APPENDIX 3:
TENURE DOCUMENTS

Government of Western Australia
Department of Mines, Industry Regulation and Safety

Home Tenement Register Online Transactions Enquiry Admin Help

Tenement Register

Register for Tenement L 52/198

Identifier: L 52/198

Status: Live
Area: 265.00000 HA
Markout:
Received: 20/09/2018 14:47:46
Term Granted: 21 Years
Commence: 31/01/2019
Expiry: 30/01/2040
Death:

Rent Status

Due for Year End 30/01/2020: PAID IN FULL
Rental for Year End 30/01/2021: $4,372.50

Expenditure Status

Expended Year End : NO EXPENDITURE REQUIRED
Current Year Commitment: NO EXPENDITURE REQUIRED

Holders | Description | Relationships | Survey | General | Shire | Grant | Conditions
Dealings | Payments | Expenditure | Combined Reporting | Bond | Map | Native Title | Documents

Current Holders | Holder Changes | Applicants On Receival

Organisation ABRA MINING PTY LIMITED 100/100

ACN 110 233 577 **ABN** 30 110 233 577

Principal Place of Business Details

Address C/- MCMAHON MINING TITLE SERVICES PTY LTD, PO BOX 592, MAYLANDS, WA, 6931
Email xxxx@mmts.net.au
Telephone xxxxxxx997

Designated Tenement Contact (Correspondence Details)

Name MCMAHON MINING TITLE SERVICES PTY LTD
Address C/- MCMAHON MINING TITLE SERVICES PTY LTD, PO BOX 592, MAYLANDS, WA, 6931
Email xxxx@mmts.net.au
Telephone xxxxxxx997

Perth Head Office Time: 09/04/2019 14:26

Logged in as Paul Rokich

Appendix D. Consultation Register

Stakeholder Engagement Register

Date	Description of Engagement	Stakeholder	Attendees	Description / Stakeholder Comments / Issues	AMPL Response	Outcome / record filed in…
21/05/2018	Initial phonecall and then follow up letter from Galena	Shire of Meekatharra	Chris East – Deputy CEO	Introduction letter from Galena sent to introduce the project to local governments along the transport route from the mine to the port of Geraldton. All stakeholders were appreciative of the early contact. Cue, Mt Magnet and Yalgoo already have similar product transported through their towns and were not concerned. Meekatharra raised the issue of road maintenance on the unsealed Ashburton Downs road. CoGG were very interested and offered to host a meeting for interested stakeholders.	Galena to follow up with Meekatharra on a road maintenance agreement. Galena to follow up with CoGG to organize a meeting of local stakeholders	
		Shire of Cue	Rob Madson -CEO			
		Shire of Mount Magnet	Kelvin Matthews - CEO			
		Shire of Yalgoo	Silvio Brenzi -CEO			
		City of Greater Geraldton (CoGG)	Trish Palmonari			
30/6/2018	Meeting at Yulga Jinna	Jidi Jidi Aboriginal Corporation (JJAC)	Galena mgt; JJAC	Discussion on the Abra project	Consultation continuing	
11/7/2018	Meeting at Yulga Jinna	JJAC	Galena mgt; JJAC	Discussion on the Abra project	Consultation continuing	
17/7/2018	Meeting	DMIRS	Danielle Risbey;Erika Eto; Nicole Tucker; Emma Ryan Reed / Paul Rokich; Troy Flannery	Scoping meeting on the project. Included mining proposal and MCP components. Notes recorded from the meeting Meeting minutes taken. Galena is addressing these issues	NA	
1/8/2018	Meeting	DWER	Tim Gentle; Jamie Pioprowski; Sharmain; Alana Kidd (phone) / Paul Rokich; Troy Flannery	Scoping meeting on the project. Discuss Part V approvals required. Notes recorded from the meeting Meeting minutes taken. Galena is addressing these issues	No comment	
13/8/2018	Meeting	CoGG	Trish Palmonari; Anne Finlay; Glen Whistler-Carr plus other community members / Troy Flannery; Paul Rokich	Meeting at Geraldton with local government and key community stakeholders Meeting minutes taken. Galena is addressing these issues	No comment	
15/8/2018	Meeting at Abra minesite	JJAC	Galena mgt; JJAC	Discussion on the Abra project	Consultation continuing	
20/8/2018	Meeting	Mid West Port Authority	Sabdra Pigdon; Russell Stevens; Geoff Mackin / Troy Flannery; Paul Rokich	Meeting with port management to discuss project, environmental and commercial aspects of export. Meeting minutes taken. Galena is addressing these issues	No comment	
26&27/9/2018	Meeting at Perth galena office	JJAC	Galena mgt; JJAC	Discussion on the Abra project	Consultation continuing	
12/10/2018	Meeting	Pilbara Ports Authority	Lial Banks; Peter King; Jaren; Ash / Paul Rokich; Troy Flannery	Meeting with GM and Commercial Trade Manager to discuss project and commercial aspects of export	No comment	
7/12/2018	Meeting	DMIRS Safety Branch	[DMIRS -Peter Capon; Peter Nissen; Steve Stirling; Dave Harvey; Nicole Tucker]. [Galena - Troy Flannery; Paul Rokich; Roger Bryant; Melanie Flynn]	Meeting to discuss project and draft PMP. Meeting notes taken. Galena is addressing these issues during preparation of the PMP.		
30/1/2019	Meeting at Meekatharra	JJAC	Galena mgt; JJAC	Discussion on the Abra project	Consultation continuing	
14/3/2019	Teleconference	Meekatharra shire	Roy McClymont; Norm Trenfield / Paul Rokich; Melanie Flynn	Discussion on the Abra project and possible haul road options from the mine to the GNH	Periodic consultation to continue	
10/4/2019	Letters sent by Registered post	Nharnuwangga Wajarri & Ngarlawanga Native Title Group Shire of Meekatharra Mulgul Pastoral Lease		Notification on lodgment of tenements L52/205 and L52/207		No objections lodged with DMIRS in the statutory objection period
10/4/2019	Letters sent by Registered post	Nharnuwangga Wajarri & Ngarlawanga Native Title Group		Notification on lodgment of tenements L52/206		No objections lodged with DMIRS in the statutory objection period

Date	Description of Engagement	Stakeholder	Attendees	Description / Stakeholder Comments / Issues	AMPL Response	Outcome / record filed in…
		Shire of Meekatharra Bryah Pastoral Lease Great Western Exploration Limited (holder of E52/3652)				
30/5/2019	Email	Meekatharra shire	Roy McClymont / Paul Rokich	Roy McClymont emailed draft road maintenance agreement to AMPL for consideration	AMPL reviewing agreement	

Appendix E. Environmental Management System

Environmental Management System

Abra Mining Pty Ltd

Revision 3

3 June 2019

Document history and status

Revision	Date	Description	By
A	21/6/2018	Preliminary EMS	P Rokich
B	16/7/2018	First draft to client for review	P Rokich
1	25/10/2018	Issue to client	E. Maller
2	13/3/2019	Update to procedures	P Rokich
3	3/6/2019	Change company to AMPL and add Fauna Management Procedure	P Rokich

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Contents

1. Introduction

Galena Mining Limited acquired exploration tenements in the Peak Hill mineral field in the Gascoyne region of Western Australia in 2017. These tenements contained the Abra Base Metals deposit. Exploration drilling has further defined the mineral resource to the point that AMPL is undertaking a Pre-Feasibility Study to develop the deposit into an operational mine. The mine will initially produce a lead – silver (Pb-Ag) concentrate, with the deposit transitioning to a polymetallic lead – silver – copper – gold (Pb-Ag-Cu-Au) product at depth. The project is now 100% owned by Abra Mining Pty Ltd (AMPL).

The project, known as the Abra Base Metals mine, will involve underground mining, base metals concentrate production via floatation processing and road transport of the concentrate to the Port of Geraldton for export.

The Abra project has been described in detail in other documents, principally the Mining Proposal. The Mining Proposal document covers elements such as project description and existing environment and is not repeated in this document.

1.1 Purpose and Scope

This Environmental Management System (EMS) documents how AMPL will manage interactions with the environment.

The EMS has been structured to be relevant for the construction and operational phases of the mine life cycle. Mine closure has a unique set of activities and potential environmental impacts to which the current EMS does not address. For mine closure, future revisions of the EMS should address the closure aspects in the Mine Closure Plan risk assessment and be prepare specific Project Operating Procedures as required.

1.2 Location

The Abra project is located in the eastern Gascoyne region, approximately 180 kilometres north of Meekatharra. The proposed mine is shown in **Figure 1.**

1.3 Requirement for an EMS

The Abra Base Metals deposit is located in a wider land precinct containing existing conservation reserves and pastoral leases. To minimise potential environmental impacts from the project, AMPL wish to develop documented processes to mitigate potential impacts to acceptable levels.

The (then) Department of Mines and Petroleum (DMP) (now Department of Industry Regulation and Safety – DMIRS) published *Guidelines for Mining Proposals in Western Australia* in April 2016. The guidelines require proponents to demonstrate an upfront assessment and identification of risk management measures in any Mining Proposal submitted to them. Due to the long term nature of mining activities and the potential for new risks to arise during operation, ongoing risk identification and monitoring of the success of the proposed management measures is required. Following approval of a Mining Proposal, DMIRS requires the risk management process to be maintained and managed throughout the life of the project via an appropriate EMS. While DMIRS does not require certification of the system under the AS/NZS ISO 1400:2016 Environmental Management System Standard (Standards Australia 2016), should proponents choose not to certify their system or implement an alternative EMS, an outline of this system must be explained in the Mining Proposal.

This EMS is consistent with AS/NZS ISO 14001:2016.

1.4 EMS Evolution

The EMS is to be implemented on commencement of activities at the site and continue throughout the operating life of mine. The EMS is adaptive and will be reviewed on an annual basis to maintain currency and addresses operational changes.

At this early stage of the Abra project, many systems, including this EMS, are also in development. As more information on how the Abra project will be developed comes to hand, this EMS will be updated. On this basis, Revision 3 of the document is regarded as a ‘Preliminary EMS’.

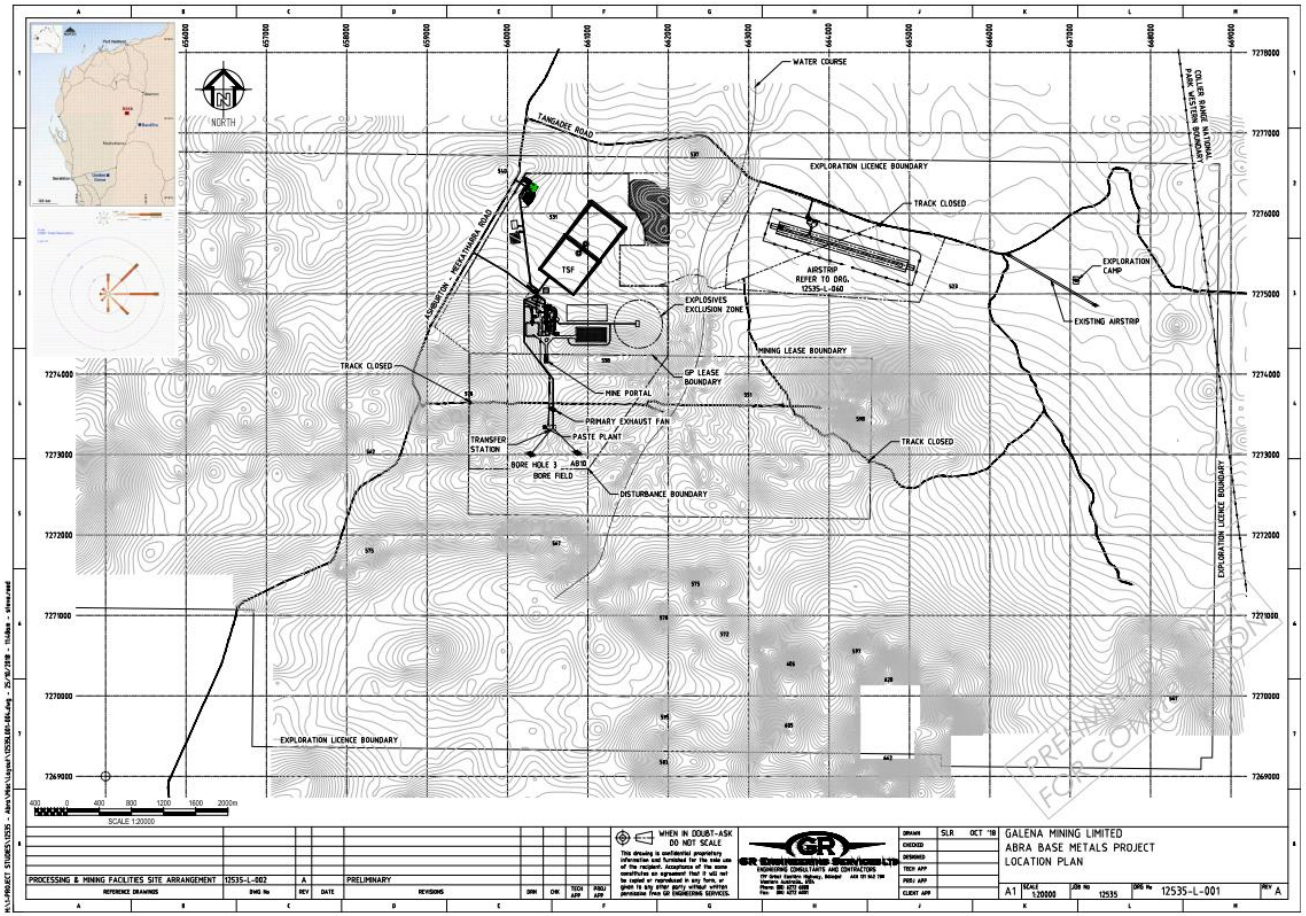


Figure 1: Location

2. Document Structure

AMPL has developed this EMS consistent with the principles of AS/NZS ISO 14001:2016. The sequent sections of this document describe the EMS. While the EMS uses the AS/NZS ISO 14001:2016 framework, AMPL does not intend to seek AS/NZS ISO 14001:2016 accreditation. **Table 2-1** demonstrates where AS/NZS ISO 14001:2016 content and also DMP (2016) example structure is reflected in the EMS document.

AMPL has developed the EMS to manage environmental impacts associated with its mining operations. At the present time, AMPL has only one proposed mining project, the Abra Base Metals mine. However, in the future, other mining projects may be developed and for minerals other than base metals. For this reason, the EMS has structured its management procedures to provide:

- Standard Operating Procedures (SOP) - to manage aspects that are common to more than one Environmental Group Site (EGS).
- Project Operating Procedures (POP) – to manage aspects unique to a specific EGS.

Table 2-1: Document Structure

DMP (2016) Model Structure	Sub Headings and Description	Section of this Document
Policy	**Environmental Policy** AMPL's Environmental Policy provides objectives for the conduct of all operations, employees and contractors. The policy details AMPL's commitment to continuous improvement in environmental performance, pollution prevention, and compliance with environmental legislation.	**3**
Planning	**Legal obligations and other commitments** Statutory requirements set the minimum standard for compliance. A Compliance Register detailing applicable legal requirements, as well as voluntary commitments made by AMPL has been developed to assist in monitoring compliance with these requirements and commitments.	**4.1**
	Management commitment AMPL management recognise the importance of leading by example. Senior management have committed to active involvement in implementation of this system. The senior mine management team will review the EMS annually, to ensure that it remains effective and appropriate. The review takes into account results of environmental audits, the extent to which environmental objectives and targets have been met, its continued relevance to changing conditions and issues raised by stakeholders.	**4.2**
	Environmental Aspects (Risk Management) Environmental aspects (issues) and risks associated with the company's activities are identified, evaluated and managed. Operational control documents have been developed to reduce environmental risks during construction, normal operations and emergency situations as low as reasonably practicable (ALARP).	**4.3**
	Responsibilities and Reporting Structure	**5.1**

DMP (2016) Model Structure	Sub Headings and Description	Section of this Document
Implementation	Environmental management is a line accountability, but every employee and contractor is also responsible for conducting activities in an environmentally acceptable manner. Successful implementation of the EMS depends on commitment of all employees and contractors. Individual responsibilities and authorities have been defined in relevant documents and communicated to personnel through inductions and meetings.	
	Induction and Training All staff and contractors working on site will be inducted and will need to have the appropriate training and/or experience for their roles.	**5.2**
	Communication AMPL commits to ongoing consultation with both internal and external stakeholders. This includes reports to government agencies, meetings and written correspondence.	**5.3**
Implementation	**Operational Control** AMPL will ensure that plans, procedures, permits, forms and checklists are implemented to reduce environmental impact of activities. Environmental monitoring will provide ongoing feedback on the effectiveness of control strategies.	**5.4**
Performance and Reporting	**Environmental Performance** Monitoring provides data on the site's performance against targets, compliance with regulatory requirements, voluntary commitments and with the EMS.	**6.1**
	Reporting Systems have been established for internal and external reporting and communication of hazard /incident reports; operational reports; environmental monitoring results.	**6.2**
	Contractor Management AMPL will implement an inspection program to ensure contractor's performance is consistent with requirements of the EMS.	**6.3**
Review	**Environmental Audits and Inspections** Audits, inspections and reviews allow the operation to identify opportunities for improvement to enable the operation to continually improve its performance. Inspections focus on the practical implementation of company procedures. Audits are conducted to ensure specific components of the EMS are being complied with. Reviews are conducted to ensure requirements of the EMS are practicable and assist the operation in meeting its regulatory and voluntary environmental commitments.	**7**

3. Environmental Policy

Appendix C provides AMPL's company policy on environmental matters.

4. Planning

4.1 Legal Compliance

Statutory requirements are the minimum compliance standard. A Compliance Register for the site shall be maintained that contains a list of approval conditions, tenement conditions, voluntary commitments and current copies of relevant licences and permits. The compliance register records:

1. Statutory conditions that include:
    a. Tenement conditions
    b. Department of Water and Environmental Regulation (DWER) Environmental Protection (EP) Act Part V licence conditions
    c. Water licence conditions
    d. Clearing permit conditions
    e. Mining Proposal commitments
2. Date of commencement and expiry of all licences and permits.
3. Status of the condition.

4.2 Management Commitment

AMPL management recognise the importance of leading by example. Senior management have committed to active involvement in implementing the EMS.

Table 4-1 details roles and responsibilities that include annual review the EMS, to ensure that it remains effective and appropriate. The review takes into account results of environmental audits, the extent to which environmental objectives and targets have been met, its continued relevance to changing conditions and issues raised by stakeholders.

4.3 Risk Management

The Australian and New Zealand Standard on Risk Management (AS/NZS 4360) defines risk as the product of the likelihood of an event occurring and the consequence of that event. AMPL has developed a risk matrix based on AS/NZS 4360:2004 to assess the risk of activities undertaken in its operation.

A risk assessment has been undertaken for key functions for the Abra project. It is included in the Mining Proposal document. To maximise the benefit in pro-active management of environmental issues, it is important that manpower and other resources are allocated on a priority basis to issues. It is normally accepted that the highest risk issues receive the highest priority.

AMPL has established a set of routine controls that comprise procedures, internal permits, forms and inspection checklists, which provide control measures to reduce environmental impacts of activities at their mining operation. These are detailed in **Section 5.4: Operational Control**.

Table 4-1: Roles and Responsibilities

Personnel	Responsibilities
Mine Manager (MM)	• Ensure the EMS is effectively implemented. • Review performance of the EMS on an annual basis. • Review any environmental non-conformances and remediation actions; • Allocate resources to manage environmental issues; and • Ensure contractors comply with environmental requirements.
Departmental Managers (DM)	• Implement the EMS on site. • Liaise with the Environmental Staff on environmental issues and non-conformances. • Ensure that site personnel are aware of their environmental obligations. • Take corrective action to resolve non-conformances.
Environmental Staff (ES)	• Assigned responsibility for the EMS's compliance. • Implement an appropriate environmental induction programme and assist site personnel to implement the programme. • Prepare Annual Environmental Report (AER), with Environmental Office, for external reporting. • Liaise with relevant local authorities to maintain effective communication. • Liaise with the general public and key stakeholders, as required. • Review and update the EMS and associated documentation. • Ensure the EMS is implemented and required records are maintained. • Prepare Quarterly Environmental Report (QER) for Mine Manager. • Prepare Annual Environmental Report (AER) for external reporting. • Ensure prestart/ toolbox meetings address environmental issues as required and these are documented in meeting minutes. • Ensure that appropriate communications are in place between AMPL and the contractors. • Confirm all personnel have been inducted prior to commencing work. • Implement environmental monitoring and audit programmes. • Ensure that environmental records and files are maintained.
Employees	• Employees are expected to conduct all activities in an environmentally responsible manner during the course of their employment. • Supervisors shall make all employees aware of their responsibilities for environmental management. • Employees will comply with any environmental instruction relating to work practices. • Employees will report and rectify unacceptable environmental conditions and practices when they are identified. • Employees are encouraged to take ownership of environmental issues through participation in decision-making and accountability in all areas of their workplace.
Contractors	• Contractors are required to uphold AMPL' environmental standards and commitments referred to in the EMS. • Relevant Departmental Managers shall ensure that all contractors in their area of responsibility are informed of their environmental responsibilities and that their performance is monitored.

5. Implementation

5.1 Responsibilities

The Registered Mine Manager has ultimate statutory responsibility for activities undertaken on the mine.

Departmental Managers are responsible for their respective areas' compliance with regulatory requirements and internal company standards. The Environmental Staff will actively assist Departmental Managers in fulfilling these responsibilities. Key site responsibilities are outlined in **Table 4-1**.

5.2 Induction and Training

The site induction ensures that employees, contractors and third parties are made aware of their roles and responsibilities in relation to the environment, safety and health. The environmental induction component of this site wide process specifically addresses:

- AMPL's Corporate Environmental Policy.
- The Environmental Management System.
- Internal environmental work permit systems.
- Emergency Response Procedures (environmental emergencies).
- Areas of environmental sensitivity at the project site.

Training requirements will be identified and documented in relevant environmental procedures. Where identified in a procedure, training will be provided if employees have specific tasks that have or may have a significant environmental impact and where their activities have the potential to influence the performance measurement of the site. Environmental training may include, but is not limited to such things as:

- Spill response (Emergency Response Team members).
- Dangerous goods storage and handling (Supply personnel).
- Water sample collection and sample dispatch (laboratory personnel).
- Waste management (environmental staff).

Environmental training shall be conducted by appropriately qualified and experienced internal personnel or external bodies. All environmental training undertaken by employees shall be recorded on their individual personnel file. Training records will be held by the Administration Manager and will be managed to ensure confidentiality is maintained.

5.3 Communication

AMPL recognises the importance of communicating the performance of the EMS with employees, contractors and stakeholders.

Employees and contractors are to be encouraged to report deficiencies, non-conformances and environmental issues at toolbox meetings.

The Resident Manager is responsible for ensuring that a monthly report is prepared and submitted to the Board. This report specifically includes details of:

- Environmental incidents recorded.
- Communications with regulatory authorities.
- New approvals obtained or amendments to existing approvals.
- Non-compliances identified in audits and actions taken to address these.

- Anomalous environmental monitoring results.

The Resident Manager is responsible for communicating the performance of the EMS to employees, contractors and, where applicable, other stakeholders:

Requests and directives from regulatory authorities shall be dealt with in a timely manner. All formal environmental related correspondence with regulatory bodies shall be issued under the Registered Manager's signature.

5.4 Operational Control

Table 5-1 details operational controls aimed at providing measures to reduce environmental impacts from site activities. These include procedures, internal permits, forms and inspection checklists. These are appended to this EMS (**Appendix A**).

Table 5-1: Operational Controls

Document	Control function	Application
Standard Operating Procedure (SOP)		
Vegetation management procedure	Documents the process for vegetation clearing, topsoil management and weed control. Includes the internal clearing permit form and clearing register.	When undertaking clearing activities
Fauna management procedure	Documents the process for fauna management. Includes the internal fauna death or injury form.	Ongoing through the life of mine
Hydrocarbon and chemical procedure	Documents the process for hydrocarbon and chemical management. Includes the Hazardous Materials Register and the Spill Procedure	Ongoing through the life of mine
Aboriginal heritage procedure	Documents the process to identify and protect Aboriginal heritage sites.	Prior to commencement of site works
Waste management procedure	Documents the process for waste management. Includes the spill procedure	Ongoing through the life of mine
Accident/Incident Form	Form to report accidents and incidents	As required
Accident Incident Investigation Form	Form to investigation Significant or High risk incidents	As required
Hot work permit	Documents the process to undertake hot work activities on site	As required
Environmental constraints map	Records environmental / heritage sites and buffer areas.	Ongoing through the life of mine
Project Operating Procedure (POP)		
Water monitoring procedure	Documents the process for water monitoring.	As required by licences and permits.
Monthly inspection of contractors area	Records inspection of contractor areas and routine reporting requirements (e.g. NPI data; clearing reconciliation).	Monthly
Monthly inspection of mine area	Records inspection of site facilities and mine features for compliance with environmental requirements.	Monthly

6. Performance and Reporting

6.1 Environmental Performance

Monitoring programs are to be established for a range of site activities that may have a significant impact on the environment. Data collected from monitoring activities is to be assessed and compared against relevant approval conditions and performance measures. A summary of monitoring results shall be included in the site's internal quarterly report and external reports (**Section 6.2**). **Table 6-1** lists the routine monitoring requirements for the site. Additional requirements will be added as approval and licence conditions are known.

6.2 Reporting

Systems have been established for internal and external reporting and communication of hazard /incident reports; operational reports; environmental monitoring results.

An internal Quarterly Environmental Report (QER) is required to be compiled from environmental staff to the Mine Manager, summarising:

- Environmental monitoring data and identifying trends.
- Anomalous monitoring records and actions resulting.
- Environmental incidents and outcomes.
- Environmental commitments and conditions relevant for the period and actions taken.

An Annual Environmental Report (AER) is required by regulatory agencies as an audit tool against compliance with their approval conditions. The AER is likely to include a summary of monitoring data collected during the reporting period, identify trends, identify reasons for any anomalous results recorded and describe any changes proposed to environmental monitoring programs. Monitoring data from the QER's will be collated and included in the AER.

6.3 Contractor Management

AMPL will implement an inspection program to ensure contractor's performance is consistent with requirements of the EMS.

Table 6-1: Monitoring Schedule

What	How	Who	Report in …
As required.			
Seed collection	Record weight of seed and species collected from cleared areas	ES	AER
Constraints Map	Update with new information on constraints and location of stockpiles	ES	AER
Monthly			
Bore flow meter readings	Record meter readings of bores and water network on site.	ES	QER
Potable water sampling	Take samples from potable water locations	ES	QER
Contractor checklist	Inspection of work areas to record general housekeeping and compliance with AMPL requirements	Contractors and AMPL ES	QER
Site checklist	Inspect each mine feature against approval conditions and performance measures	ES	QER
Quarterly			
Vegetation clearing	Maintain clearing Register. Collate clearing permit forms.	ES	QER
Environmental incidents	Collate all environmental incident reports	ES	QER
Induction records	Collate induction records	Admin officer	QER
Water monitoring	Collate monitoring records and compare against licence conditions	ES	QER
Annually			
Vegetation procedure	Review of procedure and update EMS	ES	AER
Water monitoring procedure	Review of procedure and update EMS	ES	AER
Hydrocarbon and chemical procedure	Review of procedure and update EMS	ES	AER
Waste Management Procedure	Review of procedure and update EMS	ES	AER

7. Review

Regular inspections, audits and reviews are an essential component of the EMS. The audit and review program is summarised in **Table 7-1**.

AMPL management will consult with stakeholders during annual review of the EMS. The environmental staff shall audit the site on an annual basis. Results of the audit are to be submitted to the Registered Manager as part of the annual system review.

Departmental Managers, in conjunction with environmental staff, shall develop an action plan to address identified non-compliances within their areas. Responsibilities and timeframes for completion of tasks shall be allocated and documented in the action plan.

Table 7-1: Review Schedule

Activity	Document	Frequency	Auditor/Reviewer
Inspection	Scheduled inspections of site	Monthly	Environmental staff (ES)
Inspection	Scheduled inspections of site	Quarterly	Environmental staff
Audit	Compliance Register	Annually	Environmental staff
Audit	EMS compliance	Annually	Environmental staff
Review	Procedures, permits and guidelines	Annually	Document custodians.
Review	Position Responsibilities	Annually	Employee's line manager
Review	Environmental Policy	Biennially	AMPL CEO

8. References

Department of Mines and Petroleum 2016, *Guideline for Mining Proposals in Western Australia*, Government of Western Australia. Available from http://www.dmp.wa.gov.au/. [16 July 2018].

Standards Australia 2016, *Environmental Management Systems – Requirements with guidance and use*, AS/NZS 14001:2016. Available from Australian Standards. [16 July 2018].

Appendix A. Control Documents

List of control documents

Standard Operating Procedure
Appendix B- Aboriginal Heritage Procedure
Appendix C - Environmental Policy
Appendix E - Hazard / Incident Report and Investigation forms
Appendix F - Hydrocarbon and Chemicals Procedure and Hazardous Materials Register
Appendix G- Vegetation Management Procedure
Appendix H- Waste Management Procedure
Appendix J - Fauna Management Procedure
Appendix K - Hot work permit
Project Operating Procedure
Appendix D - Monthly Contractor Inspection Checklist
Appendix I - Water Monitoring Procedure

Appendix B. Aboriginal Heritage Procedure

Aboriginal Heritage Procedure

Purpose

This standard procedure details action required to comply with the *Aboriginal Heritage Act 1972* and protect places and objects of Aboriginal heritage value in the project area.

Background

All staff and contractors will be made aware of cultural heritage issues in the site induction.

Risks

The key risk is inadvertent damage to Aboriginal heritage sites located in or adjacent to active areas.

Procedure

Prior to ground disturbance activities

Conduct heritage surveys over project areas, to identify locations to be avoided and exclusion zones.

Record all exclusion zones on the environmental constraints map.

Use signposts, flagging or fencing to protect identified heritage sites in the project area.

Where disturbance of known cultural heritage sites cannot be avoided, obtain Ministerial consent under Section 18 (Aboriginal Heritage Act, 1972).

During site activities

Immediately stop work if any new cultural heritage site is identified / uncovered and report the find to the site environmental officer. The environmental officer is to inform the Mine Manager, who is to inform the Department of Indigenous Affairs. An investigation and action plan will follow.

Monitoring

The environmental officer is to annually inspect all control measures in place to protect cultural heritage sites, to ensure no inadvertent disturbance has occurred.

Reporting

Any non-compliance with this procedure will be reported immediately as an environmental incident.

Appendix C. Environmental Policy

GALENA MINING LIMITED

Galena Mining Limited (Galena) recognises that we cannot operate or be successful without fully integrating environmental considerations into our daily processes. To achieve this, Galena will aim to:

- Comply with and, where appropriate, exceed the requirements of applicable legislation, regulations and other standards to which we subscribe.
- Promote environmental awareness among our personnel and contractors to increase understanding of their roles and responsibilities in environmental management.
- Develop our people and provide resources to meet our environmental objectives.
- Ensure that environmental issues are integrated into the decision making process of our exploration and project development.
- Identify and assess the potential environmental effects of our activities and manage environmental risk.
- At all times maintain an open and honest relationship with stakeholders.
- Continually improve and regularly monitor our environmental performance.
- Promote our environmental progress and performance to our stakeholders.

Adrian Byass
Chairman

Troy Flannery
Chief Operating Officer

Appendix D. Inspection Checklists

ABRAMINING

Version date: 20/5/2019

Monthly Inspection of Contractors Areas

Procedure.

Item	Action	Who
1	AMPL to supply all contractors on site with this procedure and instruct them to undertake monthly inspections of their areas.	Mine Manager
2	Contractors to complete the checklist below and return completed form to AMPL Environmental Staff (ES).	Contractors
3	ES to enter inspection date in the Compliance Register, and file completed checklist.	ES
4	ES to follow up with contractors to ensure close out of all items raised.	ES

Contractor Area Inspection Checklist

Inspected by (Print Name):			
Contractor area:			
Date/Time:			
General item	**Specific Criteria**	**Status Yes/No**	**Comments**
Stores, Offices & laydown yards	Any weeds growing that require eradication?		
	All products correctly stored and labelled.		
	Rubbish removed		
Hydrocarbon facilities	All bunds intact.		
	Leaks and spills cleaned up.		
	All products correctly stored and labelled.		
	Hoses located inside bunds		
Water pipelines	Leaks identified and reported for		
Parking areas	Any weeds growing that require eradication?		
	Minor leaks and spills cleaned up.		
Incidences	All environmental incidences reported.		
Plant area	Drains and sumps clear.		
	Dust management effective		
	Minor leaks and spills cleaned up.		
	Spill absorbent material available		
Vehicle washdown	Has all equipment entering the site been washed?		
	Form completed and submitted		
Personnel	Have all new employees been inducted?		
NPI reporting	Diesel use (litres)		
	Drilling (metres)		
	Heavy vehicle use (engine Kw & hrs)		
	Generators/lighting plants (engine Kw & hrs)		
Dust control	Is all dust control equipment operational		

ABRAMINING

Version date: 20/5/2019

Monthly Inspection of Mine Areas

Procedure.

Item	Action	Who
1	AMPL environmental staff (ES) to inspect each mine area on housekeeping matters and to ensure installed infrastructure to in good working order.	ES
3	ES to enter inspection date in the Compliance Register, and file completed checklist.	ES
4	ES to follow up with Area Managers to ensure close out of all items raised.	ES

Mine Area Inspection Checklist

Inspected by (Print Name):			
Contractor area:			
Date/Time:			
Area	**Specific Criteria**	**Status** **Yes/No**	**Comments**
Stores, Offices & laydown yards	Any weeds growing that require eradication?		
	All products correctly stored and labelled.		
	Rubbish removed		
Hydrocarbon facilities	All bunds intact.		
	Leaks and spills cleaned up.		
	All products correctly stored and labelled.		
	Hoses located inside bunds		
Water pipelines	Leaks identified and reported for		
Parking areas	Any weeds growing that require eradication?		
	Minor leaks and spills cleaned up.		
ROM	Drainage off ROM contained		
Process plant area	Drains and sumps clear.		
	Dust management effective		
	Minor leaks and spills cleaned up.		
	Spill absorbent material available		
TSF	Water recovery systems operating		
	No tailings dust blowing off the TSF		
WRD	Drainage off the WRD contained		

Power station	Drains and sumps clear.		
	Dust management effective		
	Minor leaks and spills cleaned up.		
	Spill absorbent material available		
Concentrate loadout facility	Drains and sumps clear.		
Explosives magazines	Minor leaks and spills cleaned up.		
Accommodation village	All products correctly stored and labelled.		
Airstrip	All products correctly stored and labelled.		
Roads	Dust generation that requires suppression (use of water cart)		

Appendix E. Hazard / Incident Forms

ABRAMINING	**Hazard/Incident Report** (Use black ball point pen only)	**Incident Number** ……. -____

PART A: INITIAL REPORT

1. Type (tick box/es)

☐Hazard ☐Near Miss ☐Injury or ☐ Illness ☐Equipment Damage ☐Environmental ☐Process Loss ☐Significant Potential (specify) _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

☐ Minor → ☐ Medical → ☐ Lost Time (Number of people injured/ill =)

2. Hazard / Incident

Date (dd/mm/yy)

Time (24 hr clock) : hrs

3. Reported

Date (dd/mm/yy)

Time (24 hr clock) : hrs

4. Location

Project/Site | Location | Work Area

5. Person Involved in Hazard/ Incident

Surname | First Name(s)

Department | Section | Occupation

Date of Birth (dd/mm/yy) | Gender ☐ Female ☐ Male | Employment Status ☐ Full Time ☐ Part Time

Employment Category

☐ Company Employee ☐ Contractor/Sub-Contractor ☐ Other (e.g. visitor)

Department_ _ _ _ _ _ _ _ _ _ _ _ Company Name_ Specify: _ _ _ _ _ _ _ _ _ _ _ _

6. Brief Description

Briefly outline the hazard/incident. List any other person(s) who have witnessed the hazard/incident.
What activity was being performed at the time of the incident?

7. Procedure Standard

Is there a written procedure & JSA aimed to prevent this hazard/incident? ☐ Yes ☐ No If yes, answer following question.

Does the JSA and procedure need to be reviewed? ☐ Yes ☐ No

8. Immediate Actions

What actions were taken immediately to control the hazard/incident?

9. Work Area Supervisor

Surname | First Name(s) | Phone Number

Person Involved in Incident or First Aid Treatment Provider

PART B: DETAILS OF INJURED/ILL PERSON

Contact Address

10. Injured/Ill Person's Details

Start Date with Company (dd/mm/yy) | Time in Present Position

Supervisor's Surname | Supervisor's First Name(s) | Supervisor's Phone Number

First Aid Treatment Provider

First Aid Treatment Provider

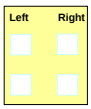
PART C: FIRST AID TREATMENT (If more than one person injured/ill, complete Part C for each person.)

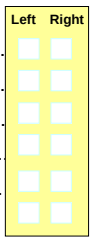
11. Injury / Illness Type (tick box/es)

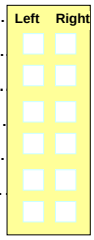
☐ Abrasions	☐ Crush	☐ Electric Shock	☐ Laceration	☐ Sprain
☐ Asphyxia	☐ Dislocation	☐ Fracture	☐ Loss of Consciousness	☐ Strain
☐ Bruising	☐ Effects of Chemicals	☐ Illness (specify)	☐ Nausea	☐ Other (specify)
☐ Burns	☐ Effects of Exposure	_ _ _ _ _ _ _ _ _ _ _	☐ Puncture Wound	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

12. Part of Body (tick box/es)

☐ Skull/Head	☐ Shoulder……	☐ Hip……	☐ Chest	
☐ Face	☐ Upper Arm……	☐ Upper Leg….	☐ Abdomen	
☐ Ear……	☐ Lower Arm……	☐ Lower Leg….	☐ Groin	
☐ Eye……..	☐ Wrist……	☐ Ankle……	☐ Other (specify)	
☐ Neck	☐ Hand……	☐ Foot……		
☐ Back …...	☐ Fingers/Thumb…	☐ Toes……	_ _ _ _ _ _ _ _ _ _ _ _ _ _	
	Finger No. ……	Toe No. ……	_ _ _ _ _ _ _ _ _ _ _ _ _ _	







13. First Aid Treatment Provided

Record any observations and treatment provided, as well as advice given to the patient.

14. Further Treatment

☐ Returned to normal duties ☐ Returned to alternate duties ☐ Referred for doctor/hospital/medical treatment

15. First Aid Provider

Name	Signature	Date (dd/mm/yy)

Supervisor

PART D: ENVIRONMENTAL IMPACT

16. Impact To

☐ Water ☐ Air ☐ Flora ☐ Fauna ☐ Land
☐ Sea ☐ Ground ☐ Surface (specify) ☐ Undisturbed ☐ Rehabilitated

Area/Volume Affected m^2 m^3	Other Comments

17. Impact By

Agent	Quantity (if relevant)	Duration of Incident

18. Incident Classification

Was the incident a: Sudden and accidental event? ☐ Yes ☐ No ☐ Unsure
Gradual onset event? ☐ Yes ☐ No ☐ Unsure

19. Further Comments

Supervisor

PART E: SUPERVISOR'S ASSESSMENT

20. Shift Details

Type of Shift	Length of Shift	
☐ Day ☐ Afternoon ☐ Night	☐ 8 hrs ☐ 10 hrs ☐ 12 hrs ☐ Other (specify)	
Shift Start Time hrs	Roster Type (e.g. 4 days on, 3 days off)	Days into Roster (e.g. Day 3)

21. Notifiable to a Govt Agency

☐ No ☐ Yes Inform Dept Head & RM prior to notification. Time/Date Reported: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Agency Name: _ Report No: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

22. Insurance Provider

Has this incident incurred any medical bills? ☐ No ☐ Yes Complete: (1) Employers Indemnity Insurance Report form
(2) Once possible - employee is to complete Workers' Compensation form.
(2b) Pass to Loss Control Department within 48 hours of incident occurring.

23. Risk Rank

From guideline, give a risk rank of: Consequence …… Likelihood ……
☐ **Low** .
☐ **Moderate**.
☐ **Significant**.
☐ **High**.

24. Further Action

Action	By Whom	By When

PART F: INTERNAL NOTIFICATION OF HAZARDS/INCIDENTS

	Name	Signature	Date
25. Responsible Area Fore-man/Super			
26. Responsible Manager			
28. Comments			

ABRAMINING	**Accident/Incident Investigation** (Use black ball point pen only)	**Incident Number** …… -_____

PART G: INVESTIGATION TEAM MEMBERS

29. Investigation Team Member Details	Surname	First Name(s)
	Surname	First Name(s)
	Surname	First Name(s)
	Surname	First Name(s)

Team Members

PART H: DETAILED HAZARD/INCIDENT DESCRIPTION

30. Detailed Description	If a hazard, describe it in clear terms. For incidents, describe the sequence of events leading to the incident. Describe what was happening. Do not restrict yourself to the events immediately preceding the incident. Attach additional pages, sketches, etc. as required and list in Part K.
31. Procedure Standard	Is there a written procedure & JSA aimed to prevent this hazard/incident? ☐ Yes ☐ No If yes, answer following question. Does the JSA and procedure need to be reviewed? ☐ Yes ☐ No

Supervisor or Investigation Team Leader

PART I: BUILDING/PLANT/EQUIPMENT DAMAGE (If more than one item damaged, complete part I for each and attach.)

32. Damage To (tick)	☐ Building/Structure ☐ Vehicle/Mobile Equipment ☐ Fixed Plant ☐ Other (specify)	
33. Damage Details	Item Damaged (e.g. 4WD)	Identifying Number (e.g. Asset No, Serial No.)
	Item owner ☐ Company ☐ Contractor-Company Name ☐ Other (specify)	
	Damage Description	
	Is it expected that this incident will cause a loss of production and/or revenue? ☐ Yes ☐ No	
	How critical to production is the item? (1 = not critical, 10 = critical) ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10	

Supervisor or Investigation Team Leader

PART J: IDENTIFYING CAUSES (Refer to the guideline to provide prompts.)

CAUSE CATEGORIES	IMMEDIATE CAUSES	ASK "WHY"	ROOT CAUSES
People What people issues were involved in the hazard/incident (e.g. competency level, training, procedures followed, fitness for work, etc.)?			
Equipment What plant/ equipment/material issues were involved in the hazard/incident (e.g. fit for purpose and maintained equipment, protective devices/guards, PPE labelling, etc.)?			
Environment What issues to do with the work environment were involved in the hazard/incident (e.g. ventilation, ground conditions, wind, lighting, space, storage conditions, explosive atmosphere, etc.)?			
Procedures What procedural issues were involved in the hazard/incident (e.g. permit system, isolation, standard operating procedures, maintenance procedures, pre-use checks, etc.)?			

PART K: ATTACHMENTS (Write the number of attachments of each type into the relevant box. Put the hazard/incident report number on each attachment.)

☐ Sketches ☐ Photographs ☐ Statements ☐ Work Instructions ☐ Plans ☐ Surveys ☐ Maintenance Records ☐ Training Records ☐ Procedures ☐ Other (specify)

PART L: SUMMARY OF IDENTIFIED CAUSES

People	
Equipment	
Environment	
Procedures	

PART M: RECOMMENDATIONS (List in point form the specific actions taken/to be taken to prevent recurrence.)

No.	Action	By Whom (Name)	By When (dd/mm/yy)

PART N: ESTIMATED COSTS

	No. Person Hours Spent:	Other Direct Costs:
Investigation	hrs	$
Retraining	hrs	$
Medical Treatment	hrs	$
Replacement Personnel	hrs	$
Clean-up	hrs	$
Other relevant administration activities	hrs	$
Replacement/Repair/Modification	hrs	$
Other (specify)	hrs	$
TOTAL	hrs	$

Supervisor or Investigation Team Leader

As per Distribution

PART O: REVIEW (Actions from Part M can be amended following consultation with Investigators.)

Safety & Health Representative	Name	Signature	Date
	Comments		
Supervisor	Name	Signature	Date
	Comments		
Department Manager	Name	Signature	Date
	Comments		

Office Use Only

PART P: ENVIRONMENTAL - OFFICE USE ONLY

Non Compliance Level	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Third Parties	Were any third parties affected? ☐ No ☐ Yes (specify)
Further Comments	

PART Q: SAFETY - OFFICE USE ONLY

Final Injury/Illness Classification	☐ MI	☐ MTI	☐ MTI Alt. Duties	☐ LTI	☐ LTI Alt. Duties	☐ Fatality
Alternate Duties/ Shifts Lost	Date Commenced Alt. Duties	Date Resumed Normal Duties	No. Days Alt. Duties	No. Full Shifts Lost		
Workers Compensation	☐ No	☐ Yes - Forms Sent to: Insurer - Date:	Claim Number:……..			
Entered into Data base	☐ Tick when completed	By Whom	Date			

Appendix F. Hydrocarbon and Chemical Procedure

HYDROCARBON AND CHEMICAL PROCEDURE

MAY 2019

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APPENDICES

1. INTRODUCTION

This procedure provides information for the storage and handling of hydrocarbons and bulk chemicals, including diesel fuel, oils, grease, chemicals and explosives. This procedure outlines the manner in which bulk and small containers of substances should be stored and handled on-site. These include bulk tanks, 1,000 litre bulk 'pods', down to small containers of 20 L drums.

Implementing good hydrocarbon and chemical management practices will minimise environmental impacts from spills and accidents.

1.1 ENVIRONMENTAL OBJECTIVES

The objectives of hydrocarbon and chemical management are:

- To ensure no release of hydrocarbons to the environment as a result of storage or handling incidents.
- To ensure storage and handling of fuels and chemicals at the site does not pose a threat to the environment.
- To ensure that any spill or incident associated with fuels and chemicals is promptly cleaned up.
- To monitor the effectiveness of this hydrocarbon and chemical management procedure.

1.2 LEGISLATION AND STANDARDS

Table 1 lists relevant legislation and standards.

Table 1: Legislation and Standards

Reference
Dangerous Good Safety Act 2004
Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007
Dangerous Goods Safety (Road and Rail Transport of Non-Explosives) Regulations 2007
Dangerous Goods Safety (Explosives) Regulations 2007
Dangerous Goods Safety (General) Regulations 2007
AS 1940 - The Storage and Handling of Flammable and Combustible Liquids.
AS 3780 - The Storage and Handling of Corrosive Substances.
AS 4452 - The Storage and Handling of Toxic Substances.
AS 4681 - The Storage and Handling of Class 9 (miscellaneous) Dangerous Goods and Articles.

1.3 OTHER RELEVANT INFORMATION

The following list of other documents is also applicable to hydrocarbon and chemical management.

- Hazardous materials register Appendix 1

- Spill procedure Appendix 2
- Emergency Response Plan
- Monthly contractor inspection checklist

2. POTENTIAL IMPACTS

It is anticipated that, due to the relatively localised nature of site activities, impacts from hydrocarbons and chemicals will also be localised. Potential impact from hydrocarbons and chemicals is the contamination of soil and water from spills and leaks.

3. MANAGEMENT ACTIONS

Actions to be undertaken to manage hydrocarbons and chemicals are outlined in **Table 2**.

Table 2: Management actions

Action	Who	When
Induction and training		
All personnel will be inducted on the appropriate precautions to minimise risk of chemical spillage and misuse. All employees are to be aware of the spill response procedure.	All personnel	Commencement on site
Product inventories		
Maintain a hazardous materials register which includes an inventory of all receivables and dispatches of hydrocarbon and chemical products. The register is to also include details of supplier, quantities, storage location and MSDS.	Supply department	Ongoing
Maintain an inventory of explosives and associated products used on site.	Mining department	Ongoing
Storage		
Storage facilities will be appropriate to the type of chemical and will, as a minimum, meet the relevant Australian Standards.	Project engineer	Ongoing
All storage facilities on site are to be recorded in the hazardous materials register (Appendix 1).	Supply department	Ongoing
Regular monitoring of facilities will be carried out on a monthly basis. Records of all inspections are to be maintained.	Environmental officer	monthly
Auditing will be carried out on an annual basis. Records of all audits are maintained in the register.	Environmental officer	annually
All hydrocarbon containers will be stored in bunded areas compliant with licence conditions, Regulations, and relevant Standards.	Area managers	Ongoing
All 200 L drums will be stored in either: • A compacted earthen floor and plastic lined bund with a spillage capacity of at least 20% of the total hydrocarbons stored in the bund, • A concrete floor and bund with a spill holding capacity of 20% of the total hydrocarbons stored in the bund. • On self contained spill pallets	Area managers	Ongoing
All 200 L drums stored vertically will be held individually or by groups on self contained spill pallets.	Area managers	Ongoing
All 200 L drums stored horizontally will be located on suitable holding tables over a steel or plastic drip tray under each row of outlet (supply) valves, with a capacity of 220 L.	Area managers	Ongoing
Handling		
Wherever possible, hydrocarbons and chemicals will be purchased in re-useable or returnable bulk containers.	Supply department	Ongoing

Action	Who	When
Wherever possible, all oils and greases used in plant maintenance and servicing at workshops will have drip trays located under outlets.	Maintenance supervisor	Ongoing
Transfer points to or from bulk containers or permanent refuelling stations will be provided with a bunded concrete apron with collection of drainage discharging to a triple oil interceptor tank.	Project engineer	Ongoing
If a spill of hydrocarbons occurs, the spill response procedure is to be followed (Appendix 2). The incident is to be reported as required in the procedure.	All personnel	Ongoing
When waste oils are collected from servicing of equipment or machinery, they should be transferred immediately to a waste oil collection system in the relevant area.	Mechanic	Ongoing
Filters should be placed on a rack to drain before disposing	Mechanic	Ongoing
Conduct regular housekeeping inspections to determine when container drip trays require emptying and to ensure area is kept clean and tidy with no fire hazards.	Area managers	Ongoing

4. OUTCOMES AND PERFORMANCE

Table 3 provides targets and performance criteria to be used to track progress in achieving hydrocarbon and chemical management objectives.

Table 3: Performance Criteria

Objectives	Outcome	Performance Measure
To ensure no significant release of hydrocarbons and chemicals to the environment as a result of storage or handling incidents.	Integrity of hydrocarbon and chemical storage bunds and containment measures is maintained.	Any hydrocarbon spills remediated so that there is no residual impact from the spill.
To ensure storage and handling of fuels and chemicals at the site does not pose a threat to the environment.	Compliance with licence conditions, Regulations and Standards	Number of environmental incidents arising from non-compliance with statutory requirements
To ensure that any spill or incident associated with fuels and chemicals will be cleaned up quickly and effectively.	All hydrocarbon and chemical spills identified and remediated to the agreed standard in the Contaminated Sites Act 2003	Any hydrocarbon or chemical spill is categorised as per the spill procedure (in the EMS) and actioned accordingly within 24 hours
To monitor the effectiveness of this hydrocarbon and chemical management procedure.	Annual review of this procedure	Audit / review record on the effectiveness of this procedure.

5. MONITORING AND AUDITING

Contractors will conduct monthly inspections of their work areas, which includes hydrocarbon facilities. Results of inspections are supplied to the site environmental officer.

The site environmental officer will conduct quarterly audits of the site to assess compliance with this procedure. The audit will record:

- Number of spill incidents reported.

- Number of workplace inspections undertaken.

6. CORRECTIVE ACTIONS

In the event that non compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedance. The process used on site to record, track and resolve non compliances is the Hazard/Incident form.

The annual environmental report (AER) will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with hydrocarbons and chemicals.

7. RECORDS AND REPORTING

Reporting to regulatory agencies on compliance with this plan is undertaken through the Annual Environmental Report (AER) process.

APPENDICES

APPENDIX 1:
HAZARDOUS MATERIALS REGISTER

Hazardous Materials Register

Date	Product	Hazchem class	Location	Location Map Ref	Storage Volume	Storage Method	Disposal Method

APPENDIX 2:
SPILL PROCEDURE

Spill Procedure

Purpose

This procedure details steps to be taken to contain and clean up spills of hydrocarbons and other liquid and solid hazardous chemicals on site.

Safety

- All products and hazardous substances used and stored on site are to have their Material Safety Data Sheets (MSDS) included in the site's Hazardous Materials Register.
- Spill clean up actions are to follow relevant MSDS requirements for PPE and other safety precautions.

Action sequence

Spills of hazardous substances are to be treated using the following action sequence:

1. Isolate the spill area.
2. Identify the spilt substance.
3. Identify hazards and PPE requirements.
4. If safe to do so, the source of the spill should be restricted or stopped (eg; if a valve is open, close it).
5. Contain spill – to reduce the area of impact and prevent flow to other areas.
6. Collect spilt material (if possible).
7. Dispose of collected material in the appropriate manner.
8. Report the spill – either through the Incident report form.
9. Remediate residual contamination in spilt area.

Actions

- **Small hydrocarbon spills** to soil in uncontained (unbunded) areas (< 20 litres or < $2m^2$ in area) are to be remediated in situ by scarifying the surface soil, applying bioremediation additives and lightly watering.
- **Large hydrocarbon spills** to soil in uncontained (unbunded) areas (> 20 litres or > $2m^2$ in area) are to be excavated and contaminated material taken to the site's bioremediation facility for treatment.
- **Large spills that cannot be excavated for some reason** (eg; buried pipelines/powerlines) are to be recorded on the site's environmental constraints map as a contaminated site, to be investigated and remediated during mine closure works.
- Spills of solid hazardous substances are to be immediately collected using spades / brooms. Collected material that is uncontaminated can be repackaged for use.
- Dispose of contaminated material in the appropriate manner – as described in the MSDS or hazardous materials register.
- Remediate any residual contaminated area in the appropriate manner – as described in the MSDS or hazardous materials register.

Techniques to collect spilled hydrocarbons

- On advice of the environmental officer or the safety coordinator, pump remaining liquids into a container for transfer to the waste oil tank for recycling.
- Use absorbent materials to soak up residual hydrocarbons.
- Use earthmoving equipment to excavate contaminated soil for treatment as directed by the environmental officer.
- Hydrocarbons contained in concrete bunds are to be transferred to the waste oil tank for recycling.
- If the spill has contaminated a water body, use mini booms to contain the spread of hydrocarbon on the surface of the water. Use a skimmer to collect contained hydrocarbon and pump to a waste oil tank or other safe container
- Hydrocarbon absorbents are to be collected and disposed of as advised by the environmental officer.

Technique to treat hydrocarbon contaminated soil

The most common technique for bioremediation is to thinly spread the contaminated soil and broadcast ammonium nitrate fertiliser over the soil at a rate not exceeding 100 kg/ha. The surface is scarified to mix in the fertiliser and regularly watered with potable quality water. Additional fertiliser and tilling applications may be required. Bioremediated soil is sampled to test for residual hydrocarbons. Once levels fall below specified threshold levels, the soil can be reused.

Reporting

- Large hydrocarbon spills are to be reported as an environmental incident using the Hazard/Incident form.
- Any non-compliance with this procedure is to be reported to the AMPL Supervisor within 24-hours of the incident occurring.

Appendix G. Vegetation Management Procedure

VEGETATION PROCEDURE

MAY 2019

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APPENDICES

1. INTRODUCTION

This vegetation procedure has been prepared to reduce potential impacts to vegetation and flora in operational areas of the Abra base metals project. It is a requirement that the actions contained in this procedure are complied with at all times by site personnel.

Clearing controls are important for the following reasons:

1. **Reduce vegetation clearing** to as small as necessary to undertake site activities. This minimises disturbance to surrounding vegetation and also reduces the area subsequently requiring rehabilitation.
2. **Manage topsoil** removal, stockpiling and return operations. Topsoil is a critical factor in achieving successful rehabilitation of disturbed areas, as it contains the majority of seeds, soil micro-organisms, organic matter and nutrients.
3. **Support rehabilitation** programmes over completed areas.

1.1 OBJECTIVES

The objectives of clearing are:

1. Minimise vegetation clearing and disturbance in the project area.
2. Protect vegetation and flora of conservation significance.
3. Maximise benefit and use from cleared areas.
4. Conserve available topsoil for use in rehabilitation.

Procedures:

- Vegetation clearing Appendix 1

Forms and checklists:

- AMPL clearing permit Appendix 2
- Vehicle inspection Appendix 3

2. POTENTIAL IMPACTS

It is acknowledged that some flora and vegetation will be disturbed as a result of mining operations. Potential impacts to vegetation can include:

- Direct loss or degradation of conservation significant flora and vegetation;
- Indirect impacts on adjacent vegetation from dust.
- Soil erosion off cleared areas;
- Disruption of natural water courses and flow paths

AMPL is committed to minimising areas of vegetation disturbance through:

- Staged approach to activities, therefore only clearing areas as necessary.
- Internal clearing permits are required prior to vegetation disturbance.
- Clearing activity will maximise salvage and retention of topsoil and cleared vegetation.

