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ABSTRACT

Rehabilitation of mined land on First Nations' country after mine closure must achieve particular criteria to be considered successful. Generally, these conditions are based on achieving a habitable condition that is more or less similar to analogue sites or to the pre–mining state. Rehabilitating a site to a habitable condition requires the restoration of cultural values, as well as environmental and economic values. This study investigates the extent to which First Nations' cultural values are considered in mine rehabilitation in northern Australia. Interviews were conducted with environment professionals who had experience rehabilitating mine sites on First Nations' land in the Northern Territory, Australia. The participants were asked about their experiences restoring First Nations' cultural values to mined land. Thematic analysis found six main themes: "Values" (which need to be restored); "Planning" (of rehabilitation activities); "Impediments/barriers" (to successful rehabilitation); "Solutions" (to the barriers); "Traditional Owners" and "Principles". This study shows that mining environmental professionals argue that, with suitable political and corporate support, many cultural values could be restored. However, it was generally agreed that government oversight and regulation in relation to reinstatement of First Nations' cultural values needed to be improved. Several participants suggested that greater consideration should be given to closure plans generally, to financial means to carry out rehabilitation, and specifically to planning to identify and address the rehabilitation of First Nations' cultural values prior to approval. Other findings were also that First Nations' cultural values and environmental values are closely aligned, and that consultation and effective communication with Traditional Owners are the key to integrating awareness of First Nations' cultural values into mine rehabilitation practices.

1. Introduction

The mining industry is an important part of Australia's economy, accounting for 12% of gross domestic product in 2019 (Geoscience Australia, 2020) and 1.1% of the 20.1 million jobs in the nation (Australian Bureau of Statistics, 2022b). However, the environmental and social impacts of mining can be problematic, particularly for First Nations Traditional Owners of mined land. Werner et al. (2020a) identified, classified, and georeferenced 95,320 mine sites in Australia; 89% of which were inactive. Of the inactive mines, only 4% were known to have been rehabilitated, and 68% were classed as neglected with most of the rest having little prospect of rehabilitation. First Nations people have some form of tenure over approximately 52% of land in Australia

(Renwick et al., 2017); therefore, a considerable number of mine sites directly affect First Nations people.

Mining companies are legally required to rehabilitate mined land in Australia (Bradfield et al., 1996). The goal of mine site rehabilitation is usually to establish a self-sustaining ecosystem similar to that which existed on the site prior to mining. General criteria include that the rehabilitated site is to be stable with sustainable landforms, soils and hydrology. It should not pollute the surrounding landscape (including impacts on water quality, dust, erosion and weeds) and it should achieve the partial or full repair of ecosystem capacity to provide habitats or biota and services for people (Anon, 2016). Criteria for stability, water quality and flora are often included but it is rare that criteria assess the re-establishment of fauna communities (Brady and Noske, 2010).

Evaluation of the outcome of rehabilitation is usually based on comparison with unmined sites in the surrounding landscape. It may seem reasonable that a site should be returned to its owners in the condition it was originally, rather than just 'something like it', and it has been argued that the site's pre-mining condition should be the yardstick (Hannan 1995). Issues for the assessment of success can include: the selection of analogue sites; determining criteria for what might be considered similar; inadequate consideration of the technical
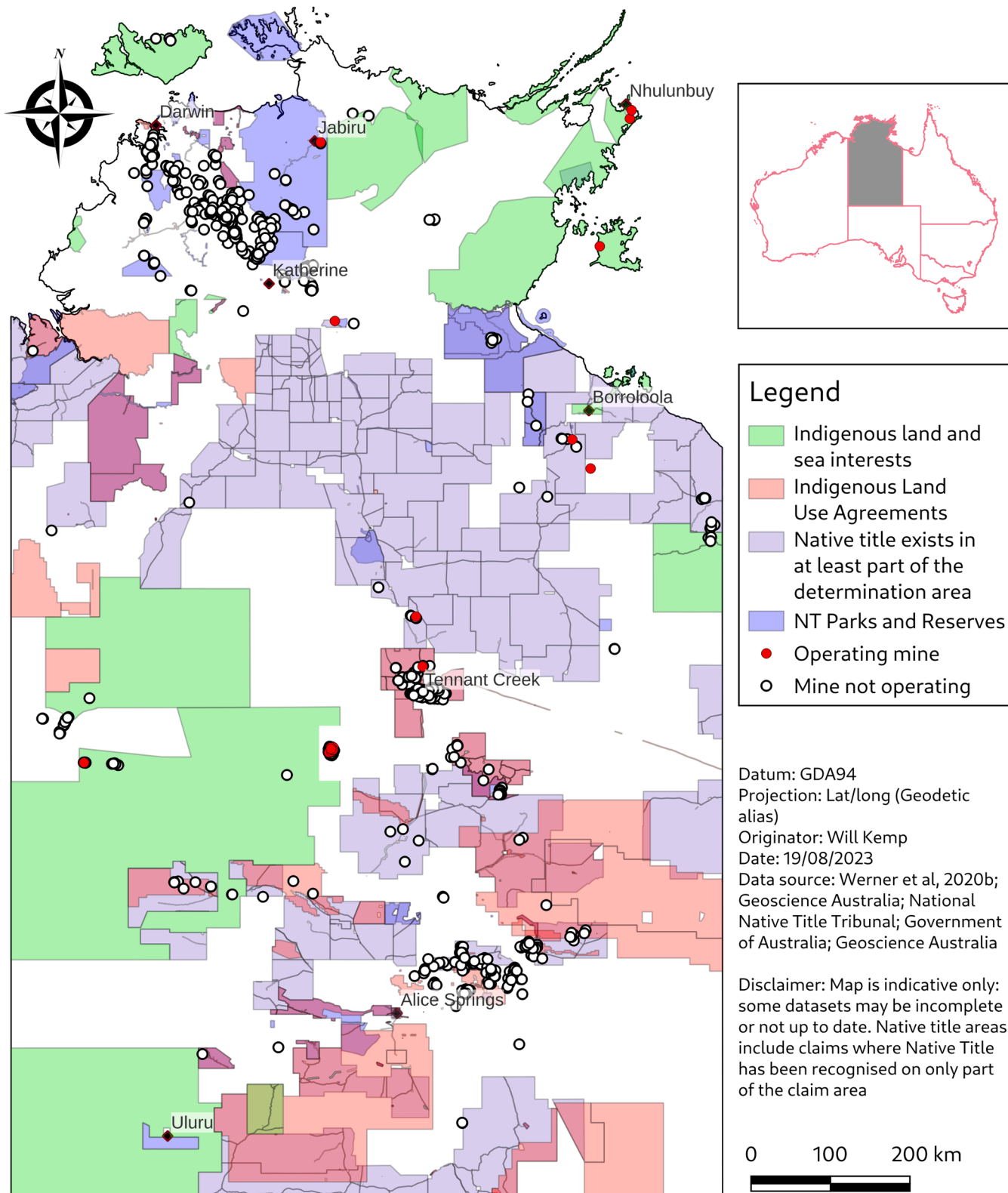

