Appendix J
Waste Management Strategy Plan

SEDGMAN
Prudentia

Queensland Resources Common User Facility

Waste Management Strategy Plan

Prepared for: Queensland Treasury

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1 Executive Summary

This report outlines the basis for waste management to support development of the Queensland Resources Council Common User Facility (QRCUF). The basis for the waste characteristics and throughputs is based on the current QRCUF design basis at the time of this report. Being a test facility, future customers' requirement and third-party waste management requirements may change as the design is progressed further. The volumes and cost estimate would need to be re-evaluated if the basis changes.

Below is a summary of daily waste disposal from the facility.

Table 1-1: Daily Waste Disposal Summary

Waste	Indicative Composition	Daily Flow Estimate
	Continuous Solids Waste	**Total = 30.9 tonne/ day**
1. Leach Residue	pH: 2-4 60% solids containing: • 30% alumina, • 30% limestone, • 30% silica, • balance carbon, Na2O and K2O 30% liquid, • ~15g/L of sulphate salt (including K, Na, Al, V)	8.1 tonne/ day
2. Impurity Removal Residue	pH: 2-4 60% solids containing: • 40% calcium silicate, • 40% gypsum, • balance iron oxide 30% liquid, • ~5g/L vanadyl sulphate,	0.3 tonne/day
3. Reject Filter Residue	pH: 6-8 60% solids containing various concentrations of: • Metal sulphate salt (K, Mn, Fe, Na, Al, Va) • Gypsum, • silica, • carbon, • Na2O, K2O and gypsum 40% liquid containing • 80g/L sulphate salt including Fe, Na, Al, 1000 ppm D70 SX diluent (kerosene like)	0.7 tonne/day
4. Tailings	60% solids, containing various concentration of • silica ~26% w/w • limestone ~47% w/w • balance, iron oxide, alumina, organic material found with shale ore 40% liquid, • Water with a composition similar to Townsville town water supply	20.8 tonne/day
5. Drum Scrubber Oversize	80% solids, containing various concentration of • silica ~26% w/w • limestone ~47% w/w • balance, iron oxide, alumina, organic material found with shale ore 20% liquid, • Water with a composition similar to Townsville town water supply	1 tonne/day
	Continuous Liquid Waste	**Total = 20.9m^3/day**
6. Neutralised liquid waste	80g/L sulphate salt including Fe, Na, Al, 1000 ppm D80 SX diluent (kerosene like).	20.9m^3 per day *
	Intermittent Wastes	
7. Sampling waste	General lab wastes containing various metal salt, organics, and solids residue	1 x 1000L IBC per week

*** Note:** Includes 3.1m^3/day of Neutralisation Reagent, in addition to the 17.8m^3/day liquid waste generation documented under Section 4.1.

The size of waste disposal equipment and containers is described in Section 5. In general the liquid waste is taken away in 20kL tankers. The solids waste will be disposed in various sized bins. Roll on / roll off bins are available in the following sizes: 12m^3, 15m^3 and 30m^3.

2 Introduction

The Queensland Government (hereinafter referred as “the State”) is developing the Queensland Resources Common Users Facility (QRCUF). This facility is delivering common user infrastructure at the Cleveland Bay Industrial Park in Townsville to support the development, extraction and production of critical minerals.

The intent of the facility is to support prospective mining companies in demonstrating their flowsheet at demonstration scale to validate commerciality and technical viability to secure finance, investor interest, off-take agreements and partnerships. The initial focus will be on vanadium with capacity to expand over time to encompass processing other critical minerals like cobalt and rare earth elements.

Prudentia was engaged as the design subcontractor to perform design work and produce the draft design documentation to support the project.

This report outlines the basis for waste management to support development of the facility. The basis for the waste characteristics and throughputs is based on the current QRCUF design basis as the time of this report.

2.1 Objective

The objective of this report is to document the waste management philosophy proposed for QRCUF to support the on-going project development. Specifically, this report:

- describes the waste management philosophy that is appropriate for QRCUF
- outlines the necessary facilities such as tanks and filters for waste management
- provides options for waste treatment and disposal methods based on feedback from a third party waste management company, e.g. Cleanaway

2.2 Project Location

The Queensland Resources Common User Facility will be located at the Cleveland Bay Industrial Park in Townsville.