- Restrict personnel and vehicles outside designated areas.
- Use existing tracks and disturbed areas where possible.

3. MANAGEMENT ACTIONS

Actions to be undertaken to manage vegetation and flora are outlined in **Table 1**.

Table 1: Management actions

Action	Who	When
Induction and training		
All personnel will be inducted on the significance of vegetation and flora in the project area and management actions established to reduce impacts.	All personnel	Commencement on site
Clearing activities		
Submit an internal clearing permit (Appendix 2) prior to conducting clearing.	All personnel	Prior to clearing
Comply with the clearing procedure (Appendix 1) and any permit conditions.	All personnel	During clearing
Clearing permits are to conform to approved clearing areas, in CPS clearing permits.	Environmental officer	Ongoing
Communications		
An environmental constraints map will be located on notice boards through the site. The map will show environmentally sensitive areas, with associated buffers if required, which are to be avoided.	Environmental officer	Ongoing
Monitoring		
Undertake vegetation monitoring contained in respective management plans and procedures	Environmental officer	Ongoing

4. OUTCOMES AND PERFORMANCE MEASURES

Table 2 provides targets and performance measures to be used to track progress in achieving the flora management objectives.

Table 2: Outcomes and Performance Measures

Objectives	Outcomes	Performance Measure
Minimise vegetation clearing and disturbance in the project area.	All site activities are undertaken within approved project disturbance boundaries.	Extent of site clearing is within approved limit and boundaries and recorded within 3 months of clearing
Conserve available topsoil for use in rehabilitation.	Topsoil salvaged and stored for use in rehabilitation	Survey quantity (m^3) of stockpiled topsoil within 3 months of construction
Monitor the effectiveness of commitments, procedures and controls.	No environmental incidents of unplanned clearing	Number of incidents of unplanned clearing recorded
Review outcomes to ensure management measures remain relevant to the operation.	Annual review of plans, procedures, forms, incidents.	Review confirms listed objectives are being met.

5. MONITORING AND AUDITING

The site environmental officer will conduct quarterly audits of the site to assess compliance with this plan. This will involve:

- Reconciliation that areas approved for clearing conform to surveyed boundaries of cleared areas.
- Inspection and photograph that topsoil and vegetation stockpiles conform to approved locations and design.
- Inspect and photograph that pre-clearing drainage paths are maintained or re-instated.

6. CORRECTIVE ACTIONS

In the event that non compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedance. The process used on site to record, track and resolve non compliances is the Hazard / Incident form. **Table 3** details corrective actions that will be implemented for identified non compliances.

Table 3: Corrective actions

Subject	Issue	Actions
Vegetation clearing / disturbance and Priority Flora.	Clearing native vegetation outside designated area.	Fill out the environmental incident report form. Report the unplanned area of disturbance to DMIRS. Reinstate fencing, barriers or flagging to delineate clearing boundaries. Place removed vegetation in over-cleared area to provide erosion control and seed stock. Include area in annual rehabilitation program.
Clearing	Fire	Follow fire management procedures. Fill out the environmental incident report form. Report the fire to DMIRS as soon as practically possible.
Altered drainage patterns.	High sediment runoff, erosion and decline in the health of vegetation in affected area	Implement corrective drainage measures. Include area of disturbance into annual rehabilitation program. Report area of impact as per vegetation disturbance.

7. RECORDS AND REPORTING

Reporting to regulatory agencies on compliance with this plan, including components such as areas cleared and environmental incidents is undertaken through the Annual Environmental Report (AER) process.

APPENDICES

APPENDIX 1:
CLEARING PROCEDURE

Vegetation Clearing Procedure

Purpose

This procedure provides generic information to be implemented during clearing activities. For other information relating to vegetation clearing, refer to the clearing procedure and clearing permit conditions.

Risks

The key risks for unplanned disturbance of native vegetation are:

- Insufficient planning to avoid environmentally significant areas.
- Failure to identify and communicate access tracks, gridlines, work area and exclusion zones.
- Insufficient planning to avoid indirect impacts by such things as changing drainage patterns.

Procedure

To ensure vegetation clearing is conducted in a responsible manner and to avoid unacceptable environmental impacts, the following procedure must be followed both during the planning of clearing and during clearing activities. This is outlined below.

Prior to Clearing

- Prior to undertaking clearing activities the AMPL clearing permit form **must be completed**.
- All personnel are to be inducted on the importance of minimising clearing and disturbance.
- Persons undertaking clearing activity and the AMPL supervisor will walk the area to verify the area to be cleared and any exclusion zones to be avoided.
- Exclusion areas are to be flagged in the field prior to any clearing.
- Salvage of seed, timber etc is to be scheduled. These activities are to be confined to the clearing area.
- No clearing is to commence until personnel implementing the clearing have been provided with a map (drawings) that indicate:
  - Designated locations to be avoided, which may include;
    - Declared Rare Flora or Priority species and any associated buffer.
    - Significant fauna habitats and any associated buffer.
    - The location of heritage sites.
    - Any other identified feature.
  - The location of access tracks.
  - The extent of the clearing area.

During Clearing

- All clearing will be supervised by the relevant site supervisor.
- Cleared vegetation is to be stockpiled adjacent to the area it was cleared from for use during rehabilitation.
- Topsoil removal (where required), will be removed to a depth of approximately 100 mm and stored immediately adjacent to the area where it was cleared and separate to any subsoil or vegetation stockpiles.
- All vegetation and topsoils stockpiles will be positioned away from any watercourses and drainage paths. Stockpiles are to be no higher than 2 m.
- Vehicles and machinery will only use designated roads, tracks and gridlines. Off-road traversing into bush areas is prohibited.
- No burning of cleared vegetation is permitted.

Rehabilitation

- Rehabilitation is to follow procedures outlined in the rehabilitation plan.

Monitoring

The AMPL Representative / supervisor will monitor the clearing activities to ensure compliance with requirements.

Reporting

- If unauthorised clearing occurs, the incident must be reported to the AMPL Environmental Officer within 24-hours of the incident occurring using the Hazard / Incident report form.

APPENDIX 2:
INTERNAL CLEARING PERMIT

Internal Clearing Permit

No: _____

Procedure Actions:

1. This Clearing Permit relates to vegetation clearing within the area shown on Attachment 1 (map to be provided).
2. Strictly no clearing is to occur outside the area shown on Attachment 1.
3. Applicant to complete Application section, sign in Signoff section and submit to site Environmental Officer.
4. Environmental Officer to complete Conditions section, sign in Signoff section and return to applicant.
5. No clearing is to commence until Signoff section has been completed by all parties.
6. A copy of the completed Form and Attachment 1 is to be filed by the Environmental officer for annual reporting purposes.

Application - (applicant to complete this section)

Requested by (print name):
_____Company/Dep't:_____
Clearing contractor: _____
Reason for clearing:

_____

_____

_____

_____

Area to be cleared: _____ha
Clearing location (give coordinates):_____
Topsoil stockpile location (give coordinates): _____
Proposed duration(date): Commence: _____ Complete: _____

Map submitted:	Yes	No
Is a Dig Permit required?	Yes	No
Is Aboriginal heritage clearance required?	Yes	No
Has Clearing procedure been complied with?	Yes	No

Conditions - (AMPL Environmental Officer to complete)

Vegetation clearing conditions: Clearly mark the area to be cleared.
Clear and stockpile vegetation in designated area.

Topsoil stockpiling conditions: Remove topsoil (top 100 mm where available) and stockpile in designated area.
Topsoil stockpiles maximum 2 m high.

Drainage design conditions: Protect stockpiles from surface runoff and flooding.

Special conditions:

_____

_____

_____

Signoff (all parties to complete this section)

Applicant:	Name	Signature	Date:
Supervisor:	Name	Signature	Date:
Environmental Officer:	Name	Signature	Date:

APPENDIX 3:
VEHICLE INSPECTION CHECKLIST

VEHICLE INSPECTION CHECKLIST

It is important that earthmoving machinery is in an acceptable condition before it enters site working areas in relation to safety, weeds, hydrocarbons, emissions and noise.

This certificate must be completed in the presence of the machine Supervisor.

Date of arrival/inspection:	
Name of machinery Supervisor:	
Name of person conducting inspection:	
What kind of machine is it?	
Where was the last site the machine worked	
Please list any problem weeds at the last site.	

Was the machine cleaned before it left the last site?	Yes ☐ No ☐
Are buckets, tracks, blades etc free of soil and vegetation?	Yes ☐ No ☐
Are the tyres free of seeds?	Yes ☐ No ☐
Is machine free of fuel and oil leaks?	Yes ☐ No ☐
Is the exhaust/muffler in good working order?	Yes ☐ No ☐

Work required/comments:	

If you have answered NO to any of these questions, please carry put the required cleaning and/or maintenance before the machine enters the site. This form must be signed by the machine Supervisor and Site Supervisor when all cleaning and/or maintenance is completed.

	Print name	**Signature**		
Machine Supervisor			Date	
Site Supervisor			Date	

Vehicle Wash down Procedure

- Wash down machine in designated wash down bay.
- Remove all soil and vegetation including seeds.
- Ensure runoff, soil and any seeds are contained on the hardstand or directed to the sediment basin.
- Carry out final inspection with site personnel before moving into site

APPENDIX 4:
WEED CHECKLIST

SITE WEED INSPECTION CHECKLIST

Name of Inspector (Print): _____ Date: _____

Weather Conditions Prior to Inspection: _____

Weed Inspection Areas	Weds Present (Yes/No)	Actions Taken
Village		
Village recreation areas		
Sewage irrigation area		
Mine workshop		
Production bore surrounds		
Storage areas		
Workshop area		
Landfill area		
Wash down bay		
Lay down areas		
Office buildings		
Haul roads and access tracks		
ROM stockpile areas		
WRD		
Other		

Eradication	Record
Weed Species	
Probable cause of occurrence	
Area (m2)	
Location	
Photo or sample of weed attached	
Eradication method	
Name (print) **Signature** **Date**	
Post Eradication	**Follow up Actions**
Weed Species	
New weed population (y/n)	
New growth (y/n)	
Follow up of eradication	
Evidence of weed death (photo)	
Name (print) **Signature** **Date**	

Appendix H. Waste Management Procedure

WASTE MANAGEMENT PROCEDURE

MAY 2019

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1. INTRODUCTION

This waste management procedure has been prepared to reduce potential contamination of soil, water and areas surrounding the Abra base metals project. It is a requirement that the actions contained in this procedure are complied with at all times by site personnel. Waste management is important for the following reasons:

1. **Mine waste rock and rubbish** has potential to adversely affect the environment of the project area and its surrounds
2. **Liquid waste** has the potential to contaminate surrounding soil and water.
3. **Hazardous waste** includes hydrocarbon waste and other chemicals which have potential to contaminate surrounding soil and water.
4. **Prompt spill cleanup** limits the area immediately contaminated and the possibility of extended impact from contaminant transport off site.
5. **Recycling** reduces the amount of waste needed to be disposed on site and provides energy and material savings from the products reuse.

1.1 ENVIRONMENTAL OBJECTIVES

The overall waste management objective is to minimise waste where practicable, using the sequence of avoid, reuse, reduce, recycle, treat, dispose. More specific objectives include:

- Dispose of waste in an acceptable manner.
- Reuse / recycle materials where practicable
- Minimise the risk of spillage of hazardous materials.

1.2 LEGISLATION

Regulatory requirements applicable to the project site include but are not limited to the following:

- Australian Standard (AS) 1940:2017 The Storage and Handling of Flammable and Combustible Liquids.
- Contaminated Sites Act 2003.
- Dangerous Good Safety Act 2004
- Dangerous Goods Safety (Explosives) Regulations 2007
- Dangerous Goods Safety (General) Regulations 2007
- Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007
- Department of Water and Environmental Regulation – Assessment and Management of Contaminated Sites (2014)
- Environmental Protection Act 1986.
- Environmental Protection (Controlled Wastes) Regulations 2004.
- Environmental Protection (Rural Landfill) Regulations 2002;
- Health (Miscellaneous Provisions) Act 1911
- Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste Regulations) 1974;
- Water Quality Protection Note 10 – Containment spills emergency response.
- Water Quality Protection Note 65 – Toxic and hazardous substances (storage and use).

2. POTENTIAL IMPACTS

The key potential impact from inappropriate disposal or accidental release of hazardous materials is contamination of surrounding soil and water.

3. MANAGEMENT ACTIONS

Actions to be undertaken to manage fauna are outlined in **Table 1**.

Table 1: Management actions

Action	Who	When
Induction and training		
All personnel will be inducted on the significance of appropriate waste management in the project area. The induction to include information on: • Procedures for handling and storing fuels and chemicals. • Refuelling vehicles and machinery. • Waste disposal. • Spill clean-up procedure. • Location of the hazardous materials register.	All personnel	Commencement on site
Mine waste		
Mine waste is stored managed so minimise impact to the surrounding environment	Mine manager	Ongoing
Waste collection and disposal		
Obtain appropriate licenses and permits for on-site waste disposal.	Environmental officer	Commencement on site
Provide appropriate waste collection, treatment and disposal facilities (e.g. bins, waste oil tank, sewage treatment plant, landfill, recycling facility).	Environmental officer, project engineer	Ongoing
Collect and empty waste disposal facilities regularly.	Camp coordinator, Project engineer	Ongoing
Putrescible and industrial waste will be collected and disposed to an onsite landfill. The landfill will be managed in accordance with the *Environmental Protection (Rural Landfill) Regulations 2002*.	Environmental officer	Ongoing
The landfill site is to be designed as follows: • Landfill trench created in the landfill site • Tipping face no greater than 30 m. • Tipping face covered on a weekly basis. • Safe access to the tipping face maintained.	Environmental officer, project engineer	Ongoing
Provide a recycling area for storage of recyclable materials, for collection and transport to a recycling facility off site. Recyclable materials include: • Heavy grade metal- located in a stockpile. • Batteries- on pallets in a bunded area; • Waste oil- in a bulk storage tank	Environmental officer	Ongoing
Wastewater		
Sewage and grey water from the accommodation village will be treated in a package treatment plant. Treated wastewater will be pumped to an irrigated field or evaporation lagoons. Sewage from the mine offices and workshops will be treated in Biocycle units / septic tanks-leach drains or similar	Project engineer	Commencement on site
Hazardous materials		
Hazardous materials will be clearly labelled and will be handled, stored and disposed in accordance with the Material	Purchasing officer, safety manager	Ongoing

Action	Who	When
Safety Data Sheet (MSDS). MSDS sheets will be stored on site and available to all personnel.		
Wash down bay waste		
Soil not contaminated with hydrocarbons above levels which require bioremediation are to be disposed in the site landfill	Area manager	Ongoing
Contaminated soil will be disposed to a licensed facility off site, or bio remediated on site.	Area manager & environmental officer	Ongoing
Waste oil from the plate separator will be added to the waste oil tank for collection by a licensed contractor.	Area manager	Ongoing
Spills and contamination		
Spills of hydrocarbons, other liquid wastes and hazardous chemicals are to be cleaned up according to the spill procedure (Appendix 1).	All personnel	Ongoing
Spill kits and shovels will be available for spillages. Spent spill kits will be handled as hazardous waste.	All personnel	Ongoing
The incident report form will be used to record any spills of hydrocarbons or chemicals > 20 litres.	All personnel	Ongoing
Hydrocarbons		
Flammable and combustible liquids will be stored to requirements of Australian Standard AS 1940 – 2004.	Project engineer	Commencement on site
Equipment will be refuelled on bunded pads in designated locations. Tracked vehicles and stationary plant (gensets etc) will be refuelled in the field by field service vehicles.	mine supervisor	Ongoing
Design		
Design workshop and washdown bay to be internally draining and routed through oil-water separators.	Construction manager	Prior to construction
Use self-bunded storage vessels and pallets where possible	Project engineer	Ongoing
Water collected in bunded facilities to be treated through an oil-water separator.	Project engineer	Ongoing

4. OUTCOMES AND PERFORMANCE

Table 2 provides targets and performance criteria to be used to track progress in achieving waste management objectives.

Table 2: Performance Criteria

Objectives	Outcomes	Performance Measure
Reuse / recycle materials where practicable.	Maximise quantity of material reused/recycled.	Register of reused / recycled materials recording quantities of materials
Dispose of waste in an acceptable manner.	All waste disposed in an acceptable manner	Annual report on landfill management including the number of waste management incidents.
	No off-site pollution from mine landforms	Surface soil Pb levels within 500 metres of the tenement boundary below NEPM[1] added contaminant limits (ACL) for commercial/ industrial use.
	Landform stability is appropriate for the stage of mine life.	No impacts to vegetation outside the mine disturbance boundary from unstable mine landforms.
Minimise risk of spillage of hazardous materials.	All spills are categorised as per the spill procedure and actioned accordingly within 24 hours	Number of incident reports.

1. NEPM (1999). Schedule B1 – Table 1(B)4

5. MONITORING AND AUDITING

The site environmental officer will conduct an annual waste audit of the site, to assess compliance with this plan. The audit will record:

- Quantity of material reused or recycled.
- Report on landfill management.
- Report on bioremediation facility management (if active)
- Number of waste incidents from the Hazard/Incident form.

6. CORRECTIVE ACTIONS

In the event that non compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedance. The process used on site to record, track and resolve non compliances is the Hazard/Incident form.

The annual environmental report (AER) will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with fauna.

7. RECORDS AND REPORTING

The following records will be maintained on site:

- A hazardous materials register which details all hazardous goods brought to site, usage and remaining inventories. The relevant MSDS will be available for all hazardous goods.
- Where applicable, the collection of hazardous waste will comply with the *Environmental Protection (Controlled Wastes) Regulations 2004*. Where controlled waste tracking forms are required, the customer's copy is to be retained onsite.

Reporting to regulatory agencies on compliance with this plan is undertaken through the Annual Environmental Report (AER) process.

APPENDICES

APPENDIX 1:
SPILL CLEAN-UP PROCEDURE

Spill Procedure

Purpose

This procedure details steps to be taken to contain and clean up spills of hydrocarbons and other liquid and solid hazardous chemicals on site.

Safety

- All products and hazardous substances used and stored on site are to have their Material Safety Data Sheets (MSDS) included in the site's Hazardous Materials Register.
- Spill clean up actions are to follow relevant MSDS requirements for PPE and other safety precautions.

Action sequence

Spills of hazardous substances are to be treated using the following action sequence:

1. Isolate the spill area.
2. Identify the spilt substance.
3. Identify hazards and PPE requirements.
4. If safe to do so, the source of the spill should be restricted or stopped (eg; if a valve is open, close it).
5. Contain spill – to reduce the area of impact and prevent flow to other areas.
6. Collect spilt material (if possible).
7. Dispose of collected material in the appropriate manner.
8. Report the spill – either through the Incident report form.
9. Remediate residual contamination in spilt area.

Actions

- Small hydrocarbon spills to soil in uncontained (unbunded) areas (< 20 litres or < 2m^2 in area) are to be remediated in situ by scarifying the surface soil, applying bioremediation additives and lightly watering.
- Large hydrocarbon spills to soil in uncontained (unbunded) areas (> 20 litres or > 2m^2 in area) are to be excavated and contaminated material taken to the site's bioremediation facility for treatment.
- Large spill areas that cannot be excavated for some reason (eg; buried pipelines/powerlines) are to be recorded on the site's environmental constraints map as a contaminated site, to be investigated and remediated during mine closure works.
- Spills of solid hazardous substances are to be immediately collected using spades / brooms. Collected material that is uncontaminated can be repackaged for use.
- Dispose of contaminated material in the appropriate manner – as described in the MSDS or hazardous materials register.
- Remediate any residual contaminated area in the appropriate manner – as described in the MSDS or hazardous materials register.

Techniques to collect spilled hydrocarbons

- On advice of the environmental officer or the safety coordinator, pump remaining liquids into a container for transfer to the waste oil tank for recycling.
- Use absorbent materials to soak up residual hydrocarbons.
- Use earthmoving equipment to excavate contaminated soil for treatment as directed by the environmental officer.
- Hydrocarbons contained in concrete bunds are to be transferred to the waste oil tank for recycling.
- If the spill has contaminated a water body, use mini booms to contain the spread of hydrocarbon on the surface of the water. Use a skimmer to collect contained hydrocarbon and pump to a waste oil tank or other safe container
- Hydrocarbon absorbents are to be collected and disposed of as advised by the environmental officer.

Technique to treat hydrocarbon contaminated soil

The most common technique for bioremediation is to thinly spread the contaminated soil and broadcast ammonium nitrate fertiliser over the soil at a rate not exceeding 100 kg/ha. The surface is scarified to mix in the fertiliser and regularly watered with potable quality water. Additional fertiliser and tilling applications may be required. Bioremediated soil is sampled to test for residual hydrocarbons. Once levels fall below specified threshold levels, the soil can be reused.

Reporting

- Hydrocarbon spills to soil in uncontained (unbunded) areas > 20 litres or > 2m^2 in area are to be reported as an environmental incident using the Hazard/Incident form.
- Any non-compliance with this procedure is to be reported to the AMPL Supervisor within 24-hours of the incident occurring.

Appendix I. Water Monitoring Procedure

WATER MONITORING PROCEDURE

MAY 2019

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1. INTRODUCTION

A series of groundwater monitoring bores and surface water monitoring locations are situated around the Abra base metals project site. Regular monitoring of water levels and quality is conducted to determine the impacts of mining on the local ground and surface water systems.

Monitoring of surface water is conducted opportunistically, as local drainage lines only flow for short periods after rainfall.

1.1 OBJECTIVES

The objectives for water monitoring are:

- Assess environmental effects of activities by regular monitoring and review of performance.
- Comply with licence conditions.

1.2 LEGISLATION AND STANDARDS

Table 1 lists relevant legislation and standards relevant to water monitoring.

Table 1: Legislation and standards

Reference	Relevance	Regulatory Authority
AS NZS:5667.1.1998.	Water quality – Sampling Guidance on sampling of groundwaters. Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.	-
Rights in Water and Irrigation Act 1914.	Licensing of groundwater abstraction	DWER
Water Quality Protection Guidelines No 11.	Mining and Mineral Processing: Mine dewatering. Guidelines on mine dewatering	DWER
Water Quality Protection Notes.	Guidelines on protection of ground and surface waters.	DWER

2. POTENTIAL IMPACTS

It is anticipated that, due to the relatively localised nature of site activities, impacts to water will also be localised.

Potential impacts to water include:

- Groundwater level drawdown beyond modelled extent.
- Vegetation loss through groundwater level drawdown.
- Contamination of groundwater or surface water.

3. MANAGEMENT ACTIONS

Monitoring is to be undertaken according to DWER licence conditions. There must be no disturbance to the monitor bore (such as bailing or pumping) one week prior to water level measurement. Actions to be undertaken for water monitoring are outlined in **Table 2**.

Table 2: Management actions

Action	Who	When
Meter readings		
Reading of water meters is required to determine water production and usage on site.	Environmental officer	monthly

Action	Who	When
Site plan showing location of bores and of meter locations is attached as Appendix 1	Environmental officer	
Meter readings taken in the field are to be recorded in the water production spreadsheet.	Environmental officer	monthly
Water levels		
Check that the water level probe is operational.	Environmental officer	monthly
Lower the probe into the bore until contact with the water is confirmed by both the audible beep and/or visual red light.	Environmental officer	
Read the depth level to the top of casing (TOC) to within the nearest centimetre. Use of previous monitoring data will help to estimate the point of contact.	Environmental officer	
Ensure the 'stick-up' distance – the height of the TOC above ground level, is recorded for the bore. This allows measured results to be calibrated to ground levels.	Environmental officer	
Note should be made if the bore is dry.	Environmental officer	
Groundwater (bore) samples		
Purge bores according to AS/NZS:5667.1.1998.	Environmental officer	quarterly
Take sample with bailer. Rinse bailer with RO water between samples	Environmental officer	
Place sample in plastic container and record Electrical Conductivity and pH.	Environmental officer	
Ensure that the bore cap is replaced.	Environmental officer	
Send samples to external laboratory for analysis.	Environmental officer	
On receipt of data from laboratory, enter data into the water production spreadsheet.	Environmental officer	
Surface water monitoring		
Opportunistic monitoring is required to be carried out at the established surface water monitoring sites whenever surface water flows occur (to a maximum of 2 per quarter).	Environmental officer	Surface water flow
Sampling is to be undertaken in accordance with AS/NZS:5667.1.1998.	Environmental officer	
Electrical conductivity and pH is to be monitored according to the steps set out under the bore water monitoring section.	Environmental officer	
Laboratory analysis to be conducted the same as groundwater samples.	Environmental officer	
On receipt of data from laboratory, enter data into the water production spreadsheet.	Environmental officer	
Potable water monitoring		
Take samples from a range of potable supply outlets (taps) and analyse for microbial content	Environmental officer	monthly

4. OUTCOMES AND PERFORMANCE

Table 3 provides targets and performance measures to be used to track progress in achieving water monitoring objectives.

Table 3: Performance Criteria

Objectives	Outcome	Performance Measure
Comply with all licence conditions.	Comply with all licence / permit water monitoring requirements.	All licence requirements met.
Assess environmental effects of activities by regular monitoring and review of performance.	Groundwater level and quality beyond the tenement boundary is maintained within the range of background levels	Groundwater level change less than 2 metres (accounting for natural variance) five years after mine closure when measured at monitoring bores established within 500 metres downstream from the tenement boundary

5. REVIEW

The site environmental officer will conduct quarterly reviews, to assess compliance with this plan. This will involve recording:

- Water abstraction against licence limit.
- Water quality parameters against licence limits.
- Commentary on important findings and notes.

6. CORRECTIVE ACTIONS

In the event that non compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedance. The process used on site to record, track and resolve non-compliance is the Hazard/Incident form.

The annual environmental report (AER) will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with water monitoring.

7. RECORDS AND REPORTING

Reporting to regulatory agencies on compliance with this plan is undertaken through the Annual Environmental Report (AER) and annual aquifer review process.

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APPENDIX 1:
WATER MONITORING LOCATIONS

Insert site map

Appendix J. Fauna Management Procedure

FAUNA MANAGEMENT PROCEDURE

MAY 2019

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1. INTRODUCTION

This fauna management procedure has been prepared to reduce potential impacts to fauna in operational areas of the Abra base metals project. It is a requirement that the actions contained in this procedure are complied with at all times by site personnel.

Fauna management is important for the following reasons:

1. **Minimise direct impact** by removing habitat (via vegetation clearing) and collisions with vehicles.
2. **Reduce indirect impact** by minimising barriers to movement, and control of feral predators.

1.1 ENVIRONMENTAL OBJECTIVES AND STANDARDS

The objectives for fauna management are:

- Minimise potential impacts of site activities on fauna species.
- Minimise potential impacts to species of conservation significance (including terrestrial and subterranean fauna).

1.2 LEGISLATION

Fauna protection is subject to legislation at both the state and federal level. Table 1 lists relevant legislation, its relevance and regulatory authority.

Table 1: Legislation

Legislation	Relevance	Regulatory Authority
Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)	Protection on environmental matters of national significance	Department of Environment, Heritage, Water and the Arts (DEHWA)
Conservation and Land Management Act 1984 (WA)	Protection and management of nature reserves, state forest, marine parks etc.	DBCA
Environmental Protection Act 1986 (WA)	Prevention, control and abatement of pollution and conservation protection and enhancement of environment	DBCA
Wildlife Conservation Act 1950 (WA)	Provides for the conservation and protection of wildlife (flora and fauna). Special provisions and schedules cover protection and management of gazetted rare flora and fauna.	DBCA

1.3 OTHER RELEVANT INFORMATION

The following list of other documents is also applicable to fauna management.

- Off road driving procedure Appendix 1
- Fauna Mortality Register Appendix 2

2. POTENTIAL IMPACTS

It is acknowledged that some fauna will be disturbed as a result of site activities. It is anticipated that, due to the relatively localised nature of site activities, impacts to fauna will also be localised. Potential impacts to fauna include:

- Habitat loss through clearing, mining (excavation) and vegetation degradation
- Direct impact on fauna.
- Indirect impacts such as barriers to movement, groundwater changes, and feral predators.

3. MANAGEMENT ACTIONS

Actions to be undertaken to manage fauna are outlined in Table 2.

Table 2: Management actions

Action	Who	When
Induction and training		
All personnel will be inducted on the significance of fauna in the project area and management actions established to reduce impacts.	All personnel	Commencement on site
Obtain appropriate training and licenses for fauna handling.	Environmental officer (EO)	Ongoing
Project actions		
Ensure barriers to native fauna movement are kept to a minimum.	EO, project engineer	Ongoing
Minimise time trenches are left open. If necessary for a trench to remain open for longer than 24 hours, install escape ramps at regular intervals along the trench;	Project engineer	At construction
For trenches open for longer than 24 hours, check them within 2 hours of sunrise and remove trapped fauna. Record number and type of relocated fauna (Appendix 2).	EO	Ongoing
Comply with speed limits on site (Appendix 1).	All personnel	Ongoing
Install fauna egress matting in lined dams/ponds	EO	At onstruction
Fence aerodrome to exclude stock	EPC contractor	At construction
Spotter vehicle to drive the airstrip prior to plane landing	EO	As required
Do not feed fauna.	All personnel	Ongoing
Communications		
A site environmental map will be located on notice boards through the site. The map will show environmentally sensitive areas, with associated buffers if required, which are to be avoided.	EO	Ongoing

4. TARGETS AND PERFORMANCE

Table 3 provides targets and performance criteria to be used to track progress in achieving fauna management objectives.

Table 3: Performance Criteria

Objectives	Target	Performance
Minimise potential impacts of site activities on native fauna species.	No significant barriers for native fauna.	Number of fauna trapped in trenches.
	Minimise injury or mortality to fauna.	Number of fauna injured or killed

5. MONITORING AND AUDITING

The site environmental officer will conduct 6 monthly audits of the site to assess compliance with this plan. This will involve providing a brief report to the Environmental Manager summarizing data on:

- Record of fauna trapped in trenches.
- Record of injured or killed fauna.

6. CORRECTIVE ACTIONS

In the event that non compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedence. The process used on site to record, track and resolve non compliances is the Accident/Incident form.

The annual environmental report (AER) will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with fauna.

7. RECORDS AND REPORTING

Reporting to regulatory agencies on compliance with this plan is undertaken through the Annual Environmental Report (AER) process.

APPENDICES

APPENDIX 1:
OFF ROAD DRIVING PROCEDURE

Off-road driving procedure

Purpose

This procedure details the actions requird for responsible off road driving by all personnel on site.

Background

The project's environmental constraints map details exclusion zones to be avoided by vehicles during site activities.

Risks

Key risks to the project from inappropriate use of vehicles includes:

- Damage to vegetation, fauna habitat and drainage lines outside approved areas of disturbance.
- Damage to Aboriginal heritage sites.
- Introduction or spread of weeds.
- Increased likelihood of collision with fauna.

Procedure

The following procedure is required to be implemented by all project personnel:

Prior to driving on site

- All employees and contractors are required to participate in the site induction, which includes information on required driving practices.
- All employees and contractors are to complete a site driving competency test with their Supervisor before driving in active areas of the site.
- All vehicles must have effective communication (2 way radio and/or satellite phone) and operating instructions for their use.
- Undertake a pre-start vehicle check, complete the appropriate form and submit to the site supervisor.

During site activities

- Vehicles must not exceed designated speed limits on site.
- Vehicles must not leave designated project areas or access tracks without approval from the Abra Supervisor.
- Any native animal injury or death is to be reported immediately to the Abra Environmental Officer
- Any road kills are to be removed from the road, to avoid further mortality of scavenger species.
- Reduce speed during adverse road conditions, such as flooding and thick bush, to a speed suitable for the driving conditions.

Reporting

- Any non-compliance with this procedure is to be reported to the Abra Supervisor within 24-hours of the incident occurring using the Incident report form.
- Any native animal injury/death is to be reported immediately as an environmental incident to the Abra environmental officer.

APPENDIX 2:
FAUNA MORTALITY REGISTER

Fauna Mortality Register

Date	Common name	Number impacted	Brief incident description	Location
when	what	how many	how	where

Appendix K. Hot work permit

HOT WORK PERMIT

BEFORE INITIATING HOT WORK, CAN THIS JOB BE AVOIDED?
IS THERE A SAFER WAY?

This Hot Work Permit is required for any temporary operation involving open flames or sparks. This includes, but is not limited to: brazing, cutting, grinding, soldering, thawing pipes, torch-applied roofing, and welding.

Date:

Building:

Location:

Description of hot work:

Name of Hot Work Operator:

Is a Fire Watch required?

_____Yes

_____No

A Fire Watch should be posted if

- combustible materials within a 35-foot radius of hot work cannot be removed
- wall or floor openings within a 35-foot radius of hot work expose combustible materials in adjacent areas, including concealed spaces in walls or floors
- combustible materials are adjacent to the opposite side of partitions, walls, ceilings or roofs and are likely to be ignited
- It is deemed necessary by the Permit Authorizing Individual

Permit Checklist

___ Flammable and combustible materials within a 35-foot radius of hot work have been removed or covered with fire retardant tarps or metal shields.

___ All floors and surfaces within a 35-foot radius of the hot work area have been swept free of combustible dust or debris.

___ Any openings or cracks in the walls, floors, or ducts that are potential travel passages for sparks, heat and flames have been covered.

___ An operable fire extinguisher is nearby and accessible.

___ Sprinkler heads that could be activated by hot work have been covered with a wet rag.

___ Smoke detectors in the area of hot work have been covered to prevent false alarms.

___ A Fire Watch has been posted, if it is required, during hot work operations and for 30 minutes after work has been completed.

AUTHORIZATION: The information on this permit has been evaluated, the site has been examined and all safety measures are in place.

Signed: _____
Permit Authorizing Individual

Reviewed 2015

WARNING!

HOT WORK IN PROGRESS
WATCH FOR FIRE!

The permit valid until: _____

If you have questions about these hot work activities:

CALL: _____

AT: _____

_____

_____

WARNING!

Appendix F. TSF design reports

Land & Marine Geological Services Pty Ltd (L&MGSPL)

ABN 15 009 320 870

PO Box 777
COWARAMUP WA 6284
AUSTRALIA
Mobile +61(0)417 932 872
lmgspl@bigpond.com

29 October, 2018

Galena Mining Limited
Suite 5, 245 Churchill Avenue
SUBIACO WA 6008

by email: tflannery@galenamining.com.au

Dear Troy

RE: THIRD PARTY GEOTECHNICAL REVIEW OF ABRA BASE METALS PROJECT TAILINGS STORAGE FACILITY DESIGN

With reference to the Third (3rd) Party Geotechnical Review of the design for the Tailings Storage Facility (TSF) for the Abra Base Metals Project, approximately 200 km north of Meekatharra, Western Australia, please find attached the signed *'Declaration by 3rd party independent technical reviewer tailings storage facility design report'*.

The following activities have been completed over the period from 23 August 2018 to 26 October 2018 as part of this review of the proposed TSF for the Abra Base Metals Project:

i) Liaison with Galena Mining Limited (the project owner) and CMW Geosciences Pty Ltd (TSF designers) during the development of the design over the period from 23 August 2018 to 26 October 2018.

ii) A site visit, on 13 September 2018, to visually assess the site for the proposed TSF and view the potential construction materials.

iii) Review of the Design Report by CMW Geosciences Pty Ltd, dated 24 October 2018, reference PER2018-0128AE Rev 1, including the appendices to the Design Report.

We trust this document meets your requirements and thank you for the opportunity to be part of this work.

Yours faithfully
pp L&MGSPL

Christopher Lane
PRINCIPAL

Attachments 'Declaration by 3rd party independent technical reviewer tailings storage facility design report'

DECLARATION BY 3RD PARTY INDEPENDENT TECHNICAL REVIEWER

TAILINGS STORAGE FACILITY DESIGN REPORT

For and on behalf of Land & Marine Geological Services Pty Ltd, I, James Christopher Lane, being a qualified engineering/environmental geologist with over 33 years relevant experience in the field of tailings management, to verify tailings storage facility design and holding professional registration through the following organisations:

- Chartered Fellow of the Geological Society London, Registration No: 14006.
- Registered Professional Geoscientist, The Australian Institute of Geoscientists, Registration No: 10009.
- Chartered Member of the Australasian Institute of Mining and Metallurgy, Member No: 109219.
- Registered Professional Engineer Queensland Geotechnical (Mining), Registration No: 14006.

and being independent of the applicant, do hereby declare and confirm that I have reviewed the Design Report for Tailings Storage Facility, Abra Gold Project, approximately 200 km north of Meekatharra, Western Australia, dated 24 October 2018, reference PER2018-0128AE Rev 1 prepared by CMW Geosciences Pty Ltd.

I do hereby confirm that the Design Report has been reviewed for compliance with the Department of Mines, Industry, Regulation and Safety (DMIRS), formerly the Department of Mines and Petroleum (DMP) document titled *'Guide to the preparation of a design for tailings storage facilities (TSFs)'*. The information contained in the Design Report meets the design, operation and closure objectives stipulated in the Department of Mines, Industry, Regulation and Safety (DMIRS), formerly the Department of Mines and Petroleum document titled *'Code of Practice tailings storage facilities in Western Australia'*.

I acknowledge that:

- The Department of Mines, Industry, Regulation and Safety (DMIRS), formerly the Department of Mines and Petroleum, may rely on this declaration; and
- That the provisions of the Design, Construction Specifications and Operating Manuals for the Abra TSF (TSF Design Documents) must be strictly adhered to by the Owner and the storage must be constructed, operated, closed and rehabilitated strictly in accordance with the provisions of the TSF Design Documents. Land & Marine Geological Services Pty Ltd shall not be liable in any respect whatsoever for any damage to or failure in the operations of TSF resulting from failure of the Owner, its servants or agents to comply with the provisions of the TSF Design Documents.

Signature of above person: C Christopher Lane

Date 29 October, 2018.

CORPORATE ENDORSEMENT

I hereby confirm my opinion that the above-mentioned 3rd Party independent technical reviewer is suitably qualified with relevant experience and competence in tailings design and management and verify that the reviewer is truly independent of the applicant.

Name of Company (applicant): Galena Mining Pty Ltd

Signature of Company (applicant): D. Flury

Date 21/3/2019

24 October 2018

TAILINGS STORAGE FACILITY

ABRA BASE METALS PROJECT, NEAR MEEKATHARRA, WA

DESIGN REPORT

Galena Mining Limited

Ref. PER2018-0128AE Rev 1

Unit 19 Wembley Green Offices,
127 Herdsman Parade, Wembley, WA 6014

www.cmwgeosciences.com

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EXECUTIVE SUMMARY

Galena Mining Limited (GML) proposes to develop the Abra Base Metals Project located approximately 200 km north of Meekatharra, Western Australia. As part of the project, GML proposes to construct a TSF in order to store tailings from the process plant. The project is a greenfields development. The project comprises the development of a box cut for an underground mining operation, processing plant, TSF, airstrip and associated infrastructure.

The Abra Project is located within the granted mining licence M52/776. The TSF is located approximately 500m north of the proposed plant site, with an approximate centre at (MGA, Zone 50) coordinates 7,275,560 m North and 660,940 m East.

The TSF has been designed to store 8.48 Mt of tailings over a 15 year life. Approximately 32.6% of the total tailings production will be used for paste backfill to the underground mining operations. The tailings have unusual characteristics when compared with other mine tailings. Air drying and settling tests, drained and undrained, indicate that the tailings will settle out of suspension very quickly, in less than 80 minutes, which is a function of the high soil particle density. The TSF will be a two cell, paddock type facility, located to the north of the plant site, between two intermittent creek lines in order to reduce diversion works. The two cell TSF will be constructed in six stages. The Stage 1 Cell A starter embankment will provide nominally 2 year's storage. Cell B will be added to provide an addition storage life of 2 years for Stage 1. The TSF starter embankments will be a zone embankment comprising an upstream zone of compacted select mine waste and a downstream zone of traffic compacted mine waste. The starter embankments will be raised using upstream construction techniques and select mine waste.

The design as incorporates a rock-ring decant in each cell to recover water from the TSF. Return water will be pumped directly to the process plant for reuse.

The starter embankments and TSF cell basins will be lined with Geosynethic clay liner (GCL) to produce a low permeability liner at the base of the TSF to reduce seepage.

A surface water diversion channels will be constructed as part of the development of the TSF site. This diversion channels and bunds will divert catchment runoff from the ridge areas, to the south of the TSF behind the plant site towards the north, away from the TSF.

Details of the design are presented on the drawings in Appendix A.

Classification of the TSF, at its ultimate height, in accordance with Tables 1 and 2 of the DMP (2013) code results in a hazard rating of 'Category 1 – High'. The ANCOLD (2012) consequence rating is 'Significant' (refer Tables 1 and 2 of ANCOLD (2012)).

Seepage, stability, deformation and water balance analyses, and a dam break assessment were performed as part of the development of the design.

The proposed TSF has been designed such that a 1% AEP, 72-hour duration storm event can be temporarily stored on top of the facility plus a minimum of 0.5 m total freeboard. The design, however, assumes correct operational controls are adhered to and that water is continually removed from the facility, such that adequate freeboard is maintained.

The probability of major embankment failure of the TSF is assessed as being very low provided the TSF is implemented (constructed and operated) within the intent of the design in accordance with the scope of works for the construction and operations manual.

GML, as operator of the project, makes the following commitments:

- The TSF construction will be undertaken in accordance with the specifications and drawings. Construction will be supervised and monitored by personnel with experience in this type of construction. Details of construction will be provided in a construction report.
- Prior to construction of the TSF, seal all investigation and exploration boreholes within the TSF footprint.
- The TSF will be managed and operated in general accordance with an Operations Manual (to be compiled). Independent audits will be performed annually.
- A minimum of twelve piezometers be installed in the foundations of the TSF cells as recommended in the design. Water levels as a minimum will be read monthly, data plotted monthly and trends assessed. The results should be reviewed as part of the yearly audits.
- The groundwater monitoring programme will be instituted for the TSF and will be integrated with the site environmental monitoring programme. Water levels will be read monthly and samples obtained quarterly. The results will be summarised in the site AER.
- The closure plan for the Abra Project will include the TSF.

This summary of the TSF design will be distributed by the mine to the local Shire Council and to the relevant local pastoralists.

1 INTRODUCTION

This document presents design details required by the Department of Mines, Industry, Regulation and Safety (DMIRS), formerly the Department of Mines and Petroleum (DMP), Western Australia, for the Tailings Storage Facility (TSF) at the Abra Base Metals Project (Abra). The project is located approximately 200 km north of Meekatharra, Western Australia.

The project is a greenfields development. The project comprises the development of a box cut for an underground mining operation, processing plant, TSF, airstrip and associated infrastructure. A site plan showing the location of the Tailings Storage Facility (TSF) in relation to other proposed infrastructure is presented as Figure 1.

The TSF has been designed to store 8.48 Mt of tailings over a 15 year life. The TSF will be a two cell, paddock type facility, located to the north of the plant site, between two intermittent creek lines in order to reduce diversion works. The two cell TSF will be constructed in six stages. The Stage 1 Cell A starter embankment will provide nominally 2 year's storage. Cell B will be added to provide an addition storage life of 2 years for Stage 1. The TSF starter embankments will be a zone embankment comprising an upstream zone of compacted select mine waste (i.e. raise bore fines supplemented with borrow as required) and a downstream zone of traffic compacted mine waste from the underground development. The starter embankments will be raised using upstream construction techniques and select mine waste (i.e. mine development waste supplemented with borrow as required).

The starter embankments and TSF cell basins will be lined with a Geosynethic Clay Liner (GCL). The design as incorporates a rock-ring decant in each cell to recover water from the TSF. Return water will be pumped directly to the process plant for reuse.

Design contained in this report were prepared to meet DMIRS requirements and in accordance with the relevant guidelines as detailed below:

- Department of Mines and Petroleum (2013), *'Code of practice: tailings storage facilities in Western Australia'*.
- Department of Mines and Petroleum (2015), *'Guide to the preparation of a design report for tailings storage facilities (TSFs)*'.
- ANCOLD Guidelines (2012) 'Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure'

Classification of the TSF, at its ultimate height, in accordance with Tables 1 and 2 of the DMP (2013) code results in a hazard rating of 'Category 1 – High' (Section 3.1). The design presented in this report has been undertaken using the hazard rating of 'High', based on the following:

- Loss of life is unlikely.
- Loss of TSF storage.
- Damage to natural environment possible (impact area<5km^2).
- Prolonged adverse effects on flora and fauna possible.
- Category 1 storage as final embankment height is 15 m.

A dam break assessment has been performed and the hazard rating is based on this assessment (refer to Section 10). A tailings storage data sheet and explanatory notes for the facility are presented as Figures 3 and 4 respectively.

The following figures and appendices complete this report:

- Figure 1 –Site Plan.
- Figure 2 – Storage Capacity Curve.
- Figure 3 – Tailings Storage Data Sheet (TSDS).
- Figure 4 – Explanatory Notes for completing TSDS.
- Figure 5 – Rainfall Intensity Chart.
- Figure 6 – Freeboard Nomenclature.
- Appendix A – Drawings.
- Appendix B – Geotechnical Investigation Report
- Appendix C – Technical Specification and Schedules of Quantities
- Appendix D – Seepage Analysis.
- Appendix E – Stability Analysis.
- Appendix F – Water Balance Analysis.
- Appendix G – Laboratory Test Results – Tailings Testwork.
- Appendix H – Operations Manual

1.1 Location

The Abra Project is located within the granted mining licence M52/776. The TSF is located approximately 500m north immediately south of the proposed plant site, with an approximate centre at (MGA, Zone 50) coordinates 7,275,560 m North and 660,940 m East. A layout plan showing the location of the TSF in relation to other mine infrastructure is presented as Figure 1.

1.2 Ownership

The project is owned and operated by publicly listed company, GML.

1.3 History

Abra is a globally significant lead-silver project located in the Gascoyne region of Western Australia. The deposit was discovered in 1981 and has been the subject of historical and modern exploration, and preliminary (scoping-level) economic studies. There has been no previous mining activity at Abra and the deposit does not outcrop, that is have a presence at the ground surface.

Galena undertook a PFS in 2017, to confirm the technical and economic robustness of developing an integrated mining and processing operation to produce a high-value, high-grade lead-silver concentrate at Abra.

2 DESIGN CONSIDERATIONS

The design for the TSF is based on the following:

- Annual tailings production approx. 1.1 Mtpa of which 0.60 Mtpa will be permanently stored in the TSF.
- Tailings slurry of 65% solids.
- Life of Mine around 15 years.
- Design in general accordance with ANCOLD Guidelines (2012). The consequence category will determine the water management (e.g. freeboard and stormwater storage capacity required) and geotechnical embankment design requirements.
- The tailings for the paste fill will be taken direct form the processing plant, as and when needed and sent direct to the paste plant, with the balance of tailings not required being sent to the TSF. The TSF may at various times receive all the tailings stream, or when the paste plant is operational a reduced tailings stream or at times no tailings stream.

2.1 Process Type

Ore will be processed using flotation methods.

2.2 Rated Throughput

GML proposes a production rate of 1.1 Mtpa to 1.2 Mtpa

2.3 Ore Type

The ore comprises fresh ore from underground operations.

2.4 Tailings Properties

2.4.1 Geochemistry

Geochemical testing of the tailings has been executed by Graeme Campbell & Associates Pty Ltd and the tailings are classified as NAF and appreciably enriched in barite (Ba) which comprised almost 1/3 of the total tailings. The tailings are also enriched in lead (Pb) chiefly associated with ‘trace galena’ not recovered during flotation.

2.4.2 Residual Water Quality

Based on geochemical testing, the tailings water is likely to have the following properties:

- pH of 7-8
- Low salinity: electrical conductivity (EC) value of 430 µS/cm.
- The concentrations of a wide range of minor-element in the tailings-slurry-water sample were either below, or close to, the respective detection-limits (0.000-0.01 mg/L).
- The concentration of Pb of 0.068 mg/L is below the stock drinking water of 0.1 mg/L in the ANZECC (2000) Guideline. The guideline does not list a Ba guideline value for stock drinking water.

2.4.3 Engineering Properties

A representative tailings sample was testing as part of the PFS study. The tailings are a non-plastic sandy Silt (ML). The engineering properties of the tailings are summarised below.

Tailings Slurry

- Slurry density ex-plant: approx. 65% solids
- Tailings density: 1.997 t/m3 – Drained settling test
  1.865 t/m3 (dry) – Undrained settling test
  Assumed design density 1.865 t/m^3
- Specific gravity: 3.52
- Angle of internal friction: 31^o (assumed based on shear box testing)
- Particle size distribution: 60% passing 75 µm, with approx. 3% passing 3 µm
- Hydraulic conductivity: 1.0 x 10^{-5}m/s to 1.0 x 10^{-7}m/s
- Tailings beach slope: 1% assumed

The above is compiled based on tailings testwork (refer Appendix G).

2.4.3.1 Comments on Tailings Testwork

The following commentary is provided for the tailings, based on the soil classification approach detailed in AS1726:2017 Geotechnical site investigations.

The results of the PSD and Atterberg Limits testing indicate that the tailings can be classified as a non-plastic sandy silt Unified Soil Classification (USC) group symbol ML.

The soil particle density of the tailings is 3.52 t/m3.

The Emerson Class Number Test indicates that the materials are dispersive.

The maximum dry density of the tailings, when compacted using the standard method of compaction, is 2.49 t/m3 with an optimum moisture content of 7.8%. The compaction curve is relatively flat.

The direct shear tests indicate a cohesion of 12.9 kPa and shear angle internal friction of 31.3^o.

The air drying and settling tests, drained and undrained, indicate that the tailings will settle out of suspension very quickly, in less than 80 minutes, which is a function of the high soil particle density. The objective of the drained and undrained settling test is to monitor the tailings settlement and the development of clear supernatant water. By monitoring the height of the solids and the achieved dry density over time, an indication of the speed at which this water is released can be assessed. The points to note from the results of the undrained settling test, undertaken on tailings slurry with a slurry density of 61.7% solids, are:

- At discharge, the tailings slurry has an equivalent dry density of nominally 1.19 t/m3 and 1.09 t/m3 for the drained and undrained settling tests, respectively.

- After a period of 260 minutes, the dry density increases to nominally 1.997 t/m3 for the drained test, whereas the undrained test reaches a dry density of 1.865 t/m3 after 107 minutes. The shape of the curves in both tests suggest significant water release can be expected within the first 4 hours following tailings deposition.

- The airdrying test indicates water is available to decant within hours of deposition.

Under field conditions it is likely that supernatant water recovery would be approximately 56% not including any contribution from rainfall. This assumes a slurry density of 65% solids at the point of discharge.

The oedometer testing (consolidation testing) indicates a slow consolidation rate which will result in an increase in the in-situ dry density of the tailings stack with time. However, with the rapid settling on initial deposition, the increase in dry density is not going to make a substantial difference to the consolidation and settlement of the tailings, given the relatively low total height of the tailings profile.

2.4.3.2 Implications for Tailings Management

The implications for the TSF design and operation from a geotechnical perspective are:

- The TSF design must provide sufficient tailings storage capacity in a timely manner for the tailings deposition. Whilst there is a significant percentage of the tailings, approximately 32.6%, being used for paste backfill to the underground mining operations, there is still a need for the remainder of the tailings to be stored.

- A GCL liner to the base of the TSF is recommended. Drainage on top of the liner to pump out leachate from the stored tailings would not be required, given the rapid settling characteristics of the tailings. An efficient high capacity supernatant water recovery system (pumps and pipes) is essential, refer to Section 5.3, which provides details of the target insitu dry density and water recovery.

- The high soil particle density and rapid settling characteristics mean that the tailings will be difficult to remobilise once they settle. In other words, release from the containment facility is not likely to result in significant runout and this has implication for the Dam Break Study.

- The dispersive properties of the tailings demonstrate that the tailings will not be suitable for use in perimeter embankment construction for embankment raising works as traditionally is used for mining operations. Borrow materials will need to be sourced and tested to demonstrate embankment raising works can be executed for upstream embankment raising.

- The supernatant water, which is readily released from the tailings slurry within very short time frames, must be recovered and utilised in the process plant. The water recovery system, pumps, pipes and process water storage dam, must be designed to accommodate a very high level of water recovery. It can reasonably be expected that a minimum of approximately 56% of the slurry water will be available for water recovery.

2.5 Geotechnical Investigations

CMW/L&MGSPL conducted site reconnaissance's of the Abra Project area in two mobilisations. Field investigations were carried out by GML explorations geologists under the direction of CMW/L&MGSPL and included.

- Preliminary investigations included the drilling of air-core boreholes on a 200 x 200m grid pattern across the site. A total of 105 boreholes were drilled to a maximum depth of 20m.
- Sampling of air-core samples as directed by CMW/L&MGSPL in order characterise materials.
- Testpitting of a potential borrow area in the south west of the project area under the supervision of GML geologists.
- Testpitting of the selected TSF site to the north of the plant under the supervision of GML geologists.

At the proposed borrow area (air-core bore locations APFS075, and APFS076) the Wiluna Hardpan was absent. The ground conditions were noted to be basically saprolite with some silicification near the surface. Testpitting in the proposed borrow area indicated shallow refusal on cemented materials at a depth of 1m or less. If this area was to be developed as a borrow area paddock blasting (long with material handling and compaction) would be required in order to generate materials suitable for embankment construction including fines within the borrow material.

At the proposed TSF site (Bore locations APFS056, and APFS029) air-core drilling indicated thick Wiluna Hardpan was observed overly saprolite at depth (>5 m). It was observed that the hardpan sample fines lacked plasticity.

The testpitting at the proposed TSF site indicated ground conditions comprising:

- Colluvium overlying
- Wiluna Hardpan
- Depth to refusal averaged 0.5 m with a maximum depth to refusal of 1.45 m

The results of the laboratory testing on submitted air-core samples, indicated the following:

- The results of the plasticity testing on samples from the proposed borrow area (depth 2-4m), indicated the fines were a non-plastic silty material to a low plasticity (CL) clayey material.
- The results of the materials classification tests on the hardpan materials from the TSF area (depth 2-4m) indicated these materials were non-plastic silty gravel (GM) with a fines content (passing 75 micron) between 14% and 23%.

This testing confirms that a GCL will be required to line the TSF to manage seepage and that the TSF site is not a source of clayey materials.

A CMW geotechnical report summarising the investigations in more detail and presenting field and laboratory data is provided in Appendix B.

3 TAILINGS STORAGE FACILITY DESIGN

The design objectives of the TSF at Abra are:

- Providing optimum removal of water from the facility for return to the process plant for re-use.
- Optimising tailings storage capacity by maximising the in-situ tailings density (i.e. undertaking cyclic tailings deposition between groups of spigots).
- Reducing environmental impact (i.e. due to seepage).

Drawings PER2018-0128-01 to PER2018-0128-03 provide the general arrangements, and sections and details for the TSF design (refer Appendix A). Preliminary specifications for earthworks are provided in Appendix C. Schedules of quantities for the staged construction of the TSF are also included in Appendix C.

3.1 Hazard Rating

Based on the DMP Code of Practice (2013), the hazard rating for the TSF has been assessed as 'High', Category 1 based on the following:

- Loss of life is unlikely.
- Loss of TSF storage.
- Damage to natural environment possible (impact area<5 km^2).
- Prolonged adverse effects on flora and fauna possible.
- Category 1 storage as final embankment height is 15m.

The ANCOLD (2012) consequence rating based on the above considerations, that is overall Major damage, (refer Table 1 of ANCOLD (2012)) and a population at risk of <1 is 'Significant' (refer Table 2 of ANCOLD (2012)). Major damage is characterised potential significant effects on river systems of local and state significance. Other impacts have been assessed as medium, that is, potential significant impacts to business (i.e. the mine), impact area <5 km^2 or less and impact duration less than 5 years. The loss of infrastructure is expected to be less than $10M (i.e. a minor damage type).

3.2 Operation and Design Considerations

The following operational considerations have been incorporated into the design:

- Tailings in the form of slurry will be discharged sub-aerially and cyclically into the facility in thin discrete layers, not exceeding 300mm thickness, in order to allow optimum density and strength gain by subjecting each layer to a drying cycle. Deposition will take place via multiple spigots from around each cell of the facility.