Fig. 1. Map of mine sites in the Northern Territory, Australia, with their status as of 2020, showing land in which First Nations People have a legal interest. Inset map shows the location of the study area within Australia.
Map data source: Werner et al., 2020b; NNTT 2022; NNTT 2023; Commonwealth of Australia, 2017; Geoscience Australia 2003.

requirements for rehabilitation; miscommunication of anticipated rehabilitation outcomes; changes in the landscape compared to pre-mining conditions; and changes in community expectations over time (Hannan 1995; Hernandez-Santin et al., 2020).

In the Northern Territory (NT) of Australia, there are many mine sites on First Nations' owned land which are undergoing rehabilitation (Fig. 1). Major mine sites in the NT are located on or near Borroloola, Groote Eylandt, Nhulunbuy and Jabiru. All of these major mines are on, or affect, Aboriginal lands. NT legislation requires consultation with affected Indigenous communities around major projects that cause disturbance to the environment (NT Environmental Protection Act, 2019). Consequently, there is Aboriginal traditional owner consultation in developing rehabilitation goals for mine sites (Smith, 2009). Where a mine occurs on Aboriginal land, there is the expectation that when such a mine has ceased operating and has been rehabilitated, the site will be returned to its First Nations Traditional Owners (TOs). However, rehabilitation criteria for assessing the success of rehabilitation after mining focus on biophysical and ecological values (Bradfield et al., 1996). Returning these sites to the condition they were before mining or, at least, to a condition acceptable to the TOs, may require more than just re–establishment of a functional ecosystem; the cultural landscape must be restored as far as possible (Smith, 2009; Bartolo et al., 2013).

1.1. Northern territory cultural context

First Nations people currently make up 26.3% percent of the Northern Territory's population (Australian Bureau of Statistics, 2022a). There are 189 Indigenous Locations (ILOCs) in the Northern Territory in the most recent census (Australian Bureau of Statistics, 2022a).

The Northern Territory (NT) has had a long history of colonisation and Aboriginal oppression and dispossession through legislation and massacre (Habibis et al., 2016; Rogers and Bain, 2016). The Australian Commonwealth 1967 Referendum changed section 127 of the constitution to include Aboriginal people in the census. Prior to the 1967 referendum, First Nations people were not recognised as Australian citizens. Historically, the Northern Territory Aboriginals Act (1910) and subsequent legislation controlled nearly every aspect of Aboriginal peoples' lives. All First Nations children were deemed wards, First Nations people were denied the vote, restrictions were imposed on where people could live and visit, and who they could marry (Gilbert, 2019).

In December 1976, the Australian federal parliament passed the Aboriginal Land Rights (Northern Territory) Act which created Aboriginal land trusts to hold title to Aboriginal land. As a result, this gave First Nations people inalienable freehold title over 50% of land in the NT (NLC 2023). The Act introduced regulation and restrictions to mining activities on Aboriginal title land (Commonwealth of Australia, 2022). In addition, the Australian Commonwealth Government Native Title Act 1993 recognised and protected native title, established a mechanism for determining claims for native title, and set standards and procedures for future dealings affecting native title (AITSIS 2016), such as approval for minerals development.

1.2. Indigenous peoples' cultural values

Indigenous people have a fundamental spiritual connection with land, which leads to an ecological connection with sustainability, health and place. The relationship with land and country includes a responsibility for care (Eckermann et al., 2006; Mignone and O'Neil 2005). Indigenous peoples' cultural values are holistic, and ecological, consisting of an interrelated spiritual view of health and well-being. This encompasses physical, mental, cultural, and spiritual dimensions, and the harmonised interrelationships between these and environmental, ideological, political, social and economic conditions (Toussaint 2003; McMurray and Param, 2008). Indigenous environmental values enable environmental justice and promote the wellbeing of cultural minorities (Gratani et al., 2016).

1.3. Aim

The aim of this study is to use thematic analysis to investigate how, when, and in what context, Indigenous people's cultural values are taken into consideration when planning and undertaking mine rehabilitation activities. To achieve this, environment professionals with experience rehabilitating mine sites on First Nations' land were interviewed in depth about their work. Interview responses were analysed to develop a description of current practice in mine rehabilitation and how restoration of First Nations' cultural values is planned, implemented, and assessed.

1.4. Methods

First Nations Traditional Owners of land affected by mining were not interviewed for this study. Initial conversations occurred with Traditional Owners and plans were made to go onto country as face-to-face conversations were seen as important to build relational values and processes for learning together (Gould et al., 2019). However, COVID-19 pandemic NT travel restrictions, community lockdowns and health-risk considerations made face-to-face interviews impossible. Consequently, this study focuses on the experiences of NT environmental professionals. Further complementary studies are needed with Traditional Owners to present their views and experiences.

1.5. Participants

Eight participants were eligible for this study. Inclusion criteria for participants in this study were: (1) environmental management professionals with extensive experience working in the Northern Territory, Australia, planning or implementing mine site rehabilitation projects on First Nations' owned country; and (2) a willingness to be interviewed and recorded. Exclusion criteria were: (1) lack of experience in planning or implementing mine site rehabilitation projects on First Nations' owned country; or (2) lack of experience in the NT context. Following thematic analysis methodology, participants were identified by word of mouth, starting with people known to the researcher and expanding to people recommended by the initial interviewee, and subsequent participants (Braun and Clarke, 2022).

