Bravo Resource Solutions

Module 3.0, Endeavour House, 11-15 Fourth Avenue Mawson Lakes, SA 5095

CRESCENT HEAD ILMENITE STOCKPILE REHABILITATION

Stockpile Geology

For Greencoast Environmental Rehabilitation

Crescent Head Ilmenite Stockpile Geology

Contents

Crescent Head Ilmenite Stockpile Geology

1. Introduction

Greencoast Environmental Rehabilitation (GER) is seeking approval under the section 11A of the NSW Mining Act 1992 to remove an existing low-grade ilmenite stockpile to natural ground level and revegetate the stockpile footprint. The stockpile covers an area of approximately two hectares and is located at the site of a former mineral separation plant or 'dry mill', approximately one kilometre south of the township of Crescent Head, New South Wales. The stockpile is located within GER's Exploration Licence 8085 on Crown Land on the eastern side of Point Plomer Road, on Lot 2281 Deposited Plan 1153793.

GER has engaged the services of Bravo Resource Solutions (BRS) to compile a summary of the geology of the stockpile.

2. Geological Setting

Ilmenite ($FeTiO_3$) is a dense, black, weakly magnetic mineral with a high resistance to weathering. Ilmenite is a common accessory mineral present in the beach sands of Eastern Australia, believed to be ultimately derived from the erosion of Tertiary Volcanic rocks from the New England Fold Belt.

Australia's east coast beaches formerly contained substantial deposits of ilmenite that were concentrated in strandlines by wave action. Economic concentrations of mineral sands were extensively mined from beaches and dunes from the Central Coast of NSW to Fraser Island in Queensland.

At the time of beach mining, which is no longer practiced in NSW, ilmenite was a low-value by product which was typically dumped as 'tailings' after the separation of more valuable minerals - predominantly rutile and zircon. However, in more recent years ilmenite has become a primary source of titanium, allowing for the removal and rehabilitation of many former ilmenite dumps, including removal of a large dump from within the Bundjalung National Park, which is in progress at time of writing.

3. Summary of Past Site Activities

Sand mining around the township of Crescent Head commenced in 1957 by Mineral Deposits Ltd (MDL). The Crescent Head mining operation was comprised of three simple dredges in ponds, and a separating plant using land based spiral units and magnetic separators, with the concentrates treated at a dry mill next to the existing ilmenite stockpile (Morely, 1981[1]).

A typical mineral sand process-flow diagram is provided in **Figure 1**, which is likely to be similar to the treatment process used by MDL. The concrete foundations of the dry mill are still present on the eastern side of the stockpile (**Figure 2**). Between 1957 and 1960, Mineral Deposits Ltd is believed to have produced 19,215 tonnes of rutile and 14,021 tonnes of Zircon from the Crescent Head operation (Morely, 1981).

The Crescent Head dry mill was one of two dry mills owned by MDL in NSW which produced approximately 75,000 tonnes of rutile, zircon and monazite concentrates annually, from up to eight different mineral sand mining operations. Mineral sand from MDL's mining leases up and down the coast is believed to have been processed at the Crescent Head dry mill, as processing is understood to have continued for many years after dredge mining in the immediate vicinity of Crescent Head had ceased. According to the recollections of a former MDL employee the Crescent Head stockpile/dump site was finally vacated by MDL in or around 1985.

1. [1] Morley, I.W (1981). Black sands: A history of the mineral sand mining industry in eastern Australia age

In more recent years illegal rubbish dumping has taken place at the stockpile site, including dumping of domestic waste and burnt out cars. GER has also noted the illegal removal of ilmenite from the northern end of the stockpile, apparently by local building contractors. GER has reported any apparently Illegal activity to the land owner (Crown Lands) as soon as it was noted.