  The tailings have rapid settling characteristics, hence some experimentation will be required on the number spigots to be utilised during deposition. If too many spigots are open, the tailings will tend to deposit near the embankment. If this occurs, single point discharge practices may be required from time to time to force the tailings away from the embankment.
- Spigotting of tailings is to be carried out such that a beach is developed to force the supernatant pond to be is maintained within and around the rock-ring decant. The pond is to be maintained away from the perimeter embankments at all times.

- Water will be removed from the facility and pumped back to the process plant via a decant pump located in a rock-ring decant structure. The recommended average water recovery should not be less than 50% of slurry water inflow or 36 t/hr.
- The tailings storage area will assume the form of a truncated prism with a depressed cone on the top surface. The facility will have the capacity to store a considerable volume of water during a storm event. The minimum operational freeboard for the TSF under normal operating conditions is 0.5m, plus allowance for temporary storage of the 1% average exceedance probability (AEP) 72-hour storm event whilst maintaining required total freeboard (Section 8).
- On eventual decommissioning, the facility will remain as a permanent feature of the landscape and drain to an increasingly stable mass. The top surface and batters will be stabilised and rehabilitated as described in Section 12.

3.3 Drawings

The following design drawings are presented in Appendix A.

Table 4: Drawings

Title	**Drawing No.**
General Arrangement – Stage 1	PER2018-0128-01
General Arrangement – Final Stage	PER2018-0128-02
Sections and Details	PER2018-0128-03
Instrumentation Arrangement and Details	PER2018-0128-04

3.4 TSF Storage Characteristics

The estimated tailings storage areas, volumes and storage capacity for the TSF are summarised in Table 5 based on a minimum of approximately 32.6%, being used for paste backfill to the underground mining operations. The estimated storage characteristics of the proposed TSF assume tailings insitu densities and beach slopes as quoted in Section 2.

Table 5 - Estimated Tailings Storage Areas and Storage Volumes

Stage	Crest RL (m)	Area (ha)	Storage Volume (m^3)	Cumulative Total Tailings Production (Mt)	Cumulative Tailings Stored in TSF (Mt)	Cumulative Storage Life (years)
1 – Cell A	539.5	26.5	800,000	2.1	1.49	2.6
1 – Cell B	535.5	37.5	800,000	4.4	2.98	5.3
2 – Cell A	542.5	24.5	764,713	6.5	4.41	7.8
2 – Cell B	538.5	35.1	1,088,858	9.5	6.44	11.4
3 – Cell A	545.5	22.5	822,896	11.0	7.54	13.3
3 – Cell B	541.5	32.8	1,187,402	13.8	9.43	16.7

Note: Storage life based on design criteria in Section 2.4.3 and an average tailings production of 0.565 Mtpa. Total tailings to TSF based on an average production 0.83 Mtpa.

3.5 Embankment Design

The TSF has been designed to store 8.48 Mt of tailings over a 15 year life. The TSF will be a two cell, paddock type facility, located to the north of the plant site, between two intermittent creek lines in order to reduce diversion works. The two cell TSF will be constructed in six stages.

The Stage 1 Cell A starter embankment, with a maximum height of 9 m, will provide nominally 2 year's storage with a tailings impoundment area of approximately 26.5 ha. Cell B will be added to provide an addition storage life of 2 years for Stage 1. Cell B Stage 1 will have a maximum height of 8 m with a tailings impoundment area of approximately 37.5 ha.

The Stage 1 embankments will be raised by 3m in Stages 2 and 3 to provide the life of mine storage of 15 years.

The TSF starter embankments will be a zone embankment comprising an upstream zone of compacted select mine waste and a downstream zone of traffic compacted mine waste. The select mine waste will be sourced from raising bore fines or other approved mine waste sources. General mine waste from underground and the box cut will be stockpiled in a waste dump area, located near the TSF site. The starter embankments and TSF cell basins will be lined with GCL.

The starter embankments will be raised using upstream construction techniques. The staged raising embankment construction will utilise select mine waste material or from external borrow areas to be identified near the TSF site.

The final stage will have a tailings impoundment area of approximately 55 ha (both cells) with a maximum embankment height of 15 m.

3.6 Embankment Geometry

The TSF embankment will have design slopes of 1(V):2(H) upstream and 1(V):3(H) downstream.

The starter embankment and upstream raised embankments will have a minimum crest width of 6 m. The embankment crest will have a 2% cross-fall towards the upstream side and 0.5m (min.) high mine waste windrow at the downstream crest.

The decant causeway has design slopes of 1:1.5 (V: H) and a 6m minimum crest width. The crest of the decant causeway will have 0.5m (min.) windrows on both sides of the accessway. Breaks in the windrow on the low side will allow surface water to run off.

The design geometry of the proposed TSF Embankment construction is presented on Drawing PER2018-0128 -03 in Appendix A.

3.7 Water Recovery System

Surface water will be removed from TSF by a decant pump located within a rock-ring type decant located centrally within the TSF. Return water will be pumped directly to the process plant for reuse.

At start-up a temporary decant pump should not be required as the rock-ring is located such that early water return will be possible.

3.8 Liners

Due to the presence of Wiluna hardpan near the surface, which has been assessed as having medium to low permeability, it is proposed to line the TSF basin (Stage 1 only) with a GCL. The permeability of a GCL is around 10^{-12} m/s.

3.9 Construction Methods

The starter embankment of the TSF will be a zoned embankment. The starter embankment will be raised in stages using upstream methods. The staging will comprise:

- Stage 1, Cell A Starter: construction of the starter embankments to crest RL539.5 m and drainage diversion. This construction will proceed utilising a civil earthworks contractor, prior to commissioning the plant.
- Stage 1, Cell B Starter: construction of the starter embankments to crest RL535.5 m in Year 2. This construction will proceed utilising a civil earthworks contractor.
- Stage 2: raising construction of embankment by 3 m:
  - Cell A: Raising of embankments in Year 4, likely by a civil contractor.
  - Cell B: Raising of embankments in Year 7, likely by a civil contractor.
  - Construction of the decant accessway and decant rock-ring either by the mining operation or a civil contractor.
- Stage 3: raising construction of embankment by 3 m:
  - Cell A: Raising of embankments in Year 11, likely by a civil contractor.
  - Cell B: Raising of embankments in Year 13, likely by a civil contractor.
  - Raising of the decant accessway and decant rock-ring either by the mining operation or a civil contractor.

As part of Stage 1, the footprint of the TSF will be cleared of vegetation. The topsoil from the footprint of the TSF will be stripped and stockpiled for use in rehabilitation. The vegetation and topsoil will be stockpiled separately.

The embankments should be constructed to the following standards:

Starter and Upstream Raises

- Construct the TSF starter embankment, upstream zone and upstream raises using select mine waste material sourced from the raise bore fines or other identified borrow sources.
- TSF starter embankment, upstream zone shall be trimmed such the embankment batter is adequate for accepting the GCL liner (i.e. free of projects that could damage the liner).
- The select mine waste should be moisture conditioned (2%, +2% of the optimum moisture content (OMC)).
- Each 0.3m layer shall be compacted to achieve a density ratio greater than 95% of the maximum dry density - standard compaction.
- Construct the downstream zone of the TSF starter embankment using general mine waste material sourced from the underground operations and stockpiled in a dump near the TSF. The downstream zone should be traffic compacted in 1 m layers using loaded construction equipment. The dump truck shall traffic the complete width of the zone.

4 SEEPAGE ANALYSIS

Seepage analyses were undertaken to estimate the position of the phreatic surface for the embankment design for the proposed starter embankment stage (embankment height 9 m) and final stage (15 m embankment height). The analyses were undertaken using the groundwater module of the Slide software package. Slide uses a 2D finite element analysis to determine groundwater seepage for saturated, steady state flow conditions. It should be noted that 2D modelling is a simplistic approach, which does not consider 3D effects.

4.1 Model Assumptions

The upstream boundary condition used in the analyses was determined based on a maximum water pond level of 1.0 to 1.5 m below the embankment crest. The water pond was assumed to be no closer than 150 m from the embankment crest. Under normal operating conditions it is expected that the decant pond would be within the rock-ring decant (i.e. > 150m from the embankment).

The material permeabilities used in the seepage analyses are based on values taken from the recent geotechnical investigations and assumed text book values. Table 6 provides a summary of the permeability values used in the analyses.

Table 6 - Permeability Values Adopted

Material Zone	Permeability, K (m/s)	Comments on Assumptions
Deposited Tailings	10^{-6}	Assumed value based on tailings testwork
Compacted Mine Waste	10^{-4}	Assumed value based on materials specification and textbook values
Select Mine Waste	10^{-9}	Assumed value for a combination of GCL over selected mine waste
Foundation Soils	10^{-9} #	Assumed value for a combination of GCL over colluvium over hardpan

GCL has a nominal permeability of 10^{-12} m/s, however 10^{-9} m/s has been adopted in the finite element analyses due to mathematical instability.

4.2 Results of Analyses

The seepage flow determinations from the analyses are summarised in Table 7, below.

Table 7 - Results of Seepage Analyses

Case	Seepage Flow (m^3/day/m of embankment)	Approximate Embankment Length (m)	Estimated Seepage per day for embankment section (m^3/day)
Starter Embankment	0.00000036	1,500	<0.0005
Final Embankment	0.0000031	1,500	<0.005

Plots of the phreatic surface and distribution of pore pressures throughout the embankment are presented in Appendix D for the two cases analysed.

The seepage analyses indicate very low seepage flow can be expected from the TSF. The use of a GCL in lining the facility will ensure negligible seepage from the TSF.

5 STABILITY ANALYSIS

5.1 Method of Analysis

Stability analyses were undertaken to assess the stability of the TSF embankment for the proposed starter embankment stage (embankment height 9 m) and final stage (15 m embankment height). The analyses were undertaken in general accordance with ANCOLD (2012).

The computer software package 'Slide' was utilised to undertake the analyses. Slide is a two-dimensional slope stability program for evaluating the safety factor of circular and non-circular failure surfaces in soil and rock slopes. The stability of the slip surfaces for static loading was assessed using vertical slice limit equilibrium methods and the stability of the slip surfaces for seismic loading was assessed using finite element method. The simplified Bishop method was used in the static analyses.

The phreatic surface adopted in all cases were based on the seepage analyses results, refer to Section 4. Drained and undrained conditions were analysed.

ANCOLD (2012) requires deformation analysis and this is presented in Section 6. It should be noted that the TSF embankment foundations are not liquefiable and hence post-seismic analyses are not applicable.

5.2 Parameters

Table 8 provides a summary of the strength parameters used in the stability analyses.

Table 8 - Summary of Strength Parameters*

Material Type	Bulk Density (kN/m³)	Undrained Strength Parameter Su (kPa)	Effective Strength Parameter*	
			Cohesion c/ (kPa)	Friction Angle φ/ (degrees)
Compacted Mine Waste	20	N/A	0	38
Select Mine Waste	20	75	5	35
Foundation Soils	21	N/A	200	38
Tailings	22	50	0	31
Rock Armour	22	N/A	0	40

5.3 Results of the Stability Analyses

The results of the stability analyses for the various cases examined assuming a 'worst' case phreatic surface are summarised in Table 9, with the computer printouts presented in Appendix E.

Table 9 - Results of Stability Analyses

Case	Factor of Safety	Recommended Minimum Factors of Safety*
Starter Embankment - Drained	2.50	1.5
Starter Embankment - Undrained	2.50	1.5
Final Embankment - Drained	2.43	1.5
Final Embankment - Undrained	2.43	1.5

The stability analyses indicate that the cases examined generally have adequate factors of safety for the drained and undrained conditions when compared with the recommended minimum factors of safety in ANCOLD (2012).

5.4 General Comments in Respect to Stability

Stability is significantly influenced by the position of the phreatic surface within the deposited tailings and confining embankment.

The tailings storage has been designed to provide temporary water storage following extreme storm events. If water does extend to the embankment, which is considered very unlikely, it is anticipated this will be a temporary occurrence given 'continuous' water removal from the TSF. The tailings storage should be operated in such a manner as to ensure that the `normal' supernatant pond is kept well away from the embankment, within the rock-ring decant, at all times.

6 DEFORMATION ANALYSIS

A preliminary assessment of embankment deformation due to earthquake was estimated using a Plaxis 2D finite element analysis (FEA) and the in-built pseudo-static acceleration module. This method is conservative as it does not attempt to model the dynamic and short-term nature of most earthquakes. The displacements and settlements expected for a 15 m high embankment were estimated under a Magnitude 8 earthquake, corresponding with a loading of 0.104g for 1 in 1,000 AEP MDE or SEE event. The stiffness parameters used for each of the soils are provided in Table 10 below.

Table 10 - Summary of Stiffness Parameters

Material Type	E' (MPa)	v
Compacted Mine Waste	80	0.2
Select Mine Waste	100	0.2
Foundation Soils	400	0.1
Tailings	20	0.3
Rock Armour	120	0.2

From the analysis, it is concluded that for the highest embankment section (worse case), the lateral deformation at the top of the embankment due to a SEE event is unlikely to exceed approximately 20 mm, with approximately 4 mm of vertical displacement. Such deformation is insignificant when compared with the operational freeboard of 0.3 m.

7 SURFACE WATER DIVERSION

A surface water diversion channels will be constructed as part of the development of the TSF site. This diversion channels and bunds will divert catchment runoff from the ridge areas, to the south of the TSF behind the plant site towards the north, away from the TSF. Based on hydrology assessments by Rockwater, diversion channels have been designed on the following basis.

CMW have designed the diversion drains based on Rockwater peak flow rates and 1:100 yr. AEP flows. The peak flow assessments were based on the Rational method. The estimated peak flows for the catchments are summarised below along with the minimum channel requirements. The channel requirements assume a nominal channel slope of 1% and a Manning's number of 0.025, further details are provided as footnotes to Table 5.

Table 5 - Estimated Tailings Storage Areas and Storage Volumes						
Catchment	Area (km^2)	Design Flow, Q100 (m^3/s)	Drain Width (invert) (m)	Drain Depth (m)	Levee height (m)	Flow Depth (m)
D	0.74	24.8	8.0	0.5	1.0	0.8 approx.
E	1.17	34.0	8.0	0.5	1.0	1.0 approx.

Note: Catchment D is above the western side of the TSF, and Catchment E is above the eastern side of the TSF. All channel batter slopes will be 1:2 (v:h)

8 FREEBOARD

The following considerations were made regarding freeboard criteria and requirements for a 'Medium' consequence category TSF (Section 3.1) based on the DMP (2013)[2] guide:

- The proposed TSF has been designed such that a 1% AEP, 72-hour duration storm event can be temporarily stored on top of the facility. The design, however, assumes correct operational controls are adhered to and that water is continually removed from the facility, such that minimum freeboard allowances are maintained.
- Provision of a minimum of 500mm total freeboard comprising minimum operational freeboard (vertical height between the tailings beach and embankment crest) of 300mm and a minimum beach freeboard of 200mm plus and allowance for the 1% AEP 72 hour event of 217 mm.

ANCOLD guidelines (2012) also recommend an allowance for wave run-up for 1:10 AEP wind plus 0.3m additional freeboard for a 'Significant' consequence category TSF (refer to Section 3.1). It should be noted that, for the proposed perimeter tailings deposition, it is expected that the separation distance between the perimeter embankments and design storm pond will be adequate to prevent wave action on the embankments.

Intensity-frequency-duration (IFD) data pertaining to the site is presented on Figure 5. Freeboard nomenclature is illustrated on Figure 6. Temporary storage of a storm-water volume of approximately 82,250m^3 (i.e. 37.9ha x 217 mm) on top of TSF resulting from a 1% AEP, 72-hour storm event was considered in the design. This storm-water volume will occupy approximately 20 to 25% of the TSF basin.

9 WATER BALANCE ANALYSES

A water balance analysis for the proposed TSF operation has been undertaken using a spreadsheet to examine expected TSF inflows and outflows.

Inflows and outflows for the facility were estimated on a monthly basis. Inflows include rainfall and slurry water. Outflows include evaporation, seepage losses and water retained in tailings (pore water). Water balance calculations are included in Appendix F.

Assumptions and other data adopted for the water balance are listed below:

- Climate data was obtained from the BOM, utilising mean monthly rainfall and mean monthly evaporation figures for Tangadee Station (1960 to 2018) and Mt Clere (1975 to 2005).
- Tailings area: half of the overall area of approx. 37 ha (the largest TSF cell)

- Runoff coefficient of 0.4 for tailings was assumed.
- Pool area and running beaches equal to 10,000m^2.
- Evaporation pan factor of 0.7.
- Average retained moisture content of tailings, 25%.
- Tailings slurry density of 65% (Section 2.4).
- Tailings production rate of 600,000tpa.
- Permeability for seepage through deposited tailings and GCL Lined TSF floor 10^{-10} m/s.

The results of the analysis indicate potential annual average water returns of around 50% to 55% of the tailings slurry water deposited into the facility can be expected under average climatic conditions.

The water recovery system, pumps and piping must be designed for a minimum recovery of not less than 1,317 m^3/day. This will allow an average water return of 860 m^3/day plus removal from the facility of stormwater from 1% AEP, 72-hour storm event over 180 days.

The results also indicate that water recovery will vary according to the management of the facility, specifically the size of the pond and running beaches. The actual quantity of water available for return to the plant may vary from the figures presented based on the following factors:

- Variations in slurry density.
- Continuity of tailings discharge.
- Distance between the discharge point and decant pond.
- Size of the decant pond and running beaches from where evaporation is greatest.
- Climatic conditions at the time of operation.
- The efficiency of the decant system during operation.

10 DAM BREAK ASSESSMENT

10.1 Breach Characteristics

If a TSF embankment breach were to occur, tailings would only be partially released from the storage impoundment, as the majority of the tailings beaches would have dried back, consolidated and gained. In addition, remobilised tailings will behave as a thickened slurry rather than lower viscosity water (refer below for addition comments in Section 10.2). It should be noted that if a dam break to occur tailings is not likely to affect the plant site and other infrastructure (i.e. portal etc) as these facilities are upslope of the TSF (by >7m).

Under worst case probable maximum precipitation (PMP) Rainy day failure conditions:

- The storage capacity of TSF is estimated at 2.4 Mm^3.
- PMP storm volume is estimated at 311,000 m^3. This was based on a PMP, 6 hour event, estimated using the generalised short duration method (GSDM), rainfall depth of 820 mm over the TSF catchment of 37.9 ha.
- The tailings failure volume likely to be released from TSF at the final stage height of nominally 15 m, in the event of an embankment failure under PMP rainy day conditions, would be in the order of 956,000 m^3, i.e. approximately 33% of the impounded storage capacity plus the PMP storm volume.

- Based on T MacDonald and J Langridge - Monopolis (1984), embankment breaches typically occur relatively quickly (typically 0.5 an hour to 4 hours), however in the instance of an IWL with a wide embankment development of a breach will occur over a longer period of time. Based on this methodology, it is estimated that the breach will occur over 1 hour.

The Rourke and Luppnow Method (ref: H Rourke, D Luppnow, 2015) for estimating volume released from the TSF was also utilised to assess potential stored volume release. This method is based on a relation between the potential volume released from a TSF and the size of the decant pond. The greater the pond area the greater the potential volume released from the TSF. The following summarises the potential volume released from the TSF due to a dam-break for various pond sizes.

Table 10: % Volume Release vs Pond size (ref: H Rourke, D Luppnow, 2015)

Pond Area (ha)	Pond Ratio (as a %)	% of TSF volume release	Comments
1.5	4	4	Normal pond area i.e. adopted in water balance
18	48	33	% released based on recommendation in Dalpatram (2011)
21	55	36	Pond area following PMP event

It was noted from Rourke and Luppnow analysis of past TSF failures, that the release volume varies between 9% and 67% of stored volume. The 33% of TSF volume or approximately 956,000 m^3 scenario represents a likely maximum release from a paddock storage TSF with no external catchment in a semi-arid region of WA (i.e. the water pond should not be this large as the water balance is a negative water gain and water shouldn't accumulate on the facility).

The Rourke and Luppnow Method demonstrates that in order to mitigate the consequence of a dam-break, the pond volume and area should be minimised by the adoption of good operating practices.

10.2 Energy Methods

Use of energy methods to estimate tailings run-out were considered for breach of the low embankment adjacent to the plant site. In these methods, the tailings and the embankment are assumed to liquefy and move as a block downstream.

The high soil particle density, rapid settling characteristics of the tailings and shear strength, means that the tailings will be difficult to remobilise once settled. In other words, release from the containment facility, in the event of a breach of the tailings embankment, will not result in significant runout.

Based on Sneddon 2010 method, assuming a 11m embankment height (near the Plant), a volume of failed material of 960,000m^3 and an undrained shear strength of 7kPa, the estimated run-out distance is 130m.

10.3 Hydraulic Modelling

The result from breach modelling indicates that the maximum run-out flow from a 'dam break' under 'worst case' (PMP) rainy day conditions will be 613 m^3/s over 1 hour (assuming a triangular hydrograph).

In a worst-case scenario, tailings and water run-out will likely flow to the north along natural drainage lines away from the plant area and other infrastructure. It should be noted that the plant and portal to the south of the TSF cannot be affected by a TSF breach.

The main consequence of a dam break is likely to be:

- Economic loss due to mine and plant shutdown and production loss, repairs of damaged sections of TSF.
- Environmental impact: the potential for contamination of soils and surface water downstream of the TSF will be limited (estimated to be less than 5 km^2).
- Loss of human life: the loss of life of personnel is not likely. There is potential for loss of life of mining personnel visiting the TSF.

10.4 Controls

The conditions for TSF embankment failure to occur would be driven largely by the size and extent of the decant pond on the facility as well as the magnitude of a trigger seismic event, embankment deformation, the grading of the tailings and saturation of the tailings adjacent to the embankment. Effective management of the decant pond to ensure excess water is continually removed and that the location of the pond is maintained within the rock-ring decant will minimise the risk of a main embankment breach and release of saturated tailings.

TSF embankment failure is not expected provided the facility is operated in accordance with the requirements set out in the TSF Operations Manual.

In the event that the TSF were in imminent danger of failure and breach, an Emergency Action Plan (EAP) would need to be enacted (see Section 11.4).

11 OPERATIONAL ASPECTS

11.1 Operating Procedures

A summary of the operations design for the TSF is presented in Section 3.2. An operations manual for TSF outlining the operating procedures, inspection criteria, monitoring requirements and log sheets for the facility should be compiled during the detailed design phase of the project development.

The following routine inspection and maintenance procedures are to be carried out for the various components of the system. A minimum of one inspection should to be undertaken during each shift by an operator or shift supervisor.

The inspections should cover:

- the pipelines (tailings delivery line and water return lines) to and from the TSF.
- leak detection.
- pumps.
- valves.
- discharge locations.
- location and size of the decant pond.

- decant and return water pumps.
- the general integrity of the embankments and GCL i.e. any new cracking (daily).
- seepage downstream of the TSF.
- any changes to existing cracking or seepage.

A monthly independent inspection should also be performed by senior site management. Operation, safety and environmental aspects should be periodically reviewed during an annual audit inspection by a suitably experienced and qualified engineer.

11.2 Dust Management

Provision for the TSF construction works will include a water cart on location to provide dust suppression as required. This control measure will prevent dust becoming airborne and subsequently being mobilised into the surrounding environment, from becoming a visibility issue, or from becoming a respiratory hazard for construction personnel.

During operations, the tailings beach will be kept damp in order to reduce the risk of dust generation during winding conditions.

11.3 Instrumentation and Monitoring

Groundwater monitoring bores will be established around the TSF perimeter, as recommended by the project hydrogeologist.

Installation of 12 piezometers (6 locations x 2 piezometers per location) have been included in the design, to monitor any phreatic surface within the embankments and foundations. For details of the piezometers, refer to drawing PER2018-0128-04.

It is recommended that as a minimum:

- Piezometer data will be collected as a minimum monthly using a data logger and the data download to a computer spreadsheet.
- Groundwater level readings in the monitoring bores are to be taken monthly.
- Groundwater samples from the monitoring bores for laboratory analyses will be taken quarterly.
- Information collected from the monitoring bores and piezometers should be reviewed regularly and reported in an annual audit.

The requirement for additional instrumentation (i.e. monitoring bores, piezometers) associated with the TSF should be reviewed as part of the yearly audit.

11.4 Emergency Action Plan

The TSF Operations Manual provides a description of the operating procedures for the facility and includes an Emergency Action Plan. The Emergency Action Plan for the site should be updated based on the results of the dam break analyses presented in Section 10. The plan should be reviewed and updated as a minimum on a yearly basis.

The plan should include:

- Management responsibilities and emergency coordination
- Muster points
- Seeking specialist geotechnical advice

- Emergency Plan Triggers
  - Freeboard less than design values
  - Elevated piezometer levels
  - Significant embankment distress
  - Imminent overtopping

12 CLOSURE CONSIDERATIONS

The downstream slopes of the TSF perimeter embankments will be progressively rehabilitated by capping the batters with 0.5 m of mine waste to reduce erosion.

At decommissioning of the TSF, all pipework and pumps will be removed and access roads and other infrastructure rehabilitated.

Further rehabilitation of the downstream batter slopes of the TSF perimeter embankments will comprise deployment topsoil recovered from the site and cross ripping with a dozer. The maximum slope angle of the embankment batters will be 20^{o}, with no intermediate benches.

Once tailings deposition has been completed within the TSF and the top surface of the tailings has gained adequate bearing capacity, it will be covered with nominally 1.5 to 2 m of NAF mine waste. This 1.5 to 2 m thick cover will act as a 'store and release' cover over the top surface of the TSF in order to reduce water ingress into the tailings profile.

At final closure, the decant structure will be decommissioned and the decant area 'sealed'.

As the TSF is a two cell paddock facility with limited external catchments reporting to the TSF basin, a closure spillway should not be required at closure to cater for a probable maximum flood (PMF) event as the TSF basin on top of the finished tailings surface should have sufficient capacity to store a PMF event (provide the cover follows the final tailings profile).

A detailed closure study will need to be undertaken for the Abra Base Metals Project and this study will incorporate the TSF.

13 REFERENCES

The following standards and references were used in the preparation of this report.

1. Department of Mines and Petroleum (2013). '*Code of Practice, Tailings Storage Facility in Western Australia'*.
2. Department of Mines and Petroleum (2015). *'Guide to the preparation of a design report for tailings storage facilities (TSFs)'*.
3. ANCOLD (2012). '*Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure'.*
4. Land & Marine Geological Services Pty Ltd (2018), '*Abra Base Metals Project, Tailings Storage Facility, Pre-Feasibility Study*', prepared for Galena Mining Limited
5. Rockwater (2018), '*Abra Lead Silver Project, Hydrology and Surface – Water Assessment*', prepared for Galena Mining Limited
6. Australian Government Bureau of Meteorology website, http://www.bom.gov.au/.
7. AS 1170.4-2007. '*Australian Standard Structural design actions Part 4: Earthquake actions in Australia'*.
8. T MacDonald and J Langridge - Monopolis (1984). *'Breaching Characteristics of Dam Failures'*, Journal of Hydraulic Engineering, May 1984.
9. A Dalpatram (2011). 'Estimation of Tailings Dam Break Discharges', presentation at USSD workshop on Dam Break Analysis Applied to Tailings Dams.
10. H Rourke, D Luppnow, (2015), *'The Risks of Excess Water on Tailings Facilities and its Application to Dam-Break Studies',* Tailings and Mine Waste Management for the 21st Century, Sydney NSW.

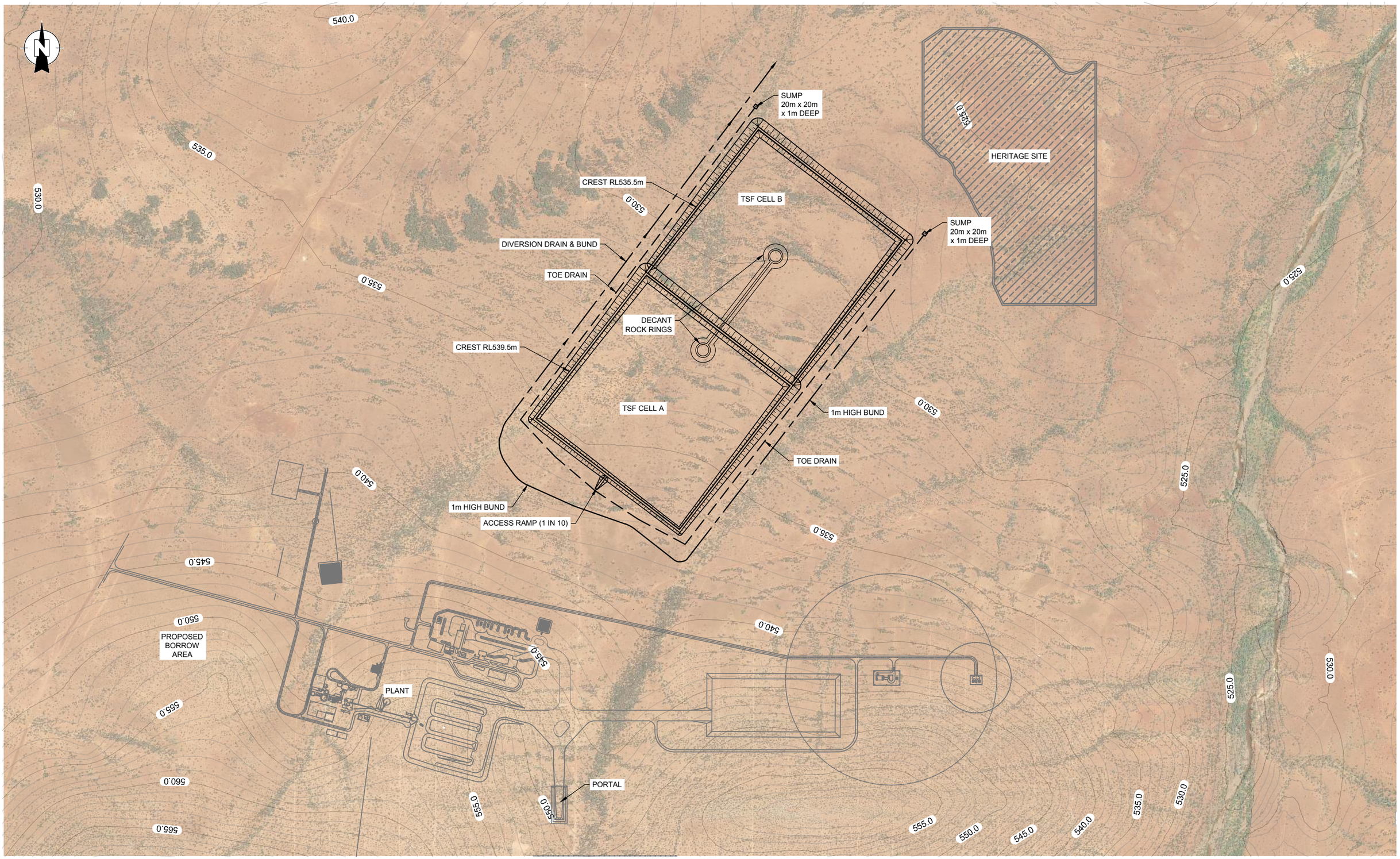
For and on behalf of
CMW Geosciences Pty Ltd

Christopher Hogg

Principal Tailings Engineer

Distribution: 1 copy to GML (electronic) Original copy held by CMW Geosciences Pty Ltd

Figures



CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

NOTES:

1. BASE PLAN PROVIDED BY CLIENT

1:10 000 — 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: LAND & MARINE GEOLOGICAL SERVICES PTY LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TSF DESIGN		CHECKED: CL	FIGURE: 01
		REVISION: 1	SCALE: 1:10,000
TITLE: GENERAL ARRANGEMENT PLAN (STARTER EMBANKMENT)		DATE: 23.10.18	SHEET: A3 L

TAILINGS STORAGE DATA SHEET

Project operator: Galena Mining Ltd			
Project name: Abra Base Metals Project		Date: October 2018	
TSF name: TSF		Commodity: Base Metals (Pb, Zn)	
Name of data provider: CMW Geosciences Pty Ltd		Phone: 08 6555 4920	
TSF centre co-ordinates: (MGA, Zone 50) coordinates coordinates 7,275,560 m North and 660,940 m East.			
Mining Tenement and Holder(s) details: M52/776			
TSF data			
TSF status: Proposed			
Type of TSF: [1] Paddock		Number of cells: [2] 2	
Hazard rating: [3] High		TSF category: [4] 1	
Catchment area: [5] 64 ha		Nearest water course: no named creek nearby	
Date deposition started (mm/yy): TBC		Date deposition completed (mm/yy):	
Tailings discharge method: [6] multi-spigots		Water recovery method: [7] pumped central decant (rock-ring type)	
Bottom of facility sealed or lined? Y / N Yes		Type of seal or liner: [8] Geosynethic Clay Liner	
Depth to original groundwater level m Current groundwater level m – not intersected in bores >> 20 m bgl		Original groundwater TDS: TBC	
Ore process: [9] Flotation		Tailings Deposition rate: [10] 0.60 Mtpa	
Impoundment volume (present) m^3 -		Expected maximum m^3 5.5 Mm^3 (Final Stage)	
Mass of solids stored (present) tonnes -		Expected maximum tonnes 9.4 Mt (Final Stage)	
Above ground facilities			
Foundation soils: Silty sand		Foundation rocks: Wiluna Hardpan	
Starter bund construction materials: [11] mine waste		Wall lifting by: TBC	
Wall construction method/materials: Upstream methods / mechanically		Wall lifting material: [12] Select mine waste	
Present maximum wall height agl: [13] m -		Expected maximum m 15 m (Stage 2)	
Crest length (present) m -		Expected maximum m 3,000 m (Stage 2)	
Impoundment area (present) ha -		Expected maximum ha 55 ha (Stage 2)	
Below ground (in-pit) facilities NA			
Initial pit depth (maximum) m		Area of pit base ha	
Thickness of tailings (present) m		Expected maximum m	
Current surface area of tailings ha		Final surface area of tailings ha	
Properties of tailings and return water			
TDS mg/l: Low salinity, <1,000 mg/L	pH: Tailings: 7 - 8	Solids content 65% (Tailings)	Deposited density t/m^3 1.86
Potentially hazardous substances: [14] -	WAD CN: Tails NA return water NA	Total CN: Tails NA; return water NA	
Any other NPI listed substances in the TSF? [15] Y / N See geochemistry report			

Explanatory notes for completing tailings storage data sheet

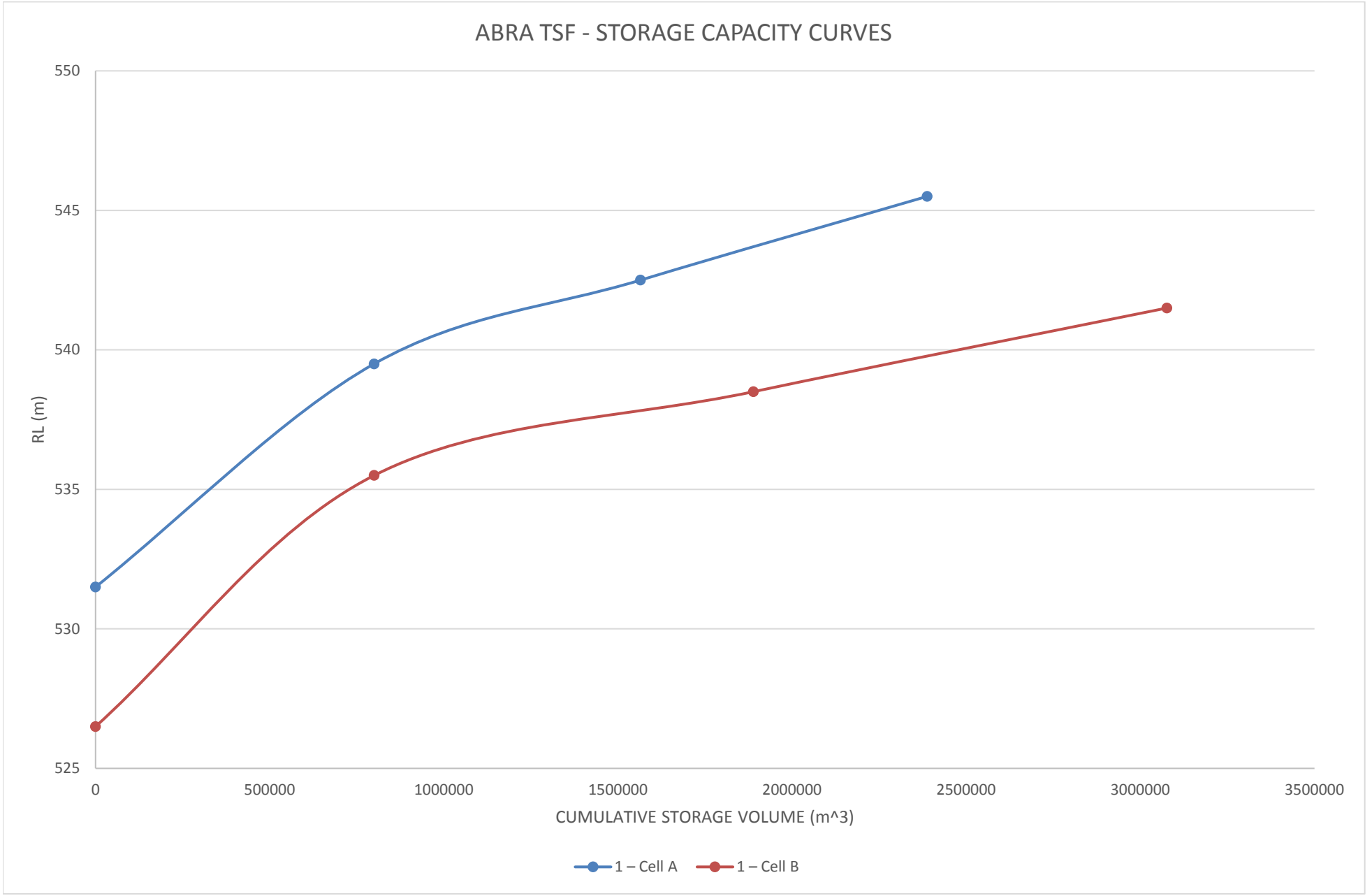
The following notes are provided to assist the proponent to complete the tailings storage data sheet.

1. Paddock (ring-dyke), cross-valley, side-hill, in-pit, depression, waste fill, central thickened discharge, stacked tailings
2. Number of cells operated using the same decant arrangement
3. See Table 1 – Hazard rating system in the Code of practice
4. See Table 2 – Matrix of hazard ratings in the Code of practice
5. Internal for paddock (ring-dyke) type, internal plus external catchment for other facilities
6. End of pipe, (fixed), end of pipe (movable) single spigot, multi-spigots, cyclone, central thickened discharge (CTD)
7. Gravity feed decant, pumped central decant, floating pump, wall/side mounted pump
8. Clay, synthetic
9. See list below for ore process method
10. Tonnes of solids per year
11. Record only the main material(s) used for construction, e.g. clay, sand, silt, gravel, laterite, fresh rock, weathered rock, tailings, clayey sand, clayey gravel, sandy clay, silty clay, gravelly clay or any combination of these materials
12. Any one or combination of the materials listed under item 11 above
13. Maximum wall height above the ground level (not AHD or RL)
14. Arsenic, Asbestos, Caustic soda, Copper sulphide, Cyanide, Iron sulphide, Lead, Mercury, Nickel sulphide, Sulphuric acid, Xanthates, radioactive elements
15. NPI – National pollution inventory (contact Department of Environmental Protection for information on NPI listed substances)

Ore process methods

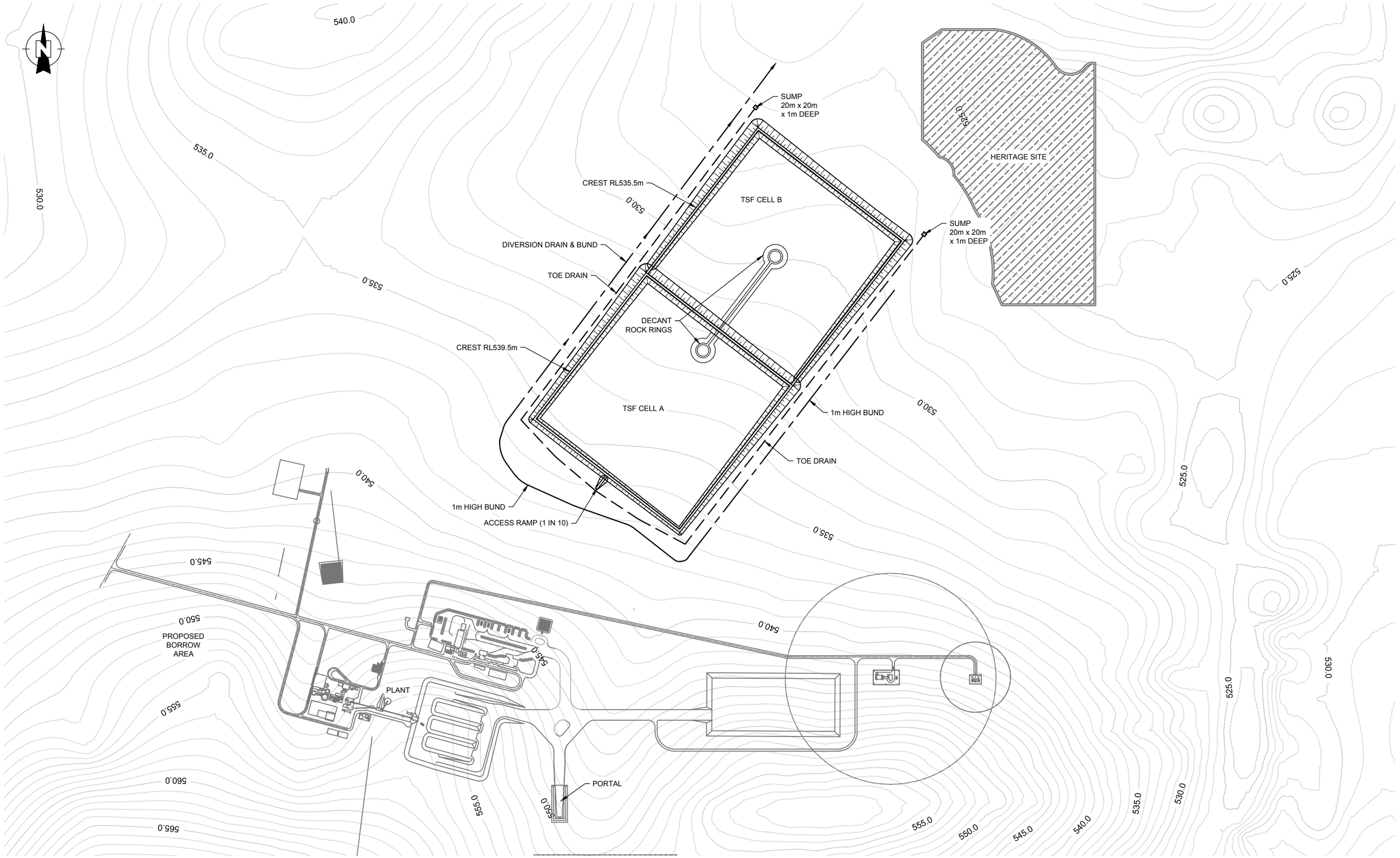
The ore process methods may be recorded as follows:

Acid leaching (Atmospheric)	Flotation
Acid leaching (Pressure)	Gravity separation
Alkali leaching (Atmospheric)	Heap leaching
Alkali leaching (Pressure)	Magnetic separation
Bayer process	Ore sorters
Becher process	Pyromet
BIOX	SX/EW (Solvent extraction/Electro wining)
Crushing and screening	Vat leaching
CIL/CIP	Washing and screening


ABRA TSF - STORAGE CAPACITY CURVES
550
545
540
535
530
525
RL (m)
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
CUMULATIVE STORAGE VOLUME (m^3)
1 – Cell A
1 – Cell B

Appendix A

Drawings (4 No.)



CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

NOTES:

1. BASE PLAN PROVIDED BY CLIENT

1:10 000 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: LAND & MARINE GEOLOGICAL SERVICES PTY LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TSF DESIGN		CHECKED: CL	DRAWING: 01
		REVISION: 1	SCALE: 1:10,000
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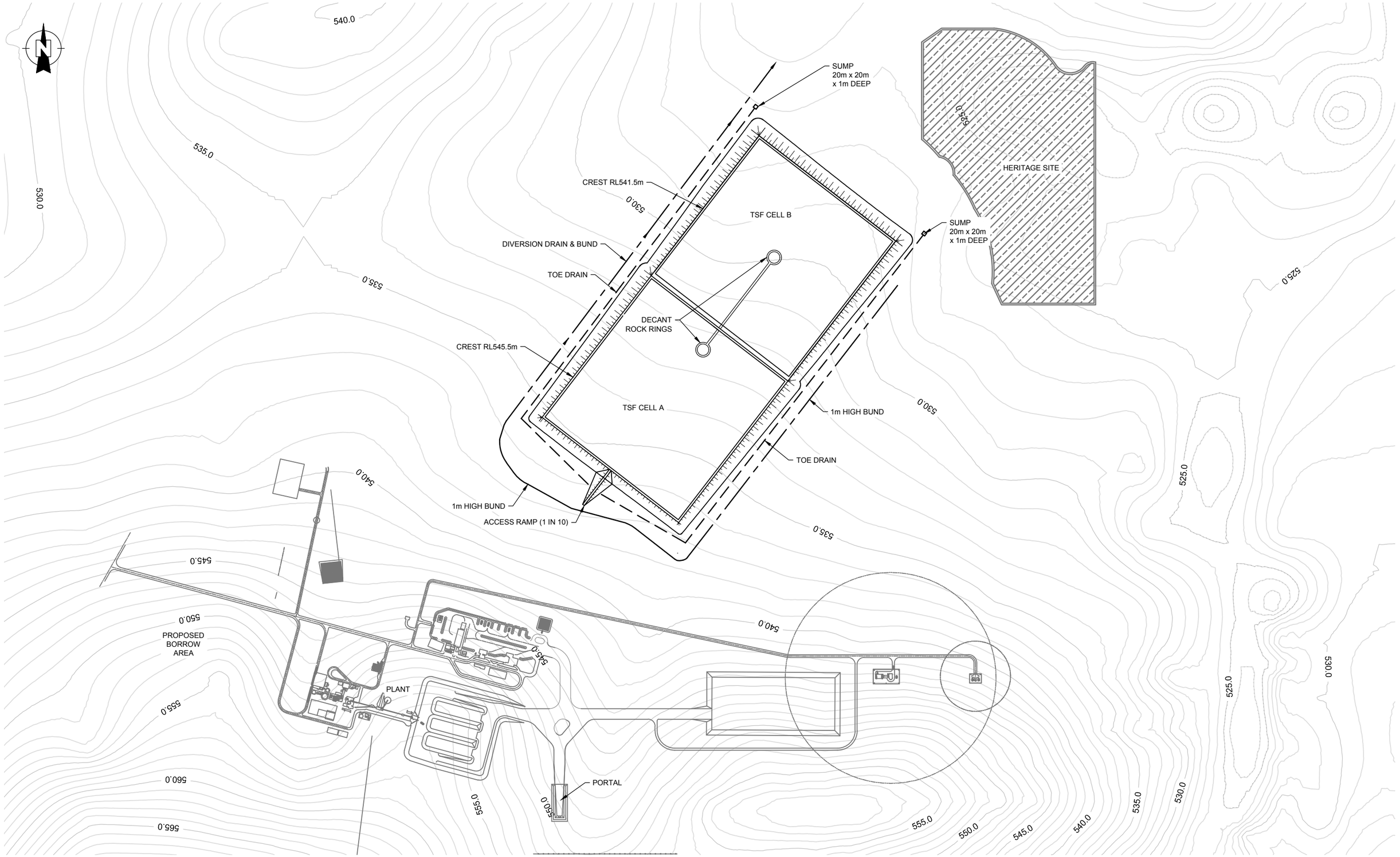

CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

NOTES:

1. BASE PLAN PROVIDED BY CLIENT

1:10 000 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: LAND & MARINE GEOLOGICAL SERVICES PTY LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TSF DESIGN		CHECKED: CL	DRAWING: 02
		REVISION: 1	SCALE: 1:10,000
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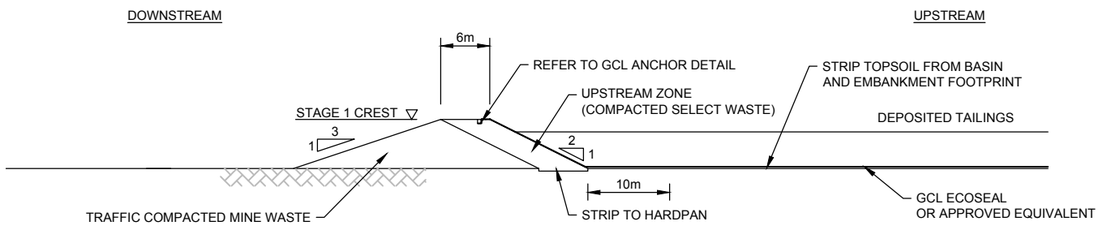

A - SECTION A - STARTER EMBANKMENT
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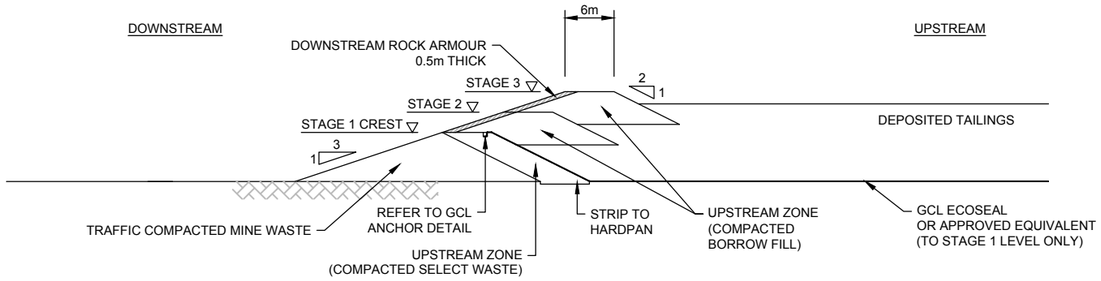

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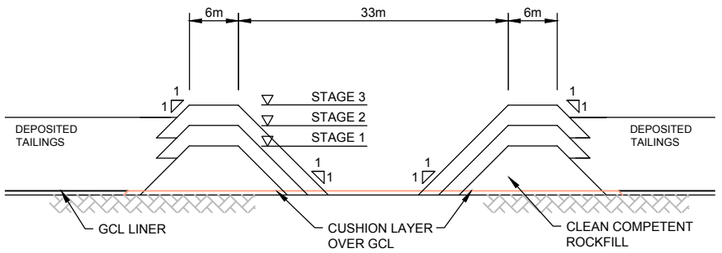
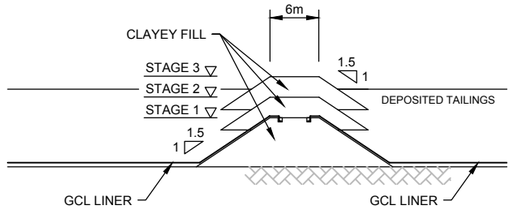


B - SECTION B - ROCK RING DECANT
1:750



C - SECTION C - DIVIDING WALL
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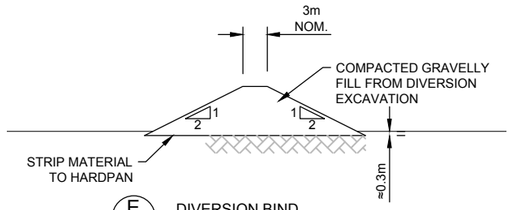

E - DIVERSION BIND
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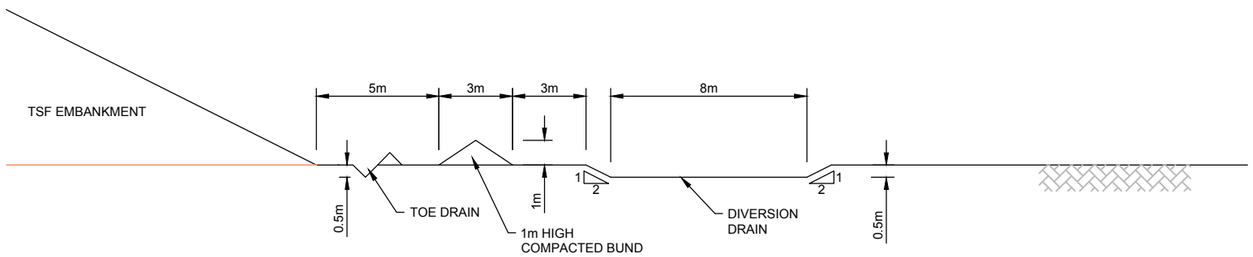

D - DRAINAGE DIVERSION
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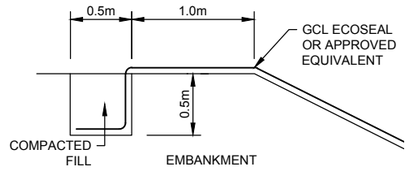


F - ANCHOR DETAIL
1:50

CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

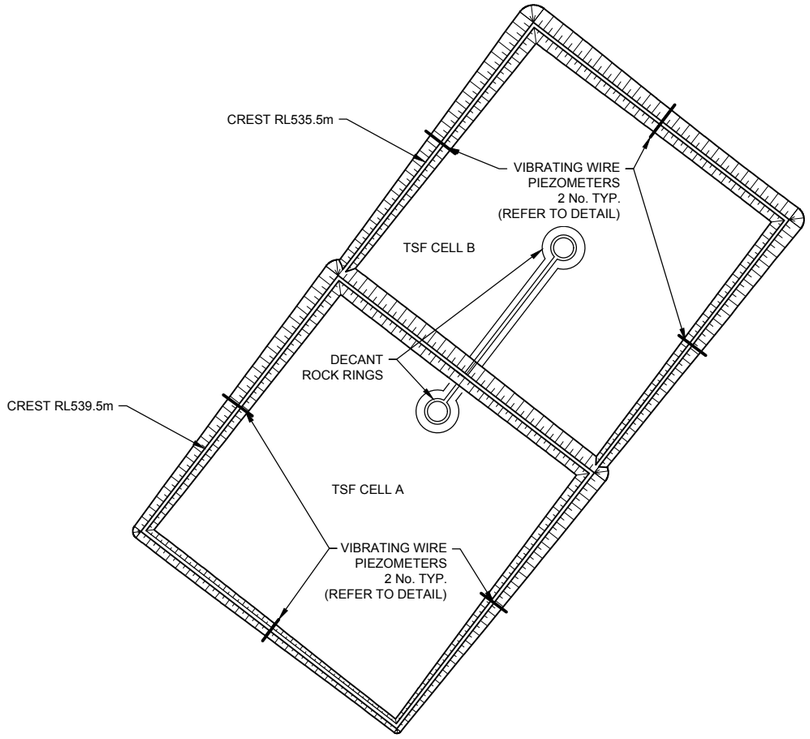
1:250 0 2.5 5 7.5 10 12.5 m

1:750 0 7.5 15 22.5 30 37.5 m

1:10 000 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: GALENA MINING LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TAILINGS STORAGE FACILITY		CHECKED: CH	DRAWING: 03
		REVISION: 1	SCALE: AS SHOWN
TITLE: SECTIONS AND DETAILS		DATE: 23.10.18	SHEET: A3 L



EMBANKMENT PIEZOMETER PLAN
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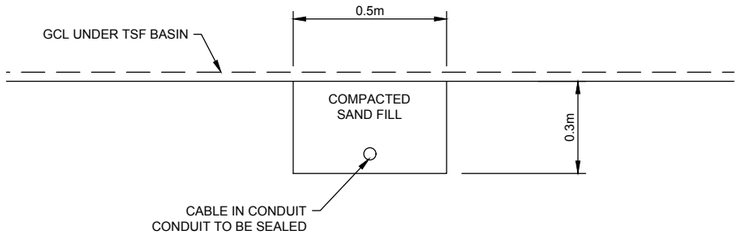

VWP TRENCH - TYPICAL DETAIL
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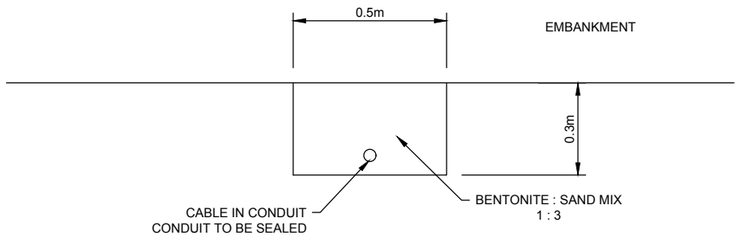

BENTONITE COLLAR - TYPICAL DETAIL
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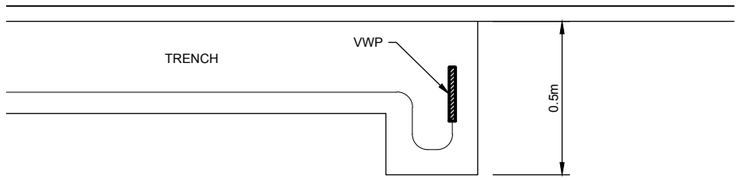

VIBRATING WIRE PIEZOMETER - TYPICAL DETAIL
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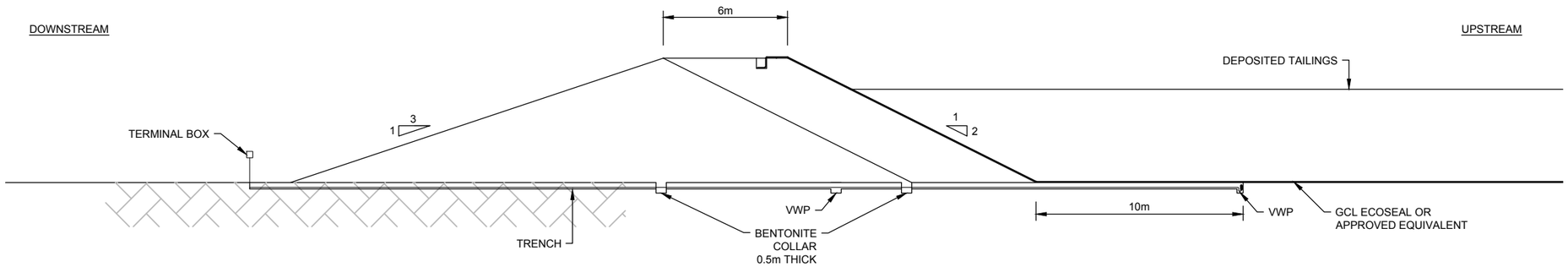


A - SECTION A - STARTER EMBANKMENT
1:250

CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

1:250 — 0 2.5 5 7.5 10 12.5 m

1:10 000 — 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: LAND & MARINE GEOLOGICAL SERVICES PTY LTD		DRAWN: LF	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TSF DESIGN		CHECKED: CL	DRAWING: 04
		REVISION: 1	SCALE: AS SHOWN
TITLE: INSTRUMENTATION ARRANGEMENT AND DETAILS		DATE: 23.10.18	SHEET: A3 L

Appendix B

Geotechnical Investigation Report

Appendix C

Technical Specification and Schedules of Quantities

16 October 2018

TAILINGS STORAGE FACILITY

ABRA BASE METALS PROJECT, NEAR MEEKATHARRA, WA

SCOPE OF WORKS AND TECHNICAL SPECIFICATION

Galena Mining Limited

Ref. PER2018-0128AG SOW Spec

Rev1

Unit 19 Wembley Green Offices,
127 Herdsman Parade, Wembley, WA 6014

www.cmwgeosciences.com

Table of Contents

1 INTRODUCTION

This Scope of Work covers the construction of the embankments for the Tailings Storage Facility and associated infrastructure and is to be read in conjunction with the Drawings.