The potential pool of senior environmental professionals with relevant experience may be surmised from the nine major mines that are operating or actively undertaking rehabilitation in the NT having up to two senior environmental managers with extensive experience. Adding the number of senior environmental managers in Australian Commonwealth and NT Government departments in Darwin, and in environmental consulting companies, we estimate that there are approximately 20 senior environmental professionals with substantial background in managing mining rehabilitation in the NT. We considered that eight participants was a suitable sample size, as it allowed for in-depth sharing and exploration of experience and ideas (Braun and Clarke, 2022). The small sample enabled the study to have sufficient information power which increasingly in qualitative studies is preferred to the more problematic concept of saturation (Ando et al., 2014). Information power is the concept that the more information the sample holds, relevant for the actual study, the lower number of participants is needed (Malterud et al., 2016).

1.6. Ethics

This research project received clearance from the Charles Darwin University Human Research Ethics Committee on 14 January 2020. Participants were informed that interviews would be confidential and that their contributions would be anonymous. In this paper, individual participants are referred to by numbers, and no details of interviews with potentially identifying information is published.

1.7. Interviews

Standardized open-ended interviews were conducted with participants (Turner and Hagstrom-Schmidt, 2022). An interview schedule was developed (Henn et al., 2006), with questions about the participants' experiences working in mine site rehabilitation on First Nations' country. The purpose of the questions was to find out about the processes involved in mine site rehabilitation where First Nations' cultural values were considered. The interview schedule was used by the interviewer to guide the flow of the interview, rather than as a rigid set of questions, allowing the participant to lead the researcher into unanticipated areas of the topic (Henn et al., 2006).

1.7.1. Interview schedule

- What does the phrase "Indigenous cultural values" mean to you in the context of land rehabilitation?
- Have you worked on a mine rehabilitation project where Indigenous cultural values have been considered in the development of rehabilitation plans?
- Has there been any explicit inclusion of restoration of Indigenous cultural values in rehabilitation plans of any mine sites you've worked on?
- Whether included explicitly in planning or not, has there been any consideration of Indigenous cultural values in the implementation of rehabilitation plans?
- If Indigenous cultural values have played a part in rehabilitation, what form did that take?
- If Indigenous cultural values have been part of rehabilitation projects, did you have any direct communication with Traditional Owners (TOs) about the planning or implementation?
- Did you get any feedback from TOs about the planning process or the outcomes of the rehabilitation project?
- If so, what form did that feedback take? And how did it affect the implementation of the rehabilitation project?
- What is your personal evaluation of the inclusion or otherwise of Indigenous cultural values in mine rehabilitation projects which you have been a part of?
- Do you think the inclusion of Indigenous cultural values in mine rehabilitation is important?
- If so (or if not), why?
- Do you think the restoration of Indigenous cultural values to mined land needs to be improved?
- If so, how could this be done?

1.7.2. Conducting interviews

Participants were interviewed at a site of their choosing. Some chose public locations, such as cafes ($n = 3$) or restaurants ($n = 1$), others chose private places such as their office ($n = 2$). Due to restrictions on movement and the need for social distancing during the Covid-19 pandemic, some interviews were conducted online, using Zoom ($n = 2$). In-person interviews were recorded using a small handheld digital audio recorder. This device has two microphones, which cross each other in an 'X' configuration, allowing one microphone to be pointed towards the participant and the other one at the interviewer. Zoom interviews were recorded using the Zoom application's built-in recording facility.

1.7.3. Transcription

As soon as practicable after the interview, the sound recording was transcribed to a text file. Oliver et al. (2005) suggests a denaturalized approach to transcription is appropriate for researchers interested in the informational content of speech. As the purpose of these interviews was to gain information about processes rather than about the participant, denaturalized transcription was used. The accuracy of this transcription method lies in the meanings of the interview, rather than a precise rendition of the speech itself. It is not concerned with rendering accents or involuntary vocalizations (Oliver et al., 2005). Some participants would frequently begin a sentence but jump to something else, without finishing the original sentence. In such cases, to simplify analysis, partial sentences were omitted from the transcription unless they contained some information, which they usually did not (they were often more akin to stuttering). Denaturalized transcription is filtered through the transcriber (Oliver et al., 2005); however, as the same person was both transcribing and analysing the transcripts, such "pre-filtering" was of no concern, as understanding the data would not be enhanced if a naturalized approach was taken instead. Rather, it would merely defer discarding potentially meaningless elements until analysis. Such pre-filtering is more beneficial than detrimental, as part of the interpretation is carried out while listening to the participant speaking, rather than reading a transcript.

1.7.4. Analysing interview data

The aim of analysing the interview data was to develop a description of current practice in mine rehabilitation and how restoration of Indigenous cultural values was planned, implemented, and assessed. With this in mind, the interview transcripts were analysed for information about what the participants do and how they do it. Theoretical saturation was reached as no additional themes were found from reviewing of successive data (Ando et al., 2014). Silverman (2007) suggests that good research does not need to criticize the world around us but may just give us a new view of the way things are, which is the hope for this project.

1.8. Thematic analysis

This study employs thematic analysis (TA) to analyse the interview data. TA is an 'umbrella' term for a collection of methods which identify, analyse, describe, and interpret patterns in qualitative data (Braun et al., 2019). Although TA is widely used, it is mainly employed in the social sciences, and the literature largely focuses on those fields. As the focus of this project is reporting environmental management, rather than social science, commonly accepted methods of applying TA are not necessarily a perfect match. Nevertheless, TA was considered to be the most useful approach for analysing the interview data collected in this project, particularly as Terry et al. (2017) and Clarke (2018) stress the method's flexibility. The approach taken here is based on the approach described and developed by Braun and Clarke (2006), Terry et al. (2017) and Braun et al. (2019).

Analysis of the interviews comprised the following TA framework: (1) familiarization; (2) generating codes; (3) constructing themes; (4) revising and defining themes; and (5) producing the report (Braun and Clarke, 2022).

Familiarization involves interviews, transcription, and analysis. These processes were carried out by the same person, which simplified the familiarization phase of analysis. Familiarization was conducted by re-reading the transcripts and making notes regarding interesting aspects of the data (Terry et al., 2017; Braun et al., 2019).

