WORSLEY ALUMINA
TAILINGS FACILITY INFORMATION

Tailings Storage Facilities (TSF) Description (GISTM Requirement 15.1 B1 & B5)

Worsley Alumina is an integrated bauxite mining and alumina refining operation in the south-west of Western Australia. Alumina processing at the Worsley Alumina refinery near the town of Collie uses the Bayer process, whereby caustic soda under heat and pressure is used to dissolve alumina from the bauxite. Following precipitation, the caustic soda is recirculated for further use. Bauxite process residue (commonly called "red mud") is thickened into a slurry comprising fine ground residue minerals, minor amounts of dissolved sodium compounds and process water. The slurry is pumped to the Bauxite Residue Disposal Areas (BRDAs) for storage.

The BRDAs are located on either side of the refinery in two tributary valleys of the Augustus River catchment, referred to as the northern and southern valleys. BRDA 1, BRDA 2, BRDA 4 and BRDA 4X are in the Northern Valley and BRDA 5 is in the Southern Valley, as shown in Figure 1.

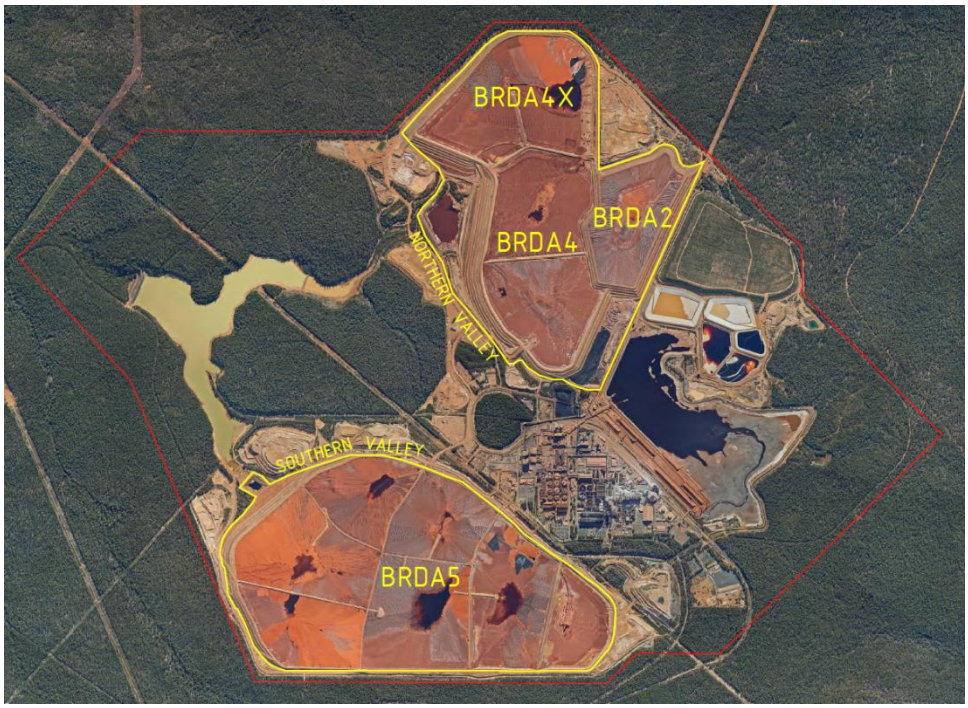

Figure 1: Worsley Alumina Refinery Site Overview

All of the BRDAs on-site are constructed in a similar manner, incorporating various elements. One of these elements is groundwater underdrainage systems, which are designed to intercept any seepage and facilitate monitoring. This includes a compacted clay floor with low permeability, and a gravel layer equipped with drainage pipework spanning the entire floor area to capture seepage effectively.

An element to provide structural integrity, is the use of a starter dam and compacted clay perimeter walls. As the BRDA continues to be raised upstream, compacted clay fill is employed in successive layers. To further manage water accumulation, each cell within the BRDA is equipped with an internal decant drainage system. Collectively, these components contribute to the reliable and efficient operation of the BRDAs.

The BRDAs are planned to increase to their final elevation of reduced level (RL) 316m Australian Height Datum (AHD) using ongoing upstream raises, then capped with a store and release vegetated cover. The height from ground level to RL316m AHD varies for each BRDA and ranges from 57 to 72 metres.

Monitoring of the BRDAs incorporates a structured combination of visual inspections, monitoring of piezometers installed in embankments, scheduled interferometric synthetic aperture radar (InSAR) and drone surveys, routine shear vane testing, and settlement monitoring.

Northern Valley BRDAs

Figure 2: Northern Valley Configuration

BRDA 1

The initial storage was created by using the 1,300m long overland conveyor embankment, from the mine, as a dam across a natural valley, to the north of the Refinery Catchment Lake (RCL).

In 2009, BRDA 1 was rehabilitated using a cap and store methodology. Cap and store approaches to tailings rehabilitation management involve the establishment of vegetation in a capped layer overlying isolated tailings materials.