The works mainly involve bulk earthworks to construct the perimeter embankments and decant facilities, and installation of a Geosynethic Clay Liner (GCL) for the Tailing Storage Facility.

The Scope of Work shall comprise the provision of all material, construction plant, equipment, labour, supervision, tools, services, warehousing if required, testing equipment, and each and every item of expense necessary for the construction, acceptance testing and preparing of "as built" drawings and documents for work shown in the drawings, schedules and specifications forming part of the construction of the tailings storage embankments for the Tailing Storage Facility (TSF) at the at the Abra Base Metals Project.

All works shall be constructed complete and operational except as specifically excluded and shall include all necessary auxiliary works, accessories and the incorporation of all miscellaneous material, minor parts and other such items, whether or not the items are specified, where it is clearly the intent that they should be supplied or where they are obviously required and necessary to complete and commission the work.

1.1 Drawings

The following Drawings complete this Scope of Work:

Table 4: Drawings

Title	Drawing No.
General Arrangement – Stage 1	PER2018-0128-01
General Arrangement – Final Stage	PER2018-0128-02
Sections and Details	PER2018-0128-03
Instrumentation Arrangement and Details	PER2018-0128-04

1.2 Code of Practice

Unless otherwise specified, or shown on the drawings, the Contractor is to provide all materials and carry out all the work in accordance with the latest revisions of the relevant Australian Standard Codes.

All work under this Contract shall be performed strictly in accordance with the following specifications, drawings and other documents, which by this reference forms part of this Contract, unless expressly noted otherwise.

AS 1289 Methods of testing soils for engineering purposes.

AS 1726 Geotechnical site investigations.

AS 3798 Guidelines on earthworks for commercial and residential developments.

The Works shall be carried out to comply with the latest revision of the Drawings, Codes and Standards specified, or where no standards are specified, to Australian Standards, or to the appropriate British or other recognised Standards.

Before making any change in any work under the Contract to comply with any revisions to the relevant codes and standards, the Contractor shall give to the Galena Mining Limited (Principal) written notice specifying the reason therefore and requesting his direction thereon. The Principal shall decide whether a change is necessary and issue an order accordingly under the provisions of the General Conditions of Contract.

1.3 Site inspection

The Contractor shall inspect the site and must allow for the following factors in their price:

- The nature and requirements of the work to be done.
- All conditions on and adjacent to the site.
- Access to the site.
- The types of soil and vegetation present on the site.
- The expected or known water table.
- The nearest sources of suitable construction material which complies with this Specification.
- The source of water for construction purposes.
- The Contractor is to manage saline water usage, hydrocarbon storage and dust suppression to the Principal's requirements.
- Prevailing climatic conditions for the site.

1.4 Safety

The Contractor shall:

- Carry out the works in a safe manner and comply with all of Principal's procedures and guidelines.
- Conform to all relevant Acts or Statutes of Parliament, Regulations, By-Laws or Orders relating to the safety of persons and property on or about the site.

1.5 Site location and description

The site is approximately 61 hectares in total area and comprises the proposed two cell, TSF site. The TSF site is located approximately 500 m north of the proposed plant site at Abra Base Metals Project.

2 DESCRIPTION OF WORK – SPECIFIC

The Scope of Work shall include, but is not necessarily limited to the following:

2.1 General

The work shall include:

- Attend a Site Induction of approximately five (5) hours' duration before the commencement of works if they have not already attended one in the last six (6) months.
- Carry out all works indicated or implied in the Drawings or in the Specification.
- Supply all labour, plant and materials (except those indicated as being supplied by the Principal) necessary for completion of the works.
- Maintain all works as required by the Contract documents and for the period stated therein.

All construction shall be to the minimum lines and grades shown on the Drawings or as required by the Owner's Representative as work progresses.

During the progress of the works, the Owner's Representative may find it necessary to revise the lines, levels and grades of any part of the works because of the conditions revealed by the works.

2.2 Survey

The Principal will supply survey services including:

- Supply of survey datums/bench marks.
- Initial pegging of the embankment toes.
- Initial pickup of the embankment foundations.
- As built survey of the completed works
- Estimation of earthworks placed.

The Contractor shall:

- Be responsible for the protection of all permanent and temporary beacons or bench marks, and Principal supplied pegging.
- Setting out and construction of the works from the Principal supplied pegging provided.
- Ensure initial and/or final surveys are undertaken by the Principal prior to the removal or placement of any material, especially where such action will destroy or cover the surface just surveyed.

The Contractor may undertake their own survey of any item, either in conjunction with the Principal, or separately. The Contractor and Owners Representative shall agree on the results of measurement surveys that are carried out prior to any works being covered up or within seven (7) days of a survey being undertaken. Should agreement not be reached, the difference shall be documented such that the matter can be later decided without disruption to the Contractor's programme.

The maximum permissible horizontal deviation from the finished lines or zone boundaries shall be -0 m to +0.5 m.

Vertical deviation shall be -0 m to +0.2 m, provided no abrupt changes in slope or level are present on any finished surface.

Measurement for payment of all embankment fill material shall be made for the compacted material, measured in place and only to the design lines and grades required (excluding ‘tolerances’).

2.3 Clearing and Establishment Works

The work shall include:

- Remove all vegetable matter and scrub from the area of the proposed TSF footprint. The area to be cleared shall extend approximately 5 m past the downstream toe of the embankment. All stripped vegetation should be pushed into heaps in locations as indicated by the Owner’s Representative.
- Remove all solid obstructions, tree stumps, roots and logs from beneath the footprint of the TSF perimeter embankment.
- Clear the agreed routes of all haul roads of all vegetation standing and fallen. Push this vegetation into heaps as approved by the Owner’s Representative.
- Form up, lay base course as is necessary and do all things necessary to form and maintain haul roads linking the pit area to the site and other haul roads necessary for the works and which are approved by the Owner’s Representative.
- Keep all haul roads sprayed and wetted to totally prevent the generation of airborne dust during the course of road construction and usage.
- Prepare a quality assurance and quality control programme to cover all aspects of work included within this Construction Specification for the Principals approval.

- On subsequent stages, remove gravel wear course materials from the embankment crests, and stockpile for re-use if possible.
- Provide all things necessary to implement the approved QA/QC programme.

2.4 Foundation Preparation

The work shall include:

- Strip topsoil from the TSF footprint to a nominal depth below the natural ground surface of 0.1 m. The depth of stripping may be increased as directed by the Owner's Representative. Stockpiling of topsoil shall be in areas nominated by the Owner's Representative. Stockpiles shall have a maximum height of 2.0 m and side slopes of 1 (vertical) to 1.5 (horizontal).
- Tyne, moisture condition (to within –2% / +2% of OMC) and compact the TSF embankment foundation to a depth of 0.3 m. The prepared surface of the embankment footprint should be compacted using a minimum of 6 passes of a 12t vibratory roller.
- All areas to receive fill shall be left in a clean and suitable condition to allow an uninterrupted placement of fill. No fill shall be placed in the cut-off until the base of all excavations has been inspected and approved by the Owner's Representative.
- Allow for keeping water from excavations by pumping, dewatering, or other suitable means, and adequately dispose of it clear of the works.
- The instrumentation as shown on drawing PER2018-0128-04 should be installed at the foundation preparation stage.

2.5 Earthworks

2.5.1 TSF Embankment Construction – Upstream Zone

The work shall include:

- Construct the tailings storage embankment using selected approved silty borrow material from borrow area located south west of the TSF site or raise bore fines waste material sourced from the underground operation. Suitable material shall comprise well graded clay free of organic matter and other deleterious material. The material shall comply with the following limits:
    - Fines content (material finer than 75 micron), greater than 10 %.
    - Fines shall be low plasticity with a Plasticity index (PI) less than 30 %.
    - Maximum particle size, 150 mm
    - Blasting in the borrow area located south west of the TSF site may be required to generate sufficient fines in the material.

Prior to construction, the borrow area should be confirmed. Only material approved by the Engineer/Owner's Representative should be utilised in construction.

The contractor shall:

- Adjust the moisture content of the select mine waste, approved for use in the perimeter embankment construction. Moisture condition the borrow to within the range of -2 %, +2 % of the optimum moisture content (OMC) as determined from laboratory test 5.1.1 of AS1289. The borrow materials shall be cured to ensure the moisture is thoroughly mixed and evenly spread through all materials proposed for embankment construction.

- Place all fill material comprising the perimeter embankment in homogeneous horizontal layers not exceeding 0.3 m loose lift thickness. Each lift shall be compacted by a minimum of 6 passes of a 12 t vibratory roller or approved equivalent. Placement should be continuous. If a break in fill placement allows the exposed surface to dry, it should be lightly tyned, watered and compacted prior to fill placement recommencing. No oversize rock is to be placed into the embankments. Largest size should be 150 mm.
- Each layer shall be compacted to achieve a density ratio greater than 95 % of the maximum dry density - standard compaction as determined from laboratory test AS 1289.5.1.1. The actual number of passes of a 12 t vibratory roller or an approved equivalent to achieve a density greater than 95% standard compaction (AS 1289.5.1.1) shall be determined on site using roller trials.
- Construct the downstream zone of the starter embankment using traffic compacted mine waste from the underground operations and stockpiled in a dump near the TSF. The material shall be moisture conditioned in the pit area to within the range of -2 %, +2 % of the optimum moisture content (OMC) as determined from laboratory test 5.1.1 of AS1289. Make-up water can be added on the embankment. The fill material shall be placed in homogeneous horizontal layers not exceeding 1 m loose lift thickness. Each lift shall be compacted by trafficking the full width of the layer with mining equipment.
- All materials shall be stockpiled, transported and placed in such a manner as to minimise segregation.
- Construct and maintain haul road(s) between the ramp at the borrow area and the works at the TSF.
- Construct and maintain access ramps as required to enable the construction equipment to access the TSF. The location of these ramps shall be approved by the Owner's Representative prior to commencement of these works. The ramps may be left in place at the discretion of the Principal.
- The crests of the completed embankment shall be graded to the inside (upstream) of the storage at a 2% cross fall. A windrow of not less than 0.5 m height (or 1/2 wheel height of largest vehicle) shall be left on the outside of the crest of embankment.
- Sheet the crest of the perimeter and internal embankments, and the decant accessway with 100 mm thick gravel wearing course. The wearing course gravel shall be sourced from a location nominated by the Owner's Representative (i.e. Calcrete borrow area north of the project area) and from reclaimed gravel wear course materials if deemed suitable for reuse (subsequent stages).
- Carry out testing to comply with the Specification and QA/QC procedures.
- Allow for keeping water from the works during construction by shaping finished surfaces with a fall to the storage.

2.5.2 Decant Accessway

The work shall include:

- Construct the decant accessway using traffic compacted mine waste sourced from mine waste dump areas located adjacent to the storage.
- The mine waste should be placed in layers no greater than 1.5 m thick and trafficked by construction equipment across the full width of the layer.

2.6 Decant structure

The decant structure will comprise a rock ring type decant. Refer to drawing PER2018-0128-03 for details.

Only clean select rock fill material with a low fines content shall be placed to form the rock ring decant. Select rock fill material shall be selected clean, fines-free (<3 % passing 75 µm), competent rock mine waste with a well-graded particle size distribution between 50 mm and 300 mm. All filter rock shall be carefully placed in such a manner as to minimise segregation.

The Contractor shall:

- Complete the foundation preparation of the decant area (i.e. placement of a minimum 0.3 m thick cushion layer over the GCL).
- Transport all materials to construct the decant.
- Transport select decant filter rock from the designated source and place around the decant. Selected rock shall comprise clean mine waste material, free of fines, sourced from a location nominated by the Owner's Representative.

2.7 Geosynethic Clay Liner

Work will include:

- The upstream batter of the Stage 1 perimeter embankments and the TSF basin shall be lined, as shown on the Drawings, to the crest RL of the embankment. The liner shall be installed onto a 'smooth' surface, free of projections that could damage the liner. In order to achieve a smooth finish, a smooth drum 12 t vibratory roller could be used on the foundation, where appropriate.
- The liner material shall comprise Ecoseal GCL or an approved equivalent.

The Contractor shall:

- Install, join, and anchor the liner in accordance with the manufacturer's recommendations. The finished GCL shall be stabilised with sand bags or similar and this stabilisation shall remain in place until covered with tailings. Details shall be provided for approval by the Owner's Representative.
- Ensure that the liner is quality control tested (both destructive and non-destructive) in accordance with the manufacturer's recommendations. Details of test procedures, all test reports and all quality assurance reports are to be submitted to the Principal's Representative.
- Ensure that all liner joins are generally constructed at 90^{o} to the embankment crests. The liner shall not be joined parallel to the embankment crest.
- Advise at the time of tender the name of the installer of the GCL for approval by the Principal. In addition, a description of processes to be adopted, equipment to be utilised and all necessary documentation in regard to QA/QC shall be provided.

The Contractor shall supply the following information with their tender:

- Liner specification
- Manufacturer's sampling and testing
- Inspection, supervision and installation methodology
- Proposed supervision and installation personnel proving experience on a similar size project
- Quality Assurance plan.

- Installation methodology
- layout drawing showing sheet numbers

Any defective or damaged liner will be rejected and replaced at the Contractor's cost.

2.8 Completion

The Contractor shall:

- Batter down the sides of the borrow pits, as appropriate, for stability on completion of the work. Materials not considered suitable for use in the works shall be evenly spread over the borrow pit surface.
- Clean up all rubbish, remove all plant and supply materials, trim all banks neatly, spread all excavated material not specified to be removed from the site and leave the site in a clean and tidy condition.

2.9 Construction sequence

The Contractor shall liaise with the Principal to agree a sequence for the works. The Contractor shall endeavour to complete the perimeter embankments in the sequence agreed.

3 EXCLUSIONS

The following works will be performed by others:

- At the completion of the construction of the embankments, the Principal will install the tailings distribution pipework (pipes, spigots, droppers etc) on the embankment crest.
- Placement of all pump equipment at the decant.
- Crushing and screening of waste rock to produce road-base and decant filter rock.
- Placement of all associated electrical equipment at the decant structure.

The Contractor shall:

- Fully co-operate with the pipe handling and operating crew and shall work in with their activities at all times.
- Avoid damaging the tailings distribution pipework and any electrical installations which is either operational or has been removed from the crest of the storage by the Principal. Any pipework or electrical equipment damaged by the Contractor through carelessness shall be replaced at no additional cost to the Principal.

4 PRINCIPAL SUPPLIED ITEMS

4.1 Survey

The Principal will provide co-ordinates and levels of survey marks within the vicinity of the storage. The works shall be set out all lines and levels using the survey marks provided.

4.2 Materials

The Principal will supply mine waste for construction of the embankment from designated sources. The Contractor shall make their own arrangements for loading and hauling of materials.

4.3 Water

Water will be made available to the Contractor at no charge. Supply will be from a standpipe located at the plant site. Access to the standpipe will not be exclusive to the Contractor. The Contractor shall determine the type and suitability of the water supplies for use in this Contract. The Contractor shall make their own arrangements for loading and hauling of water.

5 QUALITY CONTROL AND QUALITY ASSURANCE

The required quality standards for implementation of this Scope of Work are the ISO 9001:2000 Standard Series and the Contractor shall comply with the requirements of these standards.

6 INSPECTION AND TESTING

6.1 Inspection

The Owners Representative will be entitled, at all times to inspect, examine and test the materials and workmanship being provided under the Contract. Such inspection, examination or testing, if made, shall not release the Contractor from any obligation under the Contract.

The Contractor shall co-operate with and provide full opportunity to the Owners Representative to monitor regularly the progress of the Works of the Contractor and his Subcontractors to the detailed extent necessary to satisfy progress relative to the Construction Program.

All pertinent information to enable the Owners Representative to determine the adequacy of the advance planning for material procurement, machine and manpower resources to meet the Construction Program shall be made freely available to the Owners Representative.

These requirements shall be incorporated in orders placed with Subcontractors.

6.2 Test Plans

Compliance tests will be carried out by a qualified technician from a NATA registered laboratory engaged by the Contractor.

Compliance testing of compaction shall be at the rate of not less than 1 field density test per layer per material type per 2,500 m^2 (or 1 test per 750 m^3) – select mine waste only. Standard compaction testing should be performed (as a minimum) to a ratio of 1 standard compaction to 3 field density tests, or as directed by the Owners Representative. It is envisaged that the laboratory technician will be required on site full time during starter embankment construction.

The Contractor shall, at their own expense, rework or replace and re-test materials which do not meet the compaction requirements.

No testing of the downstream zone is envisaged.

The Contractor shall, at his own expense, rework or replace materials which do not meet the compaction and other compliance requirements.

Test certificates shall be made available to the Owner’s Representative on an ongoing basis throughout the construction.

7 PERMITS, LICENCES AND APPROVALS

Further to the General Conditions of Contract, the Principal will obtain the Department of Mines, Industry Regulation and Safety (DMIRS) and Department of Water and Environmental Regulation (DWER) approvals.

All other necessary permits, licenses and approvals shall be obtained by the Contractor.

8 SUBSTITUTIONS

The Contractor shall:

- Not substitute any alternative to the equipment and materials included in the Works without the prior written consent of the Principal.
- Make diligent efforts to utilise the specified Materials to be incorporated into the Works but where the Contractor considers there are commercial or other advantages to be derived by the Principal, the Contractor may submit a proposal for a substitute material for approval by the Principal prior to commencement of the work. Such proposal for substitution shall be in writing and state reasons for and (if applicable) advantages of the substitute material. The Principal shall determine whether the substitute material will be permitted and such determination shall be binding and conclusive upon the Contractor. Approval of a substitution will be given as a variation under of the General Conditions of Contract incorporating any adjustment to the Contract Sum.

9 MATERIALS

Where the Principal agrees to supply Materials to the Contractor in the performance of the Contract then the following conditions will apply:

- The items shall be included in the Contractor's materials procurement schedules. The Contractor shall, upon arrival at Site to commence work, check and ensure that Principal Supplied Materials are available and will not cause any delay to the Contractor's work progress.
- Items stored by the Principal, shall be removed from the Principal's store or storage area by the Contractor when required by him or when directed by the Owner’s Representative (whichever is the sooner). However, no items shall be removed from the Principal's store or storage area by the Contractor without first obtaining authority from the Owners Representative and the Contractor shall sign receipts or other documentation required acknowledging receipt of the Free Issue Materials.
- From the time the Principal Supplied Materials are removed from the Principal's store or storage area or are delivered to the site the Contractor shall be responsible for and shall keep safely and in good order all those Principal Supplied Materials including any returnable packing or containers.
- The Contractor shall account for all Principal Supplied Materials used and shall return to the Principal in good order and condition any Principal Supplied Materials remaining unused on completion of the work. Subject to any insurance cover the Contractor shall be responsible for the cost of replacement or repair of any Principal Supplied Materials lost or damaged while he is responsible therefore.
- The Contractor shall immediately notify the Owners Representative of any damaged to or loss of any of those Principal Supplied Materials at any time and shall as soon as possible specify the extent and circumstances of the damage or loss.
- Principal Supplied Materials used by the Contractor are used at the sole risk of the Contractor. Any failure to perform the Contract by the Contractor shall not be excused by any matter or thing arising from or incidental to the use of Principal Supplied Materials.

10 DATA REQUIREMENTS

As built Drawings, should be supplied to the Owner's Representative within 14 days of practical completion of the work.

11 ESTIMATE OF QUANTITIES

A preliminary estimate of quantities has been provided to allow material requirements to be gauged for staged construction. The figures have not been calculated by a Quantity Surveyor and are provided for convenience only.

Estimate of Quantities

Date	24-Oct-18
Job No	PER2018-0128
File	
Subject	Quantities
Revision	A

PROJECT **TAILINGS STORAGE FACILITY**

CLIENT **GALENA MINING LIMITED**

LOCATION **ABRA BASE METALS PROJECT**

Item	Description	Unit	Quantity	Rate	Amount
1.00	**CELL A STAGE 1 CONSTRUCTION**				
	Preliminaries & Site Preparation				
1.01	Site establishment, including all preliminaries, insurances etc, mobilisation, demobilisation, borrow management, maintenance of existing tracks	Item	1		$ -
1.02	Site clearing including grubbing and stockpiling of vegetation from the TSF footprint area (extend approx 5m past the final downstream toe of embankments)	ha	33		$ -
	Earthworks				
1.03	Strip topsoil (0.1m thick) from TSF footprint area and stockpile separately from vegetation	m^3	32,600		$ -
1.04	Prepare perimeter embankment foundation	m^2	72,000		$ -
1.05	Borrow, transport, place and roller compact select mine waste	m^3	69,000		$ -
1.06	Borrow, transport, and place traffic compact mine waste to downstream zone	m^3	188,000		$ -
1.07	Borrow, transport, place and traffic compact mine waste to decant accessway	m^3	1,750		$ -
1.08	Sheet perimeter embankment and decant accessway crests with 0.1m thick laterite gravel (4m width x0.1m depth).	m^3	835		$ -
1.09	Excavate diversion drain and construct bund - west side	m^3	12,700		$ -
1.10	Construct 1m high bund - east and south side	m	2,795		
1.11	Construct toe drain	m	1,700		$ -
1.12	Construct toe drain sumps	no.	2		
2.00	**Decant Structure**				
2.01	Place cushion layer, 0.3m min. thick over GCL	m^3	800		$ -
2.02	Place select filter rock to form decant ring	m^3	10,000		$ -
3.00	**GCL Liner**				
3.01	Supply and install GCL liner	m^2	271,000		$ -
	SUB-TOTAL				**$ -**
3.0	**Ancillary Items**				
3.01	Airfares for Contractors / Superintendent personnel	No.			$ -
3.02	Accommodation and meals for Contractors	Person days			$ -
3.03	Fuel supplied by Principal	L	0		$ -
3.04	Construction monitoring costs (Superintendent and vehicle incl misc)	Item			by Client
3.05	QA/QC Geotechnical Testing	Days			by Client
3.06	Construction report and office support	Allow			by Client
	SUB-TOTAL				**$ -**
	TOTAL COST-STAGE 1				**$ -**

Notes:

Date	24-Oct-18
Job No	PER2018-0128
File	
Subject	Quantities
Revision	A

PROJECT **TAILINGS STORAGE FACILITY**

CLIENT **GALENA MINING LIMITED**

LOCATION **ABRA BASE METALS PROJECT**

Item	Description	Unit	Quantity	Rate	Amount
1.00	**CELL B STAGE 1 CONSTRUCTION**				
	Preliminaries & Site Preparation				
1.01	Site establishment, including all preliminaries, insurances etc, mobilisation, demobilisation, borrow management, maintenance of existing tracks	Item	1		$ -
1.02	Site clearing including grubbing and stockpiling of vegetation from the TSF footprint area (extend approx 5m past the final downstream toe of embankments)	ha	31		$ -
	Earthworks				
1.03	Strip topsoil (0.1m thick) from TSF footprint area and stockpile separately from vegetation	m^3	30,500		$ -
1.04	Prepare perimeter embankment foundation	m^2	62,000		$ -
1.05	Borrow, transport, place and roller compact select mine waste	m^3	59,000		$ -
1.06	Borrow, transport, and place traffic compact mine waste to downstream zone	m^3	168,000		$ -
1.07	Borrow, transport, place and traffic compact mine waste to decant accessway	m^3	5,250		$ -
1.08	Sheet perimeter embankment and decant accessway crests with 0.1m thick laterite gravel (4m width x0.1m depth).	m^3	2,250		$ -
1.09	Construct diversion drainage	m^3	In Cell A		
1.10	Construct toe drain	m	1,100		$ -
1.11	Construct toe drain sumps	no.	2		
2.00	**Decant Structure**				
2.01	Place cushion layer, 0.3m min. thick over GCL	m^3	700		$ -
2.02	Place select filter rock to form decant ring	m^3	7,500		$ -
3.00	**GCL Liner**				
3.01	Supply and install GCL liner	m^2	265,000		$ -
	SUB-TOTAL				**$ -**
3.0	**Ancillary Items**				
3.01	Airfares for Contractors / Superintendent personnel	No.			$ -
3.02	Accommodation and meals for Contractors	Person days			$ -
3.03	Fuel supplied by Principal	L	0		$ -
3.04	Construction monitoring costs (Superintendent and vehicle incl misc)	Item			by Client
3.05	QA/QC Geotechnical Testing	Days			by Client
3.06	Construction report and office support	Allow			by Client
	SUB-TOTAL				**$ -**
	TOTAL COST-STAGE 1				**$ -**

Notes:

Date	24-Oct-18
Job No	PER2018-0128
File	
Subject	Quantities
Revision	A

PROJECT **TAILINGS STORAGE FACILITY**

CLIENT **GALENA MINING LIMITED**

LOCATION **ABRA BASE METALS PROJECT**

Item	Description	Unit	Quantity	Rate	Amount
1.00	**CELL A STAGE 2 UPSTREAM RAISING CONSTRUCTION TYPICAL**				
	Preliminaries & Site Preparation				
1.01	Site establishment, including all preliminaries, insurances etc, mobilisation, demobilisation, borrow management, maintenance of existing tracks	Item	1		$ -
1.02	Site clearing including grubbing and stockpiling of vegetation from the TSF footprint area (extend approx 5m past the final downstream toe of embankments)	ha	0		$ -
	Earthworks				
1.03	Strip topsoil (0.1m thick) from TSF footprint area and stockpile separately from vegetation	m^3			$ -
1.04	Prepare perimeter embankment foundation	m^2			$ -
1.05	Borrow, transport, place and roller compact select mine waste	m^3	90,000		$ -
1.06	Borrow, transport, place and traffic compact mine waste to decant accessway (8m crest)	m^3	1,750		$ -
1.07	Sheet perimeter embankment and decant accessway crests with 0.1m thick laterite gravel (4m width x0.1m depth).	m^3	800		$ -
2.00	**Decant Structure**				
2.01	Place select filter rock to raise decant ring	m^3	2,200		$ -
	SUB-TOTAL				**$ -**
3.0	**Ancillary Items**				
3.01	Airfares for Contractors / Superintendent personnel	No.			$ -
3.02	Accommodation and meals for Contractors	Person days			$ -
3.03	Fuel supplied by Principal	L	0		$ -
3.04	Construction monitoring costs (Superintendent and vehicle incl misc)	Item			by Client
3.05	QA/QC Geotechnical Testing	Days			by Client
3.06	Construction report and office support	Allow			by Client
	SUB-TOTAL				**$ -**
	TOTAL COST-STAGE 2				**$ -**

Notes:

Date	24-Oct-18
Job No	PER2018-0128
File	
Subject	Quantities
Revision	A

PROJECT **TAILINGS STORAGE FACILITY**

CLIENT **GALENA MINING LIMITED**

LOCATION **ABRA BASE METALS PROJECT**

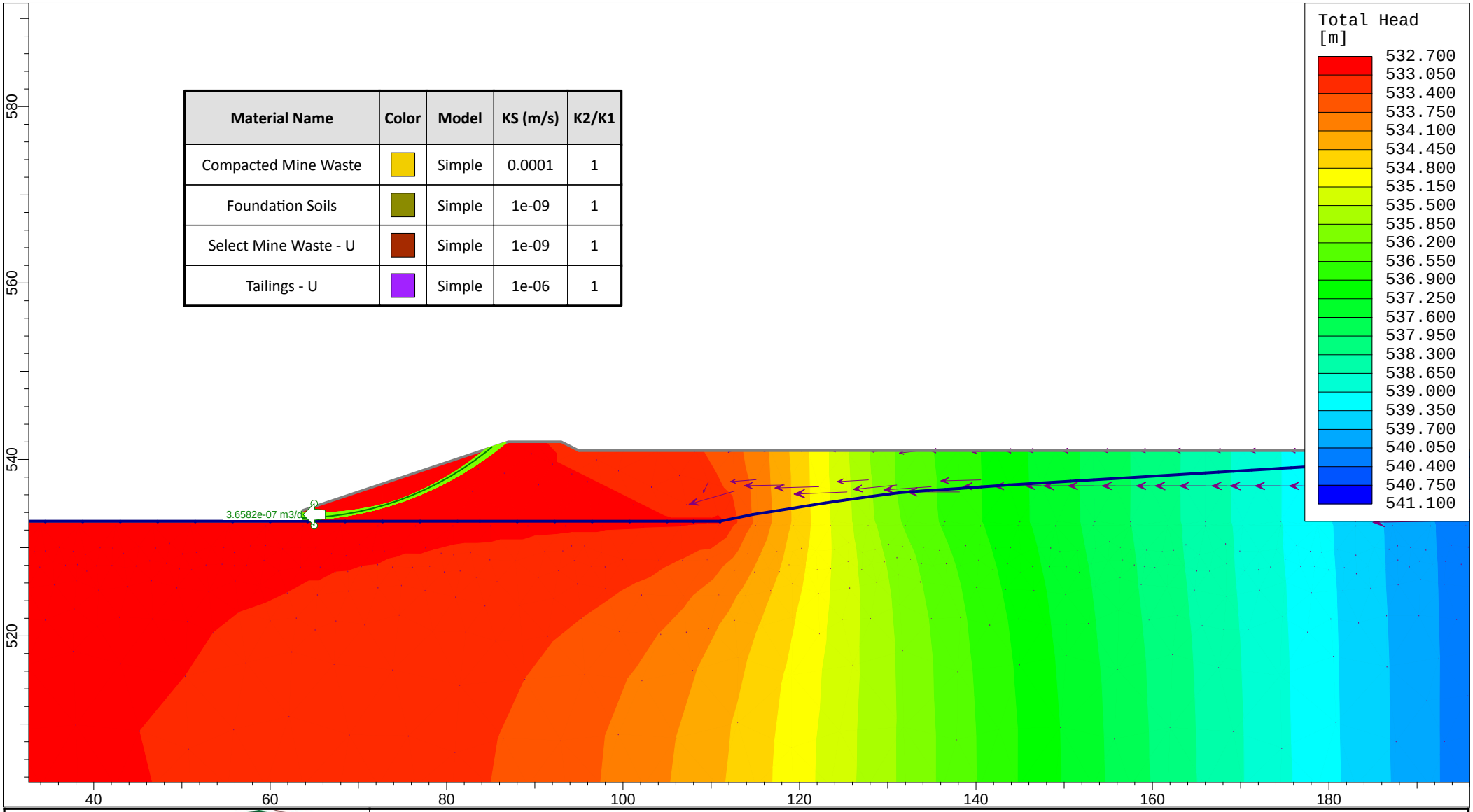
Item	Description	Unit	Quantity	Rate	Amount
1.00	**CELL B STAGE 2 UPSTREAM RAISING CONSTRUCTION TYPICAL**				
	Preliminaries & Site Preparation				
1.01	Site establishment, including all preliminaries, insurances etc, mobilisation, demobilisation, borrow management, maintenance of existing tracks	Item	1		$ -
1.02	Site clearing including grubbing and stockpiling of vegetation from the TSF footprint area (extend approx 5m past the final downstream toe of embankments)	ha	0		$ -
	Earthworks				
1.03	Strip topsoil (0.1m thick) from TSF footprint area and stockpile separately from vegetation	m^3			$ -
1.04	Prepare perimeter embankment foundation	m^2			$ -
1.05	Borrow, transport, place and roller compact select mine waste	m^3	80,000		$ -
1.06	Borrow, transport, place and traffic compact mine waste to decant accessway (8m crest)	m^3	12,400		$ -
1.07	Sheet perimeter embankment and decant accessway crests with 0.1m thick laterite gravel (4m width x0.1m depth).	m^3	720		$ -
2.00	**Decant Structure**				
2.01	Place select filter rock to raise decant ring	m^3	2,200		$ -
	SUB-TOTAL				**$ -**
3.0	**Ancillary Items**				
3.01	Airfares for Contractors / Superintendent personnel	No.			$ -
3.02	Accommodation and meals for Contractors	Person days			$ -
3.03	Fuel supplied by Principal	L	0		$ -
3.04	Construction monitoring costs (Superintendent and vehicle incl misc)	Item			by Client
3.05	QA/QC Geotechnical Testing	Days			by Client
3.06	Construction report and office support	Allow			by Client
	SUB-TOTAL				**$ -**
	TOTAL COST-STAGE 2				**$ -**

Notes:

Appendix D

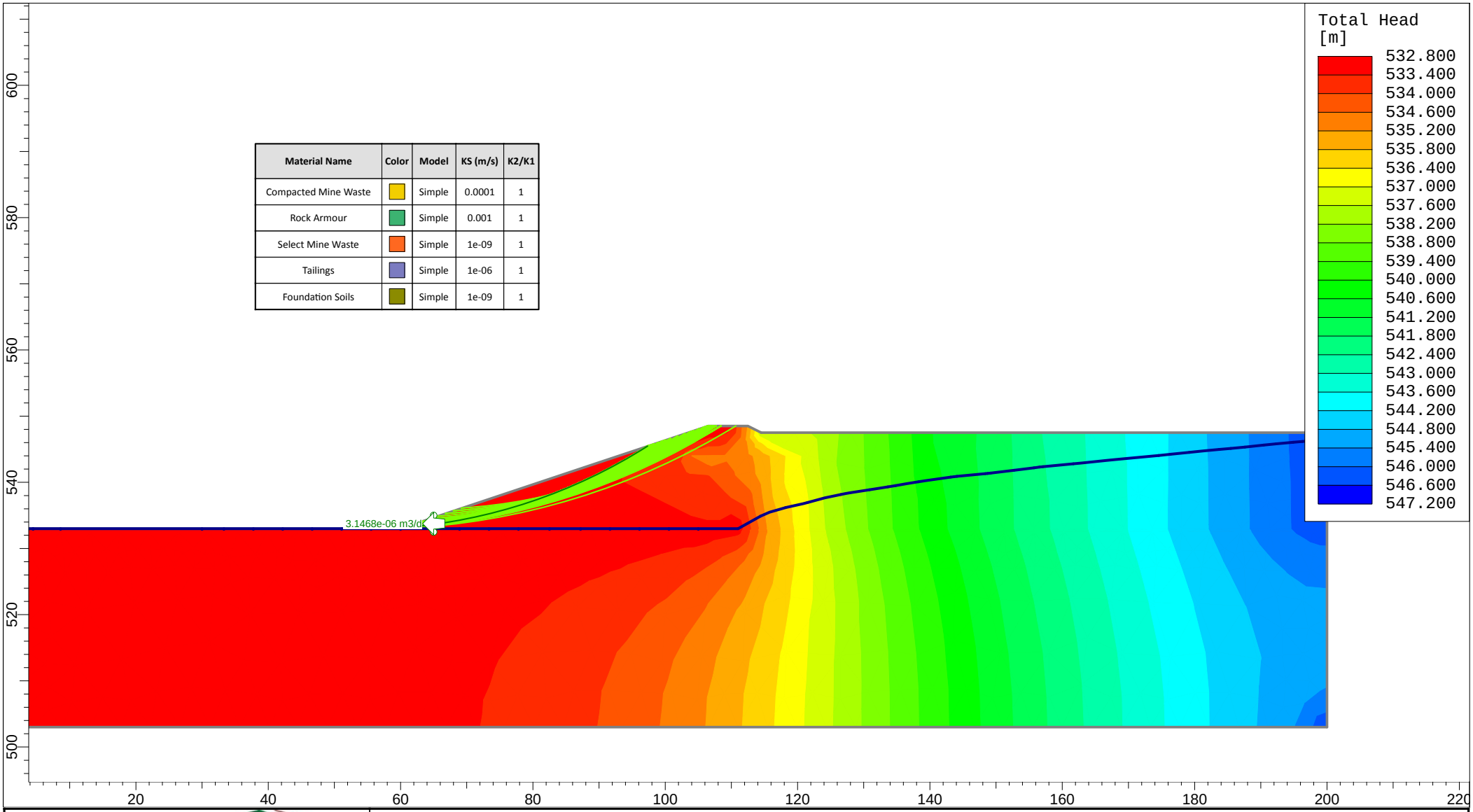
Seepage Analyses

Material Name	Color	Model	KS (m/s)	K2/K1
Compacted Mine Waste		Simple	0.0001	1
Foundation Soils		Simple	1e-09	1
Select Mine Waste - U		Simple	1e-09	1
Tailings - U		Simple	1e-06	1



CMW Geosciences

Project	GALENA ABRA TAILINGS STORAGE FACILITY				
Analysis Description	1. STARTER STAGE DOWNSTREAM SEEPAGE				
Drawn By	RP	Scale	1:600	Company	GALENA MINING LTD
Date	15/10/2018			File Name	Combined.slmd



CMW Geosciences

Project	GALENA ABRA TAILINGS STORAGE FACILITY		
Analysis Description	4. FINAL STAGE DOWNSTREAM SEEPAGE		
Drawn By	RP	*Scale* 1:800	*Company* GALENA MINING LTD
Date	15/10/2018		*File Name* Combined.slmd

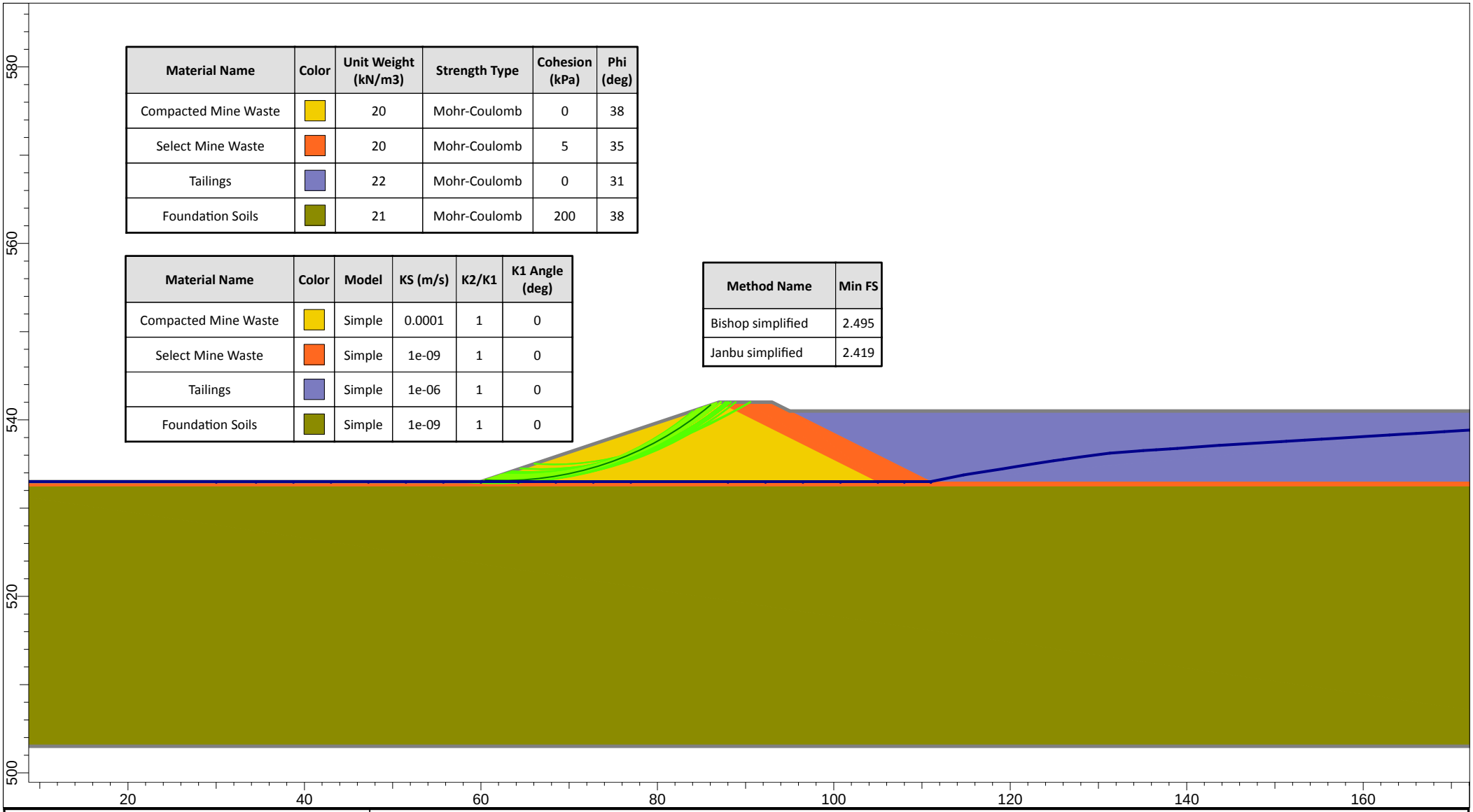
Appendix E

Stability Analyses

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Compacted Mine Waste		20	Mohr-Coulomb	0	38
Select Mine Waste		20	Mohr-Coulomb	5	35
Tailings		22	Mohr-Coulomb	0	31
Foundation Soils		21	Mohr-Coulomb	200	38

Material Name	Color	Model	KS (m/s)	K2/K1	K1 Angle (deg)
Compacted Mine Waste		Simple	0.0001	1	0
Select Mine Waste		Simple	1e-09	1	0
Tailings		Simple	1e-06	1	0
Foundation Soils		Simple	1e-09	1	0

Method Name	Min FS
Bishop simplified	2.495
Janbu simplified	2.419



CMW Geosciences

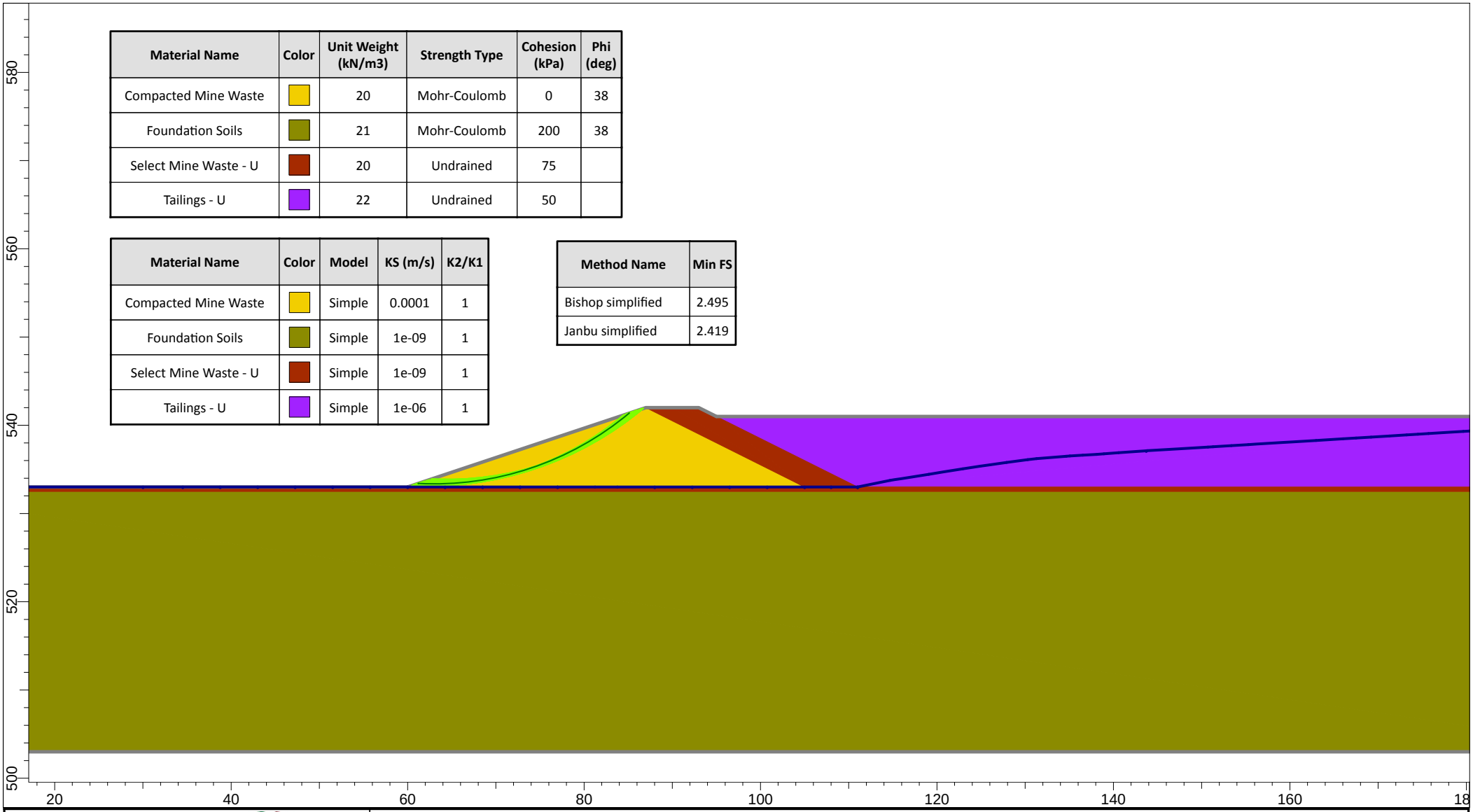
SLIDEINTERPRET 8.016

Project	GALENA ABRA TAILINGS STORAGE FACILITY		
Analysis Description	1. STARTER STAGE DOWNSTREAM DRAINED		
Drawn By	RP	*Scale* 1:600	*Company* GALENA MINING LTD
Date	24/10/2018		*File Name* Combined.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Compacted Mine Waste		20	Mohr-Coulomb	0	38
Foundation Soils		21	Mohr-Coulomb	200	38
Select Mine Waste - U		20	Undrained	75	
Tailings - U		22	Undrained	50	

Material Name	Color	Model	KS (m/s)	K2/K1
Compacted Mine Waste		Simple	0.0001	1
Foundation Soils		Simple	1e-09	1
Select Mine Waste - U		Simple	1e-09	1
Tailings - U		Simple	1e-06	1

Method Name	Min FS
Bishop simplified	2.495
Janbu simplified	2.419



CMW Geosciences

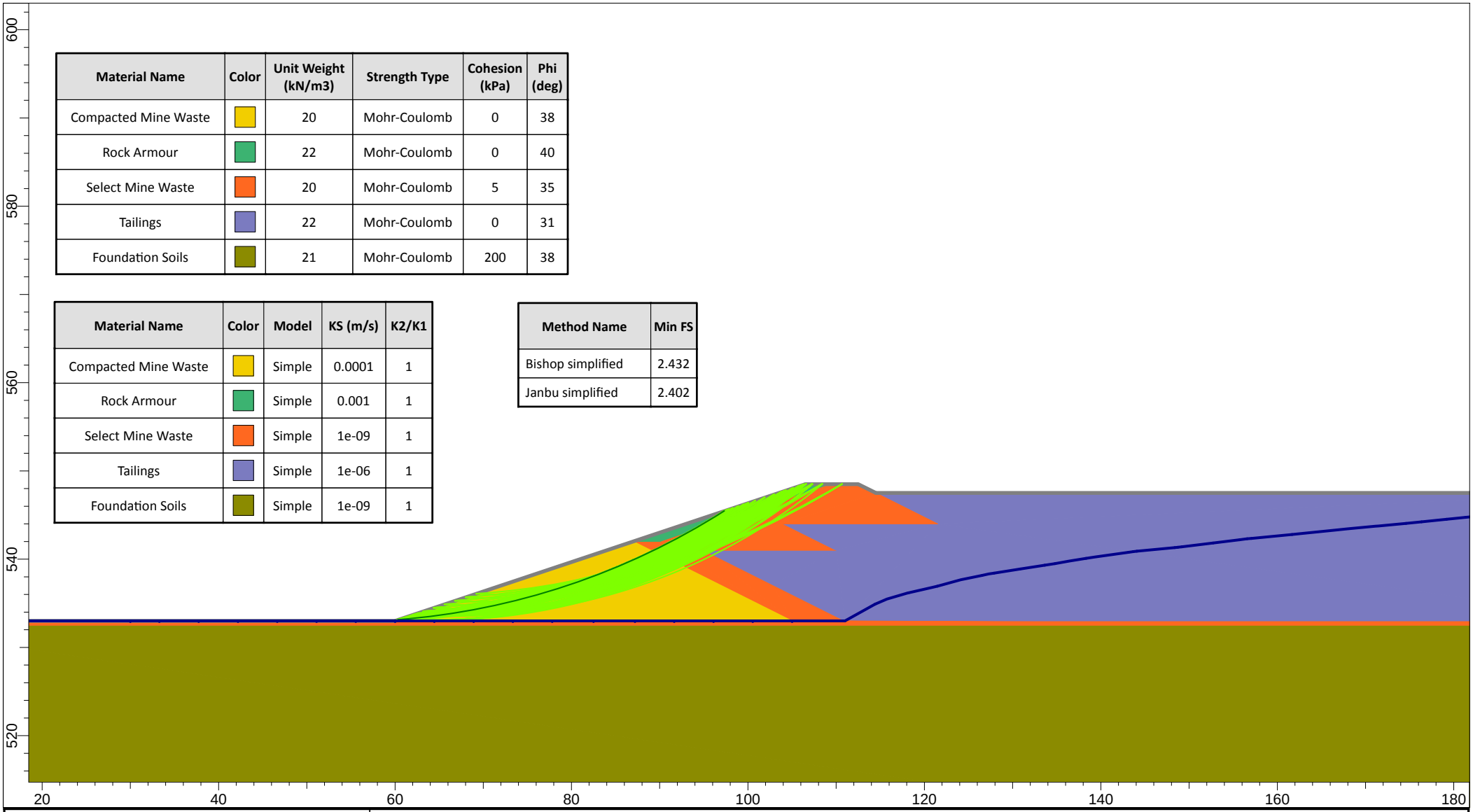
SLIDEINTERPRET 8.016

Project	GALENA ABRA TAILINGS STORAGE FACILITY				
Analysis Description	1. STARTER STAGE DOWNSTREAM UNDRAINED				
Drawn By	RP	*Scale*	1:600	*Company*	GALENA MINING LTD
Date	24/10/2018			*File Name*	Combined.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Compacted Mine Waste		20	Mohr-Coulomb	0	38
Rock Armour		22	Mohr-Coulomb	0	40
Select Mine Waste		20	Mohr-Coulomb	5	35
Tailings		22	Mohr-Coulomb	0	31
Foundation Soils		21	Mohr-Coulomb	200	38

Material Name	Color	Model	KS (m/s)	K2/K1
Compacted Mine Waste		Simple	0.0001	1
Rock Armour		Simple	0.001	1
Select Mine Waste		Simple	1e-09	1
Tailings		Simple	1e-06	1
Foundation Soils		Simple	1e-09	1

Method Name	Min FS
Bishop simplified	2.432
Janbu simplified	2.402



CMW Geosciences

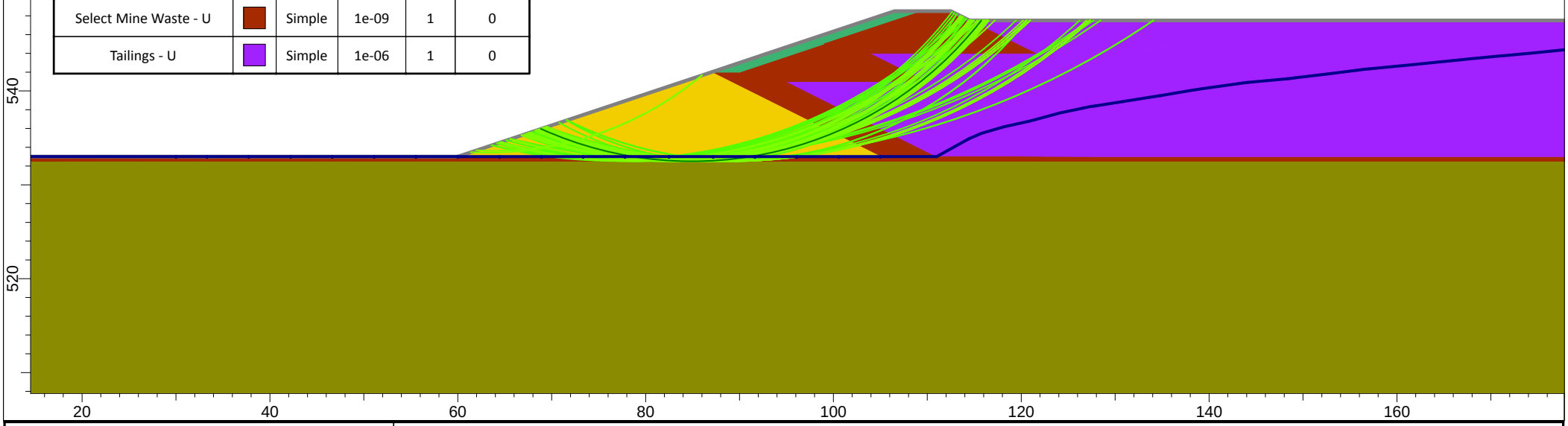
SLIDEINTERPRET 8.016

Project	GALENA ABRA TAILINGS STORAGE FACILITY				
Analysis Description	4. FINAL STAGE DOWNSTREAM DRAINED				
Drawn By	RP	*Scale*	1:600	*Company*	GALENA MINING LTD
Date	24/10/2018			*File Name*	Combined.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Compacted Mine Waste		20	Mohr-Coulomb	0	38
Rock Armour		22	Mohr-Coulomb	0	40
Foundation Soils		21	Mohr-Coulomb	200	38
Select Mine Waste - U		20	Undrained	75	
Tailings - U		22	Undrained	50	

