SANDPIPER PROJECT

Verification Programme Report:
Mining Licence Area No. 170

SECTION D : APPENDICES

APPENDIX 6

Dredging Project Description

CONDITIONS OF USE OF THIS REPORT

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1 INTRODUCTION

The information in this chapter focuses exclusively on the activities to be undertaken in marine mining licence ML 170 located some 120 km to the southwest of Walvis Bay (Figure 1).

The key operational aspects for the marine component of the project for SP-1 comprise:

- Recovery of phosphate sediment from water depths of 200 m to 225 m;
- An annual recovery volume of 5.5 million tonnes of phosphate rich sea bed material to a thickness of up to 3 m, extracted from an area of up to 3 km^2, 60 km^2 for the 20 year period of the mine licence issue;
- The phosphate sands will be recovered by a trailing suction hopper dredger (TSHD);
- A large hopper (space where the slurry is stored onboard) provides for economy of scale;
- TSHD technology is proven and is supported by well known established environmental protocols; and,
- Conducting the marine operation in a safe and responsible manner with respect to the conditions at sea, and other marine.

2 THE LOCATION OF DREDGING

The Sandpiper marine phosphate project is located on the Namibian continental shelf approximately 120 km south southwest (SSW) of Walvis Bay. The eastern boundary of the Mining Licence Area is approximately 60 km off the coast (directly west of Conception Bay). The water depths in the licence area range from 180 to 300 m, (Figure 1). The Mining Licence Area is 25.2 km wide (greatest width) and 115 km long (longest length) and covers an area of 2233 km^2.

NMP has verified to internationally approved standards the existence of a potentially world-class phosphate deposit of 1,832 Mt (at 15% P_2O_5) in the Mining Licence Area[1]. The Mining Licence Area covers 2233 km^2.

The phosphate-enriched sediments and defined mineral resources are located throughout the entire Mining Licence Area. Within the ML three target dredging areas have been identified, with the assessment of the target dredge site Sandpiper-1 (SP-1) being the focus of the Verification Programme (Figure 2). The other sites (SP-2 and SP-3) may be considered at a later stage and will be subject to their own specific environmental evaluations.

[1] 1,832 million tons (at 15% P_2O_5) [comprising: Measured 4,09 Mt, Indicated 220,35 Mt at 20.13% P_2O_5 and Inferred 1,607.8 Mt at 18.9% P_2O_5]

