPBC listed species;
- habitat fragmentation;
- generation of dust associated with the Project e.g. traffic movements or earthmoving activities may impact EPBC listed species;
- creation of resources that subsequently impact EPBC listed species i.e. tailings storage facility may result in direct death of individual fauna, particularly migratory avifauna;

- introduction or spread of feral fauna and weed species;
- altered fire regimes; and,
- emissions that may impact EPBC listed species e.g. Greenhouse Gas, hazardous materials, hydrocarbons.

Please refer to Table 7.8 for a summary of impacts to matters of NES.

Management Measures

- implementation of the Threatened Species and Communities Management Strategy;
- avoid populations of Federally protected flora;
- design infrastructure corridors to avoid EPBC listed species‘ critical habitat;
- manage dust to limit any indirect impacts on EPBC Listed species located adjacent to the Project;
- manage the tailings storage facility to prevent impacts on Listed species via the Tailings Environmental Management Strategy; and,
- work with key agencies to reduce non-Project impacts affecting EPBC Listed species.

The Joint Venture Actions

Action: Implement Joint Venture Actions 5 and 6 as described in section 7.2.2.

-Page Intentionally Left Blank-

Table 7.8: Summary of Assessment of Potential Impacts to Matters of National Environmental Significance

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
Flora				
Conospermum toddii	Endangered	*C. toddii* was located in the Operational Area and on the Pinjin Infrastructure Corridor, typically it occurs on yellow sand dunes and dune crests. Known from at least 14 dune crests, total number of plants estimated to exceed 1300.	• Loss of potentially critical habitat as a result of clearing i.e. sand dunes. • Loss of individuals of listed flora. • Fragmentation of populations. • Altered surface water flows. • Dust. • Introduced flora. • Herbivorous fauna. • Contamination of substrate.	The Proposal is not considered a significant risk to this species and is unlikely to have a significant additional impact to this species as: • The species is not restricted to the area described by the Proposal. • The species has been well surveyed and all impacts will avoid known populations.
Eucalyptus articulata	Vulnerable	*E. articulata* was not recorded in the surveys. It is known from three populations that extend over 1.5–2 km in the Mulga Rocks area, GVD. This species has a total population of approximately 120 plants. Insufficient data are available to determine the area of occupancy. The species typically occurs on red sand, sandy loams, arkose rubble. *E. articulata* is likely to be found on sand dunes.	As above.	This species was not recorded in the surveys. However if disturbed due to a surprise discovery this species may undergo a localised impact.
Terrestrial Fauna				
Southern Marsupial Mole (*Notoryctes typhlops*)	Endangered	The Southern Marsupial Mole is known to occur in the sandy deserts of central and eastern Western Australia, northern SA and the NT. Moles holes of the Marsupial Mole have been found in survey trenches on almost all sand dunes and some sandy flats within the survey area. The species is likely to occur in most of the dune systems within the Operational Area.	• Loss of an area of potentially critical habitat as a result of clearing i.e. sand dunes. • Fragmentation of populations.	This species will undergo a localised impact due to the clearing of habitat within the resource area These mammals are part of what appears to be large local populations and the loss represents a low threat to the viability of local populations within the Project footprint and in the region.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
Northern Marsupial Mole (*Notoryctes caurinus)*	Endangered	The Northern Marsupial Mole is known from the sand dune deserts of north-west Australia, particularly in the Great Sandy and Little Sandy Deserts. Traces of mole holes have been found in survey trenches on almost all sand dunes and some sandy flat areas within the survey area The moles are most likely to be the Southern form (discussed above).	• Loss of an area of potentially critical habitat as a result of clearing i.e. sand dunes. • Fragmentation of populations.	No impacts foreseen.
Sandhill Dunnart (*Sminthopsis psammophila*)	Endangered	The Sandhill Dunnart is known from four scattered arid areas of Australia: one the Northern Territory, two in South Australia and a restricted zone around the Queen Victoria Spring Nature Reserve at the south-western edge of the GVD in Western Australia. This species is likely to occur in the area. Although the Sandhill Dunnart was not recorded during any surveys, the Sandhill Dunnart has been recorded approximately 50 km south west of the Project Area (G. Gaikhorst and C. Lambert, pers. comm.) and suitable habitat occurs in the impact areas. It is likely that this species may occur in the Project area given the degree of suitable habitat in the Great Victoria Desert region.	• Clearing - Loss of critical habitat. • Fire – this species is reliant on long unburnt vegetation.	This species may undergo a localised impact due to the removal of suitable habitat. No animals where observed during the baseline surveys, including targeted surveys. The consequences of this impact will be minor, as populations of these taxa are known to persist outside the Project footprint.
Bilby *(Macrotis lagotis*)	Vulnerable	The species is now restricted to 20 % of its former range, and survives in parts of the Tanami Desert (Northern Territory), Pilbara and southern Kimberley (Western Australia), and an isolated population in southwest Queensland (DEWHA 2008a). It is unlikely to occur within the Project footprint.	Not Applicable.	No impacts foreseen.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
*Chuditch (*Dasyurus geoffroyii*)	Vulnerable	The Chuditch formerly occupied nearly 70% of the Australian mainland, occurring in every State and Territory. It is now restricted to south-west Western Australia therefore it is unlikely to be found in the Project footprint.	Not Applicable.	No impacts foreseen.
Mulgara (*Dasycercus cristicauda*)	Vulnerable. Note that *D. cristicauda* is considered to be extinct in WA. *D. blythi* is the WA species, and is not listed under the EPBC Act	The Mulgaras have a patchy but widespread distribution in sandy regions of arid central Australia and Western Australia. Surveys of the Project did not identify either Mulgara species, although suitable habitat was identified. It is more likely that any Mulgara within the region surrounding the Project is *D.blythi*.	• Loss of an area of potentially critical habitat as a result of clearing. • Fire – this species is reliant on long unburnt vegetation. • Predation by Feral Cats and European Foxes.	Impact on individuals may occur during road establishment and infrastructure development in likely habitats. This species may undergo a localised impact due to the removal of available habitat. The consequences of this impact will be minor, as populations of Mulgara are expected to persist outside the Project footprint. As the Mulgara species most likely to be present in the area is *D. blythi* not *D. cristicauda* the Joint Venture does not consider that impacts to Mulgara are a trigger under the EPBC Act.