Material Name	Color	Model	KS (m/s)	K2/K1	K1 Angle (deg)
Compacted Mine Waste		Simple	0.0001	1	0
Rock Armour		Simple	0.001	1	0
Foundation Soils		Simple	1e-09	1	0
Select Mine Waste - U		Simple	1e-09	1	0
Tailings - U		Simple	1e-06	1	0

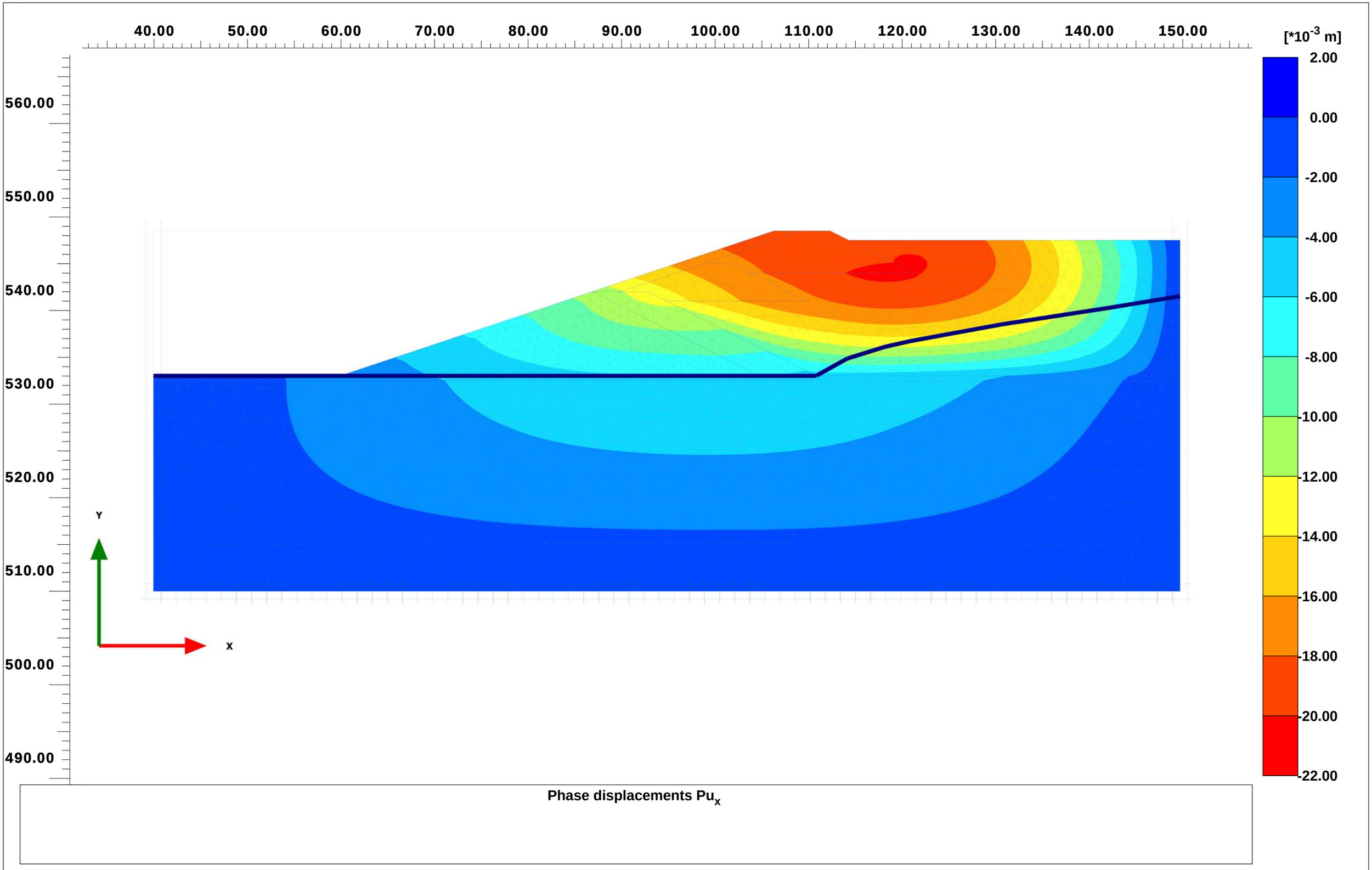
Method Name	Min FS
Bishop simplified	2.434
Janbu simplified	2.268



CMW Geosciences

SLIDEINTERPRET 8.016

Project	GALENA ABRA TAILINGS STORAGE FACILITY		
Analysis Description	4. FINAL STAGE DOWNSTREAM UNDRAINED		
Drawn By	RP	*Scale* 1:600	*Company* GALENA MINING LTD
Date	24/10/2018		*File Name* Combined.slmd



Phase displacements Pu_x

CMW Geosciences	*Project description* Galena Abra - Earthquake 0.104g		*Date* 15/10/2018
	Project filename Galena Abra	*Step* 18	*User name* CMW Geosciences Pty Ltd

Appendix F

Water Balance Analyses

PROJECT : TAILINGS STORAGE FACILITY

CLIENT : GALENA MINING

LOCATION : ABRA

SUBJECT : WATER BALANCE

Date	17-Oct-18
Job No	
File	
Subject	Water Balance
Revision	A

	Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
INFLOWS	Days per month	31	28.25	31	30	31	30	31	31	30	31	30	31	
RAINFALL														
Rainfall (mm)		49.7	55.6	39.5	23.3	18.9	20.7	15.2	6.2	2.8	4.6	11	21.6	269.10
Average Daily Rainfall (mm)		1.60	1.97	1.27	0.78	0.61	0.69	0.49	0.20	0.09	0.15	0.37	0.70	
Tailings Dam Storage Area (m2)		370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	370,000	
Runoff Coefficient Tailings		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
Catchment Area above Storage (m2)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Runoff Coefficient Catchment		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Pool Area (m2)		700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	
Running Beaches (m2)		9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	9,300.00	
Rainfall Inflow Total Volume (m3/day)		246.90	303.09	196.23	119.61	93.89	106.26	75.51	30.80	14.37	22.85	56.47	107.30	41,770.54
SLURRY WATER														
Tonnes per hour														
Operating hours per year														
Total tonnes per month		91,667	91,667	91,667	91,667	91,667	91,667	91,667	91,667	91,667	91,667	91,667	91,667	1,100,000.40
% Solids =	65	65	65	65	65	65	65	65	65	65	65	65	65	
Tailings Output Solids (tpd)		2,957	3,245	2,957	3,056	2,957	3,056	2,957	2,957	3,056	2,957	3,056	2,957	
Volume of Water (m3/day)		1,592	1,747	1,592	1,645	1,592	1,645	1,592	1,592	1,645	1,592	1,645	1,592	592,307.91
OTHER WATER INFLOWS														
Pit Dewatering (m3/day)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Other Water Inflow Total (m3/day)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL INFLOW (m3/day)		**1,839**	**2,050**	**1,788**	**1,765**	**1,686**	**1,752**	**1,668**	**1,623**	**1,660**	**1,615**	**1,702**	**1,700**	

OUTFLOW-LOSSES FROM TAILINGS DAM		**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**TOTAL**
EVAPORATION (from pond and beaches)														
Evaporation Rate (mm)		337	287	247	188	117	90	93	122	168	250	284	319	2,502.00
Pan Factor		0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
Monthly Dam Evaporation Rate (mm)		235.90	200.90	172.90	131.60	81.90	63.00	65.10	85.40	117.60	175.00	198.80	223.30	
Average Daily Evaporation Rate (mm)		7.61	7.11	5.58	4.39	2.64	2.10	2.10	2.75	3.92	5.65	6.63	7.20	
Pool Area & Running Beaches (m2)		10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	
Daily Evaporation Loss/Outflow (m3/day)		76.10	71.12	55.77	43.87	26.42	21.00	21.00	27.55	39.20	56.45	66.27	72.03	17,543.45
EVAPO-TRANSPIRATION (from drying tailings)														
Evaporation Rate (mm)		337.00	287.00	247.00	188.00	117.00	90.00	93.00	122.00	168.00	250.00	284.00	319.00	
Evapo-transpiration Rate (Pan/3)		112.33	95.67	82.33	62.67	39.00	30.00	31.00	40.67	56.00	83.33	94.67	106.33	
Average Daily Evapo-transpiration Rate (mm)		3.62	3.39	2.66	2.09	1.26	1.00	1.00	1.31	1.87	2.69	3.16	3.43	
Area Transpiring (m2)		36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	36,000.00	
Daily transpiration Loss (m3/day)		130.45	121.91	95.61	75.20	45.29	36.00	36.00	47.23	67.20	96.77	113.60	123.48	30,074.49
SEEPAGE														
Downstream Embankment (m3/day)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Upstream Embankment (m3/day)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Seepage Rate m/sec	1.00E-10													
Dam Floor (m3/day).		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Total Seepage Outflow (m3/day)		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	2.21
RETENTION														
Tailings Output (tpd)		2,957	3,245	2,957	3,056	2,957	3,056	2,957	2,957	3,056	2,957	3,056	2,957	
Assumed Moisture Content of Tailings (average)	25%													
Volume Retained in Tailings (m3/day)		739	811	739	764	739	764	739	739	764	739	764	739	275,012.28
TOTAL OUTFLOW-LOSSES FROM TAILINGS DAM		946	1,004	891	883	811	821	796	814	870	892	944	935	
BALANCE INFLOW-OUTFLOW/LOSSES (m3/day)		0	1,046	898	882	875	931	871	809	789	723	758	0	
BALANCE INFLOW-OUTFLOW/LOSSES (m3/month)		0	29,552	27,832	26,458	27,130	27,920	27,016	25,079	23,681	22,401	22,740	0	
RETURN WATER TO THE PLANT (if available)														
Total Water Return per month (balance of inflow -outflow for planning)		0	29,552	27,832	26,458	27,130	27,920	27,016	25,079	23,681	22,401	22,740	0	
Volume of Water (m3/day),estimated at		0	1,046	898	882	875	931	871	809	789	723	758	0	
Average water return			60%	56%	54%	55%	57%	55%	51%	48%	45%	46%		53%

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	
Summary of Water Balance													
Water shortfall (make up water) or excess of requirements (m3/day)	0	-701	-694	-763	-717	-715	-721	-783	-856	-870	-887	0	
Total water in excess of requirements (m3/month)	0	-19,807	-21,527	-22,901	-22,229	-21,439	-22,343	-24,280	-25,678	-26,958	-26,619	0	-233,781
Total water in excess of requirements (m3/year) =	-233,781												

Average Water return per day	**860**	**m3/day**
1:100 yr event volume	**82,250**	**m3**
Removal in 6 month	**457**	**m3/day**
Proposed pump capacity	**1317**	**m3/day**

Appendix G

Laboratory Test Results – Tailings Testwork

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

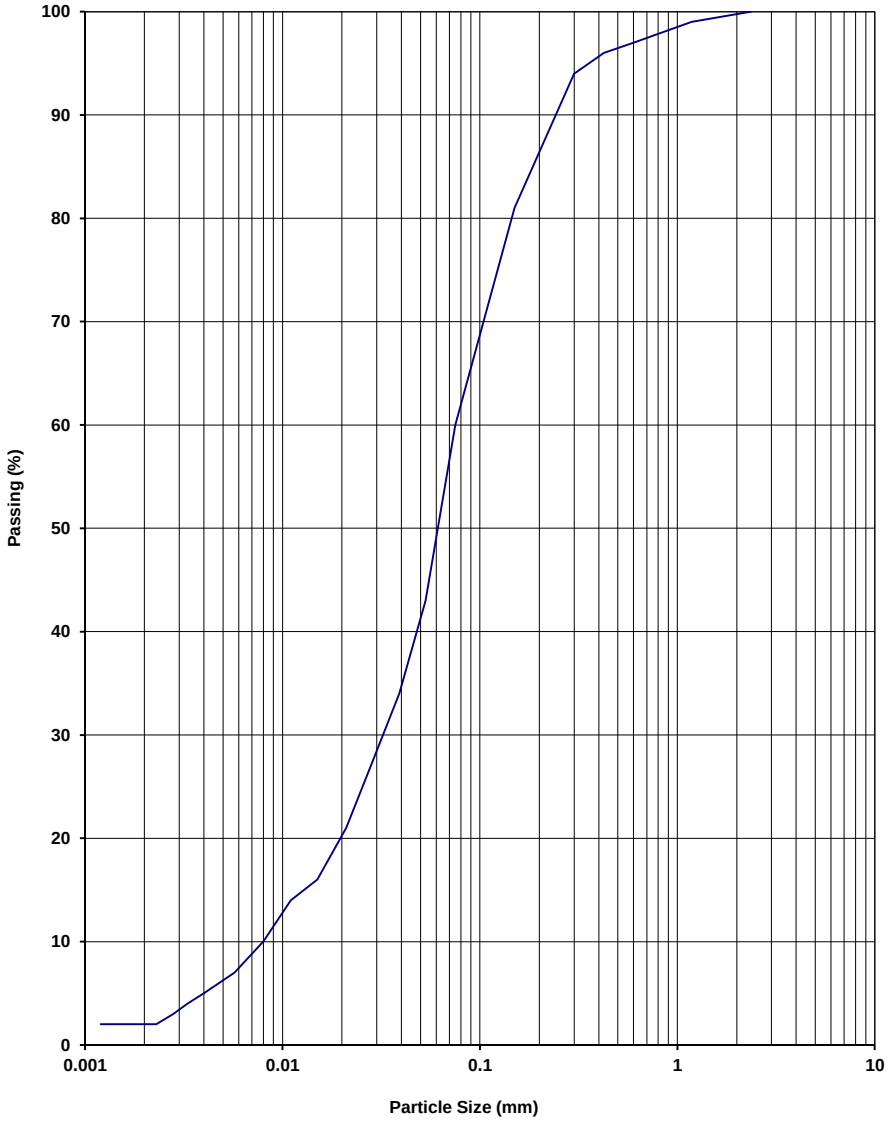
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	GR Engineering Services Ltd	**Report No.**	18060646-G
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	25/6/18-28/6/18
		Report Date	28/6/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	99
0.600	97
0.425	96
0.300	94
0.150	81
0.075	60
0.053	43
0.039	34
0.028	27
0.021	21
0.015	16
0.011	14
0.008	10
0.0057	7
0.004	5
0.0033	4
0.0028	3
0.0023	2
0.002	2
0.0012	2



NOTES/REMARKS: -

Moisture Content 0% -2.36mm Soil Particle Density(t/m^3) 3.52

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	GR Engineering Services Ltd	**Report No.**	18060646-AL
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Report Date**	03/07/2018
Project	Abra Project		

Sample No.	18060646					
Test Date	2/07/2018					
Client ID	Tailings					
Depth (m)	Not Supplied					
Liquid Limit (%)	Not Obtainable					
Plastic Limit (%)	Not Obtainable					
Plasticity Index (%)	Non Plastic					
Linear Shrinkage (%)	Not Obtainable					
Moisture Content (%)	0.0					

Sample No.						
Test Date						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

NOTES/REMARKS: The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

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Authorised Signatory

C. Park

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	GR Engineering Services Ltd	**Report No.**	18060646-EM
		Workorder No.	4401
Address	PO Box 258 Belmont WA 6984	**Test Date**	26/06/2018
		Report Date	28/06/2018
Project	Abra Project		

Sample No.	18060646	-	-	-	-	-	-
Client ID	Tailings	-	-	-	-	-	-
Depth (m)	Not Supplied	-	-	-	-	-	-
Description	TAILINGS - grey / purple	-	-	-	-	-	-
Emerson Class Number	**3**	**-**	**-**	**-**	**-**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

NOTES/REMARKS:

Sample/s supplied by the client

Tested with Distilled water at 22.3°C

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

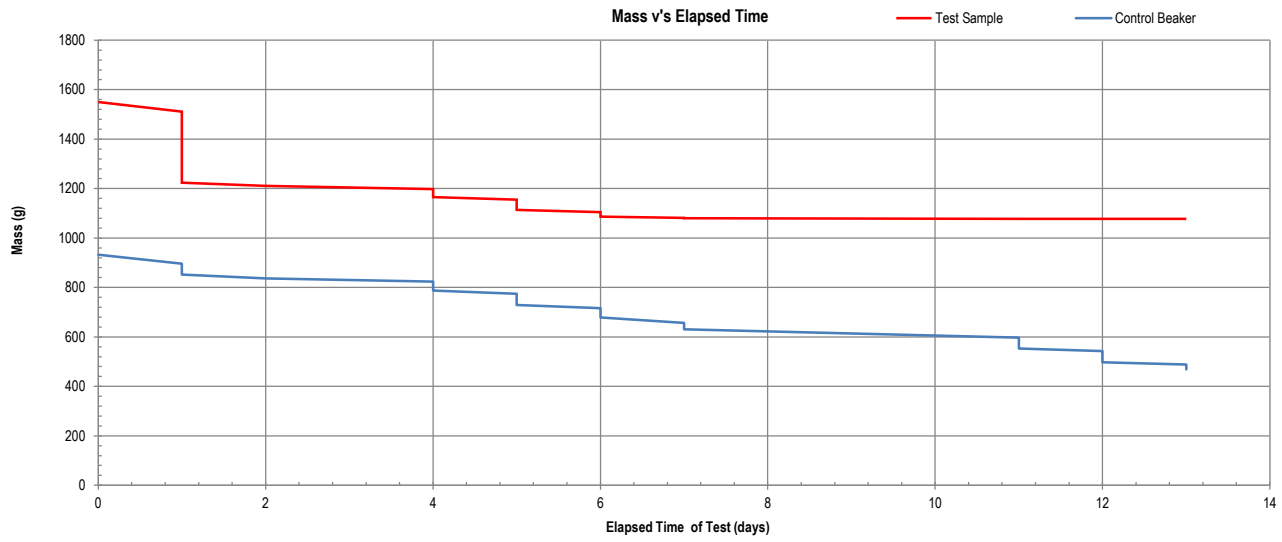
AIR DRYING TEST REPORT

Air Drying Test Procedure - as Supplied by Client

Client	GR Engineering Services Ltd	**Report No.**	18060646-AD
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	28/06/2018
		Report Date	21/07/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied
Description	TAILINGS- purple/grey	**Sample Type**	Tailings at 65% solids

RESULTS OF TESTING

Date	Control Beaker			Test Sample		Decant	
	Temperature (° C)	Mass (g)	Evaporation (g)	Mass (g)	Evaporation (g)	Mass (g)	Decantation (g)
28/06/2018 Start Date	22.0	931.97	-	1549.7	-	1549.7	-
29/06/2018	29.0	896.3	35.7	1510.7	39.0	1272.7	238.0
29/06/2018	35.1	852.8	79.2	1223.1	326.6	1223.1	0.0
30/06/2018	21.0	836.7	95.3	1210.4	339.3	1210.4	0.0
2/07/2018	21.4	823.3	108.7	1197.8	351.9	1197.8	0.0
2/07/2018	39.5	786.9	145.1	1165.0	384.7	1165.0	0.0
3/07/2018	29.3	774.3	157.7	1155.5	394.2	1155.5	0.0
3/07/2018	38.6	728.7	203.3	1113.5	436.2	1113.5	0.0
4/07/2018	28.4	716.2	215.7	1104.8	444.9	1104.8	0.0
4/07/2018	38.7	679.3	252.7	1086.0	463.7	1086.0	0.0
5/07/2018	35.6	656.9	275.1	1081.4	468.3	1081.4	0.0
5/07/2018	38.8	631.0	301.0	1079.9	469.8	1079.9	0.0
9/07/2018	27.3	596.9	335.1	1077.7	472.0	1077.7	0.0
9/07/2018	36.5	553.3	378.7	1077.5	472.2	1077.5	0.0
10/07/2018	23.6	542.1	389.9	1077.5	472.2	1077.5	0.0
10/07/2018	38.2	497.9	434.1	1077.5	472.2	1077.5	0.0
11/07/2018	21.6	487.9	444.1	1077.5	472.2	1077.5	0.0
11/07/2018	39.3	469.4	462.6	1077.5	472.2	1077.5	0.0



Remarks:

Sample/s supplied by client

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

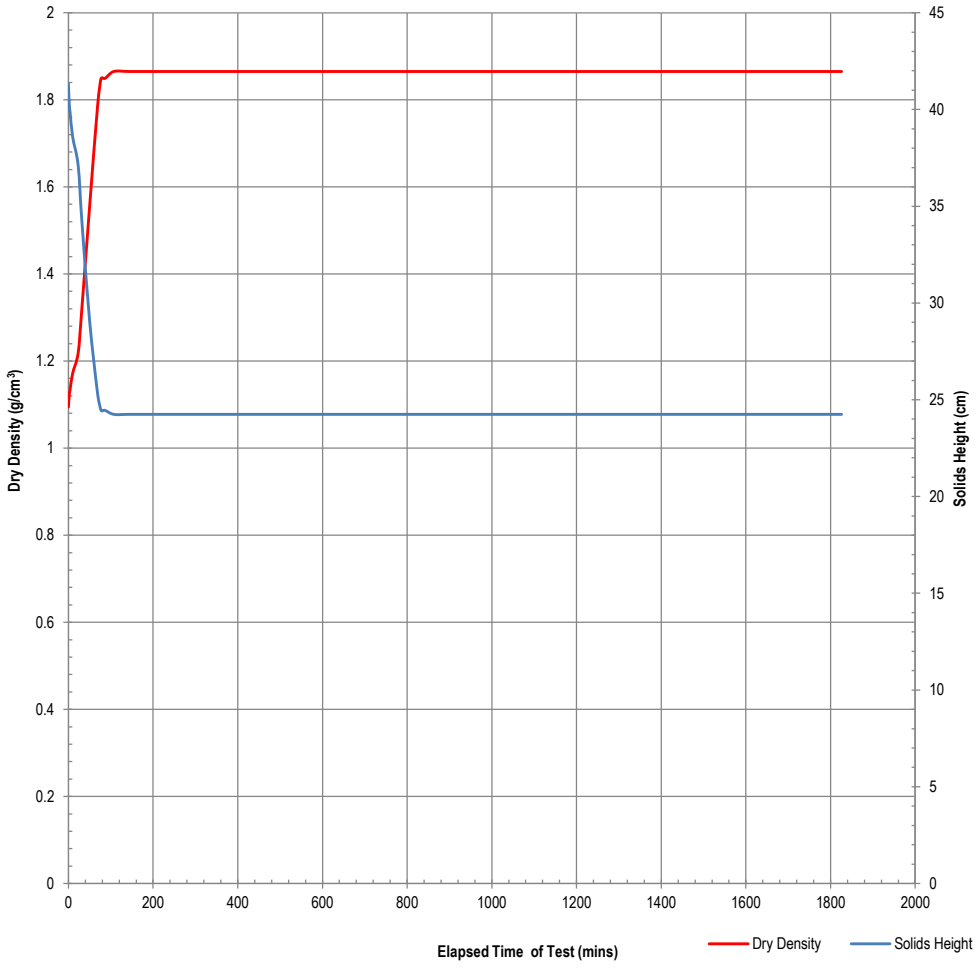
SETTLING TEST REPORT

Settling Test Procedure - as Supplied by Client

Client	GR Engineering Services Ltd	**Report No.**	18060646-SETL
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	25/06/2018
		Report Date	9/07/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied
Description	Tailings Slurry- Purple/Grey	**Sample Type**	Mixed Slurry

RESULTS OF TESTING

Initial Mass of Slurry (g):	3475.6	**Volume of water in Cylinder (ml)**		1960.0
Settling Test Type:	Undrained	**Mass of dry waste material (g)**		2144.8



Elapsed Time (min)	Solids Height (cm)	Dry Density (g/cm³)
0	41.32	1.094
2	40.27	1.123
4	39.85	1.135
10	38.58	1.172
23	37.11	1.219
32	34.15	1.324
50	29.09	1.554
69	25.30	1.787
77	24.46	1.849
86	24.46	1.849
107	24.25	1.865
142	24.25	1.865
175	24.25	1.865
210	24.25	1.865
1378	24.25	1.865
1826	24.25	1.865

Remarks: Sample at 61.7% Solids

Sample/s supplied by client

Authorised Signatory

C. Channon

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

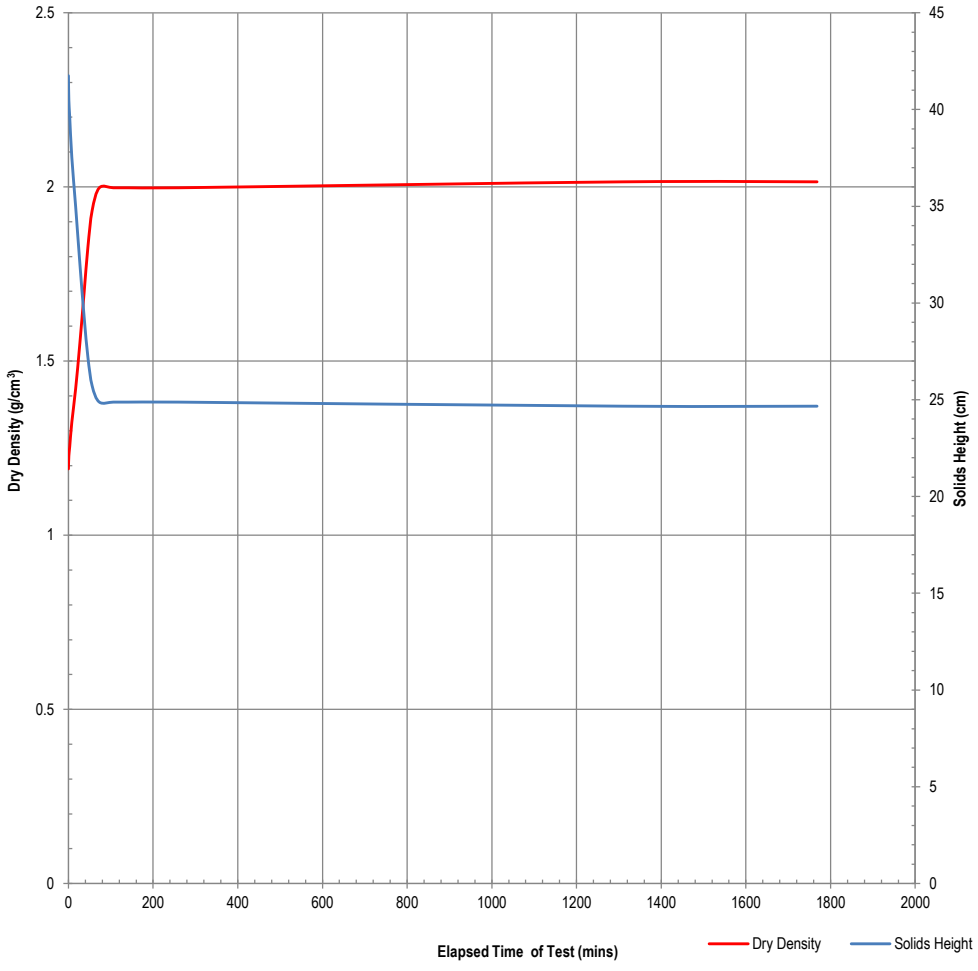
SETTLING TEST REPORT

Settling Test Procedure - as Supplied by Client

Client	GR Engineering Services Ltd	**Report No.**	18060646-SETL
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	25/06/2018
		Report Date	9/07/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied
Description	Tailings Slurry- Purple/Grey	**Sample Type**	Mixed Slurry

RESULTS OF TESTING

Initial Mass of Slurry (g):	3694.15	**Volume of water in Cylinder (ml)**		1980.0
Settling Test Type:	Drained	**Mass of dry waste material (g)**		2357.0



Elapsed Time (min)	Solids Height (cm)	Dry Density (g/cm³)
0	41.74	1.190
1	40.48	1.228
3	39.64	1.254
8	37.53	1.324
17	35.00	1.420
27	32.05	1.551
37	29.31	1.696
46	27.20	1.827
56	25.72	1.932
73	24.88	1.997
106	24.88	1.997
141	24.88	1.997
260	24.88	1.997
1309	24.67	2.015
1768	24.67	2.015

Remarks: Sample at 63.8% Solids

Sample/s supplied by client

Authorised Signatory

C. Channon

Trilab
Soil Rock Calibration

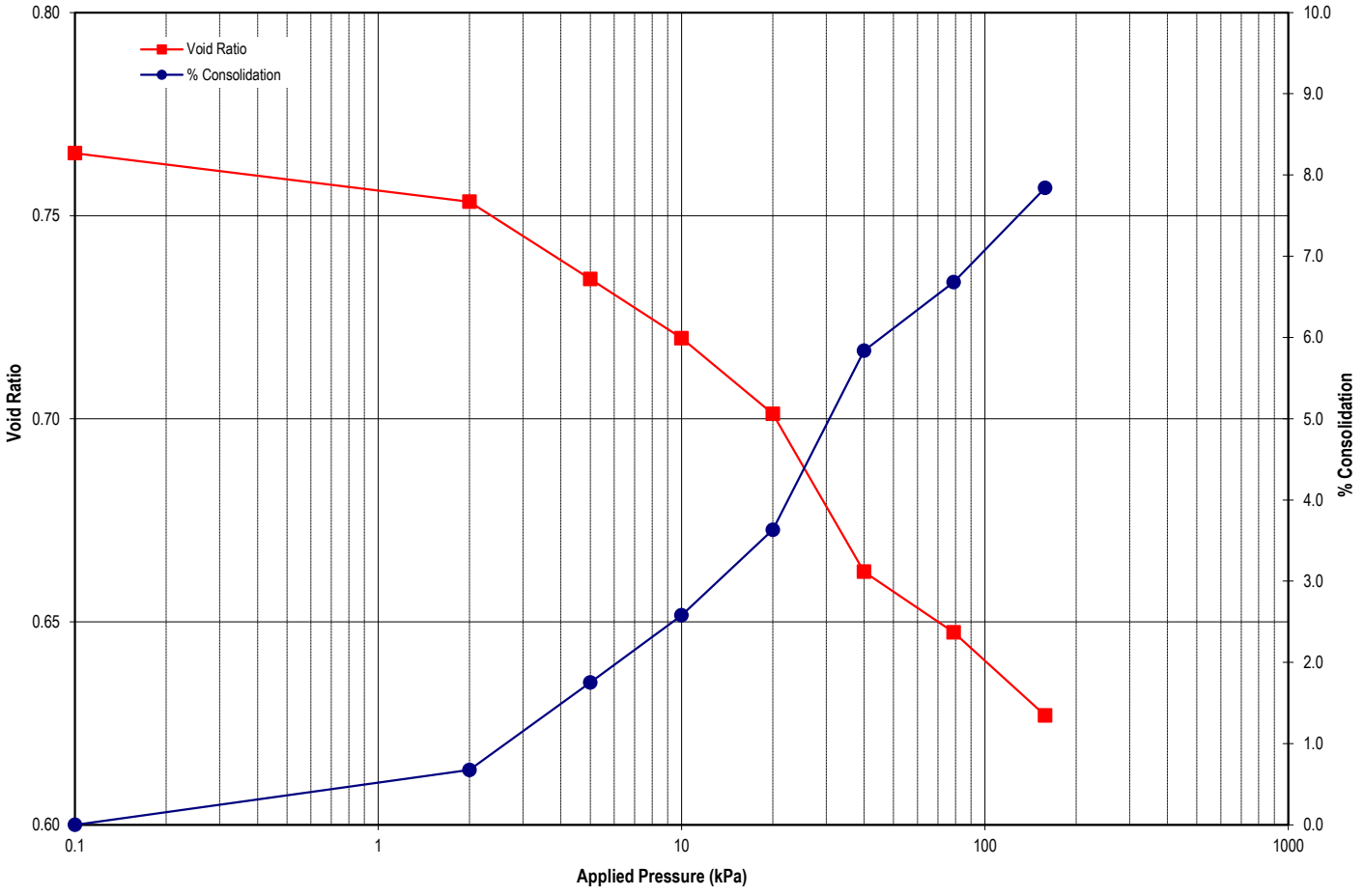
Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	GR Engineering Services Ltd	**Report No.:**	18060646-OED
		Workorder No.	4401
Address	PO Box 258 Belmont WA 6984	**Test Date:**	2/07/2018
		Report Date:	18/07/2018
Project:	Abra Project		
Client Id.:	Tailings	**Depth (m):**	Not Supplied
Description:	TAILINGS- purple/grey		



Wet Density (t/m^3):	3.15	Initial Moisture (%):	58.1	Test Condition: Inundated on load	
Particle Density (t/m^3):	3.52	Initial Voids Ratio:	0.765	Initial Degree of Saturation (%):	272.7
Sample supplied by the client		Remarks:	Sample remoulded using a target solids content of 65%		Page 1 of 2

REP03102

Authorised Signatory

C. Channon

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	GR Engineering Services Ltd	**Report No.:**	18060646-OED
		Workorder No.	4401
Address	PO Box 258 Belmont WA 6984	**Test Date:**	2/07/2018
		Report Date:	18/07/2018
Project:	Abra Project		
Client Id.:	Tailings	**Depth (m):**	Not Supplied
Description:	TAILINGS- purple/grey		

TEST RESULTS

Stage	Load (kPa)	Cc	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	0.1-2	0.009	2669.06	10798.80	3.560	0.48	0.7
2	2-5	0.048	2317.66	40988.97	3.615	0.80	1.8
3	5-10	0.048	1368.71	23155.04	1.682	0.48	2.6
4	10-20	0.062	5051.49	18610.17	1.081	0.43	3.6
5	20-40	0.129	10176.74	37560.77	1.143	0.46	5.8
6	40-79	0.050	8488.45	30478.08	0.230	0.31	6.7
7	79-158	0.068	9860.11	26552.25	0.157	0.48	7.8

Remarks: Sample remoulded using a target solids content of 65%

REP03102

Authorised Signatory

C. Channon

Trilab
Soil Rock Calibration

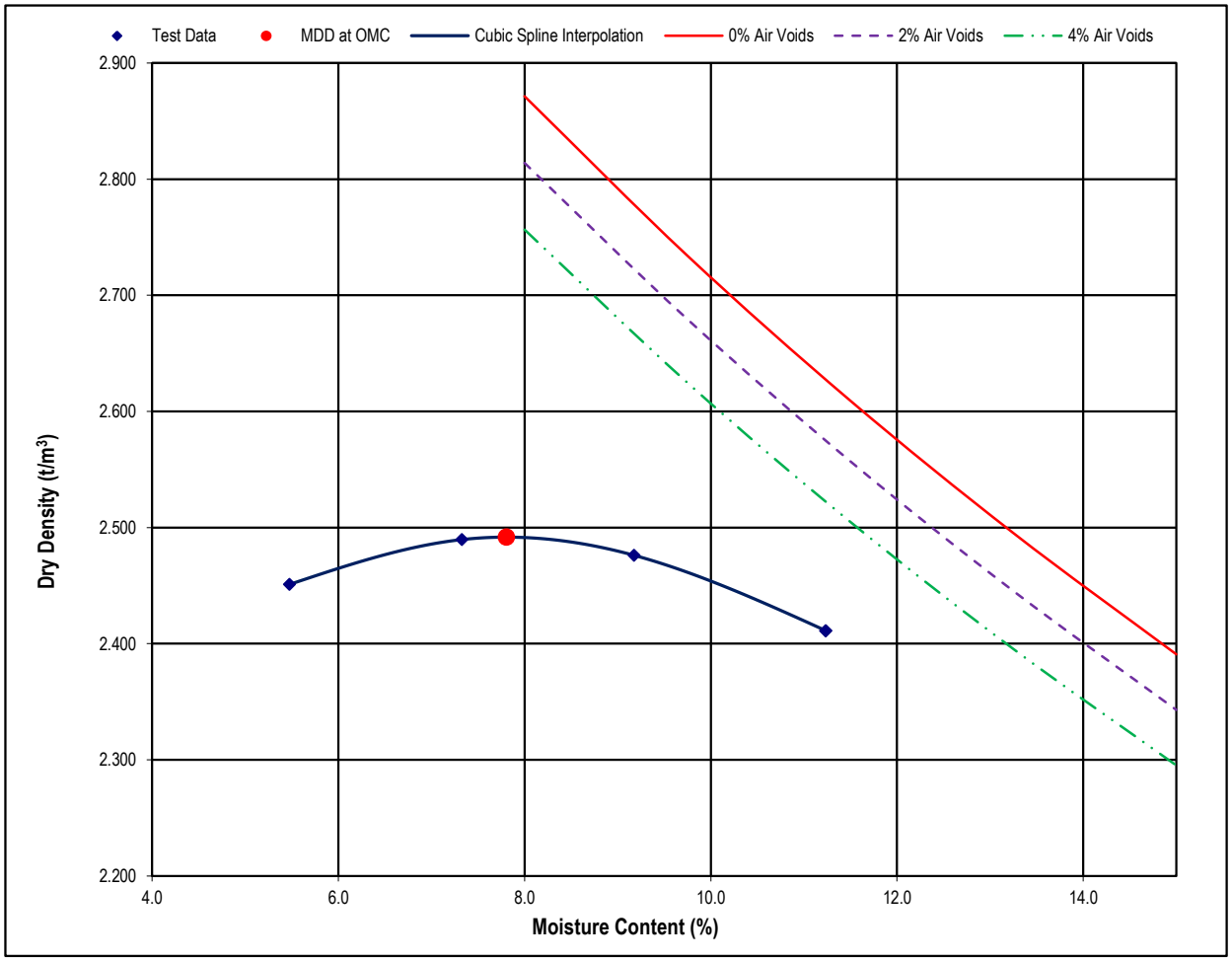
Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS 1289 5.1.1 & AS 1289.2.1.1

Client	GR Engineering Services Ltd	**Report No.**	18060646-MDD
		Workorder No.	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	27/06/2018
		Report Date	28/06/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied



Maximum Dry Density (t/m³)	2.49	**Optimum Moisture Content (%)**	7.8
Moisture Content (%)	0.0	**Percentage of Oversize/Sieve Size (mm)**	0/19

NOTES/REMARKS:

Sample/s supplied by the client

% Voids based on assumed SG of 3.73

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Authorised Signatory

C. Channon

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

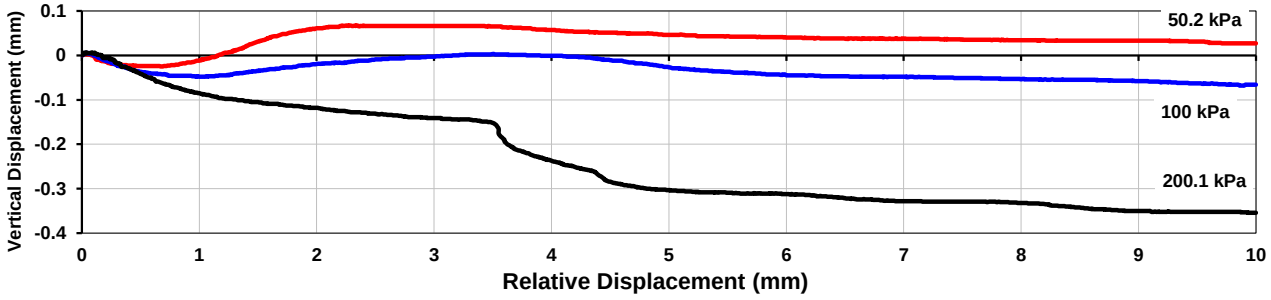
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DIRECT SHEAR TEST REPORT

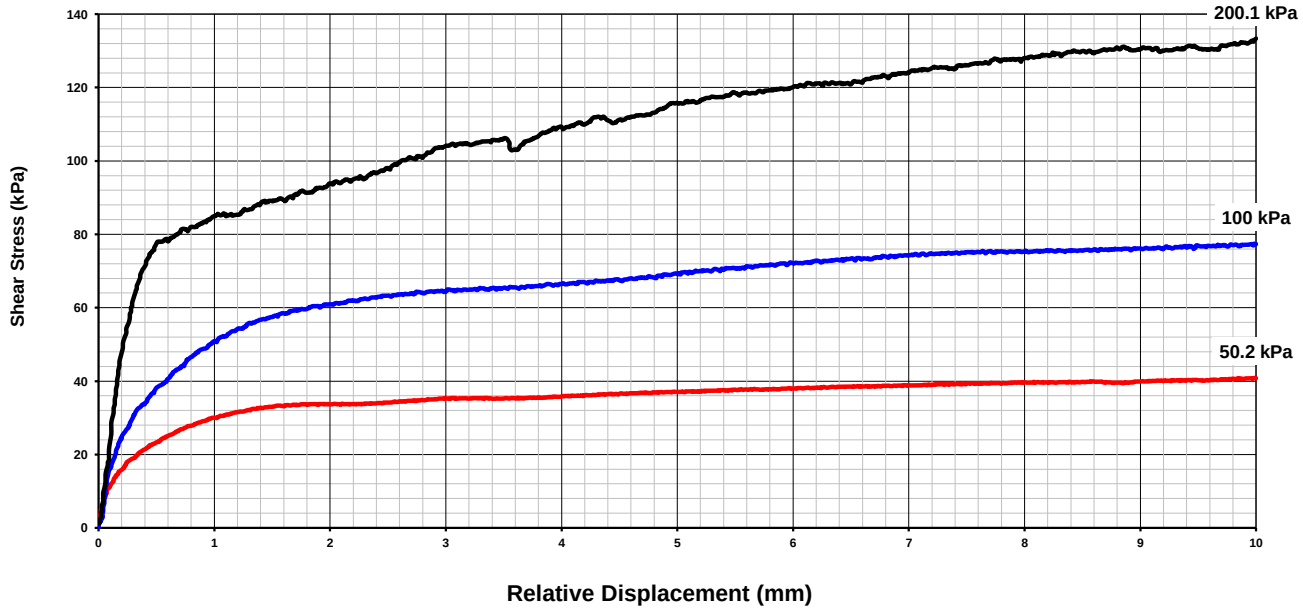
Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	GR Engineering Services Ltd	**Report No.**	18060646- DS
		Workorder No	0004401
Address	PO Box 258 Belmont WA 6984	**Test Date**	4/07/2018
		Report Date	11/07/2018
Project	Abra Project		
Client ID	Tailings	**Depth (m)**	Not Supplied
Description	SILT - grey	**Sample Type**	Three individual soil specimens - Remoulded to 92% MDD as requested by client.

Vertical Displacement/Relative Displacement Plot



Shear Stress/Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Purvis

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

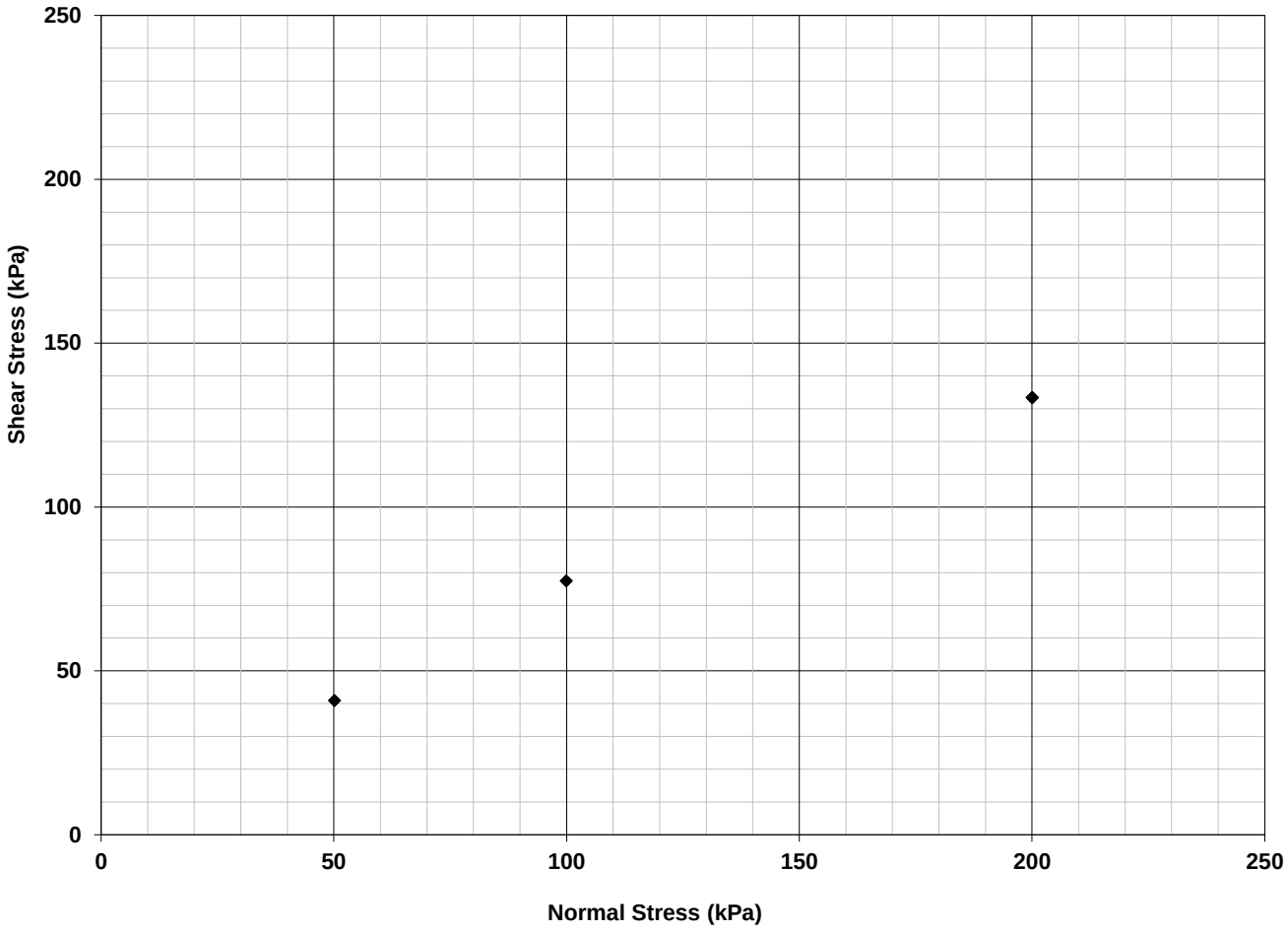
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	GR Engineering Services Ltd	**Report No.**	18060646- DS

Failure Criteria **Residual @ 10 , 10 , 10 , mm Displacement**

Residual - Normal Stress vs Shear Stress



Shear Angle (°)	31.3	Cohesion (kPa)	12.9	R^2	0.997
Specimen Condition	Inundated	Normal Stress (kPa)		Corrected Shear Stress (kPa)	
Specimen Dimensions (mm)	100*100	Stage 1	50.2		40.9
Rate of Strain (mm/min)	0.008	Stage 2	100.0		77.4
Initial Moisture Content (%)	7.8	Stage 3	200.1		133.3
Initial Wet Density(t/m^3)	2.47				

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Purvis

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

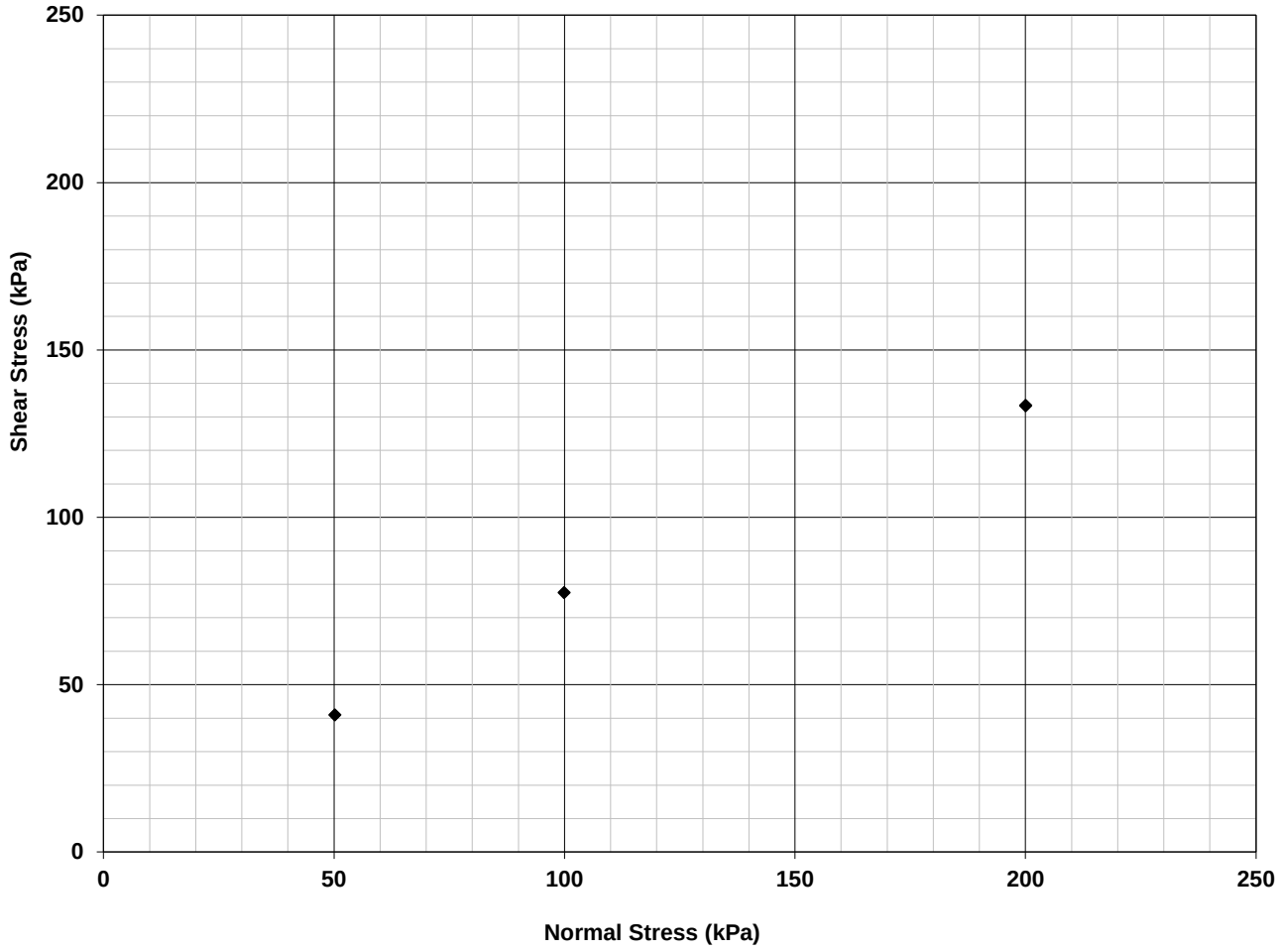
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	GR Engineering Services Ltd	**Report No.**	18060646- DS

Failure Criteria **Peak**

Peak - Normal Stress vs Shear Stress



Shear Angle (°) 31.3		Cohesion (kPa) 12.9		R^2 0.997
Specimen Condition	Inundated	Normal Stress (kPa)		Corrected Shear Stress (kPa)
Specimen Dimensions (mm)	100*100	Stage 1	50.2	40.9
Rate of Strain (mm/min)	0.008	Stage 2	100.0	77.4
Initial Moisture Content (%)	7.8	Stage 3	200.1	133.3
Initial Wet Density(t/m^3)	2.47			

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Purvis

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	GR Engineering Services Ltd	**Report No.**	18060646- DS

Notes/Remarks:

Photo not to scale

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Purvis

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Appendix H

Operations Manual

19 October 2018

TAILINGS STORAGE FACILITY

ABRA BASE METALS PROJECT, NEAR MEEKATHARRA, WA

OPERATIONS MANUAL

Galena Mining Limited

Ref. PER2018-0128AH Ops Man Rev 0

Unit 19 Wembley Green Offices,
127 Herdsman Parade, Wembley, WA 6014

www.cmwgeosciences.com

Table of Contents

Figures

Appendices

1 INTRODUCTION

This manual is intended to be used by *process plant staff* who undertake daily operations and inspections of the Tailings Storage Facility (TSF) tailings storage at the Abra Base Metals Project (ABMP). The purpose of this manual and the attached proformas is to allow both shift and daily inspection records to be taken and recorded and, if required, reported to *senior staff*. The provisions of the Operating Manual must be strictly adhered to by the owner and the storage must be operated strictly in accordance with its provisions. CMW Geosciences Pty Ltd (CMW), the designer shall not be liable in any respect whatsoever for any damage to or failure in the operations of the tailings storages resulting from failure of the Owner, its servants or agents to comply with the provisions of this Operating Manual.

This document sets out details of the components of the storage facility which are influenced by the general day to day activities. Each of these components form part of the overall operation of the storage facility and attention must be paid to each component to ensure the storage facility is operated to achieve the design objectives.

The components which are influenced by the general day to day activities include:

- Tailings deposition
- Decant pump operation
- Sorted ore rejects placement
- Routine inspections and maintenance

Site personnel involved with the TSF should be trained in the requirements of this manual. Proforma PF4 should be signed by each person and training records retained on site.

2 DESIGN CONCEPT

Details of the design are presented in the CMW (2018) report, '*Tailings Storage Facility, Abra Base Metals Project, near Meekatharra, WA, Design Report'*.

The TSF has been designed to store 8.48 Mt of tailings over a 15 year life. Approximately 32.6% of the total tailings production will be used for paste backfill to the underground mining operations. The tailings have unusual characteristics when compared with other mine tailings. Air drying and settling tests, drained and undrained, indicate that the tailings will settle out of suspension very quickly, in less than 80 minutes, which is a function of the high soil particle density.

The TSF will be a two cell, paddock type facility, located to the north of the plant site, between two intermittent creek lines in order to reduce diversion works. The two cell TSF will be constructed in six stages. The Stage 1 Cell A starter embankment will provide nominally 2 year's storage. Cell B will be added to provide an addition storage life of 2 years for Stage 1. The TSF starter embankments will be a zone embankment comprising an upstream zone of compacted select mine waste and a downstream zone of traffic compacted mine waste. The starter embankments will be raised using upstream construction techniques and select mine waste.

The design as incorporates a rock-ring decant in each cell to recover water from the TSF. Return water will be pumped directly to the process plant for reuse.

The starter embankments and TSF cell basins will be lined with Geosynethic Clay Liner (GCL) to produce a low permeability liner at the base of the TSF to reduce seepage.

A site plan showing the TSF layout is presented on Figure 1.

Operational responsibilities for the TSF have been allocated to:

- Tailings deposition and decant operation: Manager Processing
- Routine inspections and monitoring: Processing Supervisor
- Surveillance and safety reporting: CMW or an independent 3rd Party
- Routine maintenance: Maintenance Department

3 SUMMARY OF OPERATIONAL PROCEDURES

3.1 General

The operational design of the facilities is aimed at:

- Providing optimum removal of water from the facility for return to the process plant for re-use.
- Optimising tailings storage capacity by maximising the in-situ tailings density (i.e. undertaking cyclic tailings deposition between groups of spigots).
- Reducing environmental impact (i.e. due to seepage).

The following operational considerations have been incorporated into the design:

- Tailings in the form of slurry will be discharged sub-aerially and cyclically into the facility in thin discrete layers, not exceeding 300mm thickness, in order to allow optimum density and strength gain by subjecting each layer to a drying cycle. Deposition will take place via multiple spigots from around each cell of the facility.

  The tailings have rapid settling characteristics, hence some experimentation will be required on the number spigots to be utilised during deposition. If too many spigots are open, the tailings will tend to deposit near the embankment. If this occurs, single point discharge practices may be required from time to time to force the tailings away from the embankment.
- Spigotting of tailings is to be carried out such that a beach is developed to force the supernatant pond to be is maintained within and around the rock-ring decant. The pond is to be maintained away from the perimeter embankments at all times.
- Water will be removed from the facility and pumped back to the process plant via a decant pump located in a rock-ring decant structure. The recommended average water recovery should not be less than 50% of slurry water inflow or 36 t/hr.
- The tailings storage area will assume the form of a truncated prism with a depressed cone on the top surface. The facility will have the capacity to store a considerable volume of water during a storm event. Freeboard requirements are a minimum of 500 mm total freeboard comprising minimum operational freeboard (vertical height between the tailings beach and embankment crest) of 300 mm and a minimum beach freeboard of 200 mm plus and allowance for the 1% AEP 72 hour event of 217 mm.
- Frequent inspections should be made of the tailings line, water return line, discharge point, water recovery system and the position of the supernatant pond in relation to the water recovery system.
- Only by regular inspection and appropriate remedial action can the performance of the water return system be optimised and operational problems be avoided.

- Operation, safety and environmental aspects should be periodically reviewed during an inspection by a suitably experienced and qualified engineer. This inspection should be done at least every year.
- On eventual decommissioning, the facility will remain as a permanent feature of the landscape and drain to an increasingly stable mass. The top surface and batters will be stabilised and rehabilitated as detailed in the detailed design report.