Cleanaway waste services, waste management company in Townsville, is located approximately 20km northeast of the site.

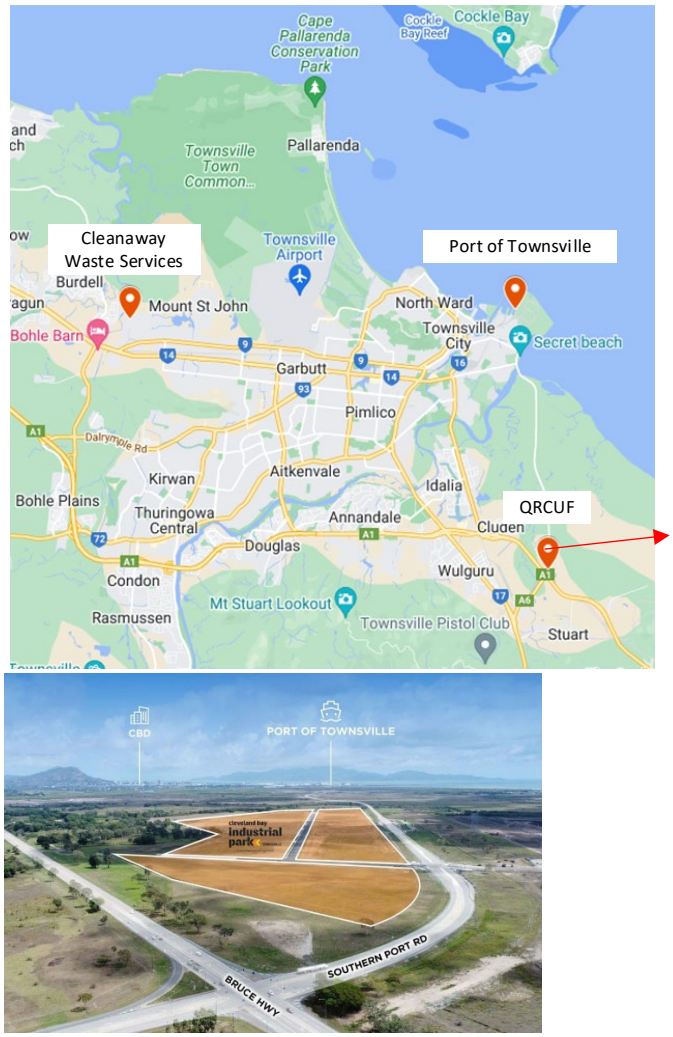

Figure 2-1 QRCUF Site Location

2.2.1 Site Layout Showing Waste Point of Production

The key wastes generated and the point of generation within the plant is presented on the site layout in Figure 2-2 below. The raffinate, spent wash, product filtrate and scrubber bleed waste is processed through effluent treatment before direct discharge.