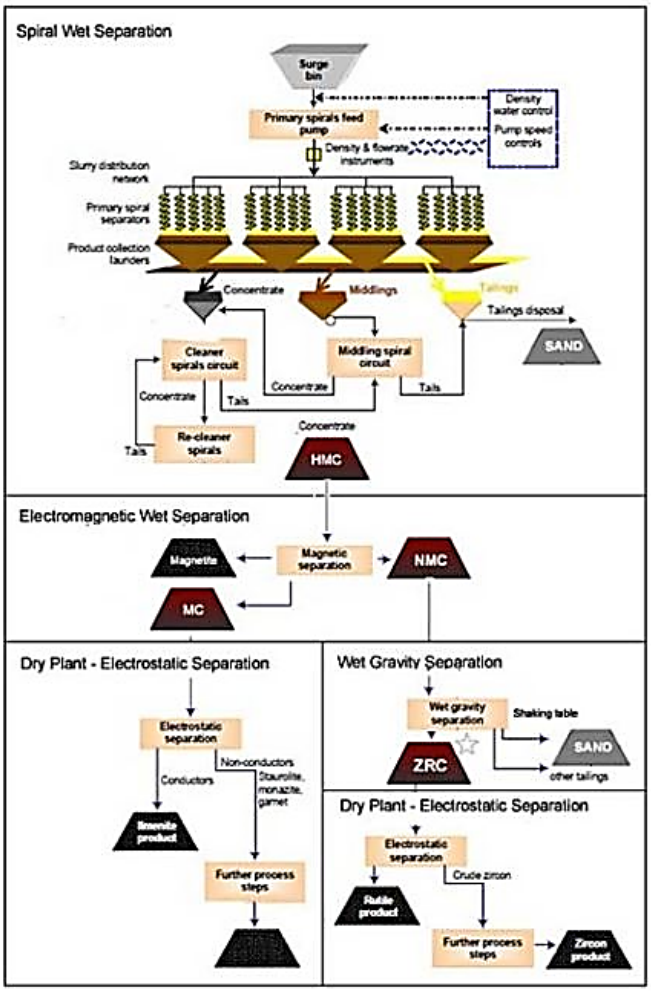

Figure 1. Typical mineral sand process-flow diagram

4. Stockpile Shape and Dimensions

The ilmenite stockpile is approximately 230m long and up to 130m wide, and is bounded on one side by Point Plomer Road (figure 2). Hand auger drilling completed by GER indicates the ilmenite stockpile has a maximum thickness of approximately 4.15m above natural ground surface.

The stockpile has a surface area of approximately two hectares, with topographically distinct northern and southern sections, separated by a saddle. The mineralogy of the stockpile changes in the vicinity of the saddle, with the northern section of the stockpile having higher titanium content than the southern section. The different mineralogy may be a result of different feed sources of mineral sand, or a change in MDL's processing and separation methods.