4 COMPONENTS OF TAILINGS STORAGE

4.1 Deposition of Tailings

The method of deposition of tailings into the storage is one of the major controlling factors in achieving:

- Higher in-situ densities in the tailings storage
- Higher water returns
- Maintaining embankment stability

In order to understand the tailings deposition requirements a detailed knowledge of the components of the tailings system is required. These components include:

- Tailings Pipe-work
- Tailings deposition process
- Ring Main Flushing

4.1.1 Tailings Pipe-work

Tailings is transported from the process plant to the TSF via a HDPE pipeline. At the TSF, the pipeline will split into two distribution lines to distribute the tailings around each storage cell.

The tailings distribution lines comprise welded HDPE pipe. The distribution lines have spigot offtakes are located at not less than 25 m and not more than 50 m intervals on the embankment. The pipework is located adjacent to the upstream crest of the embankment and perimeter access road. Figure 2 shows typical spigot arrangements.

4.1.2 Deposition Process

Tailings should be deposited over the exposed beaches, at a low velocity from several spigot discharge points. Deposition should occur for a period of around two days from each group of spigots. Each spigot comprises a mining hose fitted with a valve/scissor clamp to control flow through the spigot (or similar). Tailings should not be discharged so as to erode the perimeter containment embankments. During deposition, conductor pipes (slotted) should be utilised to ensure the tailings are deposited at the toe of the embankment.

4.1.3 Main Flushing

At the completion of the sequential deposition on each distribution main and following the change over to the alternative distribution main, the inoperative tailings line should be flushed with water (tails return water) until it is clean. The flushing operation will be supervised by the Shift Foreman.

4.2 Return Water Operation

Surface water will be removed from TSF by a decant pump located within a rock-ring type decant structure within each cell. Return water will be pumped back to the process plant for reuse.

The location of the decant water pond will be controlled by the tailings discharge sequence employed. The process of tailings deposition is aimed at ensuring that the pond is positioned around the decant facilities and that the pond is maintained in that position. The pond is positioned by altering the location of deposition point around the perimeter of the storage, as appropriate.

The pond around the decant should be maintained at the smallest practical operational size to maximise water return to the plant to enable most of the free water to be recovered through the decant for recycling to the process plant.

The size of the pond will be largely governed by the efficiency of the decant system in removing water from the tailings storage. Other controlling factors will be:

- evaporation from the surface of the pond;
- variations to the input of tailings water (percentage solids);
- rainfall events;
- difference in permeability between the tailings and the underlying rock units; and
- the ratio of horizontal to vertical permeability of the tailings.

4.2.1 Start-up

At start-up (Stage 1), it will take several months for decant pond to be established in the rock ring, such that water recovery via a pump within the rock-ring can take place. Rock fingers/temporary accessways could be provided to allow access to a temporary pump at low levels within the cells and ensure water can be recovered at the earliest opportunity.

5 ROUTINE INSPECTIONS AND MAINTENANCE

The following routine inspection and maintenance procedures are to be carried out for the various components of the system. Reporting sheets (Proformas) are attached covering the following inspections:

- Monthly Inspection Log PF1
- Daily Inspection Log PF2
- Personnel Contact Details PF3
- Staff Confirmation Log PF4
- Assembly Points To be supplied by GML

Routine inspections, as detailed below, are to be undertaken by an operator or shift supervisor, each shift on a daily basis. The date and time of each inspection is to be entered onto the inspection log and is to be signed by the person allocated to undertake the inspection on that shift to ensure the requirements have been undertaken. Suggested proformas are attached to this operations manual.

The Shift Inspection Log Sheet is to be filled out on each shift, daily. Copies of inspection logs should be retained on site.

The inspections should cover:

- the pipelines (tailings delivery line and water return lines) to and from the TSF.
- leak detection.
- pumps.
- valves.
- spigotting and deposition.
- location and size of the decant pond.
- decant and return water pumps operation.
- sorted rejects placement.
- seepage from the embankment toe.
- the general integrity of the embankments i.e. any new cracking or new seepage (daily).
- any changes to existing cracking or seepage.

5.1 Monthly Inspections

Monthly inspections of the TSF should to be carried out by process plant management, refer to PF1 in order to provide management oversight of the facility.

These inspections should assess the items listed in the proforma and note any changes which have occurred since the previous inspection.

5.2 Annual Engineer's Inspection

An inspection by a qualified geotechnical engineer with experience in the design, operation and auditing of tailings storages should be carried out at least once every year.

5.3 Inspections

5.3.1 Tailings Lines

The tailings line is to be inspected a least once per shift. The date and time of each inspection is to be entered onto the inspection log.

All tailings lines to and from the TSF will be bunded. The HDPE tailings lines are sensitive to temperature, and the expansion and contraction of this line can cause leaks, and in extreme situations, failure of the pipeline. Any leaks or failures of the tailings pipeline should be immediately reported to the following personnel or project equivalents and an incident report completed.

- Shift Foreman or
- Mill Superintendent (Processing Manager)

5.3.2 Return Water System

The position and size of the pond in relation to the rock-ring / decant pump should be inspected at the same time as the tailings lines are inspected. Any abnormalities (i.e. lack of freeboard, pumps not operable) should be reported immediately to the following personnel or project equivalents:

- Shift Foreman or
- Mill Superintendent (Processing Manager)

The return water lines to the plant from the TSF should also be inspected at the same time as the tailings line. All return water lines will be bunded. Any leaks or failure of the water pipeline should be immediately reported to the following personnel or project equivalents:

- Shift Foreman or
- Mill Superintendent (Processing Manager)

5.4 Embankments

Part of the general activities of the Shift Foreman, when visiting the storage facilities, shall be to inspect the embankments, including berms and batter slopes, and the GCL on the Stage 1 upstream batter slopes. The inspection shall note any cracking or new features, such as seepage, embankment erosion or scour (caused by tailings deposition or rainfall runoff), damage to the GCL or any other obvious changes or problems.

6 MONITORING REQUIREMENTS

The following section details the monitoring requirements to ensure the TSF is performing in accordance with the design parameters and the details presented in the detailed design report.

Monitoring results (e.g. water quality and water level) should be recorded on spreadsheets and plotted and graphed as soon as possible. The information should be reviewed after being entered and graphed to allow any changes to be identified and acted upon.

The plotting of recorded information allows trends to be determined. Where newly recorded information deviates (generally significantly) from a previously established trend the reading should be checked, the general area should be inspected and the information reported to plant management for consideration and action.

Copies of the current leased licence conditions (DWER) relevant to the tailings storage should be attached to this document to allow for easy reference. Each time the licence is renewed or updated all conditions should be checked for any changes, with appropriate confirmation they have been read and records have been updated and will be acted upon as considered appropriate.

6.1 Process Plant

In addition to the daily visual inspections of the water pond, spigots, water return pumps, tailings and return water pipelines the following information should be recorded at a minimum on a monthly basis:

- Tailings production, measured in dry tonnes.
- Tailings recovered from the TSF for underground backfill, measured in dry tonnes.
- Tailings slurry density, measured in percentage solids or slurry water volume.
- Water return from all sources from the tailings storage to the process plant, measured in cubic metres or tonnes.

This information will be utilised to estimate a water balance as part of review of the TSF.

6.2 Embankment Monitoring

Installation of 12 piezometers (6 locations x 2 piezometers per location) have been included in the design, to monitor any phreatic surface within the embankments and foundations. Piezometer data will be collected as a minimum monthly using a data logger and the data download to a computer spreadsheet for assessment of data trends.

6.3 Environmental Monitoring

6.3.1 Climatic Data

If climatic information is collected on site, the following climatic data is to be collected daily or at the end of each month:

- Rainfall for the month.
- Evaporation for the month (if recorded on site or a nearby BOM station).

This information can be utilised in order to assist with determining a water balance for the annual review of the TSF.

6.3.2 Water Quality

Water quality monitoring (sampling and testing) is required from the following areas or sources:

- Monitoring bores located in and around the tailings storage.
- Seepage and any surface water located either downstream or upstream of the tailings storage facility.
- Slurry water discharged into the storage, water stored on the storage and water returned to the plant.

The frequency of the water quality monitoring is usually determined by the regulatory authorities with the details of the water quality requirements stipulated either on a licence or other approval documents issued by the regulatory authorities.

6.3.3 Storage Monitoring

Detailed mudline and water pond level surveys are to be carried out at least on an annual basis. This will enable the storage volume that has been used to be reconciled with the tailings tonnage deposited into the storage to establish an insitu density of the tailings from comparison with the design insitu density.

If any embankment construction is undertaken, as built survey plans should be updated.

7 EMERGENCY ACTION PLAN

The Emergency Response Plan for Abra Project should be based on the results of the dam break analyses presented in the design report. The plan should be reviewed and updated as a minimum on a yearly basis.

The plan should include:

- Management responsibilities and emergency coordination
- Muster points
- Seeking specialist geotechnical advice
- Emergency Plan Triggers, namely:
  - Freeboard less than design values
  - Significant embankment distress
  - Imminent overtopping

The emergency response should be managed by the registered manager. When the triggers above have been exceeded, personnel should be directed to the muster area, upslope of the TSF area (i.e. at the plant or similar location), as appropriate. The designers should also be advised as required when geotechnical advice is required.

To enable the emergency action plan to be implemented and to allow a safe and timely response to be instigated, the attached documents (Personnel Contact Details, Assembly Points and Staff Confirmation Log) outline current information pertaining to assembly points and contact names. The sheets shall be reviewed at least six monthly or updated as required when new staff become responsible for activities in and around the facilities.

Contractors shall also be made familiar with the location of the assembly point and be made aware of their reporting responsibilities and to whom they shall report to.

The attached sheets should provide a list of relevant contact details of staff associated with the tailings storage, senior site responsible staff, safety officers and emergency services.

8 INCIDENT REPORTING

The undertaking of regular inspections and monitoring is aimed at identifying any problems prior to them causing a major impact on the operation or integrity of the structure. The inspections may result in the identification of an event that may require reporting to senior staff and in some cases to relevant government departments, i.e. new seepage as indicated by monitoring bores.

Typical reporting events include:

- Any fauna death on or near the TSF (not road kill).
- Any uncontrolled release of tailings slurry or return water and the cause (pipe break, overtopping, pump malfunction, automatic switch malfunction, operator error, etc.).
- Impact from seepage (vegetation distress, soil contamination, water quality changes).
- Defects to the tailings storage facility covering such things as the pit walls and return water system (i.e. pertaining to safety issues).
- Changes in water quality that exceed prescribed conditions of licence criteria.
- Increases in production tonnages.

It is recommended that prior to submitting an incident report to DWER or DMIRS that an assessment be undertaken to confirm the nature, type and impact of the incident by either senior site staff or an independent organisation. If an incident requires reporting to the DWER or DMIRS, as a minimum, an incident report form should be used as well as any other reporting requirements (refer licences).

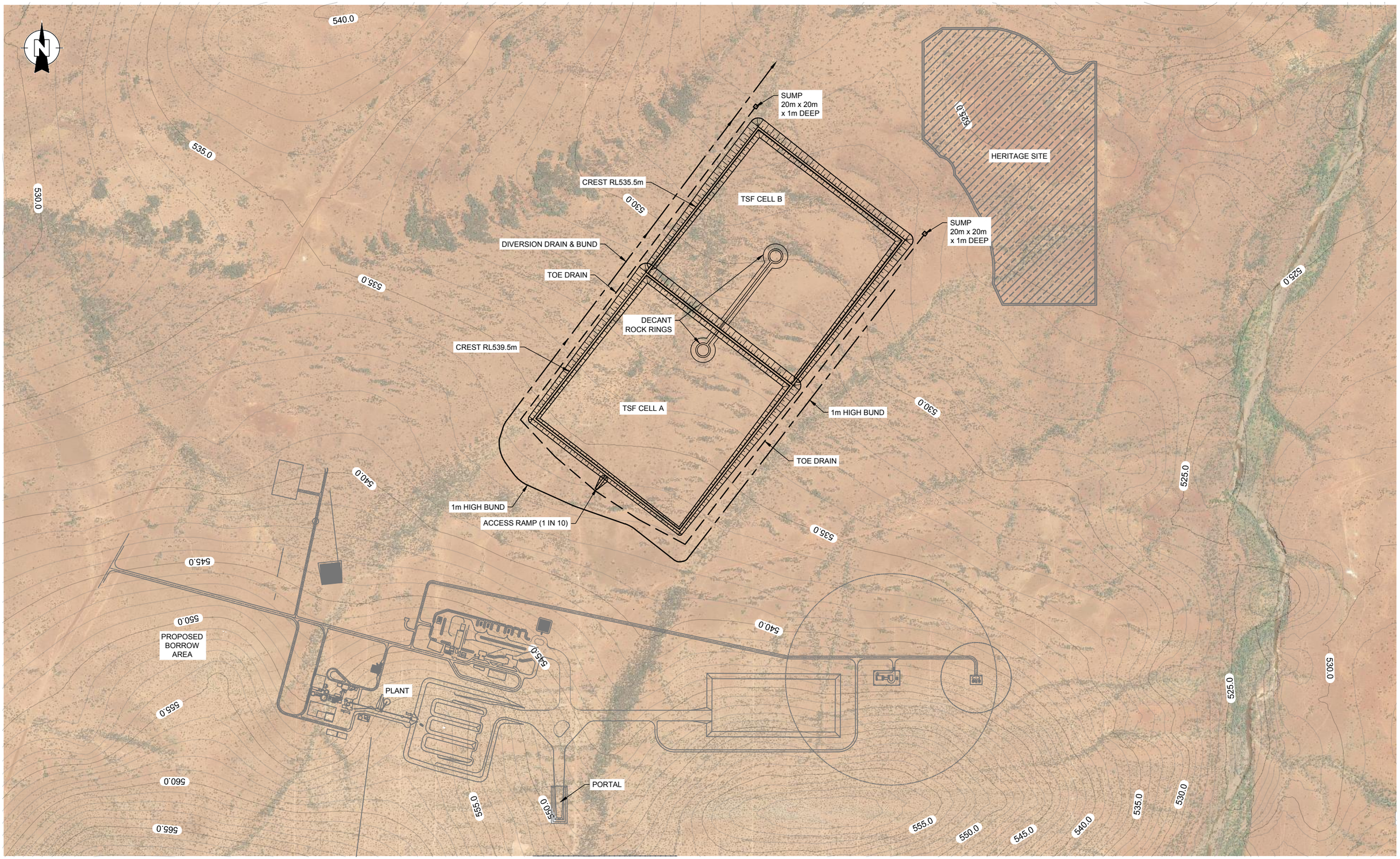
9 REHABILITATION WORKS

Refer to the detailed design report for details of closure works associated with the TSF. Progressive rehabilitation works can potentially be performed for the TSF during operations. The areas that could be progressively rehabilitated include the starter embankment downstream batters. This progressive rehabilitation could commence during Stage 2 operations.

10 CLOSURE

This Operations Manual is to be read in conjunction with the Design Report. This Operating Manual contains copies of proforma log sheets and lists of information to be inspected and recorded on a daily, monthly or yearly basis.

Figures



CREST REDUCED LEVELS

STAGE	CELL A	CELL B
1	539.5m	535.5m
2	542.5m	538.5m
3	545.5m	541.5m

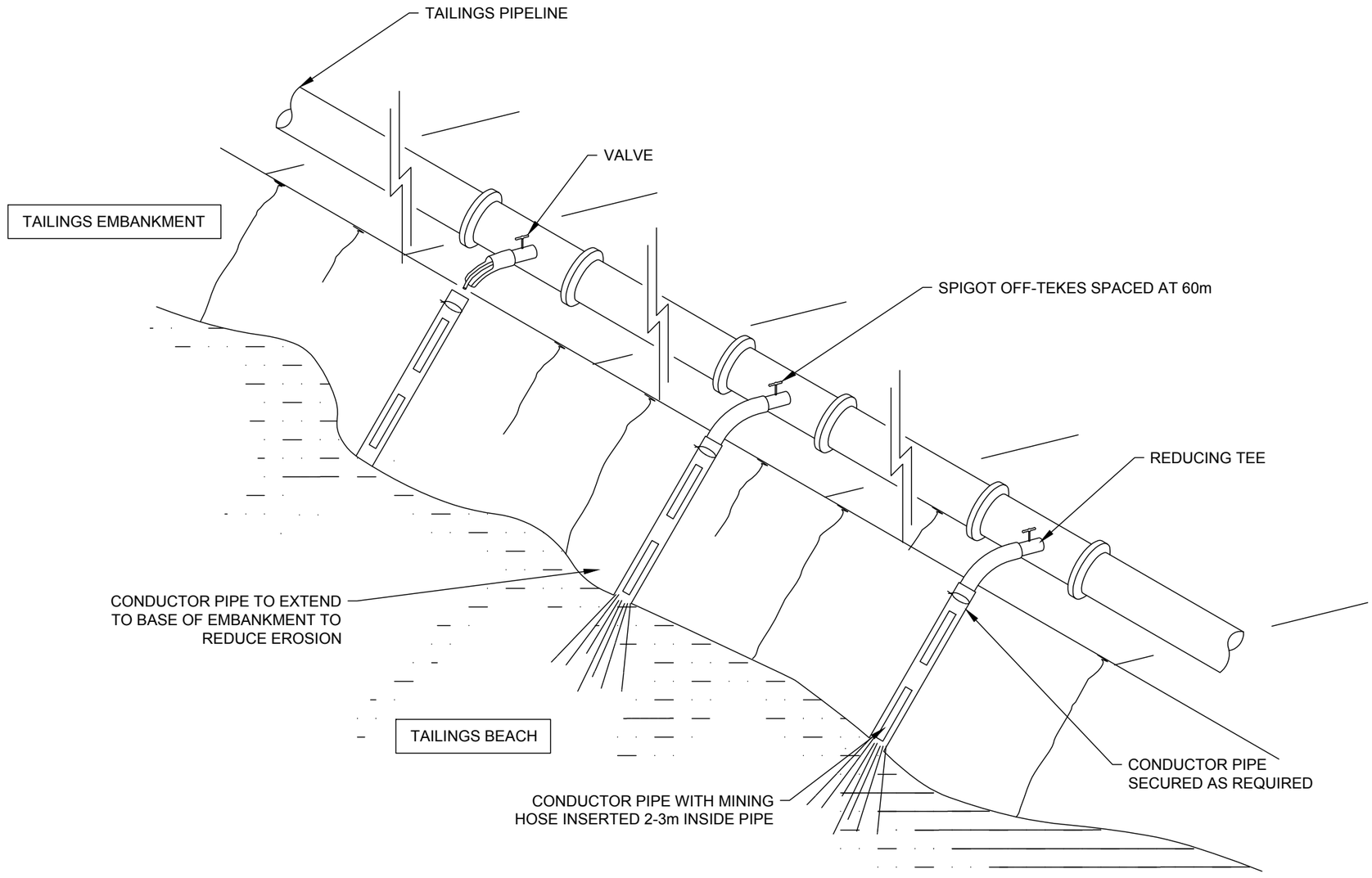
NOTES:

1. BASE PLAN PROVIDED BY CLIENT

1:10 000 — 0 100 200 300 400 500 m

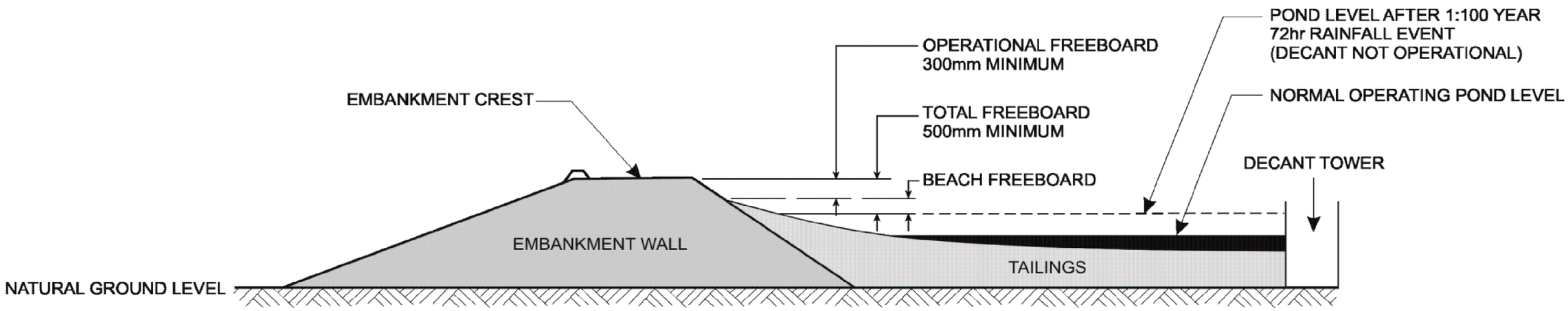
CMW Geosciences

CLIENT: LAND & MARINE GEOLOGICAL SERVICES PTY LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: GALENA ABRA TSF DESIGN		CHECKED: CL	FIGURE: 01
		REVISION: 1	SCALE: 1:10,000
TITLE: GENERAL ARRANGEMENT PLAN (STARTER EMBANKMENT)		DATE: 23.10.18	SHEET: A3 L



PROPOSED SPIGOT ARRANGEMENT
ISOMETRIC VIEW (NTS)

CMW Geosciences	CLIENT: **GALENA MINING LIMITED**	DRAWN: DE	PROJECT: PER2018-0128
	PROJECT: **ABRA BASE METALS PROJECT TAILINGS STORAGE FACILITY**	CHECKED: CH	FIGURE: 02
		REVISION: 0	SCALE: NTS
	TITLE: **SPIGOT ARRANGEMENT**	DATE: 18.10.18	SHEET: A4 L



NOTE: FOR CASE WHERE POND IS NORMALLY LOCATED AWAY FROM ANY PERIMETER EMBANKMENTS

CMW Geosciences	CLIENT: GALENA MINING LIMITED	DRAWN: DE	PROJECT: PER2018-0128
	PROJECT: ABRA BASE METALS PROJECT TAILINGS STORAGE FACILITY	CHECKED: CH	FIGURE: 03
		REVISION: 0	SCALE: NTS
	TITLE: FREEBOARD NOMENCLATURE	DATE: 18.10.18	SHEET: A4 L

Appendix A

Proformas

PROJECT	**: TAILINGS STORAGE FACILITY**	Date	22-Oct-18
		Job No	
CLIENT	**: GALENA MINING LIMITED**	File	
		Subject	Inspections
LOCATION	**: ABRA BASE METALS PROJECT**	Revision	
SUBJECT	**: MONTHLY INSPECTION LOG AND MONITORING SHEET- PROCESS PLANT MANAGEMENT**	**PF1**	sheet 1 of 1

Date: **Shift Supervisor:**	**Time:** **Inspection by:** **Employee Number:**	**Shift Number:** **Verified by:**

Item	Description of Inspection Activity	Comments	Remedial Works	
			Start	Finish
1.0	**Embankments**			
	Is cracking, slumping or other distress present around the embankment crests? If yes, is it new cracking or existing cracking? Has existing increased in extent?			
	Is the freeboard above the designated level? (Based on DMIRS criteria that is 0.3m, operation freeboard (at embankment))			
	Is staining or discolouration present on any of the downstream batter slopes of the embankments?			
	Is water ponding at the downstream toe of any of the embankments?			
	Is there evidence of seepage or seepage water flow from the downstream toe of any of the embankments? If yes, is it new or existing seepage? Has existing increased in extent?			
2.0	**Tailings Deposition**			
	Is the distribution of the tailings on the beaches as required by the operations manual?			
3.0	**Decant System**			
	Is the supernatant water positioned within the rock-ring decant facility?			
	Is the supernatant surface (within the storage) as planned, or is there excess water on the storage?			
	Can the decant system handle storm runoff in addition to the reclaim water efficiently?			
4.0	**Process Plant Information**			
	Tailings to TSF for the month (tonnes)			
	Average tailings slurry density, measured in percentage solids			
	Water return from the tailings storage to the process plant (in tonnes and m3)			
	Compare the water return to the target of 50% of slurry water inflow (on an average annual basis). Any comments? Corrections required to operations?			
5.0	**Monitoring**			
	Have the water levels in the monitoring bore been measured and data entered to the appropriate sheet?			
	Has the water quality data from the monitoring bores been checked and data entered into the appropriate spreadsheet?			
	Has the data from the vibrating wire piezometers been downloaded into a spreadsheet and the water level trends assessed?			
7.0	**Climatic Data**			
	Has the site rainfall been recorded entered daily into spreadsheet? monthly total?			
8.0	**Other Aspects**			
	Comments			

PROJECT	**: TAILINGS STORAGE FACILITY**	Date	22-Oct-18
		Job No	0
CLIENT	**: GALENA MINING LIMITED**	File	0
		Subject	Inspections
LOCATION	**: ABRA BASE METALS PROJECT**	Revision	0

SUBJECT **: PERSONNEL CONTACT DETAILS** sheet 1 of 1

Name	Company	Responsibility	Contact Details

Last updated :

ref : **0**

PROJECT	**: TAILINGS STORAGE FACILITY**	Date	22-Oct-18
		Job No	0
CLIENT	**: GALENA MINING LIMITED**	File	0
		Subject	Inspections
LOCATION	**: ABRA BASE METALS PROJECT**	Revision	0
SUBJECT	**: STAFF CONFIRMATION LOG SHEET**	**PF4**	sheet 1 of 1

As part of the requirements for the safe operation of the Tailings Storage Facility (TSF), all personnel involved with the daily or regular operation and inspection of the TSF as well as those who are responsible for the TSF, are required to sign this form as confirmation that you have attended and understood all safety and induction procedures. In particular that you are familiar with the prepared operations manual that has been prepared to in accordance with DMIRS guidelines.

NAME :

SIGNATURE :

DATE :

PROJECT	**: TAILINGS STORAGE FACILITY**	Date	22-Oct-18
		Job No	0
CLIENT	**: GALENA MINING LIMITED**	File	0
		Subject	Inspections
LOCATION	**: ABRA BASE METALS PROJECT**	Revision	0
SUBJECT	**: DAILY INSPECTION LOG SHEET**	**PF2**	sheet 1 of 1

Date:	**Time:**	**Shift Number:**
Shift Supervisor:	**Inspection by:**	**Verified by:**
	Employee Number:	

Item	**Criteria**	**Operating/Defective YES/NO**		**Comments**
		N/S	**D/S**	
Roadways	Condition		Y/N	
Downstream areas	Any seepage/wet areas		Y/N	
	Any spillages		Y/N	
Pipelines	Leaks?	Y/N	Y/N	
Decant	Pumps operating	Y/N	Y/N	
	Discharge water clarity	Y/N	Y/N	
Tailings discharge	Location, no. of spigots?	Y/N	Y/N	
Freeboard	Pond position		Y/N	
	Depth (estimate)		Y/N	
	Operational freeboard (at wall >0.3m) (Estimate)		Y/N	
Embankments	Any distress? Any cracking?		Y/N	
	Any damage to GCL? (Stage 1)			
Fauna	Any deaths		Y/N	
Flora	Any new distress		Y/N	
Monitoring	Damage to instruments? Monitoring bores and piezometers		Y/N	

NOTES :
Please provide any comments or notes relating to the tailings storage facility

Document page break

22 October 2018

TAILINGS STORAGE FACILITY
ABRA BASE METALS PROJECT, NEAR MEEKATHARRA, WA

GEOTECHNICAL ASSESSMENT REPORT

Galena Mining Limited

Ref: PER2018-0128AF Rev 1

PER2018-0128AF		
Date	Revision	Comments
18 October 2018	0	Issued as draft
22 October 2018	1	Final report

Table of Contents

Photographs

Figures

Appendices

1 INTRODUCTION

CMW Geosciences Pty Ltd (CMW) was authorised by Galena Mining Pty Ltd (GML) to carry out a geotechnical assessment of a site located at Abra, north of Meekatharra, WA, as part of the design of the Tailings Storage Facility (TSF) for the project. The scope of work and associated terms and conditions of our engagement were detailed in our short form proposal PER2018-0128AB Rev0.

2 SITE DESCRIPTION

The proposed mine site is located approximately 170 km south west of Newman. The topography of the project site is dominated by low rolling hills with rock outcropping at the ground surface where the plant site is located. A photograph of the typical ground conditions across the site is shown in Photograph 01 and 02, behind text. The tailings storage facility is located on flatter ground (approximately 1:100 to 1:150 grade) to the north of the plant site with several shallow drainage lines in the vicinity which have exposed caprock in the base of the channels (see Photograph 03).

3 PROPOSED DEVELOPMENT

The Abra Project is located within the granted mining licence M52/776 and comprises a box cut for an underground mining operation, processing plant, TSF, airstrip and associated infrastructure. The TSF is located approximately 500 m north immediately south of the proposed plant site, with an approximate centre at (MGA, Zone 51) coordinates 6,770,700 m North and 495,700 m East.

4 GEOLOGY

An extract from the Australia 1:100,000 Geology Series – Calyie (Sheet 2648) for the location of the proposed project is presented as Figure 1. Table 1 provides details of the surficial geological units adjacent to the site which have been subjected to a site reconnaissance and some intrusive geotechnical site investigations with geotechnical laboratory testing of materials.

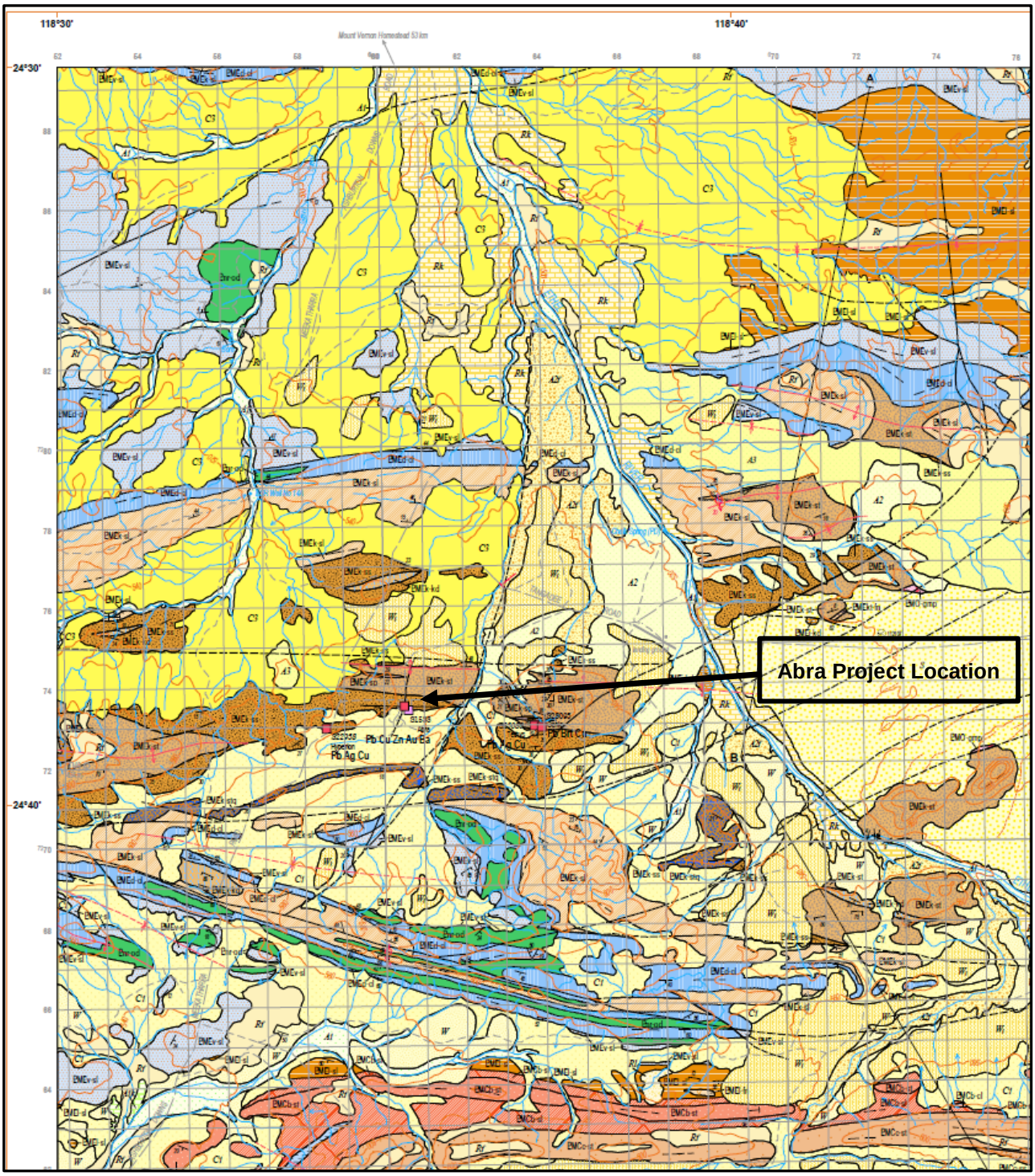
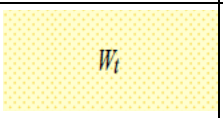
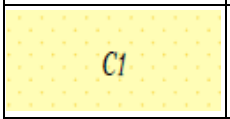
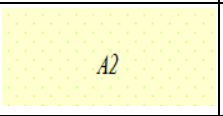
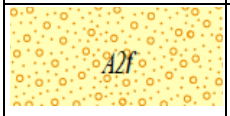
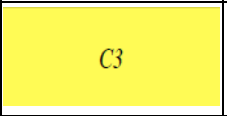
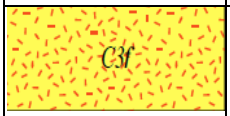
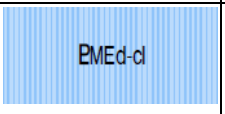


Figure 1 – Extract - Geology Map Australia 1:100,000 Geology Series – Calyie (Sheet 2648)

Table 1: Surficial geological units and geology units assessed for construction materials	
Legend/Unit	**Description**
	Sheetwash - Silt and sand, surface is characterized by shallow depressions aligned perpendicular to the slope; supports banded mosaic vegetation ('tiger bush').
	Colluvium - Quartz and rock fragments in an unconsolidated silt and sand matrix; includes ferruginous deposits.
	Alluvium - Partly consolidated silt, sand, and gravel; partly dissected by present-day drainage.
	Alluvium - Partly consolidated ferruginous silt, sand, and gravel; partly dissected by present-day drainage.
	Colluvium - Quartz and rock fragments in a weakly cemented and compacted silt and sand matrix; deeply dissected valley-fill deposits.
	Colluvium - Ferruginous rubble and scree in a weakly cemented and compacted silt and sand matrix; partly dissected.
	**Discovery Formation** - massive or laminated chert, silicified mudstone and siltstone; local silicified sandstone and conglomerate.
	**Kiangi Creek Formation** - Siltstone; minor fine-grained sandstone.
	**Kiangi Creek Formation** - Sandstone and siltstone.
	**Kiangi Creek Formation** - Medium to very thick-bedded quartz sandstone and siltstone.
	**Kiangi Creek Formation** - Silicified, feldspathic quartz sandstone, siltstone and minor conglomerate.

5 FIELD INVESTIGATION

CMW/L&MGSPL conducted site reconnaissance's of the Abra Project area in two mobilisations. Field investigations were carried out by GML explorations geologists under the direction of CMW/L&MGSPL and included.

- Preliminary investigations included the drilling of air-core boreholes on a 200 x 200 m grid pattern across the site. A total of 105 boreholes were drilled to a maximum depth of 20 m.
- A walkover survey of the site to assess the general landform and site conditions.
- Sampling of air-core samples (see Photograph 04) as directed by CMW/L&MGSPL in order to characterise materials.

- Test pitting of a potential borrow area in the south west of the project area under the supervision of GML geologists.
- Test pitting of the selected TSF site to the north of the plant under the supervision of GML geologists.

Geological logs of the boreholes (conducted by GML) are presented in Appendix A.

The approximate locations of the respective investigation sites referred to above are shown on the attached Site Plans (Figure 2 and 3). Elevations were not measured.

6 LABORATORY TESTING

Laboratory testing was carried out generally in accordance with the requirements of the current edition of AS 1289 (where applicable). Where a test was not covered by an Australian standard, a local or International standard was adopted and noted on the laboratory test certificate.

Testing was scheduled by CMW and carried out by Liquid Labs WA, a NATA accredited testing authority.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Table 2.

Table 2: Laboratory Test Schedule Summary

Type of Test	Test Method	Quantity
Particle size distribution	AS1289.3.6.1	6
Atterberg limits	AS1289.3.1.1, 3.2.1, 3.3.1	8
Linear shrinkage	AS1289.3.4.1	8

Certificates for the test results outlined above are presented in Appendix B.

7 GROUND MODEL

7.1 Subsurface Conditions

At the proposed borrow area (air-core bore locations APFS075 (Photograph 04) and APFS076) the ground conditions comprised near surface silicified rocks (siltstone/sandstone (Photograph 05)) over saprolite at depth. Testpitting in the proposed borrow area indicated shallow refusal on cemented materials at a depth of 1.45 m or less. If this area was to be developed as a borrow area paddock blasting would be required in order to generate materials suitable for embankment construction including fines within the borrow material.

At the proposed TSF site (Bore locations APFS056 (Photograph 06) and APFS029) air-core drilling indicated thick lateritic materials (Wiluna Hardpan) overlying saprolite at depth (>5 m). It was observed that the hardpan sample fines lacked plasticity.

The test pitting at the proposed TSF site indicated ground conditions comprising:

- Colluvium overlying
- Wiluna Hardpan
- Depth to refusal averaged 0.5 m with a maximum depth to refusal of 1.45 m

7.2 Laboratory Test Results

Results of the laboratory tests provided in Appendix B are summarised in Table 3:

Table 3: Summary of Civil Engineering Laboratory Test Results								
Borehole ID	**APFS076**	**APFS081**	**APFS056**	**APFS056**	**APFS056**	**APFS029**	**APFS029**	**APFS029**
Depth (m)	1 - 4	1 - 4	1 - 2	2 - 3	3 - 4	1 - 2	2 - 3	3 - 4
Gravel (%)	-	-	24	38	19	27	27	16
Sand (%)	-	-	59	47	62	59	57	61
Fines (%)	-	-	17	15	19	14	16	23
LL (%)	NO	23	NO	NO	NO	NO	NO	NO
PL (%)	NP	17	NP	NP	NP	NP	NP	NP
PI (%)	NP	6	NP	NP	NP	NP	NP	NP
LS (%)	1	2.5	0	1.5	0.5	1.5	0.5	0.5

Note: Gravel, sand and fines percentages are by weight, LL = liquid limit, PL = plasticity limit, PI = plasticity index, LS = linear shrinkage, NO = Not obtained, NP = Non-plastic

8 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the field geotechnical investigation works and laboratory testing the following conclusions have been reached:

- There is an absence of easily excavated materials for embankment construction both at the TSF site and the proposed borrow area to the south west of the TSF.
- There is an absence of materials with a fines, the soil fraction finer than 75 microns (silt and clay) and plasticity to support construction of a reasonably low permeability embankment.
- There are no alternative sites for the TSF with suitable materials in close proximity to the plant site.
- The investigated materials are structurally suitable for the intended purpose

In the absence of suitable low permeability materials, a Geosynthetic Clay Liner (GCL) is recommended to be included in the TSF design to provide the required low permeability characteristics desirable in this type of structure.

9 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, can it be considered that these findings represent the actual state of the ground conditions away from our investigation locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

This report has been prepared for use by Galena Mining Limited in relation to the Abra Project, WA in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than Galena Mining Limited and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

For and on behalf of
CMW Geosciences Pty Ltd

Amy Tsagopoulos
Project Engineering Geologist

Chris Hogg
Principal Geotechnical Engineer

Distribution: 1 copy to Galena Mining Pty Ltd (electronic)
Original held by CMW Geosciences Pty Ltd

10 REFERENCES

- *AS 1289, Methods of testing soils for engineering purposes, Standards Australia, Sydney*
- *AS 1726, Geotechnical Site Investigations, Standards Australia, Sydney, 2017*
- *Collier 1:250,000 Sheet SG 50-4, Geological Survey of Western Australia, 1981*

Photographs

Photograph 01 – Depicting ground conditions typical of the site (vicinity of borehole reference APSF034)

Photograph 02 – Depicting ground conditions typical of the site (vicinity of borehole reference APSF075)

Photograph 03 – Depicting drainage channels with laterite

Photograph 04 – Depicting drill spoil of pulverised rock (located at borehole APFS075)

Photograph 05 – Depicting interbedded claystone and siltstone with laterite

Photograph 06 – Depicting drill spoil of pulverised rock (located at borehole APFS056)

Figures

Figure 2 – Site Plan with Boreholes

659,000 659,500 660,000 660,500 661,000 661,500 662,000 662,500

7,276,500 7,276,000 7,275,500 7,275,000 7,274,500

APFS012 APFS011 APFS001 APFS002 APFS003 APFS004
APFS013 APFS014 APFS008 APFS007 APFS006 APFS005
APFS017 APFS016 APFS015 APFS009 APFS010 APFS018 APFS019
APFS043 APFS044 APFS045 APFS046 APFS023 APFS022 APFS021 APFS020
APFS050 APFS049 APFS048 APFS047 APFS024 APFS025 APFS026 APFS027
APFS051 APFS052 APFS053 APFS054 APFS055 APFS031 APFS030 APFS029 APFS028
APFS060 APFS059 APFS058 APFS057 APFS056 APFS032 APFS033 APFS034 APFS035
APFS061 APFS062 APFS063 APFS064 APFS074 APFS065 APFS042 APFS041 APFS040 APFS039 APFS038 APFS037 APFS036
APFS076 APFS075 APFS077 APFS073 APFS068 APFS067 APFS066 APFS105 APFS092 APFS091 APFS090 APFS089 APFS088 APFS087
APFS078 APFS079 APFS072 APFS071 APFS070 APFS069 APFS104 APFS106 APFS093 APFS094 APFS095 APFS096 APFS097
APFS080 APFS081 APFS082 APFS086 APFS085 APFS084 APFS083 APFS103 APFS102 APFS101 APFS100 APFS099 APFS098

12 12 8 13 - - 12 - - - 8 4 11 - - 2 - - 10 5 5 7 12 13 8 - 3 8 5 4 7 5 6 6 ? 3 2 4 ? 1 0 2 1 2

G 52/292

E 5

659,000 659,500 660,000 660,500 661,000 661,500 662,000 662,500

N

0 100 200 300 400 m

GDA94, MGA Zone 50N

LEGEND

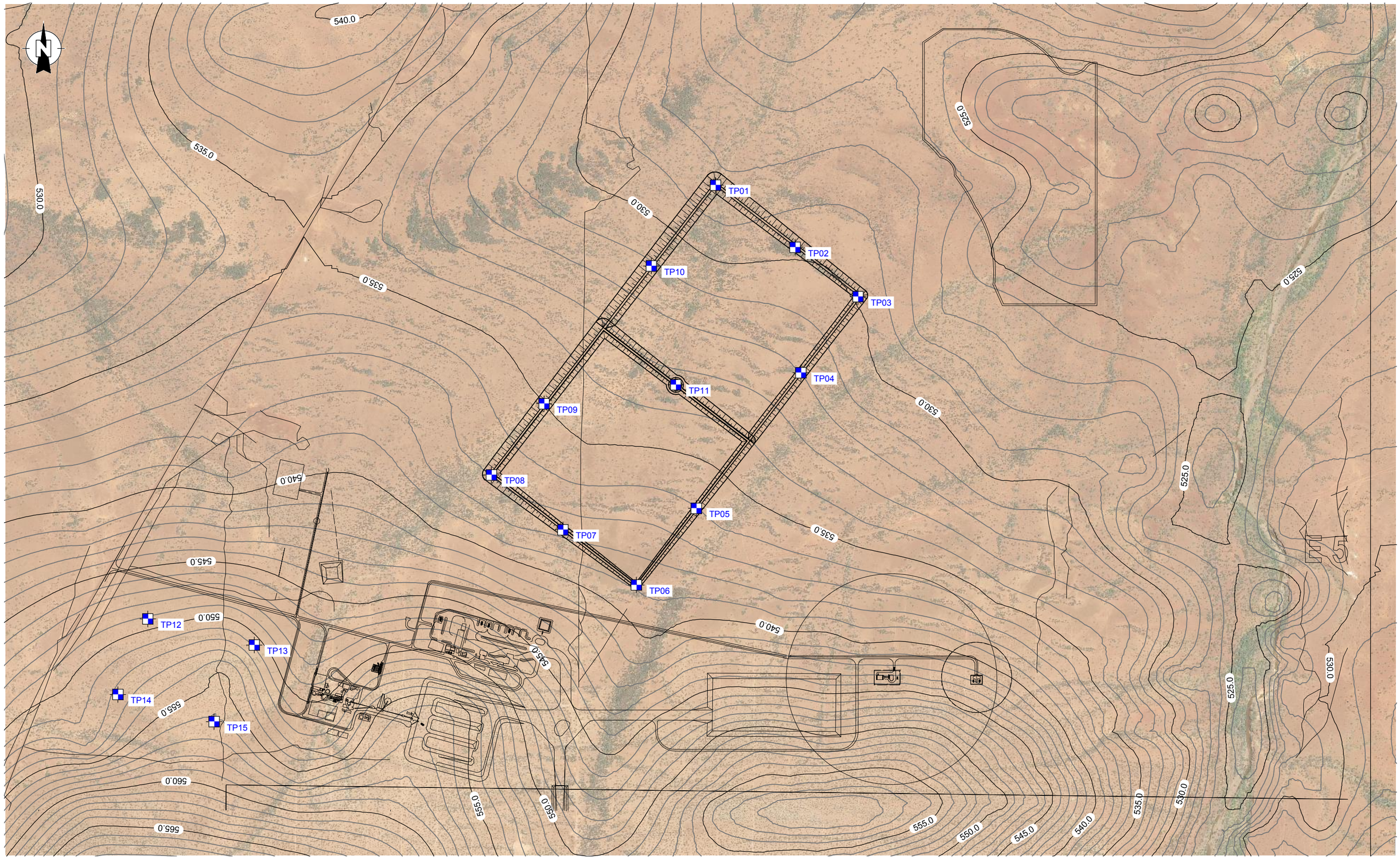
- Auger drill collar location

GALENA

Auger drill collar over site layout

Project: Mulgul	Scale: 1:10,000
Drafted by: AS	Date: 27-Aug-18

Figure 3 Site Plan with Test Pits



LEGEND:

TP01 TEST PIT (TP) LOCATION

NOTES:

1. IMAGE FROM BING MAPS
2. TSF BATTERS INDICATIVE ONLY

1:10 000 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: GALENA MINING LTD		DRAWN: DE	PROJECT: PER2018-0128
PROJECT: TSF DESIGN ABRA PROJECT		CHECKED: CH	DRAWING: 01
		REVISION: 0	SCALE: 1:10,000
TITLE: PROPOSED TEST LOCATION PLAN		DATE: 14.09.18	SHEET: A3 L