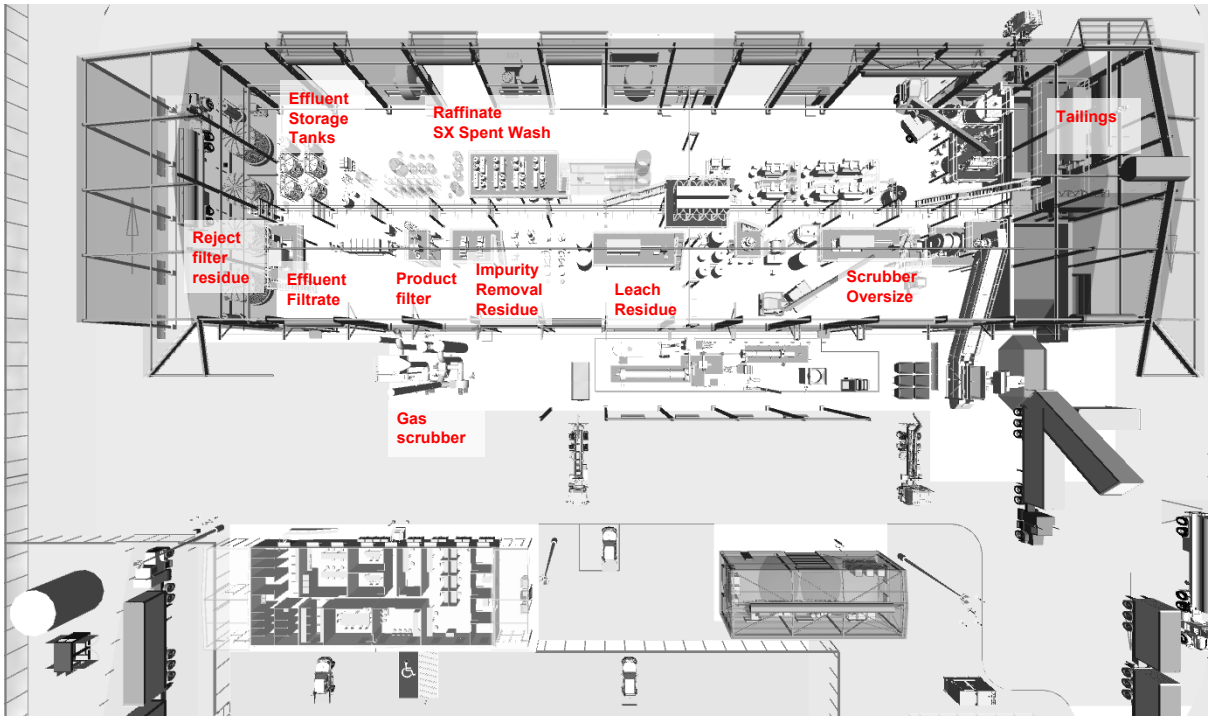

Figure 2-2 QRCUF Site Layout – Waste Generation Points

3 Waste Management Strategy Scope

The scope of this document includes:

- Outline the on-site waste management strategy and philosophy
- Define the waste treatment and storage requirements for various waste streams
- Provide a workable framework for the development of a waste management plan for QRCUF.

The scope of this document does not consider stormwater catchment or run-off that falls outside the building footprint and loading/unloading bunds and this has not been factored in to process water capture. Stormwater capture and treatment requirements will be addressed separately through the Site-Based Stormwater Management Plan (SBSMP) for the development.

The key inputs and outputs for the QRCUF Vanadium flowsheet are summarised in the figure below. The scope of this report is highlighted in a red box. Water reuse within the QRCUF vanadium flowsheet is incorporated into the design to reduce waste.