Boodie (*Bettongia lesuer*)	Vulnerable	This species lives in burrows. It was once widespread, however, it is now extinct on the mainland.	Not Applicable.	No impacts foreseen.
*Numbat - Walpurti (*Myrmecobius fasciatus*)	Vulnerable	The Numbat was originally widespread across southern semi-arid and arid Australia. There are currently two remnant native populations at Dryandra and Perup, Western Australia and several reintroduced populations. The remaining populations of the Numbat are found in eucalypt forests and woodlands dominated by *E. marginata*, E. *calophylla* and *E. wandoo*. Numbats nest in hollow logs or in burrows.	Not Applicable.	No impacts foreseen.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
*Greater Stick-nest Rat (*Leporillus conditor)*	Vulnerable	The Greater Stick-nest Rat was once found across much of the semi-arid and southern arid zone of Australia. It is now generally considered to be extinct on mainland Australia. The only known natural extant population of the Greater Stick-nest Rat is on Franklin Island. A stick-nest of indeterminate age has been found in the Joint Venture tenements, this is likely to be a remnant from when stick nest rats (Greater and/ or Lesser) were present on the mainland.	Not Applicable.	No impacts foreseen.
Reptiles				
Great Desert Skink (*Egernia kintorei*)	Vulnerable	The Great Desert Skink inhabits the sandy desert regions of central Australia. The largest populations survive in the Tanami and GVD regions. The species generally occurs on red sand plains and sand ridges and they generally prefer spinifex, grassland sand plains and some adjacent dune field swales. Regenerating vegetation appears to be a critical habitat requirement. The likelihood of Great Desert Skinks occurring in the area is low. Although suitable habitat is found in the Operational Area, the project area is not within current distribution estimates with the nearest record of occurrence over 100 km away.	• Loss of an area of potentially critical habitat as a result of clearing. • Fire - Loss of critical habitat.	If present this species may undergo a localised impact due to the removal of available habitat although no local populations have been observed. The consequences of this impact will be minor, as populations of these taxa are expected to persist outside the Project footprint.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
Birds				
Malleefowl (*Leipoa ocellata*)	Vulnerable	The Malleefowl inhabits semi-arid regions of southern Australia. In the GVD this species prefers the smaller desert – mulga *Acacia minyura.* Signs of Malleefowls in the form of individual sightings, nest mounds and tracks were found throughout the Project footprint.	• Loss of an area of potentially critical habitat as a result of clearing. • Fire – Loss of Critical Habitat. This species is reliant on long unburnt vegetation. • Vehicular collision.	This species may undergo a localised impact due to the removal of available habitat. The consequences of this impact will be minor as populations of these taxa are known to persist outside the Project footprint. If construction takes place outside of the nesting season (usually August to December) impacts to this species will be minimised.
Princess Parrot (*Polytelis alexandrae*)	Vulnerable	This species has a patchy and irregular distribution in arid Australia. The species is believed to exist in inland Australia, from south-west Queensland to the GVD in Western Australia. The Princess Parrot usually occupies swales between sand dunes and is occasionally seen on slopes and crests of dunes. Princess Parrots have a moderate likelihood of occurring in the Operational Area due to suitable habitat occurring across much of the region. However, due to the nomadic nature of this species, there is a low likelihood of recording it during discrete short-term surveys.	Loss of an additional area of potential habitat as a result of the Proposal.	No impacts foreseen.
Night Parrot (*Pezoporus occidentalis*)	Endangered	The distribution of the Night Parrot is poorly understood. Due to the presumed current distribution it is unlikely the Night Parrot occurs in the Project footprint.	Loss of an additional area of potential habitat as a result of the Proposal.	Should the alignment of the proposed corridor coincide with suitable vegetation including spinifex and/ or chenopod shrublands, especially where these are in the vicinity of water, there is the potential to impact on this ground-dwelling parrot.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
Slender-billed Thornbill (*Acanthiza iredalei iredalei*)	Vulnerable	The western Slender-billed Thornbill is endemic to Australia and occurs in arid and semi-arid regions of southern Western Australia and south-western South Australia. It is unlikely this species occurs in the region.	Not Applicable.	No impacts foreseen.
Cattle Egret (*Ardea ibis*)	Migratory	This migratory species is widely distributed in Australia, the species may potentially occur in the region but it is highly unlikely to be impacted by the Project. The likelihood of Cattle Egrets occurring in the area is very low. No suitable habitat occurs in the Operational Area and the species is a very occasional visitor to this state.	Tailing Storage Facility – attraction to the large expanse of water may lead to death of individual migratory fauna.	The Project is unlikely to have a significant additional impact on this species primarily because in the event a tailings storage facility caused death the event would have effects at the individual level only (rather than species or population level).
Great Egret, White Egret (*Ardea alba*)	Migratory	This migratory species is widely distributed in Australia, the species may potentially occur in the region but it is highly unlikely to be impacted by the Project.	As above.	As above.
Fork-tailed Swift (*Apus pacificus*)	Migratory	This species lives almost entirely aerial and was recorded in high number. This migratory species is widely distributed in Australia, the species may potentially occur in the region.	As above.	As above.
Rainbow Bee-eater (*Merops ornatus*)	Migratory	The Rainbow Bee-eater was sighted on 60 occasions in surveys of the proposed Pinjin Infrastructure Corridor, Operational Area and Water Supply Area. It is a common bird in WA, and due to its ability to travel large distances and its diverse habitat preferences, this species is unlikely to be impacted by the project.	As above.	The Proposal is not considered to present a risk and is unlikely to have a significant additional impact to this species primarily because this species is a common migratory visitor to Australia with a wide distribution, it was recorded in high numbers throughout the surveys of the proposed Project therefore it is unlikely to be impacted by the Project.