Generating codes (coding) is a commonly used tool in qualitative data analysis. It consists of identifying concepts in the transcript and labelling them with a 'code': a word or short phrase which identifies the concept and facilitates analysis of the data (Corbin and Strauss 2012; Saldana, 2016; Creswell and Poth, 2018; Braun et al., 2019). Codes were generated using Taguette, a qualitative data analysis software (Rampin and Rampin, 2021), which allowed the use of the mouse to highlight sections of the transcript and label them with a code. While the context of the interviews was on the rehabilitation of First Nations' cultural values, any comment on a topic was coded as relating to that topic, whether or not it explicitly related to First Nations' cultural values or just to the topic in general. Working on one transcript at a time, codes were applied to segments of text which were identified as relevant to the aim of coding. The length of the individual text segments identified for

coding varied from two words to more than thirty. Semantic codes (that is, codes that captured explicit meaning) (Terry et al., 2017) were initially generated inductively (that is, they were based on the content of the data, rather than questions posed by the researcher) (Braun et al., 2019). However, as the coding phase progressed, code generation shifted gradually to a more deductive approach, in that it was influenced partly by reusing codes which had been generated from previous transcripts. In response to the apparent change in the approach to code generation which had occurred through this process, earlier transcripts were reviewed and some codes were updated to reflect the modified approach to code generation.

Constructing themes occurs after all transcripts had been coded. The resulting codes and the interview statements they were associated with, were reviewed, with relationships between codes identified, and codes clustered according to these relationships. From the code clusters, a collection of candidate themes was developed (Terry et al., 2017; Braun et al., 2019). Themes were constructed and developed by grouping codes and testing the results against the research question and the overall dataset (Braun and Clarke, 2022).

Revising and defining themes was the next step. The set of candidate themes was reviewed, some were discarded or merged with others, and some codes were reassigned to different themes. The resulting themes were checked against the coded segments to ensure they accurately conveyed the meanings of the codes from which they were constructed (Braun and Clarke, 2006). The final set of themes was related to the stages of the mine rehabilitation process. The resulting themes were what Braun et al. (2019) describe as domain summaries, that is, they summarize what participants said about a topic, rather than reflecting a pattern of shared meaning (Braun et al., 2019), for example "Planning". Braun et al. (2019) suggest domain summaries may be considered underdeveloped or misconceptualized; however, this set of themes was judged to be the most appropriate for analysing this dataset in a way that would answer the research question. At this stage, larger themes were examined further, and divided into subthemes, capturing distinct aspects of their parent theme and giving analysis more depth (Maguire and Delahunt, 2017; Terry et al., 2017). Themes and subthemes were tested again against the interview data to ensure they were relevant.

Producing the report constituted the final stage of refinement and verification of the themes and subthemes compared against the interview data (Terry et al., 2017; Braun et al., 2019). Extracts of the data were used as illustrations of the meaning of each theme and subtheme (Terry et al., 2017), accompanied by a summary of the theme. Themes were reported in a 'logical' order, corresponding to conceptual stages in the process of developing and implementing a mine rehabilitation project. Minor revisions to themes were made during this phase of the analysis (Braun et al., 2019).

1.9. Results

Eight participants were included in this study. They were employed by governments, mining companies, non-government organizations, and private environmental consultancies. All participants had experience managing the rehabilitation of mine sites on First Nations' country in northern Australia. Collectively, the participants had experience of similar operations in Africa, North America, Europe, central Asia, and southeast Asia. The participants had a combined total of more than 150 years' experience in mine site environmental management.

1.10. Thematic analysis

The eight interviews ranged in duration from 19 to 72 min, with a combined total time of 350 min. Interview transcription resulted in texts between 3200 and 6985 words, with a total of 35,474 words of text. Using Braun and Clarkes thematic Analysis framework (2022), 332 interview transcript segments were coded with 227 distinct codes. Related codes were then collated into subthemes. Related subthemes

were further collated into major themes. The identified themes and subthemes aligned with visual representation in a word cloud (Fig. 2).

1.11. Themes and subthemes

The six themes identified included: Values (81 references), Planning (72 references), Impediments/ Barriers (76 references), Solutions (65 references), Principles (6 references), and Traditional Owner (10 references). The word cloud of thematic analysis codes illustrates the relationship between codes and themes (Fig. 2). A total of 43 subthemes were identified. These were then iteratively collated into six prominent themes (Table 1). See appendix for example interview statements for subthemes in Table 1.

1.12. Values

The theme of values included connection, ecological, traditional values, sacred sites, variability in viewpoints, and landscape traversability. Throughout the interviews, Indigenous cultural values and environmental values were closely aligned. However, indigenous cultural values went further into connection and the ability to live and move freely on country.

1.13. Planning

The theme of planning included goals, consultation, compromise and expertise. Environmental professionals identified 'good' planning as being inclusive, with agreed outcomes with TOs, recognition and respect for indigenous ecological knowledge and cultural engagement. Despite this, participants identified that compromise in achieving what TOs would like often occurred after the project had been approved, rather than as an agreement about outcomes prior to approval.

1.14. Impediments/ barriers

The impediments and barriers theme formed from corporate, mining industry, regulatory, history, inadequate knowledge, economic pressure, the complexity of ecological restoration, and communication issues. In the context of the Northern Territory, the historical legacy included the exclusion of TOs from country, colonization, and negative experiences between TOs and mine companies over recent decades. Participants recognised that sometimes a mine site could not be restored to its pre–mining condition and the best that could be done was to make improvements to its current state and for remediation to occur to reduce the damage.

1.15. Solutions

The theme of solutions formed from communication, planning, regulatory, respect, training, cultural, funding, remediation, engagement and different views. Again, the social context was emphasised and the

Fig. 2. Word cloud of codes.

Table 1

Themes and subthemes.

Theme	Subthemes
Values	Connection
	Ecological
	Traditional knowledge
	Sacred sites
	Variability in viewpoints
	Traversability
Impediments/ barriers	Mining industry
	Regulatory
	History
	Inadequate knowledge
	Economic
	Complexity of ecological restoration
	Communication
Traditional Owner	TOs have valuable knowledge
	TOs pragmatic
	TOs' regulatory power
	TOs responsible for off-site / downstream effects
	TOs responsible for safety on country
	TOs should be paid as consultants in closure projects
	TO landform needs
	TOs can participate in restoration work
	TOs excluded from country
	TOs can get left with liability for managing degraded land and water
Planning	Goals
	Consultation
	Compromise
	Expertise for planning
	Research
Solutions	Achieving effective communication
	Plan modifications to achieve cultural solutions
	Regulatory
	Respect
	Training needs
	Cultural inclusion
	Funding
	Remediation
	Engagement
	Different views
	Long-term maintenance
	Consent for mining
Principles	Uncomfortable with inequity
	Value of ecological knowledge
	Equality of access to technical advice

importance of working alongside TOs and their communities. Identifying the right people to communicate to in the community was an important step, followed by ensuring ease and relevance of communication i.e.: visual methods worked well. Effective techniques for communicating technical concepts in local languages were also likely to be important for communication to achieve solutions. Building the capacity to communicate effectively with TOs required respect, patience and unhurried time. Most participants agreed that better regulation was an important part of the solution to mine rehabilitation problems. However, despite a general feeling that mining regulation was inadequate, one participant suggested that some aspects of regulation in the NT were better than other jurisdictions.