Appendix A
Borehole / Test Pit Log Summaries

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS001	0	1	br	Soil	soil with gravel
APFS001	1	2	br	Soil	soil with gravel
APFS001	2	3	rb	RLd	fine to med sand + pisolith
APFS001	3	4	rb	RLd	fine to med sand + pisolith
APFS001	4	5	br	RLd	fine to med sand + pisolith
APFS001	5	6	br	RM	fine to med sand + pisolith
APFS001	6	7	br	RM	fine to med sand +fragments
APFS001	7	8	be	RS	fine to med sand + clay
APFS001	8	9	be	RS	fine to med sand + clay
APFS001	9	10	be	RS	fine to med sand + clay
APFS001	10	11	cm	RS	Clay + fine sand
APFS001	11	12	yw	RS	Clay + fine sand
APFS001	12	13	yw	RS	Clay + fine sand
APFS001	13	14	yw	RS	Clay + fine sand
APFS001	14	15	cm	RS	fine sand + clay
APFS001	15	16	be	RS	fine sand + clay
APFS001	16	17	pk	RS	fine sand + clay
APFS001	17	18	be	RS	fine sand + clay
APFS001	18	19	yw	RS	fine sand + clay + fragments
APFS001	19	20	yw	RS	fine sand + clay + fragments
APFS002	0	1	br	Soil	soil with gravel
APFS002	1	2	rb	RLd	soil with gravel
APFS002	2	3	rb	RLd	fine to med sand + pisolith
APFS002	3	4	rb	RLd	fine to med sand + pisolith
APFS002	4	5	be	RM	fine to med sand + pisolith
APFS002	5	6	be	RM	fine to med sand + med to coarse fragments
APFS002	6	7	yw	RS	fine to med sand + med to coarse fragments
APFS002	7	8	yw	RS	Clay (-) + med sand
APFS002	8	9	yw	RS	Clay (-) + med sand
APFS002	9	10	yw	RS	Clay (-) + med sand
APFS002	10	11	yw	RS	Clay (-) + med sand
APFS002	11	12	yw	RS	Clay (-) + med sand
APFS002	12	13	yw	RS	Clay (-) + med sand
APFS002	13	14	yw	RS	Clay (-) + med sand
APFS002	14	15	yw	RS	Clay (-) + med sand
APFS002	15	16	yw	RS	Clay (-) + med sand
APFS002	16	17	yw	RS	Clay (-) + med sand
APFS002	17	18	yb	RS	Clay (-) + med sand
APFS002	18	19	yb	RS	Clay (-) + med sand
APFS002	19	20	yb	RS	Clay (-) + med sand + med fragments
APFS003	0	1	br	Soil	soil with gravel
APFS003	1	2	br	Soil	soil with gravel
APFS003	2	3	rb	RLd	fine to med sand + pisolith
APFS003	3	4	rb	RLd	fine to med sand + pisolith
APFS003	4	5	rb	RLd	fine to med sand + pisolith
APFS003	5	6	rb	RLd	fine to med sand + pisolith
APFS003	6	7	rb	RLd	fine to med sand + pisolith
APFS003	7	8	rb	RLd	fine to med sand + pisolith
APFS003	8	9	pk	RM	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS003	9	10	pk	RM	fine to med sand + fragments
APFS003	10	11	be	RS	fine to med sand + fragments
APFS003	11	12	be	RS	fine to med sand + fragments
APFS003	12	13	be	RS	fine to med sand + fragments
APFS003	13	14	be	RS	fine to med sand + fragments
APFS003	14	15	be	RS	fine to med sand + fragments
APFS003	15	16	yw	RS	Clay (+) + fine sand + fragments
APFS003	16	17	yw	RS	Clay (+) + fine sand + fragments
APFS003	17	18	yw	RS	Clay (+) + fine sand + fragments
APFS003	18	19	yb	RS	Clay (+) + fine sand + fragments
APFS003	19	20	yb	RS	Clay (+) + fine sand + fragments
APFS004	0	1	br	Soil	soil with gravel
APFS004	1	2	br	Soil	soil with gravel
APFS004	2	3	rb	RLd	fine to coarse sand + pisolith
APFS004	3	4	rb	RLd	fine to coarse sand + pisolith
APFS004	4	5	rb	RLd	fine to coarse sand + pisolith
APFS004	5	6	rb	RLd	fine to coarse sand + pisolith
APFS004	6	7	rb	RLd	fine to coarse sand + pisolith
APFS004	7	8	rb	RLd	fine to coarse sand + pisolith
APFS004	8	9	pk	RM	fine to coarse sand + fragments
APFS004	9	10	pk	RM	fine to coarse sand + fragments
APFS004	10	11	yb	RS	fine to coarse sand + fragments
APFS004	11	12	be	RS	fine to coarse sand + fragments
APFS004	12	13	be	RS	fine to coarse sand + fragments
APFS004	13	14	be	RS	fine to coarse sand + fragments
APFS004	14	15	be	RS	fine to coarse sand + fragments
APFS004	15	16	be	RS	fine to coarse sand + fragments
APFS004	16	17	be	RS	fine to coarse sand + fragments
APFS004	17	18	be	RS	fine to coarse sand + fragments
APFS004	18	19	gy	RS	Clay (-) + fine sand
APFS004	19	20	gy	RS	fine to coarse sand + fragments
APFS005	0	1	br	Soil	soil with gravel
APFS005	1	2	br	Soil	soil with gravel
APFS005	2	3	rb	RLd	fine to coarse sand + pisolith
APFS005	3	4	rb	RLd	fine to coarse sand + pisolith
APFS005	4	5	rb	RLd	fine to coarse sand + pisolith
APFS005	5	6	rb	RLd	fine to coarse sand + pisolith
APFS005	6	7	rb	RLd	fine to coarse sand + pisolith
APFS005	7	8	rb	RLd	fine to coarse sand + pisolith
APFS005	8	9	br	RM	fine to med sand + fragments
APFS005	9	10	br	RM	fine to med sand + fragments
APFS005	10	11	pk	RM	fine to med sand + fragments
APFS005	11	12	be	RS	fine to med sand + fragments
APFS005	12	13	be	RS	fine to med sand + fragments
APFS005	13	14	be	RS	fine to med sand + fragments
APFS005	14	15	be	RS	fine to med sand + fragments
APFS005	15	16	be	RS	fine to med sand + fragments
APFS005	16	17	be	RS	fine to med sand + fragments
APFS005	17	18	be	RS	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS005	18	19	be	RS	fine to med sand + fragments
APFS005	19	20	pk	RS	fine to med sand + fragments
APFS006	0	1	br	Soil	soil with gravel
APFS006	1	2	br	Soil	soil with gravel
APFS006	2	3	br	Soil	soil with gravel
APFS006	3	4	rb	RLd	fine to coarse sand + pisolith
APFS006	4	5	rb	RLd	fine to coarse sand + pisolith
APFS006	5	6	rb	RLd	fine to coarse sand + pisolith
APFS006	6	7	rb	RLd	fine to coarse sand + pisolith
APFS006	7	8	br	RM	fine to med sand + fragments
APFS006	8	9	pk	RM	fine to med sand + fragments
APFS006	9	10	be	RS	fine to med sand + fragments
APFS006	10	11	be	RS	fine to med sand + fragments
APFS006	11	12	pk	RS	fine to med sand + fragments
APFS006	12	13	yw	RS	Clay (-) + fine sand
APFS006	13	14	yw	RS	Clay (-) + fine sand
APFS006	14	15	yw	RS	Clay (+) + fine sand
APFS006	15	16	yw	RS	Clay (+) + fine sand
APFS006	16	17	yw	RS	Clay (+) + fine sand
APFS006	17	18	yw	RS	Clay (+) + fine sand
APFS006	18	19	yw	RS	Clay (+) + fine sand
APFS006	19	20	yw	RS	Clay (+) + fine sand
APFS007	0	1	br	Soil	soil with gravel
APFS007	1	2	br	Soil	soil with gravel
APFS007	2	3	rb	RLd	fine to med sand + pisolith
APFS007	3	4	rb	RLd	fine to med sand + pisolith
APFS007	4	5	rb	RLd	fine to med sand + pisolith
APFS007	5	6	rb	RLd	fine to med sand + pisolith
APFS007	6	7	pk	RM	fine to med sand + fragments
APFS007	7	8	pk	RM	fine to med sand + fragments
APFS007	8	9	be	RM	fine to med sand + fragments
APFS007	9	10	pk	RM	Clay (-) + fine sand + fragments
APFS007	10	11	pk	RS	fine to med sand + fragments
APFS007	11	12	pk	RS	fine to med sand + fragments
APFS007	12	13	be	RS	fine to med sand + fragments
APFS007	13	14	be	RS	fine to med sand + fragments
APFS007	14	15	be	RS	Clay (-) + med sand
APFS007	15	16	be	RS	Clay (-) + med sand
APFS007	16	17	be	RS	Clay (-) + fine sand
APFS007	17	18	yb	RS	Clay (-) + fine sand
APFS007	18	19	pk	RS	Clay (-) + fine sand
APFS007	19	20	yw	RS	Clay (-) + fine sand
APFS008	0	1	br	Soil	soil with gravel
APFS008	1	2	rb	RLd	fine to coarse sand + pisolith
APFS008	2	3	rb	RLd	fine to coarse sand + pisolith
APFS008	3	4	rb	RLd	fine to coarse sand + pisolith
APFS008	4	5	rb	RLd	fine to coarse sand + pisolith
APFS008	5	6	rb	RLd	fine to coarse sand + pisolith
APFS008	6	7	br	RM	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS008	7	8	yb	RS	fine to med sand + fragments
APFS008	8	9	be	RS	clay (-) to med sand + fragments
APFS008	9	10	be	RS	fine to med sand + fragments
APFS008	10	11	be	RS	fine to med sand + fragments
APFS008	11	12	yw	RS	clay (-) to med sand
APFS008	12	13	yw	RS	clay (-) to med sand
APFS008	13	14	yw	RS	fine to med sand + fragments
APFS008	14	15	pk	RS	fine to med sand + fragments
APFS008	15	16	pk	RS	clay (-) to med sand + fragments
APFS008	16	17	pk	RS	clay (-) to med sand + fragments
APFS008	17	18	pk	RS	clay (-) to med sand + fragments
APFS008	18	19	yb	RS	clay (-) to med sand + fragments
APFS008	19	20	yb	RS	clay (-) to med sand + fragments
APFS009	0	1	br	Soil	soil with gravel
APFS009	1	2	br	Soil	soil with gravel
APFS009	2	3	br	Soil	soil with gravel
APFS009	3	4	rb	RLd	fine to coarse sand + pisolith
APFS009	4	5	rb	RLd	fine to coarse sand + pisolith
APFS009	5	6	rb	RLd	fine to coarse sand + pisolith
APFS009	6	7	pk	RM	fine to coarse sand + fragments
APFS009	7	8	pk	RM	fine to coarse sand + fragments
APFS009	8	9	pk	RM	fine to coarse sand + fragments
APFS009	9	10	be	RS	fine to coarse sand + fragments
APFS009	10	11	be	RS	clay (-) to med sand + fragments
APFS009	11	12	be	RS	clay (-) to med sand + fragments
APFS009	12	13	be	RS	clay (-) to med sand + fragments
APFS009	13	14	be	RS	clay (-) to med sand + fragments
APFS009	14	15	be	RS	clay (-) to med sand + fragments
APFS009	15	16	pk	RS	clay (-) to med sand + fragments
APFS009	16	17	pk	RS	clay (-) to med sand + fragments
APFS009	17	18	pk	RS	clay (-) to med sand + fragments
APFS009	18	19	pk	RS	clay (-) to med sand + fragments
APFS009	19	20	pk	RS	clay (-) to med sand + fragments
APFS010	0	1	br	Soil	soil with gravel
APFS010	1	2	br	Soil	soil with gravel
APFS010	2	3	br	Soil	soil with gravel
APFS010	3	4	rb	RLd	fine to med sand + pisolith
APFS010	4	5	rb	RLd	fine to med sand + pisolith
APFS010	5	6	rb	RLd	fine to med sand + pisolith
APFS010	6	7	rb	RLd	fine to med sand + pisolith
APFS010	7	8	rb	RLd	fine to med sand + pisolith + fragments
APFS010	8	9	pk	RM	fine to coarse sand + fragments
APFS010	9	10	pk	RM	fine to coarse sand + fragments
APFS010	10	11	be	RS	clay (-) to med sand + fragments
APFS010	11	12	be	RS	clay (-) to med sand + fragments
APFS010	12	13	be	RS	clay (-) to med sand + fragments
APFS010	13	14	be	RS	clay (-) to med sand + fragments
APFS010	14	15		RS	clay (-) to med sand + fragments
APFS010	15	16		RS	clay (-) to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS010	16	17		RS	clay (-) to coarse sand + fragments
APFS010	17	18		RS	clay (-) to coarse sand + fragments
APFS010	18	19		RS	clay (-) to coarse sand + fragments
APFS010	19	20		RS	clay (-) to coarse sand + fragments
APFS011	0	1	br	Soil	soil with gravel
APFS011	1	2	rb	RLd	fine to med sand + pisolith
APFS011	2	3	rb	RLd	fine to med sand + pisolith
APFS011	3	4	rb	RLd	fine to med sand + pisolith
APFS011	4	5	rb	RLd	fine to med sand + pisolith
APFS011	5	6	br	RM	med to coarse sand + fragments
APFS011	6	7	br	RM	med to coarse sand + fragments
APFS011	7	8	br	RM	med to coarse sand + fragments
APFS011	8	9	br	RM	med to coarse sand + fragments
APFS011	9	10	br	RM	med to coarse sand + fragments
APFS011	10	11	yg	RS	med sand + fragments
APFS011	11	12	yg	RS	fine to med sand + fragments
APFS011	12	13	yg	RS	fine to med sand + fragments
APFS011	13	14	yg	RS	fine to med sand + fragments
APFS011	14	15	be	RS	fine to med sand + fragments
APFS011	15	16	be	RS	fine to med sand + fragments
APFS011	16	17	pk	RS	fine to med sand + fragments
APFS011	17	18	pk	RS	fine to med sand + fragments
APFS011	18	19	be	RS	fine to med sand + fragments + fragments
APFS011	19	20	yb	RS	fine to med sand + fragments + clay (-)
APFS012	0	1	br	Soil	soil with gravel
APFS012	1	2	rb	RLd	fine to coarse sand + fragments
APFS012	2	3	rb	RLd	fine to coarse sand + fragments
APFS012	3	4	rb	RLd	fine to coarse sand + fragments
APFS012	4	5	br	RLd	fine to coarse sand + fragments
APFS012	5	6	br	RM	fine to coarse sand + fragments
APFS012	6	7	br	RM	fine to coarse sand + fragments
APFS012	7	8	br	RM	fine to med sand + fragments + nodules
APFS012	8	9	rb	RM	fine to med sand + fragments + nodules
APFS012	9	10	yb	RM	fine sand + fragments
APFS012	10	11	br	RM	fine to med sand + fragments
APFS012	11	12	br	RM	fine to med sand + fragments
APFS012	12	13	br	RM	fine sand + clay + fragments
APFS012	13	14	yb	RS	clay to fine sand
APFS012	14	15	wh/br	RS	clay to fine sand
APFS012	15	16	gy/br	RS	clay to fine sand
APFS012	16	17	gy/br	RS	fine sand + clay + fragments
APFS012	17	18	gy/br	RS	fine sand + clay + fragments
APFS012	18	19	pk	RS	fine sand + clay + fragments
APFS012	19	20	pk	RS	fine sand + clay + fragments
APFS013	0	1	br	Soil	soil with gravel
APFS013	1	2	rb	RLd	fine to med sand + fragments + pisolith
APFS013	2	3	rb	RLd	fine to med sand + fragments + pisolith
APFS013	3	4	rb	RLd	fine to med sand + fragments
APFS013	4	5	rb	RLd	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS013	5	6	br	RM	med to coarse sand + fragments
APFS013	6	7	br	RM	med to coarse sand + fragments
APFS013	7	8	br/wh	RM	fine to coarse sand + fragments
APFS013	8	9	wh	RM	fine to coarse sand + fragments
APFS013	9	10	pk	RM	fine to coarse sand + fragments
APFS013	10	11	pk	RM	fine to med sand + fragments
APFS013	11	12	pk	RM	fine to med sand + fragments
APFS013	12	13	pk	RM	fine to med sand + fragments
APFS013	13	14	pk	RM	fine to med sand + fragments
APFS013	14	15	br	RM	fine to med sand + fragments
APFS013	15	16	pk	RM	fine to med sand + fragments
APFS013	16	17	wh	RS	fine to med sand + fragments
APFS013	17	18	wh	RS	fine sand + clay + fragments
APFS013	18	19	wh	RS	fine to med sand + fragments
APFS013	19	20	pk	RS	fine to med sand + fragments
APFS014	0	1	br	Soil	soil with gravel
APFS014	1	2	br	Soil	soil with gravel
APFS014	2	3	br	Soil	soil with gravel
APFS014	3	4	rb	RLd	fine to coarse sand + fragments
APFS014	4	5	rb	RLd	fine to coarse sand + fragments
APFS014	5	6	br	RLd	fine to coarse sand + fragments
APFS014	6	7	br	RLd	fine to coarse sand + fragments
APFS014	7	8	br	RM	fine to coarse sand + fragments
APFS014	8	9	br	RM	fine to coarse sand + fragments
APFS014	9	10	wh/br	RS	fine to coarse sand + fragments
APFS014	10	11	wh/br	RS	med to coarse sand + fragments
APFS014	11	12	wh/br	RS	med to coarse sand + fragments
APFS014	12	13	pk	RS	gravel with some fine to med sand
APFS014	13	14	pk	RS	fine to coarse sand + fragments
APFS014	14	15	br	RS	gravel with some fine sand
APFS014	15	16	yb	RS	gravel with some fine sand
APFS014	16	17	yb	RS	med to coarse sand + fragments
APFS014	17	18	be	RS	fine to med sand + fragments
APFS014	18	19	wh	RS	fine to med sand + fragments
APFS014	19	20	pk	RS	fine to med sand + fragments
APFS015	0	1	br	Soil	soil with gravel
APFS015	1	2	br	Soil	soil with gravel
APFS015	2	3	br	Soil	soil with gravel
APFS015	3	4	br	Soil	soil with gravel
APFS015	4	5	rb	RLd	fine to med sand + fragments
APFS015	5	6	rb	RLd	fine to med sand + fragments
APFS015	6	7	rb	RLd	fine to med sand + fragments
APFS015	7	8	rb	RLd	fine to med sand + fragments
APFS015	8	9	br	RM	fine to med sand + fragments
APFS015	9	10	pk	RM	fine to med sand + fragments
APFS015	10	11	pk	RM	fine to med sand + fragments
APFS015	11	12	pk	RM	fine to med sand + fragments
APFS015	12	13	pk	RM	fine to med sand + fragments
APFS015	13	14	be	RS	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS015	14	15	be	RS	fine to med sand + fragments
APFS015	15	16	be	RS	fine to med sand + fragments
APFS015	16	17	be	RS	fine to med sand + fragments
APFS015	17	18	be	RS	fine to med sand + fragments + clay (-)
APFS015	18	19	be	RS	fine to med sand + fragments + clay (-)
APFS015	19	20	be	RS	fine to med sand + fragments + clay (-)
APFS016	0	1	br	Soil	soil with gravel
APFS016	1	2	br	Soil	soil with gravel
APFS016	2	3	br	Soil	soil with gravel
APFS016	3	4	br	Soil	soil with gravel
APFS016	4	5	rb	RLd	fine to med sand + pisolith
APFS016	5	6	rb	RLd	fine to med sand + pisolith
APFS016	6	7	br	RM	fine to med sand + fragments
APFS016	7	8	br	RM	fine to med sand + fragments
APFS016	8	9	gy/br	RM	fine to med sand + fragments
APFS016	9	10	pk	RM	fine to med sand + fragments
APFS016	10	11	pk	RM	fine to med sand + fragments
APFS016	11	12	pk	RM	fine to med sand + fragments
APFS016	12	13	pk	RM	fine to med sand + fragments
APFS016	13	14	pk	RM	fine to med sand + fragments
APFS016	14	15	pk	RM	fine to med sand + fragments
APFS016	15	16	pk	RM	fine to med sand + fragments
APFS016	16	17	be	RS	fine sand + fragments
APFS016	17	18	be	RS	fine sand + fragments
APFS016	18	19	yw	RS	fine sand + fragments + clay (-)
APFS016	19	20	yb	RS	fine sand + fragments + clay (-)
APFS017	0	1	br	LAG	Gravel and cobble sized stones
APFS017	1	2	br	LAG	Gravel and cobble sized stones + some soil
APFS017	2	3	br	Soil	soil with gravel
APFS017	3	4	rb	RLd	fine sand + pisolith + fragment
APFS017	4	5	rb	RLd	fine sand + pisolith + fragment
APFS017	5	6	br	RLd	fine sand + pisolith + fragment
APFS017	6	7	pk	RM	clay to fine sand + fragments
APFS017	7	8	pk	RM	clay to fine sand + fragments
APFS017	8	9	pk	RM	clay to fine sand + fragments
APFS017	9	10	pk	RM	clay to fine sand + fragments
APFS017	10	11	be	RS	clay to fine sand + fragments
APFS017	11	12	be	RS	clay to fine sand + fragments
APFS017	12	13	cm	RS	clay to fine sand + fragments
APFS017	13	14	be	RS	clay to fine sand + fragments
APFS017	14	15	be	RS	clay to fine sand + fragments
APFS017	15	16	wh	RS	clay to fine sand + fragments
APFS017	16	17		RS	clay to fine sand + fragments
APFS017	17	18	wh	RS	clay to fine sand + fragments
APFS017	18	19	yb	RS	clay to fine sand + fragments
APFS017	19	20	yb	RS	clay to fine sand + fragments
APFS018	0	1	br	Soil	soil with gravel
APFS018	1	2	br	Soil	soil with gravel
APFS018	2	3	br	Soil	soil with gravel

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS018	3	4	br	Soil	soil with gravel
APFS018	4	5	rb	RLd	fine to med sand + fragments
APFS018	5	6	br	RLd	fine to med sand + fragments
APFS018	6	7	br	RLd	fine to med sand + fragments
APFS018	7	8	be	RM	clay to med sand + fragments
APFS018	8	9	be	RM	clay to med sand + fragments
APFS018	9	10	pk	RM	clay to med sand + fragments
APFS018	10	11	pk	RM	clay to med sand + fragments
APFS018	11	12	pk	RM	clay to med sand + fragments
APFS018	12	13	be	RS	clay to coarse sand + fragments
APFS018	13	14		RS	clay to coarse sand + fragments
APFS018	14	15	yb	RS	clay to coarse sand + fragments
APFS018	15	16		RS	fine to coarse sand + fragments
APFS018	16	17	be	RS	fine to coarse sand + fragments
APFS018	17	18	be	RS	fine to coarse sand + fragments
APFS018	18	19	yb	RS	fine to coarse sand + fragments
APFS018	19	20	yb	RS	fine to coarse sand + fragments
APFS019	0	1	br	RLd	fine to coarse sand + fragments
APFS019	1	2	br	RLd	fine to coarse sand + fragments
APFS019	2	3	rb	RLd	fine to coarse sand + fragments
APFS019	3	4	rb	RLd	fine to coarse sand + fragments
APFS019	4	5	rb	RLd	fine to coarse sand + fragments
APFS019	5	6	rb	RLd	fine to coarse sand + fragments
APFS019	6	7	rb	RLd	fine to coarse sand + fragments
APFS019	7	8	rb	RLd	fine to coarse sand + fragments
APFS019	8	9	rb	RLd	fine to coarse sand + fragments
APFS019	9	10	rb	RLd	fine to coarse sand + fragments
APFS019	10	11	rb	RLd	fine to coarse sand + fragments
APFS019	11	12	be	RS	med to coarse sand + fragments
APFS019	12	13	be	RS	med to coarse sand + fragments
APFS019	13	14	be	RS	fine to coarse sand + fragments
APFS019	14	15	be	RS	fine to coarse sand + fragments
APFS019	15	16	pk	RS	fine to med sand + fragments
APFS019	16	17	pk	RS	fine to med sand + fragments
APFS019	17	18	pk	RS	fine to med sand + fragments
APFS019	18	19	pk	RS	fine to med sand + fragments
APFS019	19	20	be	RS	fine to med sand + fragments
APFS020	0	1	br	Soil	soil with gravel
APFS020	1	2	br	Soil	soil with gravel
APFS020	2	3	br	RLd	fine to med sand + fragments
APFS020	3	4	br	RLd	fine to med sand + fragments
APFS020	4	5	br	RLd	fine to med sand + fragments
APFS020	5	6	rb	RLd	fine to med sand + fragments
APFS020	6	7	rb	RLd	fine to med sand + fragments
APFS020	7	8	rb	RLd	fine to med sand + fragments
APFS020	8	9	rb	RLd	fine to med sand + fragments
APFS020	9	10	rb	RLd	fine to med sand + fragments
APFS020	10	11	rb	RLd	fine sand + fragments
APFS020	11	12	yb	RS	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS020	12	13	br	RS	fine to med sand + fragments
APFS020	13	14	be/br	RS	fine to med sand + fragments
APFS020	14	15	pk	RS	fine to coarse sand + fragments
APFS020	15	16	pk	RS	fine to coarse sand + fragments
APFS020	16	17	pk	RS	fine to coarse sand + fragments
APFS020	17	18	pk	RS	fine to coarse sand + fragments
APFS020	18	19	yb	RS	fine to coarse sand + fragments
APFS020	19	20	yb	RS	fine to coarse sand + fragments
APFS021	0	1	br	Soil	soil with gravel
APFS021	1	2	br	RLd	fine to coarse sand + fragments
APFS021	2	3	br	RLd	fine to coarse sand + fragments
APFS021	3	4	br	RLd	fine to coarse sand + fragments
APFS021	4	5	br	RLd	fine to coarse sand + fragments
APFS021	5	6	br	RLd	fine to med sand + fragments
APFS021	6	7	br	RLd	fine to med sand + fragments + clay (-)
APFS021	7	8	br	RLd	clay to med sand + fragments
APFS021	8	9	rb	RLd	fine to med sand + fragments + clay (-)
APFS021	9	10	br	RLd	fine to med sand + fragments + clay (-)
APFS021	10	11	br	RLd	fine to med sand + fragments
APFS021	11	12	rb	RLd	fine to med sand + fragments + clay (-)
APFS021	12	13	br	RLd	fine to coarse sand + fragments
APFS021	13	14	br	RS	fine to med sand + fragments + clay (-)
APFS021	14	15	br	RS	fine to med sand + fragments + clay (-)
APFS021	15	16	br	RS	fine to med sand + fragments + clay (-)
APFS021	16	17	br	RS	fine to med sand + fragments
APFS021	17	18	wh	RS	fine to med sand + fragments
APFS021	18	19	br	RS	fine to med sand + fragments
APFS021	19	20	br	RS	fine to med sand + fragments + clay (-)
APFS022	0	1	br	Soil	soil with gravel
APFS022	1	2	br	Soil	soil with gravel
APFS022	2	3	br	Soil	soil with gravel
APFS022	3	4	br	Soil	soil with gravel
APFS022	4	5	br	Soil	soil with gravel
APFS022	5	6	br	Soil	soil with gravel
APFS022	6	7	rb	Soil	soil with gravel
APFS022	7	8	rb	Soil	soil with gravel
APFS022	8	9	br	RLd	fine to med sand + fragments + clay (-)
APFS022	9	10	br	RLd	fine to med sand + fragments + clay (-)
APFS022	10	11	yb	RS	fine sand + fragment
APFS022	11	12	yb	RS	fine sand + fragment
APFS022	12	13	be	RS	fine to med sand + clay (-)
APFS022	13	14	be	RS	fine to med sand + clay (-)
APFS022	14	15	br	RS	fine to med sand + clay (-)
APFS022	15	16	yb	RS	fine to med sand + clay (-)
APFS022	16	17	yb	RS	fine to med sand + clay (-)
APFS022	17	18	br	RS	fine to med sand + clay (-)
APFS022	18	19	br	RS	clay to fine sand
APFS022	19	20	br	RS	fine sand + fragment + clay (-)
APFS023	0	1	br	Soil	soil with gravel

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS023	1	2	br	Soil	soil with gravel
APFS023	2	3	rb	RLd	fine to coarse sand + pisolith
APFS023	3	4	rb	RLd	fine to coarse sand + pisolith
APFS023	4	5	rb	RLd	fine to coarse sand + pisolith
APFS023	5	6	rb	RLd	fine to coarse sand + pisolith
APFS023	6	7	br	RM	clay to fine sand
APFS023	7	8	br	RM	gravel
APFS023	8	9	br	RM	fine sand + gravel
APFS023	9	10	pk	RM	fine sand + fragments
APFS023	10	11	pk	RP	clay
APFS023	11	12		RP	clay
APFS023	12	13	be	RS	fine to med sand + fragments
APFS023	13	14	be	RS	fine to med sand + fragments
APFS023	14	15	be	RS	fine to med sand + fragments
APFS023	15	16	be	RS	fine to med sand + fragments
APFS023	16	17	be	RS	fine to med sand + fragments
APFS023	17	18	be	RS	fine to med sand + fragments
APFS023	18	19	yw	RS	fine to coarse sand + fragments
APFS023	19	20	yw	RS	fine to coarse sand + fragments
APFS024	0	1	br	Soil	soil with gravel
APFS024	1	2	br	Soil	soil with gravel
APFS024	2	3	br	Soil	soil with gravel
APFS024	3	4	br	Soil	soil with gravel
APFS024	4	5	rb	RLg	Gravel and clay to fine sand
APFS024	5	6	rb	RLd	fine sand + fragments
APFS024	6	7	rb	RLd	fine sand + fragments
APFS024	7	8	rb	RLd	fine sand + fragments
APFS024	8	9	br	RM	fine to coarse sand + fragments
APFS024	9	10	pk	RM	fine sand + gravel
APFS024	10	11	pk	RM	fine sand + fragments
APFS024	11	12	pk	RM	fine sand + fragments
APFS024	12	13	pk	RM	fine sand + fragments
APFS024	13	14	br	RS	fine sand + fragments
APFS024	14	15	gy/br	RS	clay (-) to fine sand + fragments
APFS024	15	16	gy	RS	clay (-) to fine sand + fragments
APFS024	16	17	yb	RS	clay (-) to fine sand + fragments
APFS024	17	18	pk	RS	clay (-) to fine sand + fragments
APFS024	18	19	wh	RS	clay (-) to fine sand + fragments
APFS024	19	20	wh	RS	clay (-) to fine sand + fragments
APFS025	0	1	br	Soil	soil with gravel
APFS025	1	2	br	Soil	soil with gravel
APFS025	2	3	br	Soil	soil with gravel
APFS025	3	4	rb	RLd	fine to med sand + fragments + pisolith
APFS025	4	5	rb	RLd	fine to med sand + fragments + pisolith
APFS025	5	6	rb	RLd	fine to med sand + fragments + pisolith
APFS025	6	7	rb	RLd	fine to med sand + fragments + pisolith
APFS025	7	8	rb	RS	fine to med sand + fragments
APFS025	8	9		RS	fine to med sand + fragments
APFS025	9	10	rb	RS	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS025	10	11	wh	RS	clay (-) to fine sand + fragments
APFS025	11	12	wh	RS	clay (-) to fine sand + fragments
APFS025	12	13	be	RS	fine to med sand + fragments
APFS025	13	14	pk	RS	fine to med sand + fragments
APFS025	14	15	gy	RS	fine to med sand + fragments
APFS025	15	16	or/be	RS	fine to med sand + fragments
APFS025	16	17	yb	RS	fine to med sand + fragments
APFS025	17	18	or/be	RS	fine to med sand + fragments
APFS025	18	19	yb	RS	fine to med sand + fragments
APFS025	19	20	yb	RS	fine to med sand + fragments
APFS026	0	1	br	Soil	soil with gravel
APFS026	1	2	br	Soil	soil with gravel
APFS026	2	3	br	Soil	soil with gravel
APFS026	3	4	br	Soil	soil with gravel
APFS026	4	5	br	Soil	soil with gravel
APFS026	5	6	rb	RLd	fine to med sand + pisolith
APFS026	6	7	rb	RLd	fine to med sand + pisolith
APFS026	7	8	rb	RLd	fine to med sand + pisolith
APFS026	8	9	rb	RLd	fine to med sand + pisolith
APFS026	9	10	rb	RLd	fine to med sand + pisolith
APFS026	10	11	rb	RLd	fine to med sand + pisolith
APFS026	11	12	rb	RLd	fine to med sand + pisolith
APFS026	12	13	be/yb	RS	fine to med sand + fragments
APFS026	13	14	be	RS	fine to med sand + fragments
APFS026	14	15	be	RS	fine to med sand + fragments
APFS027	0	1	br	Soil	soil with gravel
APFS027	1	2	br	Soil	soil with gravel
APFS027	2	3	br	Soil	soil with gravel
APFS027	3	4	br	Soil	soil with gravel
APFS027	4	5	rb	RLd	fine to med sand + fragments + pisolith
APFS027	5	6	rb	RLd	fine to med sand + fragments + pisolith
APFS027	6	7	rb	RLd	fine to med sand + fragments + pisolith
APFS027	7	8	rb	RLd	fine to med sand + fragments + pisolith
APFS027	8	9	rb	RLd	fine to med sand + fragments + pisolith
APFS027	9	10	rb	RLd	fine to med sand + fragments + pisolith
APFS027	10	11	rb	RLd	fine to med sand + fragments + pisolith
APFS027	11	12	be	RS	fine to med sand + fragments
APFS027	12	13	be	RS	fine to med sand + fragments
APFS027	13	14	be	RS	fine to med sand + fragments
APFS027	14	15	be	RS	fine to med sand + fragments
APFS028	0	1	br	Soil	soil with gravel
APFS028	1	2	br	Soil	soil with gravel
APFS028	2	3	rb	RLd	fine to coarse sand + fragments
APFS028	3	4	rb	RLd	fine to med sand + fragments
APFS028	4	5	rb	RLd	fine to med sand + fragments
APFS028	5	6	rb	RLd	fine to med sand + fragments
APFS028	6	7	rb	RLd	fine to med sand + fragments
APFS028	7	8	rb	RLd	fine to med sand + fragments + pisolith
APFS028	8	9	yb	RLd	fine to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS028	9	10	yb	RLd	fine to med sand + fragments
APFS028	10	11	gy/br	RS	clay (-) to fine sand + fragments
APFS028	11	12	be	RS	clay (-) to fine sand + fragments
APFS028	12	13	be	RS	fine to med sand + fragments
APFS028	13	14	wh	RS	fine to med sand + fragments
APFS028	14	15	wh	RS	clay (-) to fine sand + fragments
APFS029	0	1	br	Soil	soil with gravel
APFS029	1	2	br	Soil	soil with gravel
APFS029	2	3	br	Soil	soil with gravel
APFS029	3	4	rb	RLd	fine to med sand + pisolith
APFS029	4	5	rb	RLd	fine to med sand + pisolith
APFS029	5	6	rb	RLd	fine to med sand + pisolith
APFS029	6	7	rb	RLd	fine to med sand + pisolith
APFS029	7	8	rb	RLd	fine to med sand + pisolith
APFS029	8	9	rb	RLd	fine to med sand + pisolith
APFS029	9	10	yb	RS	fine to med sand + fragments
APFS029	10	11	yb	RS	fine to med sand + fragments
APFS029	11	12	be	RS	fine to med sand + fragments
APFS029	12	13	be	RS	fine to med sand + fragments
APFS029	13	14	cm	RS	fine to med sand + fragments
APFS029	14	15	cm	RS	fine to med sand + fragments
APFS030	0	1	br	Soil	soil with gravel
APFS030	1	2	br	Soil	soil with gravel
APFS030	2	3	br	Soil	soil with gravel
APFS030	3	4	br	Soil	soil with gravel
APFS030	4	5	rb	Soil	soil with gravel
APFS030	5	6	rb	RLd	fine to med sand + fragments + pisolith
APFS030	6	7	rb	RLd	fine to med sand + fragments + pisolith
APFS030	7	8	rb	RLd	fine to med sand + fragments + pisolith
APFS030	8	9	rb	RLd	fine to med sand + fragments
APFS030	9	10	rb	RLd	fine to med sand + fragments
APFS030	10	11	rb	RLd	fine to med sand + fragments
APFS030	11	12	yb	RS	fine to med sand + fragments
APFS030	12	13	pk	RS	fine to med sand + fragments
APFS030	13	14	yb	RS	fine to med sand + fragments
APFS030	14	15	yb	RS	fine to med sand + fragments
APFS031	0	1	rb	RLd	fine to med sand + fragments
APFS031	1	2	rb	RLd	fine to med sand + fragments
APFS031	2	3	rb	RLd	clay (+) to med sand + fragments
APFS031	3	4	rb	RLd	clay (+) to med sand + fragments
APFS031	4	5	rb	RLd	clay (+) to fine sand + fragments
APFS031	5	6	rb	RLd	clay (+) to fine sand + fragments
APFS031	6	7	rb	RLd	clay (+) to fine sand + fragments
APFS031	7	8	br	RLd	clay (+) to fine sand + fragments
APFS031	8	9	br	RLd	clay (+) to fine sand + fragments
APFS031	9	10	yb	RM	clay (+) to fine sand + fragments
APFS031	10	11	cm	RM	clay (+) to fine sand + fragments
APFS031	11	12	cm	RS	clay (+) + fragments
APFS031	12	13	yb	RS	clay (+) to fine sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS031	13	14	yb	RS	clay (+) to fine sand + fragments
APFS031	14	15	yb	RS	clay (+) to fine sand + fragments
APFS032	0	1	br	Soil	soil with gravel
APFS032	1	2	br	Soil	soil with gravel
APFS032	2	3	br	Soil	soil with gravel
APFS032	3	4	rb	RLd	fine sand + fragments/gravel + pisolith
APFS032	4	5	rb	RLd	fine sand + fragments/gravel + pisolith
APFS032	5	6	rb	RLd	fine sand + fragments/gravel + pisolith
APFS032	6	7	rb	RLd	fine sand + fragments/gravel + pisolith
APFS032	7	8	be	RLd	fine sand + fragments/gravel + pisolith
APFS032	8	9	be	RS	clay (-) to fine sand + fragments
APFS032	9	10	cm	RS	clay to fine sand + fragments
APFS032	10	11	cm	RS	clay to fine sand + fragments
APFS032	11	12	be	RS	clay to fine sand + fragments
APFS032	12	13	cm	RS	clay (-) to fine sand + fragments
APFS032	13	14	yw	RS	clay (+) + fragments
APFS032	14	15	yw	RS	clay (+) + fragments
APFS033	0	1	br	Soil	soil with gravel
APFS033	1	2	br	Soil	soil with gravel
APFS033	2	3	br	Soil	soil with gravel
APFS033	3	4	rb	RLd	fine to med sand + fragments + pisolith
APFS033	4	5	rb	RLd	fine to med sand + fragments + pisolith
APFS033	5	6	rb	RLd	fine to med sand + fragments + pisolith
APFS033	6	7	rb	RLd	fine to med sand + fragments + pisolith
APFS033	7	8	yb	RS	fine to med sand + fragments
APFS033	8	9	br	RS	fine to med sand + fragments
APFS033	9	10	br	RS	fine to med sand + fragments
APFS033	10	11	cm	RS	fine to med sand + fragments
APFS033	11	12	cm	RS	fine to med sand + fragments
APFS033	12	13	cm	RS	fine to med sand + fragments
APFS033	13	14	cm	RS	fine sand + fragments
APFS033	14	15	pk	RS	fine sand + fragments
APFS034	0	1	br	Soil	soil with gravel
APFS034	1	2	br	Soil	soil with gravel
APFS034	2	3	rb	RLd	fine sand + fragments + pisolith
APFS034	3	4	rb	RLd	clay (-) to fine sand + fragments + pisolith
APFS034	4	5	rb	RLd	clay (-) to fine sand + fragments + pisolith
APFS034	5	6	cm	RM	clay to fine sand + fragments
APFS034	6	7	gy	RS	clay to fine sand + fragments
APFS034	7	8	gy	RS	clay to fine sand + fragments
APFS034	8	9	gy	RS	fine to med sand + fragments
APFS034	9	10	cm	RS	fine to med sand + fragments
APFS034	10	11	be	RS	fine to med sand + fragments
APFS034	11	12	yb	RS	fine to med sand + fragments
APFS034	12	13	yb	RS	fine to med sand + fragments
APFS034	13	14	pk	RS	fine to med sand + fragments
APFS034	14	15	pk	RS	fine to med sand + fragments
APFS035	0	1	br	Soil	soil with gravel
APFS035	1	2	br	RLg	soil with gravel

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS035	2	3	br	RLg	soil with gravel
APFS035	3	4	br	RLg	soil with gravel
APFS035	4	5	rb	RLd	fine sand + pisolith
APFS035	5	6	rb	RLd	fine sand + pisolith
APFS035	6	7	rb	RLd	fine sand + pisolith
APFS035	7	8	rb	RLd	fine sand + pisolith
APFS035	8	9	rb	RS	clay (-) to fine sand + fragments
APFS035	9	10	cm	RS	clay (-) to fine sand + fragments
APFS036	0	1	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	1	2	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	2	3	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	3	4	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	4	5	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	5	6	rb	RLd	fine to coarse sand + fragments + pisolith
APFS036	6	7	rb	RLd	fine to med sand + fragments
APFS036	7	8	cm	RM	fine to med sand + fragments
APFS036	8	9	cm	RS	fine to coarse sand + fragments + pisolith
APFS036	9	10	be	RS	fine to coarse sand + fragments + pisolith
APFS036	10	11	pk	RS	fine to coarse sand + fragments + pisolith
APFS036	11	12	wh	RS	clay (-) to med sand + pisolith
APFS036	12	13	yw	RS	clay (-) to med sand + pisolith
APFS036	13	14	yw	RS	clay (-) to med sand + pisolith
APFS036	14	15	yw	RS	clay (-) to fine sand + pisolith
APFS037	0	1	rb	RLd	fine to coarse sand + fragments
APFS037	1	2	rb	RLd	fine to coarse sand + fragments
APFS037	2	3	rb	RLd	fine to coarse sand + fragments
APFS037	3	4	rb	RLd	fine to coarse sand + fragments
APFS037	4	5	br	RLd	fine to coarse sand + fragments
APFS037	5	6	br	RLd	fine to med sand + fragments
APFS037	6	7	pk	RM	fine to med sand + fragments
APFS037	7	8	br	RS	fine to med sand + fragments
APFS037	8	9	yb	RS	fine to med sand + fragments
APFS037	9	10	br	RS	fine to med sand + fragments
APFS037	10	11	br	RS	Gravel / fragments and fine sand
APFS037	11	12	yb	RS	Gravel / fragments and fine sand
APFS037	12	13	yb	RS	Gravel / fragments and fine sand
APFS037	13	14	yb	RS	clay + fragments
APFS037	14	15	yb	RS	clay + fragments
APFS038	0	1	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	1	2	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	2	3	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	3	4	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	4	5	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	5	6	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	6	7	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	7	8	rb	RLd	fine to coarse sand + fragments + pisolith
APFS038	8	9	rb	RLd	fine to coarse sand + fragments
APFS038	9	10	rb	RLd	fine to coarse sand + fragments
APFS038	10	11	cm	RM	fine to coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS038	11	12	yb	RM	fine to med sand + fragments
APFS038	12	13	wh	RS	fine to med sand + fragments
APFS038	13	14	cm	RS	fine to med sand + fragments
APFS038	14	15	cm	RS	fine to med sand + fragments
APFS039	0	1	br	Soil	soil with gravel
APFS039	1	2	br	RLd	fine sand + fragments + pisolith
APFS039	2	3	rb	RLd	fine sand + fragments + pisolith
APFS039	3	4	rb	RLd	fine sand + fragments + pisolith
APFS039	4	5	rb	RLd	fine sand + fragments + pisolith
APFS039	5	6	rb	RLd	fine sand + fragments + pisolith
APFS039	6	7	rb	RLd	fine to med sand + fragments
APFS039	7	8	rb	RLd	fine to med sand + fragments
APFS039	8	9	br	RLd	fine to med sand + fragments
APFS039	9	10	be	RM	fine to med sand + fragments
APFS039	10	11	gy	RM	clay (-) to fine sand + fragments
APFS039	11	12	gy	RS	clay (-) to fine sand + fragments
APFS039	12	13	wh	RS	clay (+) + fragments
APFS039	13	14	wh	RS	clay (+) + fragments
APFS039	14	15	wh	RS	clay (+) + fragments
APFS040	0	1	rb	RLd	fine to med sand + fragments
APFS040	1	2	rb	RLd	fine to med sand + fragments
APFS040	2	3	rb	RLd	fine to med sand + fragments
APFS040	3	4	rb	RLd	fine to med sand + fragments
APFS040	4	5	rb	RLd	fine sand + fragments
APFS040	5	6	cm	RM	fine sand + fragments
APFS040	6	7	cm	RM	fine sand + fragments
APFS040	7	8	be	RM	fine to med sand + fragments
APFS040	8	9	be	RM	fine to med sand + fragments
APFS040	9	10	pk	RM	fine to med sand + fragments
APFS040	10	11	pk	RM	fine to med sand + fragments
APFS040	11	12	pk	RM	fine to coarse sand + fragments
APFS040	12	13		RM	fine to coarse sand + fragments
APFS040	13	14	yb	RM	fine to coarse sand + fragments
APFS040	14	15	yb	RM	clay to coarse sand + fragments
APFS041	0	1	br	Soil	soil with gravel
APFS041	1	2		Soil	soil with gravel
APFS041	2	3		Soil	soil with gravel
APFS041	3	4	rb	RLd	fine to coarse sand + fragments
APFS041	4	5		RLd	fine to coarse sand + fragments
APFS041	5	6		RLd	fine to med sand + fragments + pisolith
APFS041	6	7	or/br	RLd	fine to med sand + fragments + pisolith
APFS041	7	8	cm	RM	fine to med sand + fragments + pisolith
APFS041	8	9	be	RS	clay (-) to fine sand + fragments
APFS041	9	10	cm	RS	fine to med sand + fragments
APFS041	10	11	or/br	RS	fine to med sand + fragments
APFS041	11	12	cm	RS	fine to med sand + fragments
APFS041	12	13	wh	RS	fine to med sand + fragments
APFS041	13	14	r	RS	clay (-) to fine sand + fragments
APFS041	14	15	pk	RS	clay (-) to fine sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS042	0	1	rb	RLd	fine to coarse sand + gravel
APFS042	1	2	rb	RLd	fine to coarse sand + gravel
APFS042	2	3	rb	RLd	fine to coarse sand + gravel
APFS042	3	4	yb	RS	fine to coarse sand + gravel
APFS042	4	5	yb	RS	fine to coarse sand + gravel
APFS042	5	6	yb	RS	fine to coarse sand + fragments
APFS042	6	7	yw	RS	clay + fragments
APFS042	7	8	yw	RS	clay + fragments
APFS042	8	9	yw	RS	clay + fragments
APFS042	9	10	yw	RS	clay + fragments
APFS042	10	11	yw	RS	clay + fragments
APFS042	11	12	cm	RS	clay + fragments
APFS042	12	13	yb	RS	clay + fragments
APFS042	13	14	yb	RS	clay + fragments
APFS042	14	15	wh	RS	clay + fragments
APFS043	0	1	rb	RLd	fine to med sand + fragments
APFS043	1	2	rb	RLd	fine to med sand + fragments
APFS043	2	3	be	RS	fine to med sand + fragments
APFS043	3	4	be	RS	fine to med sand + fragments
APFS043	4	5	be	RS	fine to med sand + fragments
APFS043	5	6	be	RS	fine to med sand + fragments
APFS043	6	7	be	RS	fine to med sand + fragments
APFS043	7	8	be	RS	clay (-) to med sand + fragments
APFS043	8	9	cm	RS	clay (+) to coarse sand + fragments
APFS043	9	10	be	RS	clay (+) to fine sand + fragments
APFS043	10	11	be	RS	clay (+) to fine sand + fragments
APFS043	11	12	wh	RS	clay + fragments
APFS043	12	13	cm	RS	clay + fragments
APFS043	13	14	cm	RS	clay to fine sand + fragments
APFS043	14	15	cm	RS	clay to fine sand + fragments
APFS044	0	1	br	Soil	soil with gravel
APFS044	1	2	br	RLd	fine to med sand + fragments
APFS044	2	3	br	RLd	fine to med sand + fragments
APFS044	3	4	rb	RLd	fine to med sand + fragments
APFS044	4	5	rb	RLd	fine to med sand + fragments
APFS044	5	6	rb	RLd	clay to fine sand + fragments
APFS044	6	7	rb	RLd	clay to fine sand + fragments
APFS044	7	8	pk	RM	clay to fine sand + fragments
APFS044	8	9	pk	RM	clay to fine sand + fragments
APFS044	9	10	pk	RS	fine to med sand + fragments
APFS044	10	11	be	RS	fine to med sand + fragments
APFS044	11	12	pk	RS	fine to med sand + fragments
APFS044	12	13	be	RS	fine to med sand + fragments
APFS044	13	14	be	RS	fine sand + fragments
APFS044	14	15	be	RS	fine sand + fragments
APFS045	0	1	br	Soil	soil with gravel
APFS045	1	2	br	Soil	soil with gravel
APFS045	2	3	rb	RLd	clay to fine sand + fragments
APFS045	3	4	rb	RLd	clay to fine sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS045	4	5	rb	RLd	clay to fine sand + fragments
APFS045	5	6	br	RS	med to coarse sand + fragments
APFS045	6	7	br	RS	med to coarse sand + fragments
APFS045	7	8	br	RS	fine to coarse sand + fragments
APFS045	8	9	pk	RS	fine to coarse sand + fragments
APFS045	9	10	be	RS	fine to coarse sand + fragments
APFS045	10	11	be	RS	fine to coarse sand + fragments
APFS045	11	12	be	RS	fine to med sand + fragments
APFS045	12	13	be	RS	fine to med sand + fragments
APFS045	13	14	be	RS	fine to med sand + fragments
APFS045	14	15	yb	RS	fine to med sand + fragments
APFS046	0	1	br	Soil	soil with gravel
APFS046	1	2	br	Soil	soil with gravel
APFS046	2	3	br	RLd	fine to med sand + pisolith + fragments
APFS046	3	4	br	RLd	fine to med sand + pisolith + fragments
APFS046	4	5	br	RLd	fine to med sand + pisolith + fragments
APFS046	5	6	rb	RLd	fine sand + pisolith
APFS046	6	7	rb	RLd	fine sand + pisolith
APFS046	7	8	yb	RS	fine sand + pisolith
APFS046	8	9	yb	RS	fine sand + fragments
APFS046	9	10	be	RS	fine to med sand + fragments
APFS046	10	11	be	RS	fine to med sand + fragments
APFS046	11	12	be	RS	fine to med sand
APFS046	12	13	gy	RS	fine sand
APFS046	13	14	gy	RS	fine to med sand + fragment
APFS046	14	15	be	RS	fine to med sand + fragment
APFS047	0	1	br	Soil	soil with gravel
APFS047	1	2	br	RLd	fine to med sand + pisolith + fragments
APFS047	2	3	br	RLd	fine to med sand + pisolith + fragments
APFS047	3	4	br	RLd	fine to med sand + pisolith + fragments
APFS047	4	5	br	RLd	fine to med sand + pisolith + fragments
APFS047	5	6	rb	RLd	fine sand + pisolith + fragments
APFS047	6	7	br	RLd	fine to coarse sand + pisolith
APFS047	7	8	br	RM	fine to coarse sand + fragments
APFS047	8	9	yb	RS	fine to med sand + fragments
APFS047	9	10	yb	RS	fine to med sand + fragments
APFS047	10	11	yb	RS	fine to med sand + fragments
APFS047	11	12	br	RS	fine to med sand + fragments
APFS047	12	13	br	RS	fine to med sand + fragments
APFS047	13	14	be	RS	fine sand + fragment
APFS047	14	15	pk	RS	fine to med sand + fragment
APFS048	0	1	br	Soil	soil with gravel
APFS048	1	2	br	Soil	soil with gravel
APFS048	2	3	br	Soil	soil with gravel
APFS048	3	4	rb	RLd	fine to med sand + pisolith + fragments
APFS048	4	5	rb	RLd	fine to med sand + pisolith + fragments
APFS048	5	6	rb	RLd	fine to med sand + pisolith + fragments
APFS048	6	7	br	RLd	fine to med sand + gravel + pisolith
APFS048	7	8	cm	RS	fine to coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS048	8	9	pk	RS	fine sand + few fragments
APFS048	9	10	be	RS	fine to med sand + fragments
APFS048	10	11	pk	RS	fine to med sand + fragments
APFS048	11	12	be	RS	fine to coarse sand + fragments
APFS048	12	13	be	RS	fine to coarse sand + fragments
APFS048	13	14	be	RS	fine to coarse sand + fragments
APFS048	14	15	be	RS	fine to med sand + fragment
APFS049	0	1	br	Soil	soil with gravel
APFS049	1	2	rb	RLd	fine sand + pisolith + fragments
APFS049	2	3	rb	RLd	fine sand + pisolith + fragments
APFS049	3	4	rb	RLd	fine sand + pisolith + fragments
APFS049	4	5	rb	RLd	fine sand + pisolith + fragments
APFS049	5	6	be	RS	fine sand + fragments
APFS049	6	7	pk	RS	fine to med sand + fragments
APFS049	7	8	pk	RS	fine to coarse sand + fragments
APFS049	8	9	pk	RS	fine to coarse sand + fragments
APFS049	9	10	br	RS	fine to coarse sand + fragments
APFS049	10	11	be	RS	fine to coarse sand + fragments
APFS049	11	12	be	RS	fine to coarse sand + fragments
APFS049	12	13	gy	RS	fine to coarse sand + fragments
APFS049	13	14	wh	RS	clay (-) to coarse sand + fragments
APFS049	14	15	wh	RS	clay (-) to coarse sand + fragments
APFS050	0	1	br	Soil	soil with gravel
APFS050	1	2	rb	RLd	fine to coarse sand + fragments
APFS050	2	3	rb	RLd	fine to coarse sand + fragments
APFS050	3	4	yb	RS	fine to med sand + fragments
APFS050	4	5	be	RS	fine to med sand + fragments
APFS050	5	6	yb	RS	fine to med sand + fragments
APFS050	6	7	be	RS	fine to med sand + fragments
APFS050	7	8	be	RS	fine to coarse sand + fragments
APFS050	8	9	wh	RS	clay (-) to coarse sand + fragments
APFS050	9	10	cm	RS	clay (-) to coarse sand + fragments
APFS050	10	11	cm	RS	clay (-) to coarse sand + fragments
APFS050	11	12	be	RS	clay (-) to coarse sand + fragments
APFS050	12	13	be	RS	clay (-) to coarse sand + fragments
APFS050	13	14	be	RS	clay (-) to coarse sand + fragments
APFS050	14	15	wh	RS	clay (-) to coarse sand + fragments
APFS051	0	1	br	Soil	soil with gravel
APFS051	1	2	br	Soil	soil with gravel
APFS051	2	3	rb	RLd	fine to med sand + fragments
APFS051	3	4	rb	RLd	fine to med sand + fragments
APFS051	4	5	br	RLd	fine to med sand + fragments
APFS051	5	6	cm	RS	fine to med sand + fragments / gravels
APFS051	6	7	cm	RS	fine to med sand + fragments / gravels
APFS051	7	8	be	RS	fine to med sand + fragments / gravels
APFS051	8	9	be	RS	clay (-) to fine sand + fragments
APFS051	9	10	be	RS	clay (-) to fine sand + fragments
APFS051	10	11	pk	RS	clay (-) to fine sand + fragments
APFS051	11	12	gy	RS	clay to coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS051	12	13	yb	RS	clay to coarse sand + fragments
APFS051	13	14	yb	RS	clay (+) to fine sand + fragments
APFS051	14	15	wh	RS	clay (+) to fine sand + fragments
APFS052	0	1	br	Soil	soil with gravel
APFS052	1	2	br	Soil	soil with gravel
APFS052	2	3	rb	RLd	fine to coarse sand + fragments
APFS052	3	4	yb	RLd	fine to coarse sand + fragments
APFS052	4	5	br	RM	clay to coarse sand + fragments
APFS052	5	6	br	RS	clay to coarse sand + fragments
APFS052	6	7	br	RS	fine to coarse sand + fragments
APFS052	7	8	br	RS	fine to coarse sand + fragments
APFS052	8	9	br	RS	fine to coarse sand + fragments
APFS052	9	10	be	RS	fine to coarse sand + fragments
APFS052	10	11	be	RS	fine to med sand + fragments
APFS052	11	12	be	RS	clay (+) to fine sand + fragments
APFS052	12	13	wh	RS	clay (+) to med sand + fragments
APFS052	13	14	be	RS	clay (+) to med sand + fragments
APFS052	14	15	yb	RS	clay (+) to med sand + fragments
APFS053	0	1	br	Soil	soil with gravel
APFS053	1	2	br	RLd	fine to med sand + fragments
APFS053	2	3	br	RLd	fine to med sand + fragments
APFS053	3	4	rb	RLd	fine to med sand + fragments
APFS053	4	5	rb	RLd	fine to med sand + pisolith
APFS053	5	6	yb	RLd	fine to coarse sand + fragments + pisolith
APFS053	6	7	be	RS	fine sand + fragments + clay
APFS053	7	8	pk	RS	fine to coarse sand + fragments
APFS053	8	9	cm	RS	med to coarse sand + fragments + pisolith
APFS053	9	10	cm	RS	med to coarse sand + fragments + pisolith
APFS053	10	11	br	RS	coarse sand + fragments
APFS053	11	12	be	RS	clay (-) to med sand + pisolith
APFS053	12	13	cm	RS	clay (-) to med sand + pisolith
APFS053	13	14	be	RS	clay (+) to med sand + pisolith
APFS053	14	15	be	RS	clay (+) to med sand + pisolith
APFS054	0	1	br	Soil	soil with gravel
APFS054	1	2	br	Soil	soil with gravel
APFS054	2	3	rb	RLd	fine to med sand + fragments
APFS054	3	4	br	RLd	fine to med sand + fragments
APFS054	4	5	br	RLd	fine to med sand + fragments
APFS054	5	6	rb	RLd	fine sand + fragments
APFS054	6	7	yb	RS	fine to coarse sand + pisolith
APFS054	7	8	yb	RS	fine to coarse sand + pisolith
APFS054	8	9	yb	RS	fine to coarse sand + fragments + pisolith
APFS054	9	10	br	RS	fine to coarse sand + fragments + pisolith
APFS054	10	11	br	RS	fine to coarse sand + fragments + pisolith
APFS054	11	12	br	RS	fine to med sand + fragments + pisolith
APFS054	12	13	br	RS	fine to med sand + fragments + pisolith
APFS054	13	14	cm	RS	fine to med sand + pisolith
APFS054	14	15	cm	RS	fine to med sand + pisolith
APFS055	0	1	br	Soil	soil with gravel