Species	EPBC Status	Occurrence within the Project Area	Key Potential Impacts from the Project	Significance of Potential Impact
Oriental Dotterel (*Charadrius veredus*)	Migratory	This migratory species is widely distributed in Australia, the species may potentially occur in the region but it is highly unlikely to be impacted by the Project. The likelihood of this species occurring in the area is very low. Very little suitable habitat occurs in the Operational Area, which is also well outside of the oriental plovers current distribution.	As above.	The Project is not considered to have a risk and is unlikely to have a significant additional impact to this species primarily because in the event a tailings storage facility caused death the event would have effects at the individual level only (rather than species or population level).
Oriental Plover, Oriental Dotterel (*Charadrius veredus*)	Migratory	This migratory species is widely distributed in Australia, the species may potentially occur in the region but it is highly unlikely to be impacted by the Project. No impact from construction is predicted for this species.	As above.	As above.
Common Greenshank (*Tringa nebularia*)	Migratory	The Common Greenshank was sighted at small lake north of Lake Rebecca. The species is typical of well-watered regions; casual or vagrant on west-coast islands and in the arid east (Simpson and Day 2004).	As above.	As above.
Wood Sandpiper (*Tringa glareola*)	Migratory	This species was sighted at small lake north of Lake Rebecca. The Wood Sandpiper is typical of well-watered regions, particularly coastal plains and plains about lower courses of larger rivers. Wood Sandpipers are not thought to be impacted by the Project.	As above.	As above.