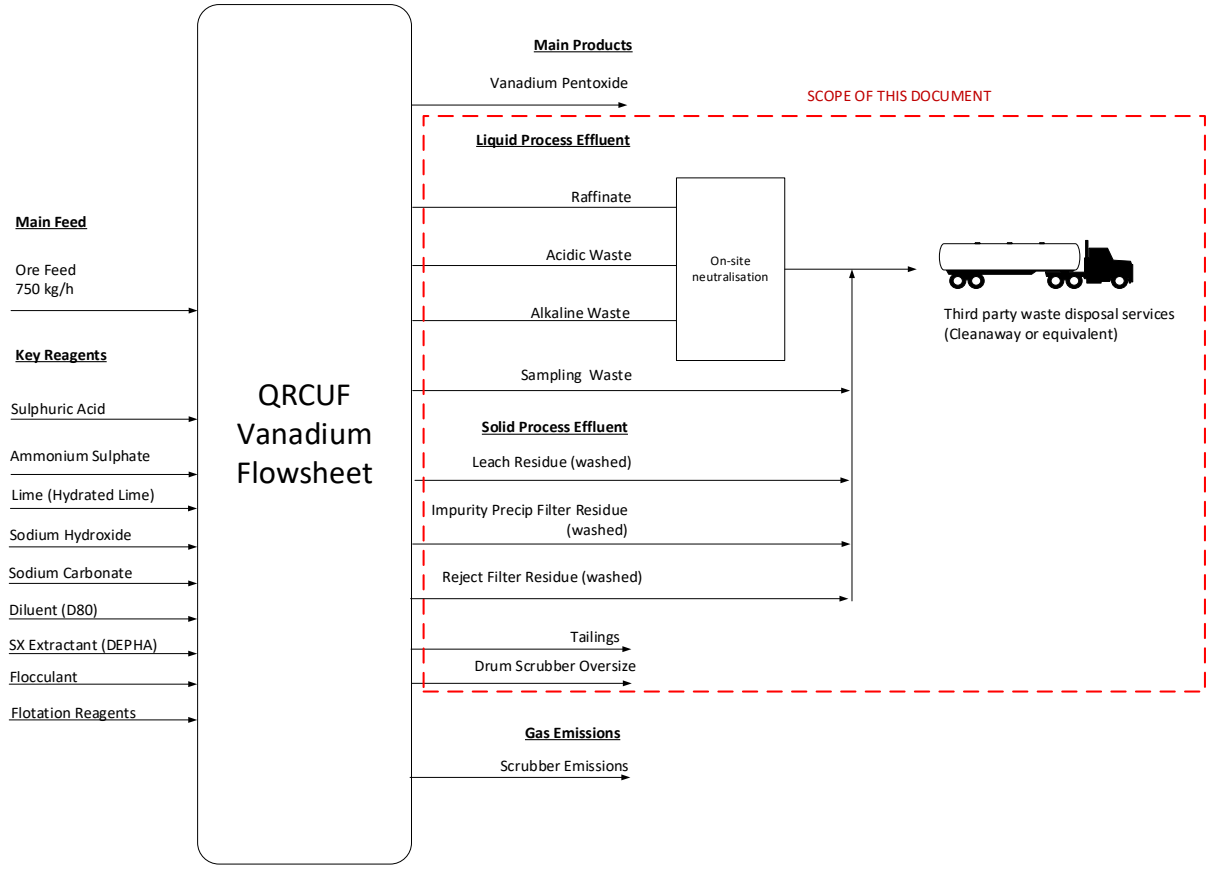

Figure 3-1 QRCUF Key Input and Outputs

4 Waste Overview

4.1 Waste Flows and Composition Summary

QRCUF is intended to be a multi-use hub that is used by future customers for flowsheet and technology demonstration purposes. It is expected that the flowsheets will not be optimised or fully incorporate recycle streams and may produce a large variety of wastes at varying flows and compositions. It is not possible to accurately predict the range of waste properties that different future customers will generate due to both to limited data or customers still developing technologies. Therefore, the waste management plan is developed based on the flows and composition indicated by the mass balance model (MC23059-CAL-001_RevD) for the QRCUF project. This has been developed with a combination of testwork, relevant published data and assumptions.

The plant is expected to operate in approx. 2-week campaigns followed by a period of downtime either due to future customer change-over, waiting for future customers, or no demand. The waste flows and composition for the flowsheet considered are summarized in Table 4-1 below.