1.16. Principles

The theme of principles comprised of participants expressing their discomfort with inequity, equal access to experts by TOs and the value of ecological knowledge. These views included underlying moral standpoints, for example, that Traditional Owners should be paid for their time and be able to access independent expert advice. Traditional Owners often recognise complex and fine scale ecological relationships. The concept and importance of "patchiness" was noted as an ecological attribute which is not usually considered in rehabilitation planning. Yet

"patchiness" is an ecological concept related to small–scale variability of the landscape which is considered an important part of ecosystem restoration (Wiens, 1997).

1.17. Traditional owner

The theme of Traditional Owners acknowledged their valuable knowledge, pragmatic approach, landform needs, regulatory power, responsibilities for off-site and downstream effects, and impact of being excluded from country. It was noted that TO's should be paid as consultants in closure projects and participate in restoration work. It was also noted that if rehabilitation is poor, TOs can get left with liability for managing a landscape with degraded land and water.

2. Discussion

This study showed that First Nations' cultural values are considered in mine site rehabilitation at least some of the time. When a mine site is rehabilitated, environmental professionals believe that some cultural values can be restored to some extent. This study of mine site rehabilitation provides an insight into the approach that is taken to restoring such values. Some participants believed that certain places should never be mined, and some resources should be left in the ground. Their statements imply knowledge and understanding of the cultural importance of sites that are irreplaceable. Some values cannot be restored after mining, and some cultural sites will be destroyed forever if mined. So, part of the answer to the question of the extent to which First Nations' cultural values can be restored is that sometimes they cannot, and therefore they should not be damaged in the first place. Mine planning should take into account the unique significance of cultural values at some sites and avoid damaging them.

An issue for restoration of cultural values is that evaluation of natural resources in Australia is from a 'Western' viewpoint with a focus on physical, biological and economic criteria (Gratani et al., 2016). Cultural values of Indigenous peoples are complex, are related to their environment in various ways, and the values of a community take effort, time and mutual respect to identify and describe (Gratani et al., 2016). Socio-economic values provided by the environment impacted by a mine site can be substantial over time, and risks to spiritual and environmental values can be high. However, background evaluations prior to mining often lack adequate evaluation of these attributes (Smith, 2011). Internationally, there is recognition of the importance of including First Nations' values and using local traditional ecological knowledge when carrying out rehabilitation projects, and when developing criteria to evaluate success (Gann et al., 2019).

First Nations' cultural values in mine site rehabilitation are considered in some mines, but even when cultural values can be restored, restoration is often not completed. While environmental professionals believe some values can be addressed with appropriate planning, communication and resources, mine site rehabilitation is rarely carried out to completion (Campbell et al., 2017). There are approximately 65,000 abandoned mine sites in Australia that have not been rehabilitated (Werner et al., 2020a). This indicates there are a lot of Traditional Owners who have been left with health and safety, economic, and cultural problems that will persist for many generations. Australia's legacy of abandoned mines may be seen as a historical issue; however, mines continue to be abandoned and left unrehabilitated (Pepper et al., 2014; Vivoda et al., 2019).

An example of an abandoned mine in the NT which is causing distress to its TOs is the Redbank Copper Mine. Redbank Mine was last operated in the 1990s and has been effectively abandoned since then. It is discharging polluted runoff into local waterways, which flow into the Gulf of Carpentaria, potentially harming threatened species, such as freshwater sawfish, gulf snapping turtle, and dugong (Gangalidda and Garawa, 2014). Its current owners hope to start mining again in the future, but the company's share price of less than 3 cents suggests

investors may not be optimistic about their prospects (NT Minerals, 2022).

Effective communication was identified in the interviews as important in achieving solutions. However, it is vital to recognise that communication takes time, requires identifying the right people to talk to about different cultural aspects, and adopting appropriate modes of communication. Using images and other visual material can be particularly important for generating effective communication. Where English is not the TOs' first language, consultation about technical and conceptual issues can be difficult. Developing aids and guides for translating and effectively communicating technical concepts in local languages is important for communication and informed agreement about success criteria.

This study shows that mining environmental officials believe that to restore First Nations' cultural values after mining, legislation must require it and regulation must facilitate it. With political and corporate support, a lot can be achieved, but there are economic and other impediments which can reduce that necessary technical and economic support. Rehabilitation requirements, techniques and goals should be included in the initial planning of mine projects, increasing the options and reducing the eventual cost (Fawcett and Laurencont, 2019). Limitations to technical abilities to achieve cultural values need to be clearly understood by the company and then informed consent can only be given if such limitations are clearly communicated in the appropriate language and formats. A crucial element of restoration of First Nations' cultural values is consultation and engagement with the TOs; a subject which was mentioned by all participants. Bond and Kelly (2021) emphasize the importance of engaging First Nations people in plans for mine rehabilitation and closure. They suggest that including First Nations communities in mine rehabilitation and closure planning has the greatest potential to bring economic opportunities and restore cultural values to the landscape. However, they state that typically very little detailed planning is done before mining operations cease and the rehabilitation phase begins (Bond and Kelly, 2021).

It is important that detailed planning is carried out, and goals are clear, as mining rehabilitation to achieve particular goals is expensive. The cost of rehabilitation of mine sites is high. In 2022, ERA estimated the cost of completing the rehabilitation of the Ranger Project Area, including spending incurred since 1 January 2019, was estimated to be between AUS\$1.6 billion and AUS\$2.2 billion (ERA, 2022).