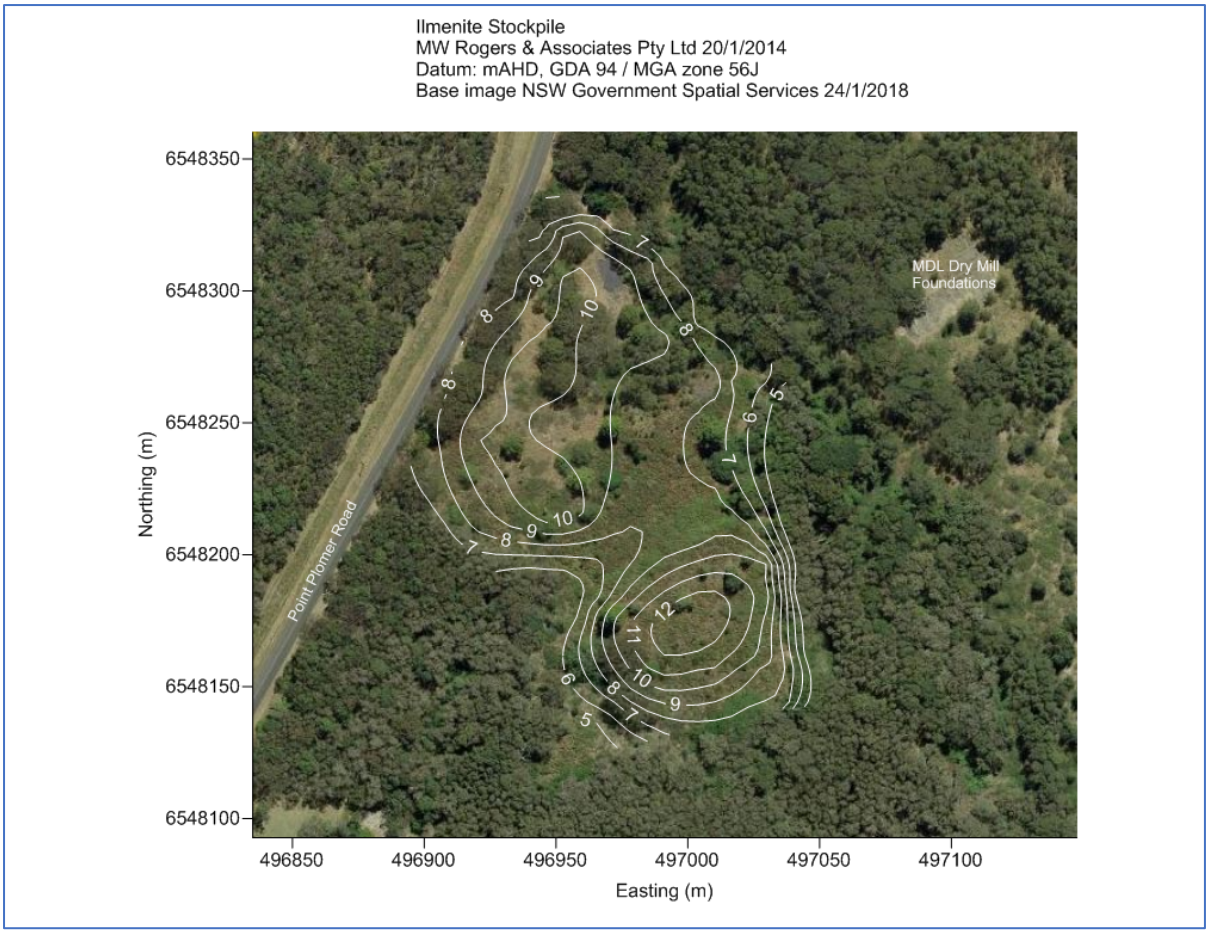

Figure 2. Elevation contours (mAHD) of GER's wireframe model showing the morphology of the ilmenite dump/stockpile and distinct northern & southern sections. Note location of former MDL dry mill 50m northeast of the stockpile.

5. Stockpile Tonnage and Grade

Hand auger drilling and surface sampling completed by GER and a volumetric survey completed by MW Rogers in 2014 were used by GER to produce a kriged 3D wireframe model of the stockpile, using Surpac resource modelling software (Figure 3).

The wireframe model indicates the stockpile contains approximately 105,000 tonnes of recoverable ilmenite, including the northern part of the stockpile comprising approximately 58,000 tonnes of recoverable material (average 42.6% TiO_2) and the southern low-grade part of the stockpile comprising approximately 47,000 tonnes of recoverable material (average 27.6% TiO_2).

6. Saleable Product

GER have provided representative ilmenite samples from the northern and southern sections of the stockpile to a number of potential buyers domestically and overseas. Feedback from potential customers suggests that low-grade ilmenite in the northern section of the stockpile is suitable for titanium dioxide manufacture via the sulphate process[2]. The market price for low-grade ilmenite such as the Crescent Head dump/ stockpile is dependent on the titanium dioxide price. As with most metals titanium is

[2] In the sulphate process low grade ilmenite ($FeTiO_3$) is normally used as feedstock. Ilmenite is treated with concentrated sulphuric acid (H_2SO_4) and the resulting titanium oxygen sulphate ($TiOSO_4$) is selectively extracted and converted into titanium dioxide.

subject to significant price fluctuation over both the short and long term, which can affect project economics.

Ilmenite from the southern section of the stockpile is not currently marketable as titanium feedstock for the sulphate process, due to lower titanium and higher chromium content. However, buyers have indicated it is potentially suitable for other lower value end-uses eg steel furnace lining, abrasive media or as a weighting agent in drilling mud.