7.3. CUMULATIVE IMPACTS

7.3.1. Improved Infrastructure and Access

As the Project will require the development of a Mine Access Road of higher quality than the existing tracks in the area, visitor numbers to the wider region may increase. This may lead to substantial growth and tourist visitation and prospectors that may place pressure on the region.

Potential impacts to the region due to improved infrastructure have been identified are:

- increased incidence of fire;
- introduction/ spread of feral species (animals and weeds);
- increased use of regional nature reserves; and,
- inappropriate disposal of waste.

Potential Impacts

Increased Incidence of Fire

Fire ignition may be caused by activities such as intentional actions (e.g. arsonists), accidental activities (e.g. camp-fires getting out of control); littering (e.g. glass bottles) or ignition sources (e.g. catalytic converters on off-road vehicles).

Fire can have a significant impact to ecosystems. The impact of fire on vegetation is known to be varied depending on the species impacted, fire interval and fire intensity. Although the native flora is adapted and in many instances dependent upon fire for activation of seed germination, too frequent or too hot bushfires can result in detrimental changes to the composition and diversity of the vegetation and the alteration/ removal of critical fauna habitat potentially causing local extinctions of vulnerable flora and fauna species.

The potential effects of fire on the biological values in the region are discussed in this document.

Introduction/ Spread of Feral Plant and Animal Species

The GVD has relatively few weed species, the introduction of any would be a significant degradation environmental values. Introduced weeds may have the following impacts:

- competition for resources with DRF and priority flora;
- degradation of critical habitats for conservation interest flora and fauna species;
- contribution to altered fire regimes resulting in altered habitats for conservation interest flora and fauna species; and,
- reduced success of rehabilitation.

Feral animal species are established in the region; however the Project may potentially increase the incidence of feral animals in the area. Introduced mammals such as the European fox, wild dog and feral cat potentially pose a threat to all conservation interest species in the GVD as they are small to medium and are therefore susceptible to predation by introduced predators.

Increased Use of Regional Nature Reserves

The Class A Nature Reserves, the Queen Victoria Spring and Plumridge Lakes Nature Reserve may be subject to increased visitation following the construction of the Project Access Road (regardless of which option is developed). Therefore the following negative impacts to the Reserves may be expected:

- degradation of environmental values caused by introduction/ spread of feral taxa;
- degradation of environmental values caused by increased erosion from off-track driving; and,
- degradation of environmental values caused by increased incidence of fire and inappropriate waste disposal.

Inappropriate Disposal of Waste

The Joint Venture has expected the worst case scenario, that visitors to the region will have little regard for the management of litter and therefore take little care in its disposal. This may be an overly pessimistic view but it is one possible outcome that may arrive from the improved access to the region. The Inappropriate disposal of waste may result in:

- pollution;
- habituation of fauna to an unnatural source of sustenance;
- visual impacts; and,
- fire (e.g. glass bottles or cigarette butts acting as ignition sources).