Table 4-1 QRCUF Waste Flow and Composition Summary

Waste	Indicative Composition	Waste Generation Rate	Waste Storage	Collection Frequency
	Continuous Solids Waste	**Total = 30.9 tonne per day**		
1. Leach Residue	60% solids: • 30% alumina, • 30% limestone, • 30% silica, • balance carbon, Na_2O and K_2O 40% liquid: • ~15g/L sulphate salt ~15g/L sulphuric acid	8.1 tonne/ day	Stored in skips $12m^3$ /$15m^3$/ $30m^3$ and collected by roll on roll off skips	Approx. 2-3 days
2. Impurity Removal Residue	60% solids, • 40% calcium silicate, • 40% gypsum, • balance iron oxide 40% liquid: • ~20g/L sulphate salt (5g/L as Vanadyl sulphate)	0.3 tonne/day	Stored in skips $1m^3$, and collected by a skip loader	Approx.1-2 weeks
3. Reject Filter Residue	60% solids, containing various concentration of • Iron sulphate • Aluminium sulphate • Gypsum • Manganese sulphate 40% liquid, • 80g/L sulphate salt including Fe, Na, Al, 1000 ppm D70 SX diluent (kerosene like)	0.7 tonne/day	Stored in skips $1m^3$ and collected by a skip loader	Approx.1-2 weeks
4. Tailings	60% solids, containing various concentration of • silica ~26% w/w • limestone ~47% w/w • balance, iron oxide, alumina, organic material found with shale ore 40% liquid, • Water with a composition similar to Townsville town water supply	20.8 tonne/day	Stored in skips $12m^3$ /$15m^3$/ $30m^3$ and collected by roll on roll off skips	Approx.2-3 days
5. Drum Scrubber Oversize	80% solids, containing various concentration of • silica ~26% w/w • limestone ~47% w/w • balance, iron oxide, alumina, organic material found with shale ore 20% liquid, • Water with a composition similar to Townsville town water supply	1.0 tonne/day	Stored in skips $1m^3$ and collected by a skip loader	Approx.2-3 days
	Continuous Liquid Waste	**Total = 17.8m^3/day**		
6. Raffinate	pH: 2-4 100% liquid containing: • 80g/L sulphate salt including Fe, Na, Al , • 1000 ppm D70 SX diluent (kerosene like)	10.8m^3per day	Stored in Effluent Storage Tanks and Collect by	Approx.2 days

			~20m^3 Tanker Trucks	
7. SX Spent Wash	pH: 2-4 100% liquid containing: • <1% sulphuric acid • <10g/L sulphate salts	0.5m^{3}per day	Stored in Effluent Storage Tanks and Collect by ~20m^3 Tanker Trucks	Approx.2 days
8. Product Filtrate	pH 2-4 100 % liquid containing: • <1% sulphuric acid • Sodium ~ 5.4 %	1.9 m^3 per day	Stored in Effluent Storage Tanks and Collect by ~20m^3 Tanker Trucks	Approx.2 days
9. Scrubber Bleed	pH 2-4 100 % liquid containing: • <0.1% sulphuric acid • Trace of aluminium and sodium	4.6 m^3 per day	Stored in Effluent Storage Tanks and Collect by ~20m^3 Tanker Trucks	Approx.2 days
Intermittent Waste				
10. Sampling waste	General lab wastes containing various metal salt, organics, and solids residue	Allow for 1000L IBC per week	Stored in Effluent Storage Tanks and Collect by ~20m^3 Tanker Trucks	Approx.1-2 weeks

In addition to the above process plant and laboratory generated waste, the operation of the facility will also generate general waste, some recyclable, through functions such as operations deliveries (packaging waste) and through the general use of the administration and operations building.

Waste is also expected to be generated during the construction period of the facility, including delivery packaging and pallets, and general construction material off-cuts (steel, timber, other materials).

Refer Section 5 for details on the planned management and disposal of the waste categories outlined above.

4.2 Regulated Waste Assessment/ Hazardous Material

The Environmental Protection Regulation (2019) specifies waste categories as summarised below:

- Category 1 regulated waste (highest risk)
- Category 2 regulated waste (moderate risk)
- Non-regulated waste/general waste

Some examples of Category 1 and 2 wastes relevant to the facility as listed below:

Category 2 (moderate risk):

- Acidic solutions and acids in solids form
- Basic (alkaline) solutions and bases (alkalis) in solid form
- Non-toxic salts, including, for example, saline effluent
- Oil and water mixtures or emulsions, or hydrocarbons and water mixtures or emulsions
- Organic solvents, other than halogenated solvents, including, for example, ethanol
- vanadium compounds

Category 1 (highest risk):

- filter cake, other than filter cake waste generated from the treatment of raw water for the supply of drinking water
- oxidising agents

Regulated wastes require a more stringent management requirements than unregulated wastes. It is the waste generators' responsibility to identify, categorise and track the wastes.

For the assessment completed in this report, apart from the tailings and drum scrubber oversize solid waste (non-regulated / benign general waste), the wastes generated from the facility are assumed to be a mix of Category 1 and 2.