Description	Year	Method	Height (toe to crest) [m]	RL [m]
Starter Embankment	1982/84		15.3	289.3
Stage 2	1985/86	Upstream	20.1	294.1
Stage 3	1987/88	Upstream	24.3	298.3
Stage 4	1988/89	Upstream	29.0	303.0
Stage 5	1990/91	Upstream	33.0	307.0
Stage 6	1992/93	Upstream	37.0	311.0
Stage 7	2006	Upstream	39	313
Active Closure[1]	2009		40	314

Table 1: BRDA 1 Construction History

BRDA 2

Construction of BRDA 2 commenced with a high starter embankment and utilised an upstream raise methodology. The duration between raises is progressively increasing due to the steep valley profile.

Description	Year	Method	Height (toe to crest) [m]	RL [m]
Starter Embankment	1987		18.0	276.3
Stage 2	1989	Upstream	24.0	282.0
Stage 3	1990	Upstream	28.0	286.0
Stage 4	1994	Upstream	35.5	293.5
Stage 5	1997	Upstream	40.5	298.5
Stage 6	2001	Upstream	45.5	303.5
Stage 7	2006	Upstream	50.5	308.5
Stage 8	2016	Upstream	55.5	313.5

Table 2: BRDA 2 Construction History

[1] BRDA 1 is considered under Active Closure due to part of Overland Bauxite Conveyor embankment still requiring closure once operation ceases.

BRDA 4

Construction of BRDA 4 commenced in 1994, with a starter embankment and utilising an upstream raise methodology. BRDA 4 and BRDA 4X are at the same RL elevation and are planned to be raised consecutively to maintain both facilities at the same elevation.

Description	Year	Method	Height (toe to crest) [m]	RL [m]
Starter Embankment	1994		28.1	273.1
Stage 2	2001	Upstream	33.0	278.0
Stage 3	2005	Upstream	38.0	283.0
Stage 4	2009	Upstream	43.0	288.0
Stage 5	2014	Upstream	49.0	294.0
Stage 6	2018	Upstream	54.0	299.0
Stage 7	2022	Upstream	59.0	304.0

Table 3: BRDA 4 Construction History

BRDA 4X

Construction of BRDA 4X commenced in 2002, following a similar design concept to BRDA 4. The design incorporated an improvement by adopting washed laterite gravel for the floor drainage layer, to improve the permeability and increase underflow recovery.

Description	Year	Method	Height (toe to crest) [m]	RL [m]
Starter Embankment	2002		30.6	283.6
Stage 2	2009	Upstream	36.0	289.0
Stage 3	2013	Upstream	41.0	294.0
Stage 4	2015	Upstream	46.0	299.0
Stage 5	2021	Upstream	51.0	304.0

Table 4: BRDA 4X Construction History

Southern Valley BRDAs

BRDA 5

The Southern Valley consists solely of BRDA 5, construction commenced in 1994, with a starter embankment along the west perimeter. The current configuration of BRDA 5 is displayed in Figure 3.

Figure 3: Southern Valley Configuration

Description	Year	Method	Height (toe to crest) [m]	RL [m]
Starter Embankment	1997/2000		17.0	264.5
Stage 2	2004/06	Upstream	22.5	270.0
Stage 3	2009/11	Upstream	27.5	275.5
Stage 4	2014/16	Upstream	32.5	280.5
Stage 5	2018/20	Downstream	37.5	285.5
Stage 6	2022/24	Upstream	42.5	290.5

Table 5: BRDA 5 Construction History

SOLAR EVAPORATION PONDS (SEPs)

The solar evaporation ponds (SEPs) were constructed to store waste acid liquid and have been repurposed as a temporary storage for sodium oxalate. The sodium oxalate is stored under moist conditions using process water through oxalate hoppers.

The SEPs are located between BRDA1 and the RCL as shown in Figure 4.

All SEPs are composite lined facilities. The SEPs (1, 2A and 4) are high-density polyethylene (HDPE) lined facilities. SEP3 is polyvinyl chloride (PVC) lined facility. All SEP embankments are constructed in a single stage like a typical downstream embankment with locally sourced clay fill. All SEPs have underdrainage pipes reporting to the RCL.

Monitoring of the SEPs incorporates a structured combination of visual inspections, scheduled InSAR (settlement), drone surveys, bathymetric surveys and groundwater monitoring bores.

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Figure 4: Solar Evaporation Ponds Configuration (including SEP1, 2A, 3 and 4)

Description	Year	Method	Height (toe to crest) [m]	Crest RL [m]
SEP1	2003	Clay & HDPE lined	7.0	295.0
SEP2A	2023	GCL & HDPE lined	14.7	301.3
SEP3	1983	CCL & PVC lined	8.0	295.2
SEP4	2021	GCL & HDPE lined	11.0	301.75

Table 6: SEP Construction History