In Australia, rehabilitation of mine sites is regulated by the state/territory and by the Australian Commonwealth Governments, depending on whether international agreements are affected. Governments emphasize that Indigenous cultural values need to be considered. In the NT, activities that have a significant impact on the environment are referred to the NT Environment Protection Authority for assessment. The proponent is required, under the environmental impact assessment process, to consult with affected Aboriginal communities in a culturally appropriate manner; to seek and document community knowledge and understanding (including scientific and traditional knowledge and understanding) of the natural and cultural values of areas that may be impacted by the proposed action; and to address Aboriginal values and the rights and interests of Aboriginal communities in relation to areas that may be impacted by the proposed action (NT Environmental Protection Act, 2019).

If mining is approved, authorisation of mining activities by the Minister is required under the NT Mining Management Act (2001). Authorisation deals with the management of mining sites and the protection of the environment, where "the environment includes: the land, air, water, organisms and ecosystems on a mining site; the well-being of humans; the amenity values of the site; and economic, cultural and social conditions" (NT Mining Management Act (2001). In the authorisation, the Minister may impose conditions for the protection of the environment. Successful rehabilitation of a site is required for a certificate of closure, which is issued when the rehabilitation of a mining site is to the satisfaction of the Minister, when the operator has met the closure criteria for the mining site, which includes meeting the standard or level of performance, as specified in the Mining Management Plan for the site. Aboriginal cultural values are an important consideration in developing the closure criteria for some sites, such as the Ranger mine site and the Rum Jungle mine site (Smith 2012). Thus, there are legislative instruments which can potentially require many Indigenous cultural values to be included in closure criteria, but it then depends on what values are considered and included when specifying closure criteria for the site.

This study has shown that environmental professionals are supportive of the restoration of cultural values. Cultural values are recognized, but it seems likely that the complexity of First Nations' values is not always recognized. Further there is a lack of experience in implementing First Nations' values, as in these interviews, there was much less detail provided on solutions and impediments to achieving First Nations' cultural values.

3. Conclusions

The impression gained from participants while conducting the interviews was of a general attitude that it was morally imperative to do the right thing by the Traditional Owners of mined land by restoring it to a condition that they would be happy with. Consequently, First Nations' values, including connection to country, the economic and ecological values of country, and important sites, should be treated with care. Yet the historical legacies make successful mine site rehabilitation difficult. As a result, in the Northern Territory, the regulation of mining approval with respect to rehabilitation, and rehabilitation of cultural values in particular, is inadequate and should be improved. Regulatory oversight is important, although largely absent. Respect for First Nations people and their culture are essential if cultural values are to be restored to mined land. However, one of the interviewees suggested that the culture of large mining corporations may not be compatible with such social responsibility. Properly implemented mine site rehabilitation is very expensive and may even cost more than the resource is financially worth.

Another finding was recognition of the fundamental importance that consultation and effective communication with Traditional Owners is for integrating First Nations' cultural values into mine rehabilitation practices. TOs can be involved in the implementation of mine site rehabilitation, and there are other ways to reconnect TOs with mined country before rehabilitation is complete. Importantly, TOs need to be involved at all stages, from planning and defining the criteria for restoration of cultural values, through to consultation and development of solutions. Rehabilitation should require the approval of TOs before the mining company is allowed to relinquish its lease at the completion of operations. The importance of understanding First Nations' perspectives on cultural values in mine rehabilitation is eloquently summed up in Participant 6′s recount of a conversation with a Traditional Owner:

[The participant asked] a very respected Traditional Owner lady, "Which one would you pick, this one or that one, cultural values or environmental values?" And she said, "What's the difference?"

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Appendix 1. Themes, subthemes, and example interview statements

Theme	Subtheme	Text Example
Values	Connection	Traditional stories connected to locations and/or features (Participant 5). The Indigenous cultural values, up here, 65,000 years, and in this area ended in 20 years.
		It's not going to be here anymore. It's just immoral to do that (Participant 3).
	Ecological	When you actually have a look at cultural values, so many of them align perfectly with ecosystem protection. (Participant 6).
		The Traditional Owner ideas of the bush and what we as ecologists or whatever are trying to define as the bush, they're generally aligned.
		If I say the top species is *Eucalyptus tetrodonta* for the standard savanna woodland, it wouldn't surprise you that the Indigenous list equally started with *tetrodonta* (Participant 5).
		Culturally people see that open forest environment is one they can easily move through going from hunting ground to hunting ground or camping place to camping place, so people want to see that returned (Participant 1).
	Traditional knowledge	Traditional housing [...] hunting grounds [...] medicinal uses (Participant 5).
	Sacred sites	Birthing sites (Participant 6).
		If the deposit will disturb a culturally significant sacred site that may mean that it can't be exploited (Participant 7).
		Ceremonial sites (Participant 5).
		Barramundi Dreaming is a landmark site (Participant 6).
		I think that [TOs] can accommodate or can adapt to some disturbance of [sacred site] – the obliteration of it, no. (Participant 7).
	Variability in viewpoints	Different groups would certainly have different views (Participant 1).
		People, Traditional Owners, Countrymen, change just as much as anybody else and their values will change over time (Participant 7).
	Traversability	Being able to traverse the landscape without obstructions, like rock piles or ripped landscapes (Participant 4).
		Culturally, people see that open forest environment is one they can easily move through going from hunting ground to hunting ground or camping place to camping place, so people want to see that returned (Participant 1).
Impediments/ barriers	Mining industry	Most mining companies have beautiful sustainable development policies, environmental policies, social policies, community relations policies, diversity policies, but on the ground, they don't implement them (Participant 3).
		They have a reconciliation plan, but do you talk every month about your reconciliation plan, or do you talk about the bottom line and next year's ore reserve? So don't be surprised, at the bottom, if somebody who lives and breathes getting enough ore reserves for next year, blew up the caves because that's what [the mining company] values (Participant 6).
		I think people like to tell people what they want to hear. And I think the mining industry has been plagued by that its entire life. They so desperately want to commence operations or to expand, they'll just promise anything. And nine times out of ten, the person who promised it, by the time it has to be delivered, is long gone anyway. And somebody else will find it and go 'Why did we agree to that?' (Participant 5).
		They didn't think about that ability to walk over, so that's why [rehabilitated mine site] is a problem (Participant 3).
	Regulatory	At the moment mining regulation in the Northern Territory is just woeful (Participant 6).
		there's not enough of a legal driver, talking about regulatory frameworks (Participant 3).
		It doesn't actually explicitly say it has to be returned in a manner by which the Traditional Owners can use it (Participant 3).
		Government is there as the regulator, and they're supposed to be looking out for all of those other aspects. The mine shouldn't necessarily have to choose to manage things properly, there should be this oversight. When mines become legacies, there's certainly a lot of discussion around where does the government's responsibility lie. Because they should have actually been providing better oversight, they should have been providing better regulation, they should have been thinking about the long term. And they don't (Participant 6).
	History	40 years of bad blood [...] a lot of bad blood there still (Participant 1).
		Mining companies and governments struggle to recognize Traditional Owners as the legitimate landowners (Participant 7).
	Inadequate knowledge	For northern Australia, we don't know enough about disturbed landscapes and bringing them back (Participant 4).
		We have not done well in advancing remediation technology and the industry generally (Participant 7).
	Economic	The smaller operators just can't afford to do anything that's beyond the minimum legal. And if you look for the minimum legal, there's often not much there, on this at all (Participant 5). If you look at things like [two mine sites], the cost of cleanup is more than the actual money made out of the resource, so the taxpayer is basically funding the industry (Participant 1).
	Complexity of ecological restoration	Ecosystem restoration is complicated. People say whatever will grow will just grow there. That has not happened before. That's not happened in our other examples and that's not going to be good enough for this site (Participant 4).
		Trajectories for those sites show that there's no natural recruitment from the surrounding environment back in there [...] that sites like 20 years plus now and there's no natural recruitment (Participant 4).
		Stuff like airport strips, or anything that's been significantly compacted for decades or an absence of topsoil or a pile of waste rock [...], they're not natural features and anyone who promises to return exact replicas of the existing bush is not doing anyone a favour. You could map [mine site] still by the veg that you can see, to the domains that were there. You can still see the influence of the substrate and the hydrology on what's succeeding and what's not. There are areas that are going really well, got really good complex understory (Participant 5).
	Communication	You can't communicate via PowerPoint presentations. TOs are very visual, but PowerPoint doesn't cut it (Participant 7).
		English is not their first language, it's quite technical, no translators are available. So, there's a bit of cultural bias, cultural arrogance. The technical information [they] are meant to preview is all presented in English. It's