Management Measures

The Joint Venture in conjunction with the DEC will implement the following management strategies to reduce the impacts to the adjacent Reserves:

- discourage unauthorised road users utilizing the Project Access Road;
- restrict vehicle movement by staff with private vehicles on site to minimise impact to nearby Nature Reserves and wider region;
- educational initiatives throughout the region to promote environmentally friendly behaviour by visitors (e.g. signage); and,
- undertake or contribute to specific environmental surveys to describe the regional environment and identify high value environmental assets (e.g. conservation interest species) that may be at risk or require mitigation/ offset.

The Joint Venture may also support regional access management which could include permanent or seasonal road closures, controlled access to certain roads and the use of barriers and other measures to control off-road vehicle access.

7.3.2. Biodiversity and Ecosystem Functionality

This EIA has identified activities of the proposed Project that could have adverse impacts on the conservation of biodiversity and ecosystem functionality. Threatened species, their natural habitats and threatened ecological communities require special measures to preserve biodiversity within the region.

In 2001-02, the (then) Department of Conservation and Land Management undertook an extensive audit of the State's terrestrial biodiversity as part of the National Land and Water Resources Audit Biodiversity Assessment

(McKenzie et al. 2002). As the majority of the Project footprint lies within the Great Victoria Desert (GVD) this chapter focuses on threats within the GVD.

Key conservation priorities within the GVD are:

- rare species such as the *Notoryctes typhlops* (Southern Marsupial Mole) *Polytelis alexandrae* (Princess Parrot), *Conospermum toddii* and *Eucalyptus articulata* all of which are considered endangered;
- three ecosystems are considered vulnerable – the yellow sandplain communities, assemblages of Queen Victoria Spring and the Mirramiratjarra dune field. The 'Yellow sandplain communities of the Great Victoria Desert' has diverse mammal and reptile assemblages. Their distinctive plant communities are threatened by grazing, feral animals, mining and changed fire regimes; and,
- in addition to the ecosystems at risk described above, eight vegetation associations have a high priority for reservation.

The main threats to biodiversity and ecosystems in the GVD are:

- feral herbivore and carnivores;
- altered fire regimes; and,
- lack of knowledge of the bioregion.

Major data gaps and research priorities within the GVD identified by the biodiversity audit (McKenzie et al. 2002) are:

- regolith mapping is unavailable at better than 1:25,000 resolution;
- no systematic biological survey has been made of the region, although there has been some assessment of biota on proposed and current reserves and a number of localised studies have been completed;
- there is little fine scale floristic data available for the subregion;
- there is little data on habitat requirements of virtually all invertebrate species, most ephemeral plants, persisting critical weight range mammals and uncommon vertebrate and plant species; and,
- there is no data to provide a regional context on life-history (including population trend) of any species.

Threats to Biodiversity and Ecosystem Function

The major potential impacts to ecological function as a result of Joint Venture's activities in, and around the Project area are:

- reduced species diversity through native vegetation clearing, wildlife corridor reduction and habitat fragmentation;
- conservation significant fauna impacted by loss of habitat from clearing;
- conservation significant flora clearing impacts;
- vegetation complexes impacted directly by clearing and indirectly by impacts to groundwater;
- groundwater dependent ecosystems impacted by water abstraction;
- reduced water quality through increased sediment and pollution runoff and an increase in impervious surface runoff; and,
- ecosystem functionality may be impacted by the introduction of feral taxa (flora or fauna) and increased incidence of fire.

Surveys commissioned by the Joint Venture to date have identified:

- over 600 flora taxa identified within the 230,000 ha flora and vegetation survey area;
- one Declared Rare Flora, 20 Priority Flora species and one flora species of interest were recorded in the 230,000 ha (the Project may clear up to 3,440 ha Project Area) survey area;
- no TEC identified;
- both Infrastructure Corridors skirt the edge of the recently identified 'Yellow sandplain communities of the Great Victoria Desert' PEC;
- evidence of nine conservation interest terrestrial fauna species:
    - Malleefowl;
    - Marsupial Mole;
    - Rainbow Bee-eater;
    - Wood Sandpiper;
    - Common Greenshank;
    - Crested Bellbird;
    - Peregrine Falcon;
    - Fork-tailed Swift;
    - Australian Bustard.
- Seventeen putative short range endemic species of conservation significance were recorded in the project area and the surrounds, two of which will be impacted by the project based on current knowledge;
- three troglobitic species were recorded in the Operational Area;
- feral fauna established in the region; and,
- four weed species were identified in the surveys.