4.3 Third-Party Waste Disposal Facility

It is proposed that a third-party waste disposal service provider is engaged to support the development of the site waste management strategy. Hence, Prudentia has approached Cleanaway managers in their Townsville office to review the disposal options of the following wastes:

1. Leach Residue
2. Impurity Residue
3. Tailings
4. Process solids wastes
5. Raffinate
6. Product filtrate
7. Scrubber liquid bleed
8. General acidic waste (5% sulphuric acid)
9. General alkaline waste (5% caustic, 5% ammonia and 100g/L ammonium salt).
10. Treated process liquid wastes (neutralised liquid wastes)

Key outcomes identified from this exercise are:

- Receipt and disposal of neutralised liquid waste is preferred.
- Cleanaway had not been able to provide a quote for disposal of alkaline wastes.
- Cleanaway is able to receive solids waste in skips (as long as there is no free liquid that could leak during transport).
- Cleanaway can provide options for 10kL or 20kL collection on a schedule or adhoc basis.
- Lift on / lift off bins are available in $6m^3$ and $12m^3$. Roll on / roll off bins are available in $12m^3$, $15m^3$ and $30m^3$.

It is further noted that a licensed contractor such as Cleanaway or another waste disposal contractor would also be proposed to remove and dispose of the non-regulated (tailings) waste. This provides opportunity to streamline the removal of regulated and non-regulated waste from the facility.

Following this Prudentia had formulated a process liquid waste treatment strategy in Section 5.1 and defined the storage requirements for solids waste in Section 5.2.

5 Waste Management Strategy

5.1 Process Liquid Waste

A request for information from Cleanaway identified two key outcomes driving the liquid waste strategy:

1. Cleanaway does not have capability to handle alkaline wastes; therefore, alkaline waste must be neutralised prior to disposal, and
2. Cleanaway does have capability to handle acid waste: however, there is a substantial cost saving by neutralising onsite prior to disposal, hence this is the basis.

The following strategy is proposed for the neutralisation of process liquid wastes:

- Two acidic waste treatment are provided. The tanks will be operating batchwise in a parallel arrangement to allow for manual sampling of the neutralised wastes for QA/QC purposes. There are no alkaline waste produced on-site based on the mass balance model however it is suggested that a similar arrangement is allowed for due to the flexibility nature of the facility.
- Then the neutralised waste is transferred to a common filter feed tank and the operator can initiate the filter sequence to remove the precipitations that resulted from the neutralisation process. The solid waste is collected in a skip bin and stored on-site.
- The filtrate is stored in the filtrate tank to allow for a final check of the quality (e.g. clarity and colour) before transferring to the storage tanks.
- Two storage tanks were allowed for segregation of neutralised wastes if required. The waste will be collected by tanker trucks which are self-loading (with pump on board).

A Block Flow Diagram (BFD) is provided below for reference:

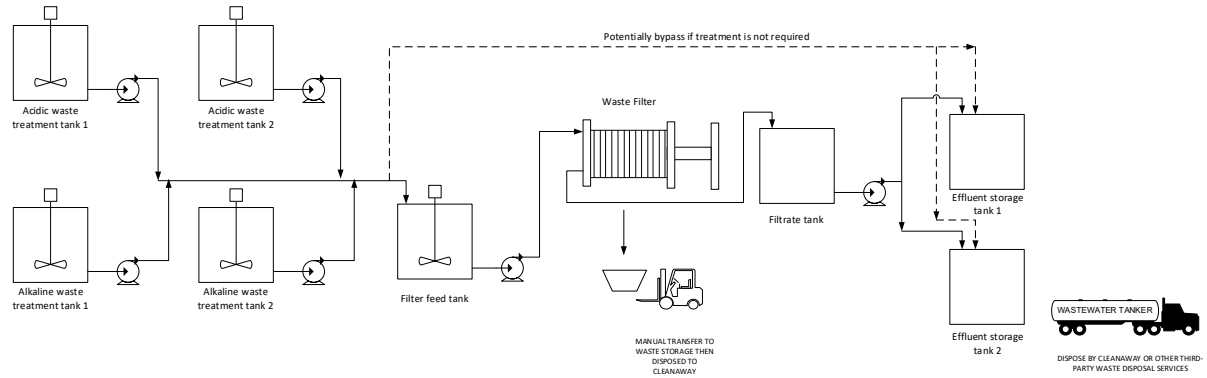

Figure 5-1 Process Liquid Waste Treatment BFD

The proposed tank sizes are summarised in the table below:

Tanks	Quantity	Tank sizes	Residence time (Based on mass balance model)
Acidic Waste Treatment Tank	2	$9m^3$ each	9 hours
Alkaline Waste Treatment Tank	2	$3m^3$ each	9 hours
Filter feed tank	1	$9m^3$	9 hours
Filtrate Tank	1	$9m^3$	9 hours
Effluent Storage Tanks	2	$12m^3$ each	23 hours (1.9 days)

5.2 Process Solids Waste

Regarding regulated waste, there is no apparent benefit to further process waste solids based on the information provided by Cleanaway. Therefore, it is proposed that the solid wastes are stored in skip bins as is, with delineation of waste, and removed by the waste disposal service provider.

The proposed solids storage arrangement is as follows:

- 1 x 10 tonne and 2 x 2.5 tonnes skips for solid storage
- A tailing bunker with a capacity of 75 m3 (105 m3 with FEL management)

5.3 Bund Water

Bund water is collected in various process bunds and directed to either the acidic waste or alkaline waste tanks (based on the expected material pH) and treated as per described in Section 5.1

5.4 Waste Movement and Storage Area

Figure 5-2 illustrates the movement of waste solids to storage areas and the process of liquid effluent from the treatment area to the effluent storage tanks. The red lines represent leach filter residue solid waste movement, the yellow lines represent the reject and impurity removal filter residue movement, the green line will be offspec concentrate stored with or near the tailings, and the blue arrow is liquid waste storage.

Section 4.1 further details the quantum and frequency of these expected waste removal movements.