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Theme	Subtheme	Text Example
		too hard to do it in country language (Participant 3).
		They didn't think about that ability to walk over, so that's why [rehabilitated mine site] is a problem (Participant 3).
Traditional Owner	TOs have valuable knowledge	The Traditional Owner ideas of the bush and what we as ecologists or whatever are trying to define as the bush, they're generally aligned. If I say the top species is *Eucalyptus tetrodonta* for the standard savanna woodland, it wouldn't surprise you that the Indigenous list equally started with *tetrodonta* (Participant 5).
		They know their trees better than any botanist I've ever worked with. They really do know them, and when they're getting to be in flower. They know everything about them (Participant 2).
	TOs pragmatic	TOs are much more pragmatic than the average regulator (Participant 5)
	TOs' regulatory power	So, the Traditional Owners actually have, or are, the third regulatory authority. If they don't sign off on the closure, it technically does not close (Participant 3).
		[The mining company] was having a braver moment and they had very honest discussions with the Traditional Owners, who originally said absolutely no, you cannot mine Jabiluka because it is the source of these really important spirits to us, that you're supposed to leave alone. And they committed never to opening Jabiluka (Participant 6).
	TOs responsible for off-site / downstream effects	[…] this radiologically contaminated material, shall we pick it up and take it out of the park? Take it somewhere and bury it? That was an absolute no. This was their responsibility, it's our country it can't go into someone else's country. And that's again a concern with the groups at Rum Jungle is their impact on, sites on their country, on downstream Finniss, on people further down (Participant 7).
	TOs responsible for safety on country	One of the things that people don't realise is that Traditional Owners feel responsible for their land, and should someone be hurt on their land, they feel a responsibility for it (Participant 7).
	TOs should be paid as consultants in closure projects	I was getting paid, the Commonwealth rep was getting paid, the NLC rep was being paid, the AAPA person was being paid. And the Traditional Owners are there for free. Really?! Why does that sound fair? And there's this real begrudging, you know, they should be just giving their free knowledge, blah (Participant 7).
		Aboriginal people should be involved heavily in the rehabilitation. They should be provided employment opportunities, and to ensure that their cultural values are being met (Participant 4).
	TO landform needs	Being able to traverse the landscape without obstructions, like rock piles or ripped landscapes (Participant 4).
		They didn't think about that ability to walk over, so that's why [rehabilitated mine site] is a problem (Participant 3).
		Culturally people see that open forest environment is one they can easily move through going from hunting ground to hunting ground or camping place to camping place, so people want to see that returned (Participant 1).
	TOs can participate in restoration work	Got the Countrymen to do the seeding. We put the seeding program together and worked with them. They spread the seed on the side of the hill (Participant 7).
	TOs excluded from country	Sometimes I've discovered our engagement, taking people onto their country, inside the mine, is the first time they've seen it in a long time. It's quite emotional (Participant 5).
	TOs can get left with liability for managing degraded land and water	I think it's really important that this is part of regulation. This should be part of the establishment of a mine. There should be a closure plan, there should be a plan to have it funded, the government should be holding the majority of the money needed to fund the rehabilitation. Otherwise, it comes down to, often what's happened in the NT is the money's gone, the company has disappeared, and the Traditional Owners get left with the mess, or the taxpayer, or both. [. . .]. So, I think it's really important that closure planning is done prior to mining (Participant 1).
Planning	Goals	Agreed cultural criteria [based on] discussions (Participant 1).
		Returning the land to as close as possible as it was before (Participant 2).
		Returning the land to a state that the Traditional Owners can recognize in a traditional way (Participant 3).
		Being able to traverse the landscape without obstructions, like rock piles or ripped landscapes (Participant 4).
		If they really need a particular cultural criterion, what the scientific implications of that are (Participant 4).
		[Restoration of cultural values is] not always possible of course, because of the land disturbance (Participant 2).
		How our ecological ecosystem closure criteria marry up with those cultural closure criteria and how they can capture both elements rather than having the cultural criteria sitting off separately (Participant 4).
		The Traditional Owner ideas of the bush and what we as ecologists or whatever are trying to define as the bush, they're generally aligned. If I say the top species is *Eucalyptus tetrodonta* for the standard savanna woodland, it wouldn't surprise you that the Indigenous list equally started with *tetrodonta* (Participant 5).
	Consultation	It is about inclusion. So, it's saying yes, your opinions matter and your understanding of this land matters. And what's important to you matters (Participant 6).
		I like to listen a lot, listen to what they're saying, and try to understand what it is, and then clarify with questions, like 'What do you mean? Is this what you mean?' (Participant 2)
		It's a two-way communication process. And it's made sure that the Traditional Owners are able to get to grips, understand, and come to terms with the process that is being done to their land (Participant 5).
	Compromise	People have been asked to start with what would they like, and then the discussion has been around what the engineers and environmental scientists feel has to happen to get an outcome, and they are now working towards a compromise. In reality there is going to be compromises made (Participant 1).
	Expertise for planning	The mining industry is probably the best people in the world at building native ecosystems from the ground up (Participant 5).
	Research	Fauna's a little bit trickier, there's been less work done on that. A lot of it's about making sure the habitats there. But you can't just rely on that for fauna recolonization (Participant 4).
		There is a fauna research program and lots of survey work and we're linking it in with the rehab trajectory to understand what habitat features are going to benefit which species, what recolonization strategies could we put in (Participant 5).
Solutions	Achieving effective communication	The first thing they did was identify who spoke for that country (Participant 6).
		You just sort of go week after week with these dry discussions about what could happen, and they just couldn't give a crap. But you just put up some pictures and they're like oh, where's that and what's that and will it really look like that? (Participant 6).
		There was probably two years involved in gaining that story [how TOs wanted country rehabilitated] (Participant 7).