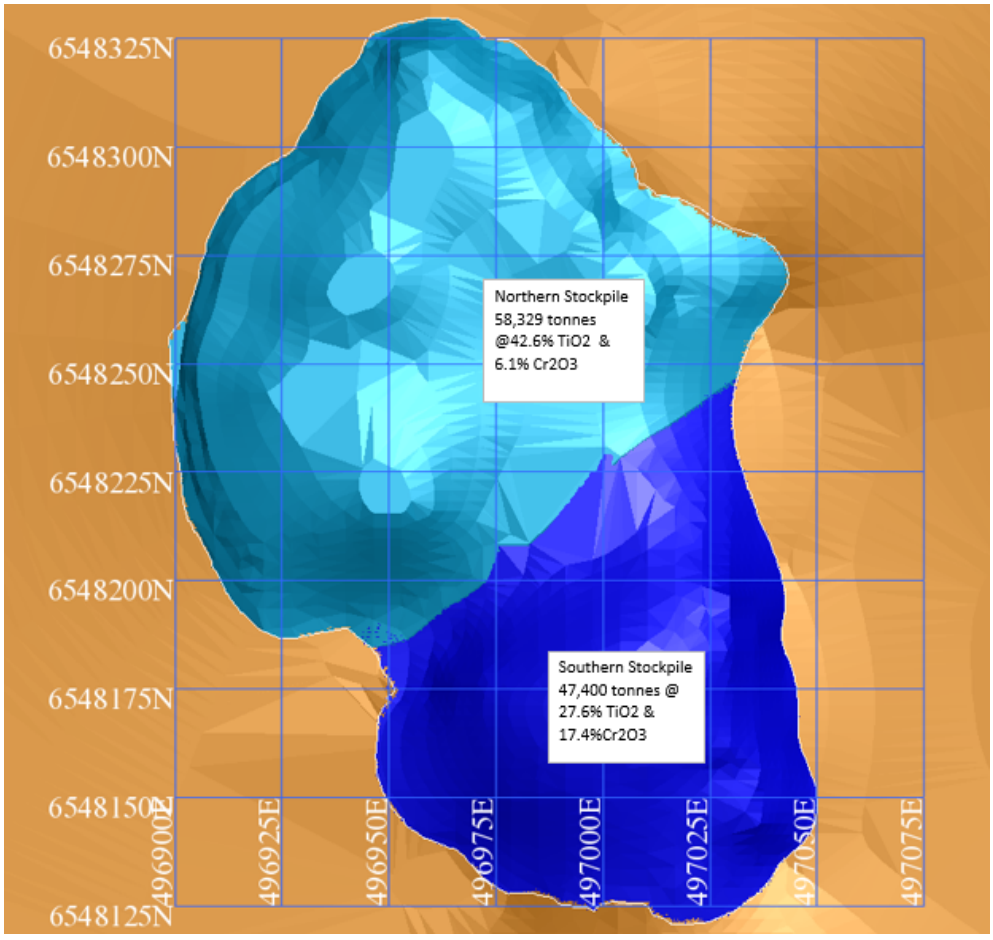

Figure 3. Wireframe model of the Crescent Head ilmenite dump/stockpile showing recoverable tonnes and average ilmenite grades. 25m grid GDA 94 / MGA Zone 56J.

7. Acid Sulphate Soils

Auger drilling conducted by GER indicates the ilmenite stockpile/dump sits on quartz sand and Acid Sulphate Soils (ASS) were not identified.

In addition, Kempsey Shire Council has prepared ASS maps as part of Development Control Plan 30, indicating five classes of land based on the likely depth of ASS and works categories likely to result in disturbance. The map relevant to the project [3] indicates that natural ground beneath the stockpile consists of Class 4 and 5 [4] (Figure 3).

As GER intend to remove the stockpile back to natural ground level there is little likelihood of any disturbance of Class 4 or Class 5 soils, even if they were present, and therefore Development Controls relating to ASS are not required for the project.

[3] Acid Sulfate Soils Map – Sheet ASS_012B. Kempsey Local Environmental Plan 2012.

[4] https://www.kempsey.nsw.gov.au/development/pubs/dcp-30-acid-sulfate-soils.pdf

Figure 4. Screen shot of Lot 2281 DP1153793 showing classes of Development Control Requirements from Kempsey Local Environmental Plan 2012 Acid Sulphate Soils Map – Sheet ASS_012B.

8. Radioactivity

GER have commissioned an assessment of the potential radioactivity of the stockpile[5]. Based on laboratory analyses and a gamma radiation survey (**Table 1**) the assessment found that the ilmenite stockpile contains very low concentrations of thorium and uranium and is not classified as 'radioactive ore' in NSW.

Although no specific radiation measures are required in the process of dealing with the ilmenite during its removal, it was recommended that it not be used in any situations where it came into long term contact with the general public, for example it should not be used as landfill or in other construction activities. In addition, it was recommended a gamma radiation meter should be used by GER to take regular readings during and after removal to establish that all ilmenite has been successfully removed, prior to placement of mulch or topsoil.

Table 1. Gamma Radiation Survey Summary Results

Location Description	Number of measurements	Gamma radiation level (µSv/hour)	
		Range	Average
Ilmenite stockpile	55	0.10 – 2.13	0.27±0.30
Background	20	0.08 – 0.26	0.14±0.05
Crescent Head township	2	0.11 – 0.80	0.46±0.49

[5] Tsurikov, N (2018). An Assessment of Potential Radioactivity Associated with the Crescent Head Ilmenite Stockpile.