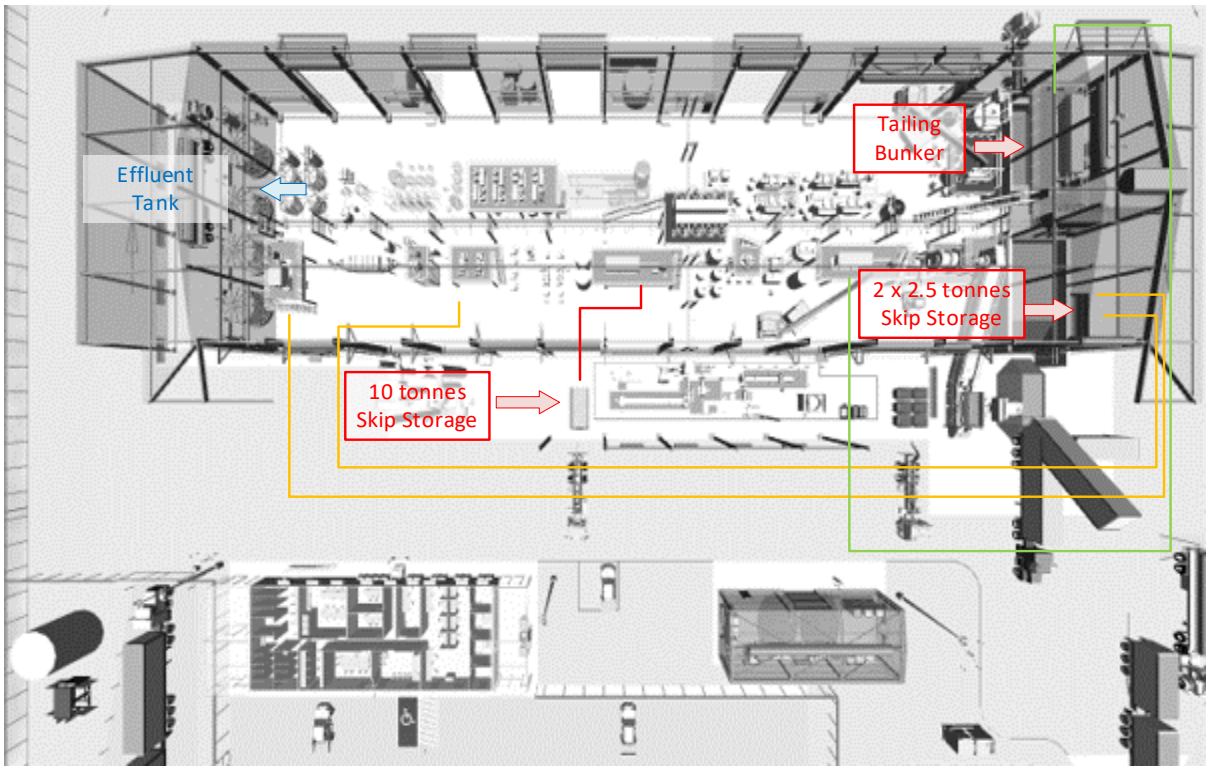

Figure 5-2 QRCUF Site Layout – On-Site Waste Movements

5.5 General Waste

General waste generated through the day-to-day use of the operations buildings will be captured and stored in the general and recyclable waste bins located within the refuse yard adjacent to the main administration building. The waste in these bins will be collected via front-loader garbage truck on an as-required (e.g. weekly) basis via the public carpark.

Non-typical waste generated through the operation of the facility (e.g. material off-cuts resulting from ongoing maintenance of the facility) would be assessed on a case-by-case basis, generally managed through the use of skip bins provided and removed by licensed operators.

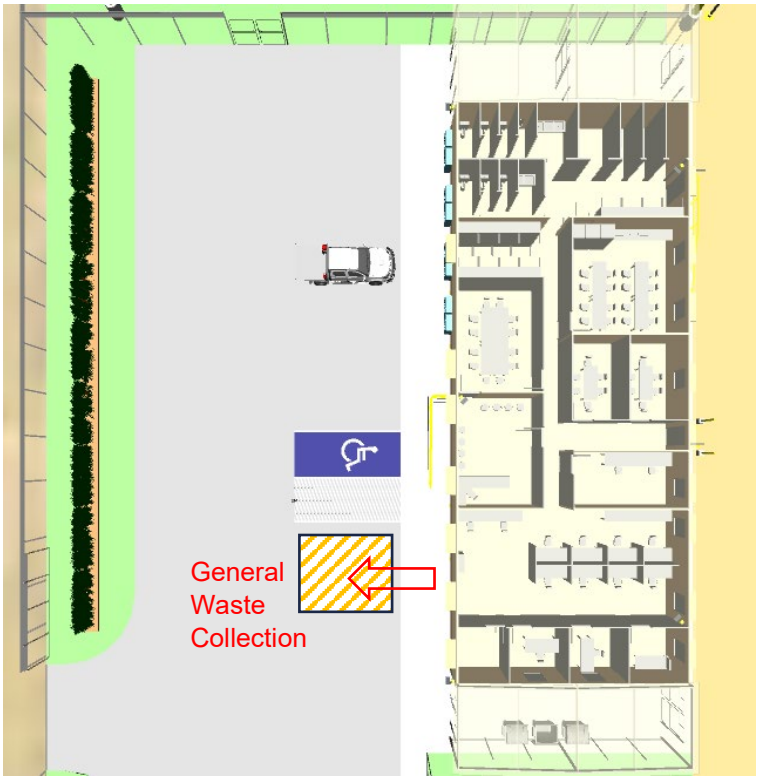

Figure 5-3: QRCUF General Waste Collection

During the construction period, waste generated from construction activities and deliveries will be managed and disposed of consistent with relevant industry practice – i.e.:

- Generated waste will be temporarily held within appropriate delineated skip bins (e.g. metal, general, timber) and delivery pallets will be stored in a designated area ready for truck load-out.
- Area supervisor will assess the generated waste at regular intervals to coordinate removal from site and replacement with new (empty) skip bins as required.

6 References

Environmental Protection Regulation (2019)

https://www.business.qld.gov.au/running-business/environment/waste-management/regulated-waste/classification

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