The Joint Venture Impacts to Biodiversity

Over 80% of the vegetation proposed to be cleared by the Project is of low conservation significance. The Project will disturb some locations of Priority Flora species, however, as these species are not restricted to the Project footprint and occur relatively broadly throughout the GVD, their conservation status will not alter as a result of the Project.

Loss of habitat due to clearing is likely to displace individual Marsupial Moles within the Project area, specifically within the Resource Area. These mammals are part of what appears to be large local populations and the loss represents a low threat to the viability of local populations within the Project footprint and in the region.

Similarly species such as the Malleefowl, Mulgara and Sandhill Dunnart may undergo a localised impact due to the removal of available habitat. Populations of these taxa will persist outside the Project footprint.

Fauna habitats occurring across the Project area are typical of the surrounding area and are well represented across the GVD region. No fauna habitat of high conservation significance will be significantly affected by the Project and significant impacts to fauna of conservation significance at a regional, state, national or international level are highly unlikely.

The Project will require water for the purposes of process and other mine-related operations. The Project requires up to 14 ML/day based on 7 Mtpa processing, ideally having salinity levels less than 100,000 mg/L. Potential impacts include:

- Mine water supply extraction: The water investigations to date indicate that, while the permeability of the sandstone in the Minigwal Trough may be poor relative to other basin aquifers in Western Australia, the aquifer is sufficient to meet the Project's process water requirements without causing unacceptable environmental impacts;
- Dewatering of the confined aquifer: There should therefore be no significant change in the existing groundwater quality;
- Groundwater Dependent Ecosystems: The depth to groundwater over the impacted area is greater than the rooting depth of local vegetation. Drawdowns should therefore have no impacts on groundwater dependent ecosystems as linkage between surface to the deep aquifers is minimal (due to clay layers); and,
- Given the deep water tables, the only potential biological dependence on groundwater in the impacted area are subterranean species. No Stygofauna have been identified and the drawdown effects are not likely to have wider ranging affects on the habitat of Troglobitic species observed within the Operational Area.

Assessment of Impacts

While there will be a localised impact on biodiversity (i.e. loss of fauna from within clearance areas), it is not anticipated that the Project will have a major or ongoing impact on flora/ fauna biodiversity, provided that sufficient management measures are implemented.

Possible impacts to biodiversity will occur if habitat suitable to support conservation interest species is removed, or the site layout results in habitat fragmentation. Considering that the proposed Operational Area is located in an area with little disturbance or degradation (with the exception of fire), and local habitats are regionally well represented, it is not anticipated that the Project will have a significant effect on the biodiversity of the adjacent areas or the region.

Threatened species, their natural habitats and TEC require special measures to preserve biodiversity. Action will be taken to maintain, and where possible restore, natural processes and communities by protecting them from unnatural disturbances and maintaining ecological processes. Biodiversity will be protected from threatening processes, agents and activities such as feral animals, weeds, and inappropriate fire management.

The Joint Venture has undertaken extensive surveys of the region. Flora and vegetation surveys span some 230,000 ha, the vegetation mapping associated with the Operational Area alone covered 131,000 ha. These surveys clearly demonstrate the intact nature of the local environment and occurrence of all communities outside the proposed Project footprint.

The Joint Venture has participated in a number of regional studies that will greatly expand the knowledge and understanding of the regions biodiversity:

- Marsupial Mole Assessment within the WA Great Victoria Desert (May 2008) (Appendix 2-F2);
- Joint surveys with DEC in the Neale Junction Nature Reserve:
    - Terrestrial Fauna – Vertebrate and Invertebrate (April and October 2008);
    - Short Range Endemic Invertebrate (October 2008);
    - Threatened Flora Species (October 2008);

  - Broad Vegetation Assessment (October 2008);

- Assisted with the Great Victoria Desert Feral Camel Assessment – May 2008; and,
- Regional Threatened Flora Species – Joint Venture Exploration area, Plumridge Lake and Queen Victoria Spring Nature Reserve (December 2008 – January 2009; Appendix 2-F6).