(*continued*)

Theme	Subtheme	Text Example
	Plan modifications to achieve cultural solutions	Engineers themselves are often people who get given a problem and they solve it. Social context doesn't often come into it, but if their manager tells them I don't want my rip lines two metres apart, I want them done in this way, then engineers will come up with solutions. There are things like, they're developing tines that don't create a straight rip, they move, they wander. That's an engineering solution to a cultural issue (Participant 1).
	Regulatory	I think it's really important that this is part of regulation. This should be part of the establishment of a mine. There should be a closure plan, there should be a plan to have it funded, the government should be holding the majority of the money needed to fund the rehabilitation (Participant 1).
		How is the community going to have access to land in a safe way following completion of the project? If you can't answer that, in the way that they're going to do it that and this way, then the mine should not operate, should not start. The rehabilitation plan has to satisfy cultural values before you get to permit (Participant 3).
		I mean it sounds like a bad news story here. It's just that we're much more aware of it, I think, in the [Northern] Territory, surprisingly. I don't think in any other State there's an Aboriginal Areas Protection Authority which has got quite significant power (Participant 7).
	Respect	I think the real value was in this respectful display of we understand that's important to you, and we understand that you might have opinions about it (Participant 6).
	Training needs	[To] make decisions for a company, related to closure, you need to be trained, at uni perhaps, if it's not a part of your corporate culture to expand your thinking beyond what colour plants do I put on the waste dump? (Participant 8).
		We want to be able to train [TOs] in some of the monitoring technologies that we're using, like drones and stuff as well, so that they can take on some of the monitoring post closure (Participant 4).
	Cultural inclusion	Aboriginal people should be involved heavily in the rehabilitation. They should be provided employment opportunities, and to ensure that their cultural values are being met (Participant 4). If it's on Aboriginal land, then the values of those people need to be considered in the planning and agreed to (Participant 1).
	Funding	The mining company have now come in and guaranteed they'll pay for the rehab. It has to be better than what has been done in the past […] There's all kinds of high-tech ways they can go about it and that costs money (Participant 4).
	Remediation	We have not done well in advancing remediation technology and the industry generally (Participant 7).
		You can't restore it, no. But what you can do is try and make it more sympathetic to what it used to be (Participant 6).
		We spoke to Traditional Owners and said, would you like us to do the best we can at tidying these sites up? (Participant 7).
	Engagement	Traditional Owner ranger groups are involved (Participant 5).
		We're working on a program of people being able to reconnect with the site, doing cultural monitoring, perhaps looking at a facility there that makes it easier for people to be in the area. That, I think, will help people reconnect with the landscape (Participant 1).
	Different views	Different groups would certainly have different views (Participant 1).
	Long-term maintenance	We can't hand this stuff over until we're confident it's got a degree of resilience to those disturbance features, which should be absolutely expected and anticipated. (Participant 5).
		[Waste rock dumps will] never be maintenance-free Never (Participant 7).
		Tailings have to be contained for 10,000 years (Participant 4).
	Consent for mining	Where there aren't sacred sites, then, quite possibly, yes, you could have mines that are in places people are comfortable with and are comfortable with the proposed post mining land use (Participant 1).
		Free prior and informed consent. If you look at IAP2 – International Association for Public Participation – if you look at their best practice on how to consult with communities, and look up FPIC, where that's going, you've got a lot of really good ideas for what best practice could be or should be (Participant 3).
Principles	Uncomfortable with inequity	I was getting paid, the Commonwealth rep was getting paid, the NLC rep was being paid, the AAPA person was being paid. And the Traditional Owners are there for free. Really?! Why does that sound fair? And there's this real begrudging, you know, they should be just giving their free knowledge, blah (Participant 7).
		The Indigenous cultural values, up here, 65,000 years, and in this area ended in 20 years. It's not going to be here anymore. It's just immoral to do that (Participant 3).
		If the deposit will disturb a culturally significant sacred site that may mean that it can't be exploited (Participant 7).
		Maybe that's actually the best thing, to leave some things in the ground (Participant 6).
		You have to demonstrate that you've had consultation, engagement, and hopefully leading to empowerment and a consent-based approach. Free, prior, informed consent (Participant 3).
	Value of ecological knowledge	We're using methods like patchiness – patch metrics, which are not commonly used in assessing landscapes, but we're doing that because we know it links to function of the landscape." While patchiness is a technical aspect of the restoration of ecological values, it could also be expected to add cultural value to the rehabilitated site (Participant 4).
	Equality of access to technical advice	[overseas, some First Nations people are] able to engage their own scientific experts and represent themselves at meetings. We have completely failed to include them in a meaningful way. And they need to be able to do that themselves, and there needs to be money for them to be able to fund that and fund experts and be able to get independent reviews […] (Participant 6).

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