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS055	1	2	br	Soil	soil with gravel
APFS055	2	3	br	Soil	soil with gravel
APFS055	3	4	rb	RLd	fine to coarse sand + pisolith
APFS055	4	5	rb	RLd	fine to coarse sand + pisolith
APFS055	5	6	rb	RLd	fine to coarse sand + pisolith
APFS055	6	7	rb	RLd	fine to coarse sand + pisolith
APFS055	7	8	yb	RM	fine to coarse sand + pisolith
APFS055	8	9	yb	RM	fine to med sand + pisolith
APFS055	9	10	be	RS	fine to coarse sand + pisolith
APFS055	10	11	be	RS	fine to coarse sand + pisolith
APFS055	11	12	be	RS	fine to med sand + fragments
APFS055	12	13	be	RS	fine to med sand + fragments
APFS055	13	14	cm	RS	fine to coarse sand + fragments
APFS055	14	15	br	RS	fine to coarse sand + fragments
APFS056	0	1	br	Soil	soil with gravel
APFS056	1	2	rb	RLd	fine to coarse sand + pisolith + fragments
APFS056	2	3	rb	RLd	fine to coarse sand + pisolith + fragments
APFS056	3	4	br	RLd	fine to coarse sand + pisolith + fragments
APFS056	4	5	br	RLd	fine to coarse sand + pisolith + fragments
APFS056	5	6	br	RM	fine to coarse sand + fragments
APFS056	6	7	yb	RM	fine to coarse sand + fragments
APFS056	7	8	pk	RM	fine to coarse sand + fragments
APFS056	8	9	pk	RM	fine to coarse sand + fragments
APFS056	9	10	pk	RM	fine to med sand + fragments
APFS056	10	11	pk	RM	fine to coarse sand + fragments
APFS056	11	12	pk	RM	fine to coarse sand + fragments
APFS056	12	13	pk	RM	fine to coarse sand + fragments
APFS056	13	14	be	RM	clay to fine sand + fragments
APFS056	14	15	be	RS	clay to fine sand + fragments
APFS057	0	1	br	RLd	soil with gravel and sand
APFS057	1	2	rb	RLd	fine to coarse sand + pisolith + fragments
APFS057	2	3	rb	RLd	fine to coarse sand + pisolith + fragments
APFS057	3	4	br	RM	fine to med sand + fragments
APFS057	4	5	br	RM	fine to med sand + fragments
APFS057	5	6	br	RM	fine to med sand + fragments
APFS057	6	7	br	RS	fine to coarse sand + fragments
APFS057	7	8	br	RS	fine to coarse sand + fragments
APFS057	8	9	br	RS	fine to coarse sand + fragments
APFS057	9	10	br	RSr	fine to coarse sand + fragments
APFS057	10	11	gy	RSr	fine to coarse sand + fragments
APFS057	11	12	gy	RSr	fine to med sand + fragments
APFS057	12	13	gy	RSr	clay (-) to med sand + fragments
APFS057	13	14	wh	RSr	clay (-) to med sand + fragments
APFS057	14	15	wh	RSr	clay (-) + fragments
APFS058	0	1	rb	RLd	fine to med sand + fragments
APFS058	1	2	rb	RLd	fine to med sand + pisolith
APFS058	2	3	yb	RM	fine to med sand + fragments
APFS058	3	4	yb	RS	coarse sand + fragments
APFS058	4	5	yb	RS	coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS058	5	6	yb	RS	coarse sand + fragments
APFS058	6	7	be	RS	coarse sand + fragments
APFS058	7	8	yb	RS	clay (-) to coarse sand + fragments
APFS058	8	9	gy	RS	clay (+) to fine sand + fragments
APFS058	9	10	gy	RS	clay (+) to fine sand + fragments
APFS058	10	11	gy	RS	clay (+) to fine sand + fragments
APFS058	11	12	pk	RS	clay (+) to fine sand + fragments
APFS058	12	13	pk	RS	clay (+) to fine sand + fragments
APFS058	13	14	pk	RS	clay (+) to fine sand + pisolith
APFS058	14	15	cm	RS	clay (+) to fine sand
APFS059	0	1	br	Soil	soil with gravel
APFS059	1	2	br	Soil	soil with gravel
APFS059	2	3	rb	RLd	fine to coarse sand + fragments
APFS059	3	4	rb	RLd	fine to coarse sand + fragments
APFS059	4	5	br	RM	fine to coarse sand + fragments
APFS059	5	6	br	RM	clay (-) to med sand + fragments
APFS059	6	7	be	RM	clay (-) to fine sand + fragments
APFS059	7	8	be	RM	clay (-) to fine sand + fragments
APFS059	8	9	pk	RM	clay (-) to fine sand + fragments
APFS059	9	10	pk	RM	clay (-) to fine sand + fragments
APFS059	10	11	pk	RM	clay (-) to fine sand + fragments
APFS059	11	12	be	RP	clay (+) + fragments
APFS059	12	13	be	RP	clay (++)
APFS059	13	14	be	RS	clay (+) to fine sand + fragments
APFS059	14	15	pk	RS	clay (+) to fine sand + fragments
APFS060	0	1	rb	RLd	fine to coarse sand + fragments
APFS060	1	2	rb	RLd	fine to coarse sand + fragments
APFS060	2	3	rb	RLd	fine to coarse sand + fragments
APFS060	3	4	br	RM	fine to coarse sand + fragments
APFS060	4	5	br	RM	fine to coarse sand + fragments
APFS060	5	6	pk	RM	clay (-) to fine sand + fragments
APFS060	6	7	be	RM	clay (-) to fine sand + fragments
APFS060	7	8	be	RM	clay (-) to fine sand + fragments
APFS060	8	9	pk	RM	clay (-) to fine sand + fragments
APFS060	9	10	pk	RM	clay (-) to fine sand + fragments
APFS060	10	11	pk	RM	clay (-) to fine sand + fragments
APFS060	11	12	pk	RS	clay (+) to fine sand + fragments
APFS060	12	13	be	RS	clay (+) to fine sand + fragments
APFS060	13	14	be	RS	clay (+) to fine sand + fragments
APFS060	14	15	pk	RS	clay (+) to fine sand + fragments
APFS061	0	1	br	RSr	sand + fragments
APFS061	1	2	br	RSr	sand + fragments
APFS061	2	3	br	RSr	sand + fragments
APFS061	3	4	rb	RSr	fine to med sand + fragments
APFS061	4	5	br	RSr	fine to med sand + fragments
APFS061	5	6	be	RSr	clay (-) to med sand + fragments
APFS061	6	7	pk	RSr	clay (-) to med sand + fragments
APFS061	7	8	pk	RSr	clay (-) to med sand + fragments
APFS061	8	9	pk	RSr	clay (+) to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS061	9	10	pk	RSr	clay (+) to med sand + fragments
APFS061	10	11	yb	RSr	clay (+) + fragments
APFS061	11	12	yb	RSr	clay (+) + fragments
APFS061	12	13	yb	RSr	clay (+) + fragments
APFS061	13	14	wh	RSr	clay (+) + fragments
APFS061	14	15	yb	RSr	clay (+) + fragments
APFS062	0	1	br	RSr	fine to med sand + fragments
APFS062	1	2	br	RSr	fine to med sand + fragments
APFS062	2	3	be	RSr	fine to med sand + fragments
APFS062	3	4	be	RSr	fine to med sand + fragments
APFS062	4	5	be	RSr	clay (+) + fragments
APFS062	5	6	pk	RSr	clay (+)
APFS062	6	7	pk	RSr	clay (+) + fragments
APFS062	7	8	be	RSr	clay (+) + fragments
APFS062	8	9	be	RSr	clay (+) + fragments
APFS062	9	10	yb	RSr	clay (+)
APFS062	10	11	be	RSr	clay (+) + fragments
APFS062	11	12	or	RSr	clay (+)
APFS062	12	13	be	RSr	clay (+) + fragments
APFS062	13	14	yb	RSr	clay (+)
APFS062	14	15	yb	RSr	clay (+)
APFS063	0	1	rb	RLd	fine to med sand + fragments
APFS063	1	2	br	RLd	fine to med sand + fragments
APFS063	2	3	rb	RLd	fine to med sand + fragments
APFS063	3	4	rb	RLd	fine to med sand + fragments
APFS063	4	5	or/br	RLd	fine to med sand + fragments + clay (-)
APFS063	5	6	or/br	RLd	fine to med sand + fragments + clay (-)
APFS063	6	7	rb	RLd	fine to med sand + fragments + clay (-)
APFS063	7	8	pk	RM	clay (-) to fine sand + fragments
APFS063	8	9	pk	RS	clay (-) to fine sand + fragments
APFS063	9	10	be	RS	clay (-) to fine sand + fragments
APFS063	10	11	be	RS	clay (-) to fine sand + fragments
APFS063	11	12	wh	RS	clay (+) to fine sand + fragments
APFS063	12	13	wh	RS	clay (+) to fine sand + fragments
APFS063	13	14	wh	RS	clay (+) to fine sand + fragments
APFS063	14	15	wh	RS	clay (+) to fine sand + fragments
APFS064	0	1	br	RLg	fine to coarse sand + fragments
APFS064	1	2	rb	RLg	fine to coarse sand + fragments
APFS064	2	3	rb	RLg	fine to coarse sand + fragments
APFS064	3	4	rb	RLg	fine sand + fragments
APFS064	4	5	rb	RLg	fine to med sand + fragments
APFS064	5	6	br	RM	fine to med sand + fragments
APFS064	6	7	br	RM	fine to med sand + fragments
APFS064	7	8	br	RM	fine to med sand + fragments
APFS064	8	9	pk	RS	clay (-) to fine sand + fragments
APFS064	9	10	pk	RS	clay (-) to fine sand + fragments
APFS064	10	11	yb	RS	clay (-) to fine sand + fragments
APFS064	11	12	yb	RS	clay (-) to fine sand + fragments
APFS064	12	13	yb	RS	clay (-) to fine sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS064	13	14	yw	RS	clay (-) to fine sand + fragments
APFS064	14	15	yw	RS	clay (-) to fine sand + fragments
APFS065	0	1	rb	RLd	fine to med sand + fragments + pisolith
APFS065	1	2	rb	RLd	fine to med sand + fragments + pisolith
APFS065	2	3	rb	RLd	fine to med sand + fragments + pisolith
APFS065	3	4	rb	RLd	fine to med sand + fragments + pisolith
APFS065	4	5	rb	RM	fine to med sand + fragments + pisolith
APFS065	5	6	be	RSr	fine to med sand + fragments + pisolith
APFS065	6	7	be	RSr	clay (-) to fine sand + fragments
APFS065	7	8	be	RSr	clay (-) to fine sand + fragments
APFS065	8	9	be	RSr	clay (-) to fine sand + fragments
APFS065	9	10	cm	RSr	clay (-) to fine sand + fragments
APFS065	10	11	wh	RSr	clay (+) + fragments
APFS065	11	12	wh	RSr	clay (+) + fragments
APFS065	12	13	wh	RSr	clay (++)
APFS065	13	14	wh	RSr	clay (++)
APFS065	14	15	wh	RSr	clay (++)
APFS066	0	1	br	RM	fine to med sand + fragments + pisolith
APFS066	1	2	br	RM	fine to med sand + fragments + pisolith
APFS066	2	3	or/br	RS	fine to med sand + fragments + pisolith
APFS066	3	4	pk	RS	fine to med sand + fragments + pisolith
APFS066	4	5	yb	RS	fine sand + fragments + pisolith
APFS066	5	6	yb	RS	fine sand + fragments + pisolith
APFS066	6	7	pk	RS	fine sand + fragments + pisolith
APFS066	7	8	yb	RS	fine sand + fragments + pisolith
APFS066	8	9	yb	RS	fine sand + fragments + pisolith
APFS066	9	10	be	RS	fine sand + fragments + pisolith
APFS066	10	11	be	RSr	fine sand + fragments + pisolith
APFS066	11	12	gb	RSr	fine sand + fragments + pisolith
APFS066	12	13	gb	RSr	fine sand + fragments + pisolith
APFS066	13	14	bk	FR	fine sand + fragments + pisolith
APFS067	0	1	br	RLd	fine to med sand + fragments + pisolith
APFS067	1	2	cm	RM	clay to med sand + fragments
APFS067	2	3	cm	RM	clay to med sand + fragments
APFS067	3	4	pk	RM	clay to fine sand + fragments
APFS067	4	5	gy	RS	clay (+) + fragments
APFS067	5	6	gy	RS	clay (+) + fragments
APFS067	6	7	gy	RS	clay (+) + fragments
APFS067	7	8	gy	RS	clay (+) + fragments
APFS067	8	9	yb	RS	clay (+) + fragments
APFS067	9	10	wh	RS	clay (++)
APFS067	10	11	be	RS	clay (++)
APFS067	11	12	wh	RS	clay (++)
APFS067	12	13	wh	RS	clay (++)
APFS067	13	14	yb	RS	clay (++)
APFS067	14	15	yb	RS	clay (+) + fragments
APFS068	0	1	yb	RM	fine to med sand + fragments
APFS068	1	2	cm	RM	fine sand + fragments
APFS068	2	3	cm	RM	fine sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS068	3	4	cm	RM	clay (-) to fine sand + fragments
APFS068	4	5	cm	RM	fine sand + fragments
APFS068	5	6	cm	RM	fine sand + fragments
APFS068	6	7	yb	RS	fine sand + fragments + pisolith
APFS068	7	8	yb	RS	clay (+) to fine sand + fragments
APFS068	8	9	yb	RS	clay (+) to fine sand + fragments
APFS068	9	10	be	RS	clay (++)
APFS068	10	11	yb	RS	clay (+) to fine sand + fragments
APFS068	11	12	yb	RS	clay (+) + fragments
APFS068	12	13	yb	RS	clay (++)
APFS068	13	14	yb	RS	clay (++)
APFS068	14	15	yb	RS	clay (++)
APFS070	0	1	pk	RM	clay (+) to fine sand
APFS070	1	2	pk	RM	clay (+) to fine sand + fragments
APFS070	2	3	pk	RM	clay (+) to fine sand + fragments
APFS070	3	4	be	RS	clay (+) to fine sand + fragments
APFS070	4	5	be	RS	clay (+) to fine sand + fragments
APFS070	5	6	be	RS	clay (+) to fine sand + fragments
APFS070	6	7	pk	RS	clay (+) to fine sand + fragments
APFS070	7	8	cm	RS	clay (+) to fine sand + fragments
APFS070	8	9	cm	RS	clay (+) + fragments
APFS070	9	10	cm	RS	clay (+) + fragments
APFS070	10	11	cm	RS	clay (+) + fragments
APFS070	11	12	yb	RS	clay (++)
APFS070	12	13	yb	RS	clay (++)
APFS070	13	14	yb	RS	clay (++)
APFS070	14	15	yb	RS	clay (++)
APFS071	0	1	br	RSr	fine to coarse sand + fragments
APFS071	1	2	cm	RSr	fine to coarse sand + fragments
APFS071	2	3	cm	RSr	fine to coarse sand + fragments
APFS071	3	4	br	RSr	fine to coarse sand + fragments
APFS071	4	5	be	RSr	clay (+) to med sand + fragments
APFS071	5	6	be	RSr	clay (+) to fine sand + fragments
APFS071	6	7	be	RSr	clay (+) to fine sand + fragments
APFS071	7	8	be	RSr	clay (+) to fine sand + fragments
APFS071	8	9	gy	RSr	clay (+) to fine sand + fragments + Mn
APFS071	9	10	bk	RSr	clay (+) to fine sand + fragments + Mn
APFS071	10	11	pk	RSr	clay (+) to fine sand + fragments
APFS071	11	12	pk	RSr	clay (+) to fine sand + fragments
APFS071	12	13	pk	RSr	clay (+) to fine sand + fragments
APFS071	13	14	pk	RSr	clay (+) + fragments
APFS071	14	15	pk	RSr	clay (+) to fine sand + fragments
APFS072	0	1	pk	RSr	fine to med sand + fragments
APFS072	1	2	pk	RSr	fine to med sand + fragments
APFS072	2	3	be	RSr	clay (+) to fine sand + fragments
APFS072	3	4	yb	RSr	clay (-) to fine sand + fragments
APFS072	4	5	yb	RSr	clay (+) + fragments
APFS072	5	6	yb	RSr	clay (+) + fragments
APFS072	6	7	yb	RSr	clay (++)

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS072	7	8	yb	RSr	clay (++)
APFS072	8	9	yb	RSr	clay (++)
APFS072	9	10	yb	RSr	clay (++)
APFS072	10	11	yb	RSr	clay (++)
APFS072	11	12	yb	RSr	clay (++)
APFS072	12	13	yb	RSr	clay (++)
APFS072	13	14	yb	RSr	clay (++)
APFS072	14	15	yb	RSr	clay (++)
APFS073	0	1	rb	Soil	fine to coarse sand + fragments
APFS073	1	2	br	RSr	fine to coarse sand + fragments
APFS073	2	3	br	RSr	fine to coarse sand + fragments
APFS073	3	4	pk	RSr	fine to coarse sand + fragments
APFS073	4	5	pk	RSr	clay (+) to fine sand + fragments
APFS073	5	6	yb	RSr	clay (+) to fine sand + fragments
APFS073	6	7	be	RSr	clay (-) to fine sand + fragments
APFS073	7	8	cm	RSr	clay (+) to fine sand + fragments
APFS073	8	9	cm	RSr	clay (+) + fragments
APFS073	9	10	cm	RSr	clay (+) + fragments
APFS073	10	11	wh	RSr	clay (++)
APFS073	11	12	yb	RSr	clay (++)
APFS073	12	13	yb	RSr	clay (++)
APFS073	13	14	wh	RSr	clay (++)
APFS073	14	15	be	RSr	clay (++)
APFS074	0	1	yb	RM	fine to coarse sand + fragments
APFS074	1	2	yb	RM	fine to coarse sand + fragments
APFS074	2	3	yb	RM	fine to coarse sand + fragments
APFS074	3	4	yb	RS	fine to coarse sand + fragments
APFS074	4	5	yb	RS	fine to coarse sand + fragments
APFS074	5	6	pk	RS	clay (-) to fine sand + fragments
APFS074	6	7	or	RS	clay (-) to fine sand + fragments + pisolith
APFS074	7	8	yw	RS	clay (+) to fine sand + fragments + pisolith
APFS074	8	9	cm	RS	clay (+) to fine sand + fragments + pisolith
APFS074	9	10	cm	RS	clay (+) to fine sand + fragments + pisolith
APFS074	10	11	cm	RS	clay (++)
APFS074	11	12	yw	RS	clay (+) + fragments
APFS074	12	13	yw	RS	clay (++)
APFS074	13	14	yw	RS	clay (++)
APFS074	14	15	yw	RS	clay (++)
APFS075	0	1		RM	fine to med sand + fragments
APFS075	1	2		RM	fine to med sand + fragments
APFS075	2	3		RM	clay (-) to fine sand + fragments
APFS075	3	4		RM	clay (+) to fine sand + fragments
APFS075	4	5		RM	clay (+) to fine sand + fragments
APFS075	5	6		RM	clay (+) to fine sand + fragments
APFS075	6	7		RSr	clay (+) + fragments
APFS075	7	8		RSr	clay (++)
APFS075	8	9		RSr	clay (+) + fragments
APFS075	9	10		RSr	clay (+) + fragments
APFS075	10	11		RSr	clay (++)

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS075	11	12		RSr	clay (++)
APFS075	12	13		RSr	clay (++)
APFS075	13	14		RSr	clay (+) + fragments
APFS075	14	15		RSr	clay (++)
APFS076	0	1	pk	RM	fine to med sand + fragments
APFS076	1	2	pk	RM	fine to med sand + fragments
APFS076	2	3	pk	RM	fine to med sand + fragments
APFS076	3	4	yb	RS	clay (-) to fine sand + fragments + pisolith
APFS076	4	5	yb	RS	clay (+) to fine sand + fragments + pisolith
APFS076	5	6	yb	RS	clay (+) to fine sand + fragments + pisolith
APFS076	6	7	yb	RS	clay (+) + fragments + pisolith
APFS076	7	8	yb	RS	clay (+) + fragments
APFS076	8	9	yb	RS	clay (+) + fragments
APFS076	9	10	gy	RS	clay (++)
APFS076	10	11	gy	RS	clay (++)
APFS076	11	12	yb	RS	clay (++)
APFS076	12	13	gg	RS	clay (++)
APFS076	13	14	gg	RS	clay (+) + fragments
APFS076	14	15	gg	RS	clay (+) + fragments
APFS077	0	1	gr	RM	fine sand + fragments
APFS077	1	2	yb	RM	fine sand + fragments
APFS078	0	1	br	RM	fine to med sand + fragments
APFS078	1	2	br	RS	clay (-) to fine sand + fragments
APFS078	2	3	yb	RS	clay (+) to fine sand + fragments
APFS078	3	4	yb	RS	clay (+) to fine sand + fragments
APFS078	4	5	yb	RS	clay (+) to fine sand + fragments
APFS078	5	6	pk	RS	clay (+) + fragments
APFS078	6	7	yb	RS	clay (+) to fine sand + fragments
APFS078	7	8	yb	RS	clay (+) + fragments
APFS078	8	9	yb	RS	clay (+) + fragments
APFS078	9	10	yb	RS	clay (+) + fragments
APFS078	10	11	yb	RS	clay (++)
APFS078	11	12	yb	RS	clay (+) + fragments
APFS078	12	13	pk	RS	clay (+) + fragments
APFS078	13	14	pk	RS	clay (+) + fragments
APFS078	14	15	pk	RS	clay (+) + fragments
APFS080	0	1	pk	RM	clay (-) to med sand + fragments
APFS080	1	2	pk	RS	clay (-) to fine sand + fragments
APFS080	2	3	yb	RS	clay (+) to fine sand + fragments
APFS080	3	4	pk	RS	clay (+) to fine sand + fragments
APFS080	4	5	pk	RS	clay (++)
APFS080	5	6	yb	RS	clay (+) + fragments
APFS080	6	7	yb	RS	clay (++)
APFS080	7	8	yb	RS	clay (++)
APFS080	8	9	yb	RS	clay (++)
APFS080	9	10	yb	RS	clay (+) + fragments
APFS080	10	11	yb	RS	clay (+) + fragments
APFS080	11	12	cm	RS	clay (+) + fragments
APFS080	12	13	gb	RS	clay (+) + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS080	13	14	gb	RS	clay (+) + fragments
APFS080	14	15	cm	RS	clay (+) + fragments
APFS081	0	1	pk	RM	fine to med sand + fragments
APFS081	1	2	pk	RM	fine to med sand + fragments
APFS081	2	3	pk	RM	clay (+) to fine sand + fragments
APFS081	3	4	be	RS	clay (+) to fine sand + fragments
APFS081	4	5	yb	RS	clay (+) to fine sand + fragments
APFS081	5	6	yb	RS	clay (+) to fine sand + fragments
APFS081	6	7	pk	RS	clay (+) to fine sand + fragments
APFS081	7	8	yb	RS	clay (+) to fine sand + fragments
APFS081	8	9	or	RS	clay (+) to fine sand + fragments
APFS081	9	10	cm	RS	clay (+) + fragments
APFS081	10	11	yb	RS	clay (+) + fragments
APFS081	11	12	yw	RS	clay (+) + fragments
APFS081	12	13	yb	RS	clay (+) + fragments
APFS081	13	14	yw	RS	clay (+) + fragments
APFS081	14	15	wh	RS	clay (+) + fragments
APFS082	0	1	pk	RM	fine sand + fragments
APFS082	1	2	pk	RM	clay (+) to fine sand + fragments
APFS082	2	3	pk	RM	clay (+) to fine sand + fragments
APFS082	3	4	pk	RM	clay (+) to fine sand + fragments
APFS082	4	5	yw	RS	clay (++)
APFS082	5	6	yw	RS	clay (++)
APFS082	6	7	be	RS	clay (++)
APFS082	7	8	gy	RS	clay (++)
APFS082	8	9	wh	RS	clay (++)
APFS082	9	10	wh	RS	clay (++)
APFS082	10	11	wh	RS	clay (++)
APFS082	11	12	wh	RS	clay (++)
APFS082	12	13	be	RS	clay (+) + fragments
APFS082	13	14	be	RS	clay (++)
APFS082	14	15	be	RS	clay (++)
APFS083	0	1	br	RM	fine to coarse sand + fragments
APFS083	1	2	yb	RM	med to coarse sand + fragments
APFS083	2	3	wh	RS	clay (-) to fine sand + fragments
APFS083	3	4	wh	RS	clay (-) to fine sand + fragments
APFS083	4	5	wh	RS	clay (-) to fine sand + fragments
APFS083	5	6	wh	RS	clay (-) to fine sand + fragments
APFS083	6	7	wh	RS	clay (+) to fine sand + fragments
APFS083	7	8	cm	RS	clay (+) to fine sand + fragments
APFS083	8	9	cm	RS	clay (+) + fragments
APFS083	9	10	cm	RS	clay (++)
APFS083	10	11	cm	RS	clay (+) + fragments
APFS083	11	12	cm	RS	clay (++)
APFS083	12	13	cm	RS	clay (+) + fragments
APFS084	0	1	pk	RM	fine to med sand + fragments
APFS084	1	2	pk	RM	clay (-) to med sand + fragments
APFS084	2	3	pk	RM	clay (-) to med sand + fragments
APFS084	3	4	pk	RM	clay (-) to med sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS084	4	5	gy	RS	clay (+) + fragments
APFS084	5	6	gy	RS	clay (+) + fragments
APFS084	6	7	gy	RS	clay (+) to fine sand + fragments
APFS084	7	8	gy	RS	clay (+) to fine sand + fragments
APFS084	8	9	be	RS	clay (+) + fragments
APFS084	9	10	pk	RS	clay (+) + fragments
APFS084	10	11	pk	RS	clay (+) + fragments
APFS084	11	12	pk	RS	clay (+) + fragments
APFS084	12	13	pk	RS	clay (++)
APFS084	13	14	pk	RS	clay (++)
APFS084	14	15	pk	RS	clay (++)
APFS085	0	1	pk	RM	fine to med sand + fragments
APFS085	1	2	pk	RM	fine to med sand + fragments
APFS085	2	3	gy	RS	clay (-) to fine sand + fragments
APFS085	3	4	pk	RS	clay (-) to fine sand + fragments
APFS085	4	5	be	RS	clay (-) to fine sand + fragments
APFS085	5	6	pk	RS	clay (+) to fine sand + fragments
APFS085	6	7	pk	RS	clay (+) to fine sand + fragments
APFS085	7	8	pk	RS	clay (+) to fine sand + fragments
APFS085	8	9	pk	RS	clay (++)
APFS085	9	10	cm	RS	clay (+) + fragments
APFS085	10	11	cm	RS	clay (++)
APFS085	11	12	cm	RS	clay (++)
APFS085	12	13	cm	RS	clay (++)
APFS085	13	14	cm	RS	clay (++)
APFS085	14	15	cm	RS	clay (++)
APFS086	0	1	pk	RM	fine to med sand + fragments
APFS086	1	2	pk	RM	clay (-) to fine sand + fragments
APFS086	2	3	cm	RS	fine to med sand + fragments
APFS086	3	4	cm	RS	fine to med sand + fragments
APFS086	4	5	be	RS	fine to med sand + fragments
APFS087	0	1	br	RLd	fine to coarse sand + fragments
APFS087	1	2	yb	RM	fine to med sand + fragments
APFS087	2	3	yb	RM	fine to med sand + fragments
APFS087	3	4	pk	RM	fine to med sand + fragments
APFS087	4	5	pk	RM	fine to med sand + fragments
APFS087	5	6	yb	RS	fine to med sand + fragments
APFS087	6	7	pk	RS	fine to med sand + fragments
APFS087	7	8	br	RS	fine to med sand + fragments
APFS087	8	9	br	RS	clay (-) to fine sand + fragments
APFS087	9	10	br	RS	clay (-) to fine sand + fragments
APFS087	10	11	br	RS	clay (-) to fine sand + fragments
APFS087	11	12	br	RS	clay (-) to fine sand + fragments
APFS087	12	13	yb	RS	clay (+) to fine sand + fragments + pisolith
APFS087	13	14	yb	RS	clay (+) + fragments + pisolith
APFS087	14	15	yw	RS	clay (+) + fragments + pisolith
APFS088	0	1	br	RLd	fine to med sand + fragments
APFS088	1	2	br	RLd	fine to med sand + fragments
APFS089	0	1	be	RM	fine to coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS089	1	2	yb	RM	fine to coarse sand + fragments
APFS090	0	1	rb	RLd	fine sand + fragments
APFS090	1	2	rb	RLd	fine sand + fragments
APFS090	2	3	be	RM	fine sand + fragments
APFS090	3	4	be	RM	fine sand + fragments
APFS090	4	5	yb	RS	fine sand + fragments / gravel
APFS090	5	6	yb	RS	fine sand + fragments / gravel
APFS090	6	7	yb	RS	fine sand + fragments / gravel
APFS090	7	8	be	RS	fine sand + fragments
APFS090	8	9	pk	RS	clay (-) to fine sand + fragments
APFS090	9	10	be	RS	clay (+) to fine sand + fragments
APFS090	10	11	be	RSr	clay (+) to fine sand + fragments
APFS090	11	12	be	RSr	clay (+) to fine sand + fragments
APFS090	12	13	bk	RSr	clay (-) to fine sand + fragments
APFS091	0	1	rb	RLd	fine to med sand + fragments + pisolith
APFS091	1	2	rb	RLd	fine to med sand + fragments + pisolith
APFS091	2	3	rb	RLd	fine to med sand + fragments + pisolith
APFS091	3	4	br	RLd	fine to med sand + fragments + pisolith
APFS091	4	5	pk	RM	fine sand + fragments
APFS091	5	6	pk	RM	fine sand + fragments
APFS092	0	1	rb	RLd	fine to coarse sand + fragments
APFS092	1	2	rb	RLd	clay (-) to med sand + fragments
APFS092	2	3	yb	RS	clay (-) to med sand + fragments
APFS092	3	4	yb	RS	clay (-) to med sand + fragments
APFS092	4	5	yb	RS	clay (-) to fine sand + fragments
APFS092	5	6	yb	RS	clay (-) to fine sand + fragments
APFS092	6	7	or	RS	clay (-) to fine sand + fragments
APFS092	7	8	pk	RS	clay (-) to fine sand + fragments
APFS092	8	9	yb	RS	clay (-) to fine sand + fragments
APFS092	9	10	yb	RS	clay (-) to fine sand + fragments
APFS092	10	11	yb	RS	clay (-) to fine sand + fragments
APFS092	11	12	yb	RS	clay (+) to fine sand + fragments
APFS092	12	13	yb	RS	clay (-) to fine sand + fragments
APFS092	13	14	br	RS	clay (++)
APFS092	14	15	yb	RS	clay (++)
APFS093	0	1	pk	RM	fine to med sand + fragments
APFS093	1	2	be	RS	fine to med sand + fragments
APFS093	2	3	be	RS	clay (-) to fine sand + fragments
APFS093	3	4	pk	RS	clay (-) to fine sand + fragments
APFS093	4	5	pk	RS	clay (+) to fine sand + fragments
APFS093	5	6	pk	RS	clay (+) to fine sand + fragments
APFS093	6	7	pk	RS	clay (+) to fine sand + fragments
APFS093	7	8	pk	RS	clay (+) to fine sand + fragments
APFS093	8	9	pk	RS	clay (+) to fine sand + fragments
APFS093	9	10	pk	RS	clay (+) to fine sand + fragments
APFS093	10	11	pk	RS	clay (+) to fine sand + fragments
APFS094	0	1	rb	RLd	fine sand + fragments + pisolith
APFS094	1	2	or	RM	clay (-) to fine sand + fragments + pisolith
APFS094	2	3	yb	RS	clay (-) to fine sand + fragments + pisolith

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS094	3	4	be	RS	clay (-) to fine sand + fragments + pisolith
APFS094	4	5	or/br	RS	clay (-) to fine sand + fragments + pisolith
APFS094	5	6	be	RS	clay (-) to fine sand + fragments + pisolith
APFS094	6	7	be	RS	clay (-) to fine sand + fragments + pisolith
APFS094	7	8	or	RS	clay (-) to fine sand + fragments + pisolith
APFS094	8	9	cm	RS	clay (+) to fine sand + fragments
APFS094	9	10	cm	RS	clay (+) + fragments
APFS094	10	11	cm	RS	clay (+) + fragments
APFS094	11	12	gy	RS	clay (++)
APFS094	12	13	gy	RS	clay (++)
APFS094	13	14	wh	RS	clay (++)
APFS094	14	15	wh	RS	clay (++)
APFS095	0	1	be	RM	clay (-) to fine sand + fragments
APFS095	1	2	be	RM	clay (-) to fine sand + fragments
APFS095	2	3	be	RM	clay (-) to fine sand + fragments
APFS096	0	1	be	RM	fine to coarse sand + fragments
APFS096	1	2	yb	RM	clay (+) to coarse sand + fragments
APFS096	2	3	pk	RM	clay (+) to coarse sand + fragments
APFS096	3	4	be	RS	clay (+) to coarse sand + fragments
APFS096	4	5	be	RS	clay (+) to coarse sand + fragments
APFS096	5	6	pk	RS	clay (+) + fragments
APFS096	6	7	pk	RS	clay (+) + fragments
APFS096	7	8	pk	RS	clay (+) to fine sand + fragments
APFS096	8	9	wh	RS	clay (++)
APFS096	9	10	wh	RS	clay (++)
APFS096	10	11	wh	RS	clay (++)
APFS096	11	12	cm	RS	clay (++)
APFS096	12	13	cm	RS	clay (+) + fragments
APFS096	13	14	cm	RS	clay (++)
APFS096	14	15	cm	RS	clay (++)
APFS097	0	1	cm	RM	fine to coarse sand + fragments
APFS098	0	1	pk	RM	med to coarse sand + fragments
APFS098	1	2	be	RS	med to coarse sand + fragments
APFS098	2	3	be	RS	med to coarse sand + fragments
APFS098	3	4	be	RS	med to coarse sand + fragments
APFS100	0	1	be	RM	fine to coarse sand + fragments
APFS100	1	2	be	RS	fine to coarse sand + fragments
APFS101	0	1	pk	RM	fine to coarse sand + fragments
APFS101	1	2	pk	RM	fine to coarse sand + fragments
APFS102	0	1	yb	RM	fine to coarse sand + fragments
APFS102	1	2	be	RM	fine to coarse sand + fragments
APFS102	2	3	pk	RM	fine to med sand + fragments
APFS103	0	1	pk	RM	fine to coarse sand + fragments
APFS104	0	1	rb	RLd	fine to med sand + fragments
APFS104	1	2	rb	RLd	fine to med sand + fragments
APFS104	2	3	rb	RLd	fine to med sand + fragments
APFS104	3	4	be	RM	fine to med sand + fragments
APFS105	0	1	br	RLd	fine to coarse sand + fragments
APFS105	1	2	yb	RS	fine to coarse sand + fragments

Hole_ID	mFrom	mTo	Lith_Colou	Regolith	Description
APFS105	2	3	yb	RS	fine to coarse sand + fragments
APFS105	3	4	yb	RS	fine to coarse sand + fragments
APFS105	4	5	yb	RS	fine to coarse sand + fragments
APFS105	5	6	yb	RS	fine to med sand + fragments
APFS105	6	7	yb	RS	fine to med sand + fragments
APFS105	7	8	pk	RS	fine to med sand + fragments
APFS105	8	9	pk	RS	fine to med sand + fragments
APFS105	9	10	yb	RS	fine to med sand + fragments
APFS106	0	1	pk	RM	fine to coarse sand + fragments

Test Pit ID	Easting	Northing	Final Depth (m)	Depth_From	Depth_To	Interval	Colour	Regolith	Description	Matrix/Clast supported	% clasts	% matrix particles finer than v-fine sand
TP_01	660920	7275978	0.35	0	0.05	0.05	br	sand + gravel	thin layer of river sediments at surface			
TP_01	660920	7275978	0.35	0.05	0.35	0.3	rb	Rld	2-10mm rounded clasts in a silt to med-sand matrix, white chalky evaporite and black manganese like alteration layers throughout	matrix supported	10-15%	30-40%
TP_02	661142	7275793	1.45	0	0.2	0.2	br	soil	soil + gravel to cobble sized stones			
TP_02	661142	7275793	1.45	0.2	1.45	1.25		Rld + soil	channel like structure with hardened duricrust rock wall that has been infilled with soil. Duricrust comprises 2-10mm irregular clasts in a v-fine to coarse sand matrix, duricrust at face of rock wall is much harder and overall coarser than other test pits, cannot break with geo pick	matrix supported	10-15%	0%
TP_03	661321	7275650	0.75	0	0.3	0.3	br	soil	soil + gravel to cobble sized stones			
TP_03	661321	7275650	0.75	0.3	0.4	0.1	bk/br	soil	soil and gravel appears darker with a dark brown to black coating similar to manganese alteration.			
TP_03	661321	7275650	0.75	0.4	0.75	0.35	rb/bk/wh	Rld	2-15mm rounded irregular clasts in a silty to medium sand matrix, layers of black manganese like alteration throughout and white chalky evaporite like coatings on weathered surfaces	matrix supported	10-15%	30%
TP_04	661163	7275434	0.25	0	0.25	0.25	br	soil	soil + gravel to cobble sized stones			
TP_04	661163	7275434	0.25	0.25	0.25		rb	Rld	2-25mm rounded irregular clasts in a silt to med-sand matrix	matrix supported	40%	20-30%
TP_05	660868	7275056	0.5	0	0.45	0.45	br	soil	soil + gravel to cobble sized stones			
TP_05	660868	7275056	0.5	0.45	0.5	0.05	rb	Rld	2-20mm rounded irregular clasts in a v-fine to coarse sand matrix	matrix supported	15-25%	0%
TP_06	660700	7274838	0.5	0	0.3	0.5	br	soil	soil + gravel to small boulder sized stones			
TP_06	660700	7274838	0.5	0.3	0.5	0.2	bk/br	soil	soil and gravel appears darker with a dark brown to black coating similar to manganese alteration.			
TP_06	660700	7274838	0.5	0.5	0.5		rb	Rld	2-20mm irregular clasts in a v-fine to med sand matrix, layers of darker manganese like alteration throughout and white chalky evaporite like layers on weatherd surfaces.	matrix supported	25-35%	< 5%
TP_07	660493	7274993	0.4	0	0.4	0.4	br	soil	soil + gravel to cobble sized stones			
TP_07	660493	7274993	0.4	0.4	0.4		rb	Rld	3-10mm rounded irregular clasts in a silt to v-fine sand matrix	clast supported	45-55%	40-50%
TP_08	660287	7275145	0.3	0	0.3	0.3	br	soil	Soil + gravel to cobble sized stones			
TP_08	660287	7275145	0.3	0.3	0.3		rb	Rld	3 to 20 mm rounded irregular clasts in a very fine to medium sand matrix, defined chalky white evaporite like layer on outer weathered surfaces of duricrust.	matrix supported	30-40%	<10%
TP_09	660444	7275354	0.9	0	0.9	0.9	br	soil	soil + gravel to cobble sized stoned			
TP_09	660444	7275354	0.9	0.9			rb	Rld	2-15mm rounded clasts in a silt to med sand matrix, moderately sorted clasts compared to all other test pits	matrix supported	15-25%	20%
TP_10	660741	7275744	0.2	0	0.2	0.2	br	soil	soil + gravel to cobble sized stoned			
TP_10	660741	7275744	0.2	0.2	0.2		rb	Rld	1-8mm irregular clasts in a silt to med sand matrix	matrix supported	10%	10-15%
TP_11	660818	7275399	0.3	0	0.3	0.3	br	soil	soil + gravel			
TP_11	660818	7275399	0.3	0.3	0.3		rb	Rld	2-10mm clasts in a v-fine to med sand 1mm thick layer of white chalky evaporite like substance occurs on topmost layer of duricrust.	matrix supported	15-25%	0%
TP_12	659309	7274745	0.5	0	0.35	0.35	br	soil	soil + gravel			
TP_12	659309	7274745	0.5	0.35	0.5	0.15	gy/yb	sst	v-fine to fine sandstone, massive, well sorted, soft; easily broken with geo-pick		0%	
TP_12	659309	7274745	0.5				cm/gy	ssi	laminated f-sand siltstone			
TP_13	659608	7274669	0.6	0	0.4	0.4	br	soil	soil + gravel to boulder sized rock			
TP_13	659608	7274669	0.6	0.4	0.6	0.2	rb/gy/yb	sst	v-fine to fine laminated sand, weathered surfaced coated in a red iron oxide like layer, fresh broken surfaces show a laminated grey and yellowbrown well-sorted sand that is soft and easily broken with geo pick		0%	
TP_13	659608	7274669	0.6				cm/yb	ssi	interbedded layers of siltstone-sandstone, fine sandstone and coarse qtz sandstone, all layers moderately to well sorted		0%	
TP_14	659233	7274522	0.3	0	0.2	0.2	br	soil	soil + gravel			
TP_14	659233	7274522	0.3	0.2	0.3	0.1	gy	sst	fine grained, massive, well sorted, soft sand			
TP_14	659233	7274522	0.3	0.3	0.3		cm/gy/yb	ssi	laminated v-fine to fine well sorted sandstone, few siltstone layers, few medium to coarse well sorted qtz sandstone, majority fine sst, units much harder than overlying sandstone,		0%	
TP_15	659493	7274441	0.5	0	0.3	0.3	br	soil	soil + gravel			
TP_15	659493	7274441	0.5	0.3	0.5	0.2	cm	sst	thinly laminated v-fine to medium sanstone, layers well sorted with finer layers typically softer with coarser layers much harder to break.		0%	

Appendix B
Laboratory Test Results

Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

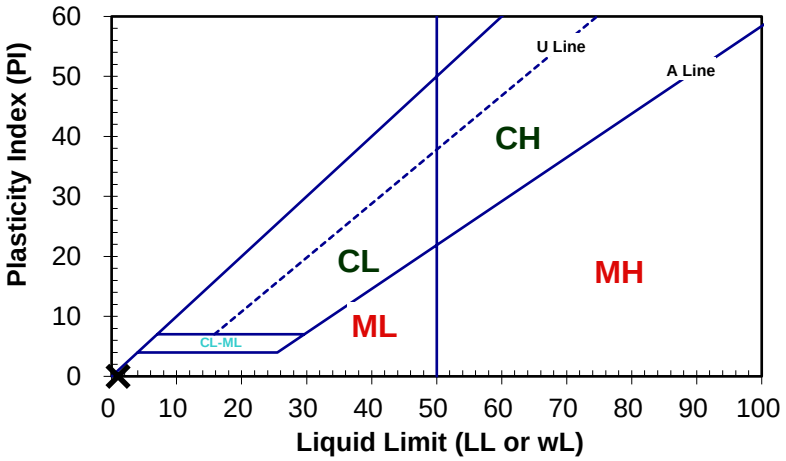
SOIL CLASSIFICATION TEST REPORT

Client	CMW Geosciences	Ticket No.	S2296
Client Address	Unit 19/127 Herdsman Parade Wembley, WA 6014	Report No.	LLS18/4237_1_PI
Project	ABRA TSF Project	Sample No.	LLS18/4237
Sampling Location	Abra Lead-Silver Project	Sampled By	Client
Sample Identification	G15337		
Sampling Method	Sampled by Client, Tested as Received	Preparation Method	AS1289.1.1
Sample History	Air Dried	Wet or Dry Sieved	Dry Sieved

CONSISTENCY LIMITS

Liquid Limit (%)	AS1289.3.1.1	Not Obtainable
Plastic Limit (%)	AS 1289.3.2.1	Non Plastic
Plasticity Index (%)	AS1289.3.3.1	Non Plastic
Linear Shrinkage (%)	AS 1289.3.4.1	1.0

Mould Length (mm)
250
Condition of Dried Specimen
Cracked,



Comments:

Approved Signatory

Name Matt van Herk

Function Laboratory Manager

Issue Date 30-September-2018

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation No. 19872

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY

Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

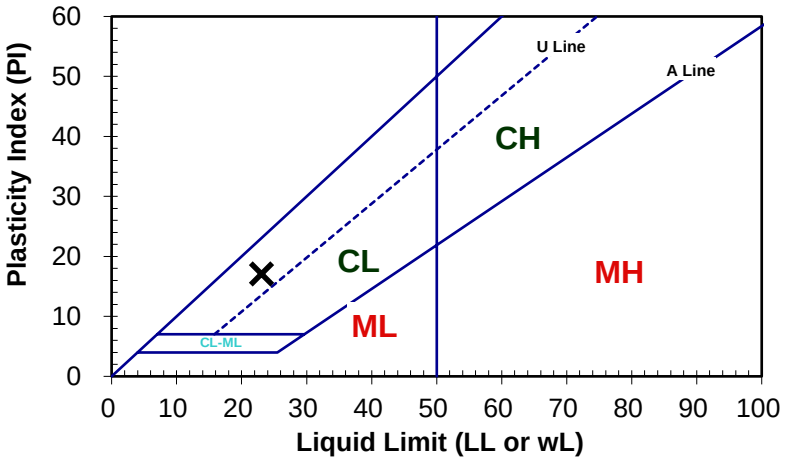
SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**Unit 19/127 Herdsman Parade Wembley, WA 6014**	Report No.	**LLS18/4238_1_PI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4238**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15339**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

CONSISTENCY LIMITS

Liquid Limit (%)	**AS1289.3.1.2**	**23**
Plastic Limit (%)	**AS 1289.3.2.1**	**17**
Plasticity Index (%)	**AS1289.3.3.1**	**6**
Linear Shrinkage (%)	**AS 1289.3.4.1**	**2.5**

Mould Length (mm)
250
Condition of Dried Specimen
-



Comments:

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Name Matt van Herk

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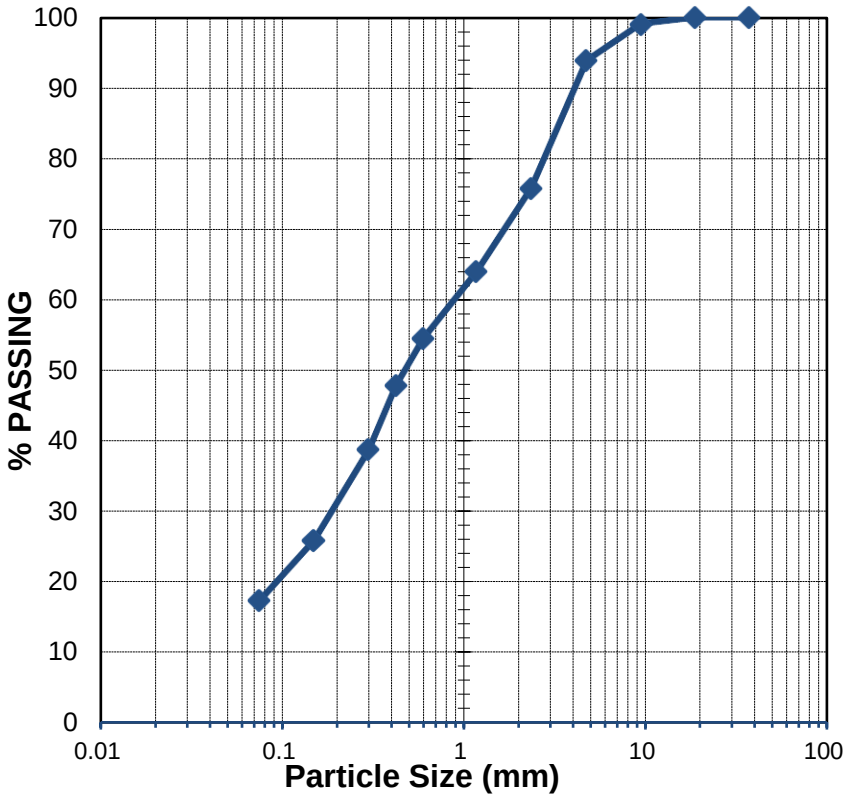
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**Unit 19/127 Herdsman Parade Wembley, WA 6014**	Report No.	**LLS18/4239_1_PSDPI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4239**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15340**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	100
19.00	100
9.50	99
4.75	94
2.36	76
1.180	64
0.600	54
0.425	48
0.300	39
0.150	26
0.075	17

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	**Plastic Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**	**Mould Length (mm)**	***Condition of Dried Specimen***
Not Obtainable	**NP**	**NP**	**0.0**	**250**	**-**

Comments:

Approved Signatory

Name Matt van Herk
Function Laboratory Manager
Issue Date 30-September-2018

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing
Accreditation No. 19872

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY

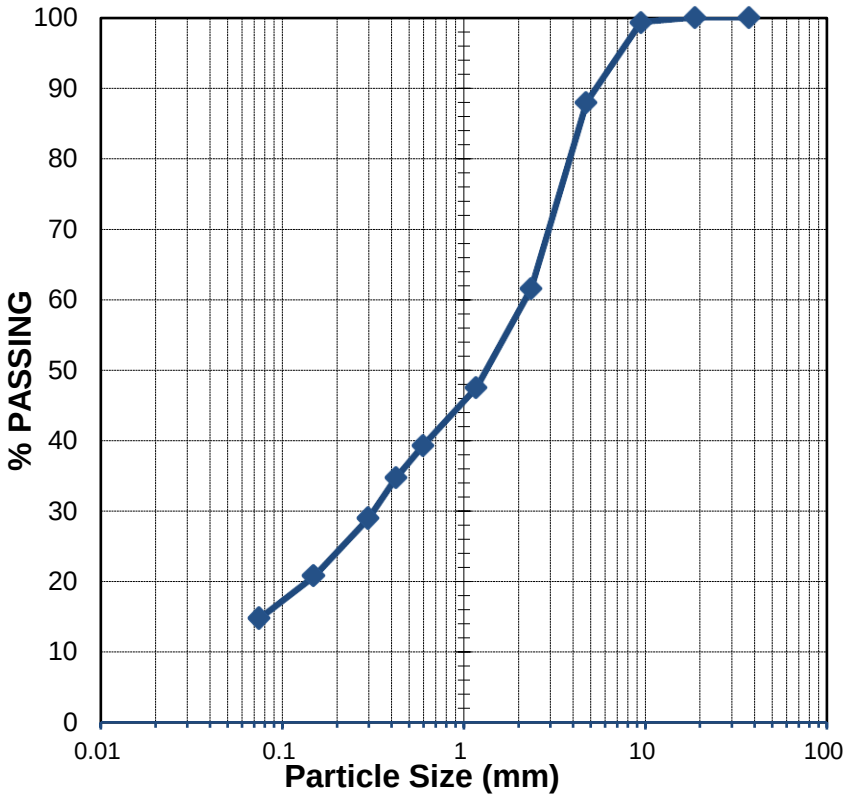
Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**Unit 19/127 Herdsman Parade Wembley, WA 6014**	Report No.	**LLS18/4240_1_PSDPI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4240**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15341**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	100
19.00	100
9.50	99
4.75	88
2.36	62
1.180	48
0.600	39
0.425	35
0.300	29
0.150	21
0.075	15

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	**Plastic Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**	**Mould Length (mm)**	***Condition of Dried Specimen***
Not Obtainable	**NP**	**NP**	**1.5**	**250**	**-**

Comments:

Approved Signatory

Name Matt van Herk
Function Laboratory Manager
Issue Date 30-September-2018

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing
Accreditation No. 19872

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY

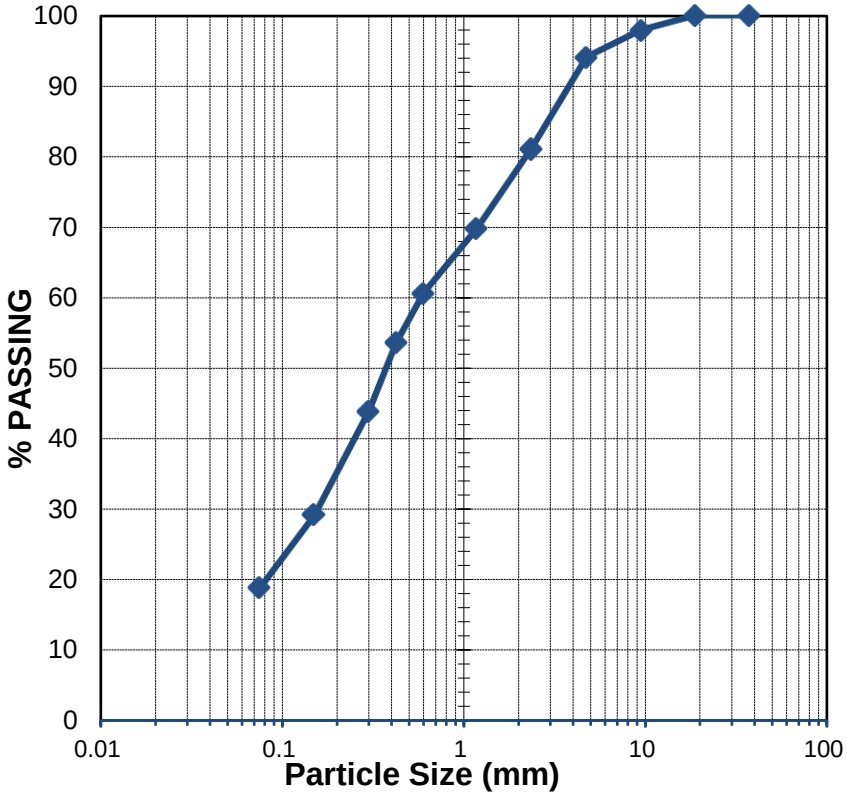
Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**Unit 19/127 Herdsman Parade Wembley, WA 6014**	Report No.	**LLS18/4241_1_PSDPI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4241**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15342**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	100
19.00	100
9.50	98
4.75	94
2.36	81
1.180	70
0.600	61
0.425	54
0.300	44
0.150	29
0.075	19

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	**Plastic Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**	**Mould Length (mm)**	***Condition of Dried Specimen***
Not Obtainable	**NP**	**NP**	**0.5**	**250**	**-**

Comments:

Approved Signatory

Name Matt van Herk
Function Laboratory Manager
Issue Date 30-September-2018

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LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY

Liquid Labs WA
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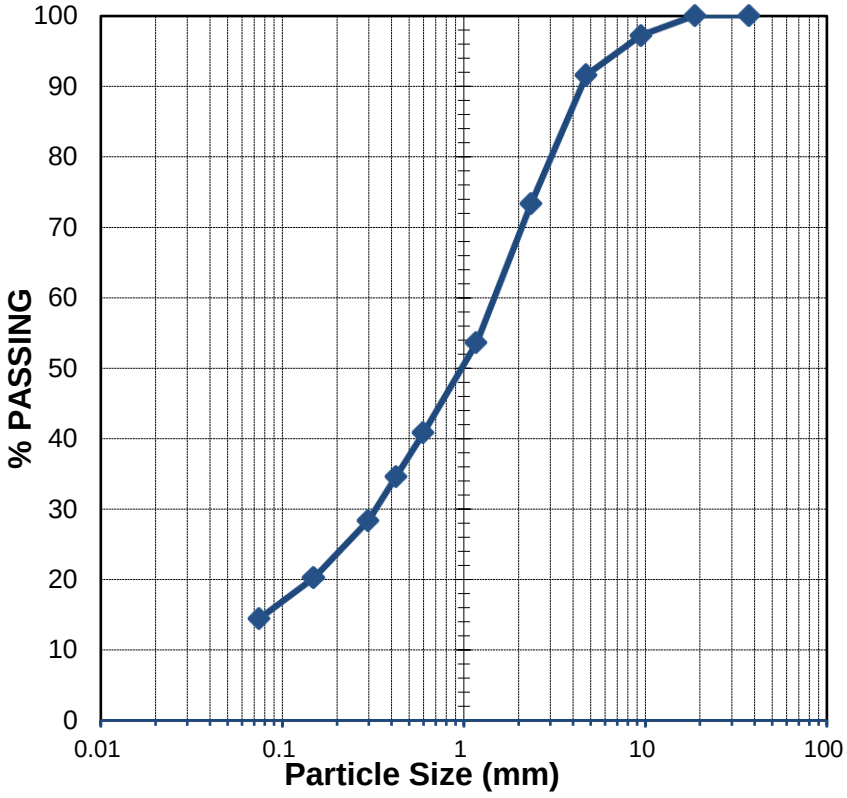
16B/81 Briggs Street
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**Unit 19/127 Herdsman Parade Wembley, WA 6014**	Report No.	**LLS18/4242_1_PSDPI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4242**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15343**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	100
19.00	100
9.50	97
4.75	92
2.36	73
1.180	54
0.600	41
0.425	35
0.300	28
0.150	20
0.075	14

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	**Plastic Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**	**Mould Length (mm)**	***Condition of Dried Specimen***
Not Obtainable	**NP**	**NP**	**1.5**	**250**	**-**

Comments:

Approved Signatory

Name Matt van Herk
Function Laboratory Manager
Issue Date 30-September-2018

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LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY

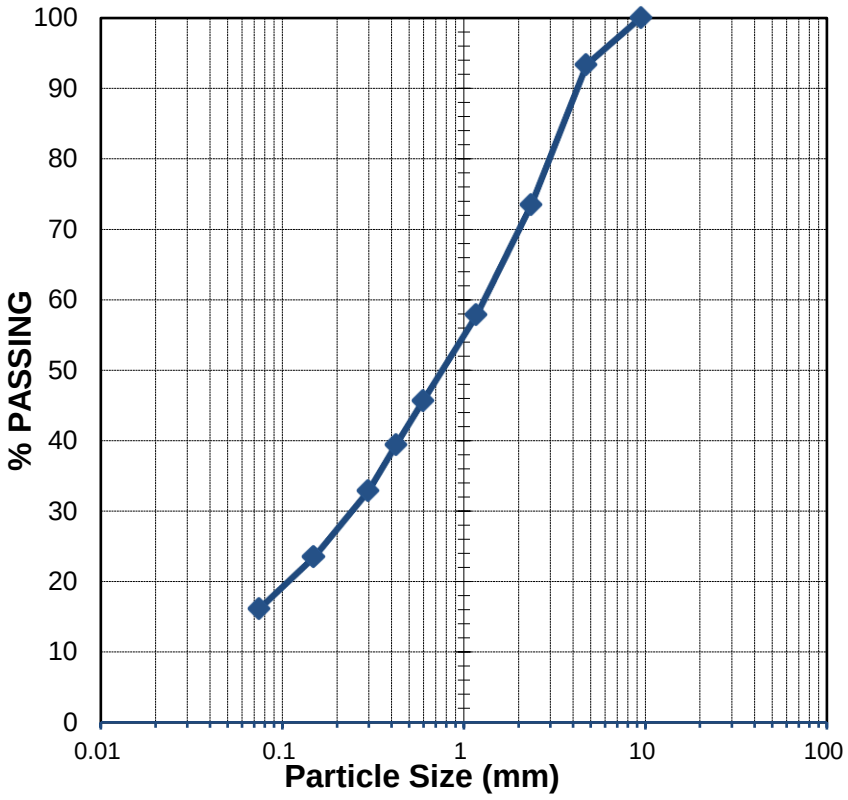
Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	**CMW Geosciences**	Ticket No.	**S2296**
Client Address	**19/127 Herdsman Parade, Wembley WA 6014**	Report No.	**LLS18/4243_1_PSDPI**
Project	**ABRA TSF Project**	Sample No.	**LLS18/4243**
Sampling Location	**Abra Lead-Silver Project**	Sampled By	**Client**
Sample Identification	**G15344**		
Sampling Method	**Sampled by Client, Tested as Received**	Preparation Method	**AS1289.1.1**
Sample History	**Air Dried**	Wet or Dry Sieved	**Dry Sieved**

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	
19.00	
9.50	100
4.75	93
2.36	73
1.180	58
0.600	46
0.425	39
0.300	33
0.150	23
0.075	16

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	**Plastic Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**	**Mould Length (mm)**	***Condition of Dried Specimen***
Not Obtainable	**NP**	**NP**	**0.5**	**250**	**-**

Comments:

Approved Signatory

Name Matt van Herk
Function Laboratory Manager
Issue Date 30-September-2018

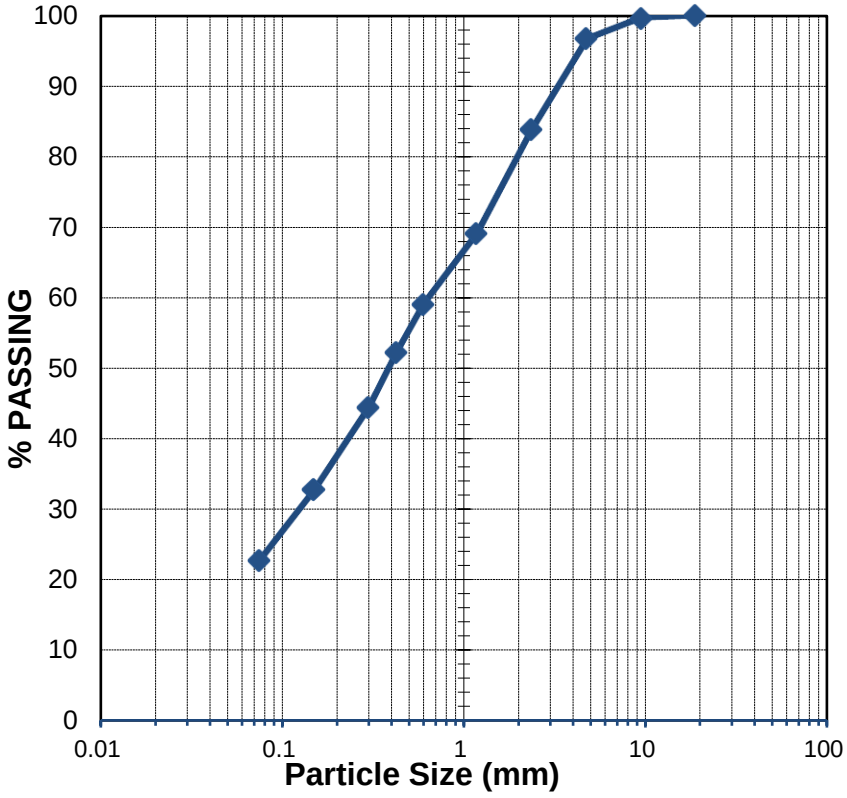
Liquid Labs WA
08 94723349
16B/81 Briggs Street
Carlisle, WA 6101

SOIL CLASSIFICATION TEST REPORT

Client	CMW Geosciences	Ticket No.	S2296
Client Address	19/127 Herdsman Parade, Wembley WA 6014	Report No.	LLS18/4244_1_PSDPI
Project	ABRA TSF Project	Sample No.	LLS18/4244
Sampling Location	Abra Lead-Silver Project	Sampled By	Client
Sample Identification	G15345		
Sampling Method	Sampled by Client, Tested as Received	Preparation Method	AS1289.1.1
Sample History	Air Dried	Wet or Dry Sieved	Dry Sieved

PARTICLE SIZE DISTRIBUTION - ANALYSIS BY SIEVING

AS 1289.3.6.1



Sieve Size (mm)	Percent Passing Sieve (%)
75.00	
53.00	
37.50	
19.00	100
9.50	100
4.75	97
2.36	84
1.180	69
0.600	59
0.425	52
0.300	44
0.150	33
0.075	23

CONSISTENCY LIMITS

AS1289.3.1.1	AS 1289.3.2.1	AS1289.3.3.1	AS 1289.3.4.1		
Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Mould Length (mm)	*Condition of Dried Specimen*
Not Obtainable	NP	NP	0.5	250	-

Comments:

Approved Signatory

Name	Matt van Herk
Function	Laboratory Manager
Issue Date	30-September-2018

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Appendix G. Waste Characterisation