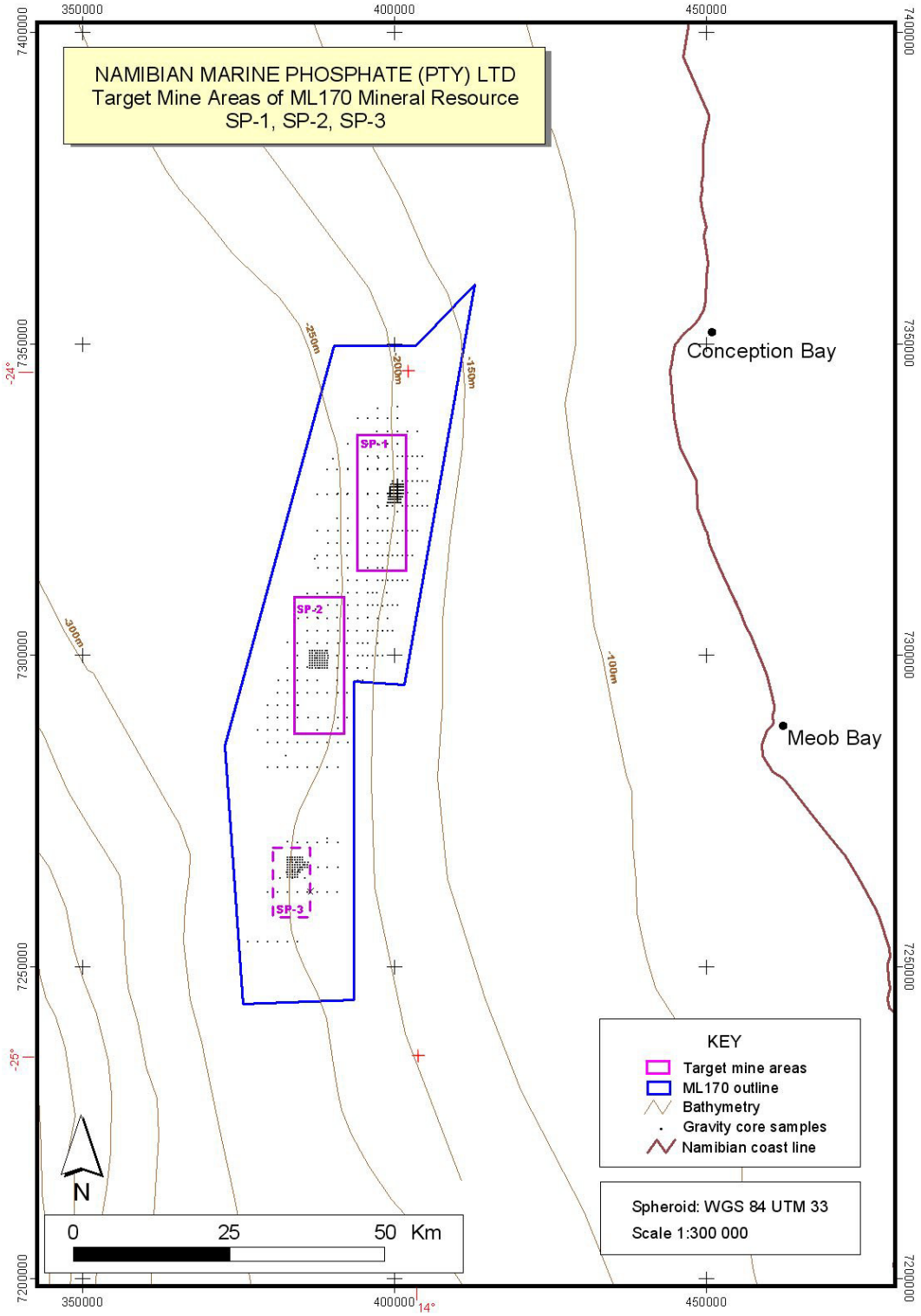

Figure 1: General Location of the project of Mining Licence 170.

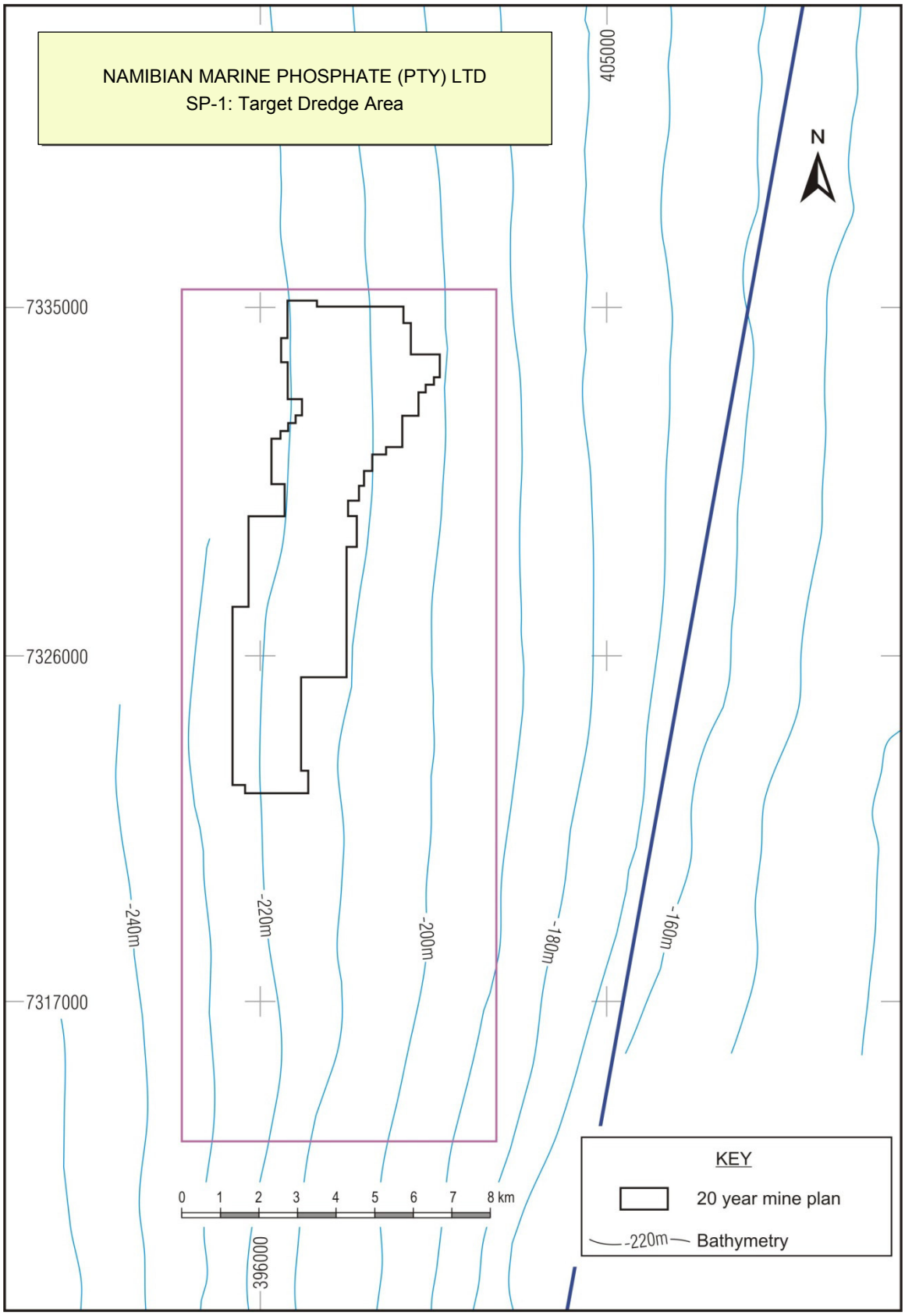

Figure 2: SP-1, the primary target dredge area.

Details of the target dredge site within SP-1 are presented in Table 1.

Table 1: Parameters describing the target recovery area of the Sandpiper-1 (SP-1) deposit.

Detail	Sandpiper -1 (SP-1)
Approx width - km	8
Approx length - km	22
Area (km^2)	176
Thickness Avg - m	1.69
Thickness Max - m^2	2.5
Thickness Min (m)	0.50
Area mineable - km^2	160
Avg area mined/pa - km^2	2.44
Water depth range - m	190 - 235
Life of deposit - yrs	51

3 THE DREDGING SYSTEM

Trailing suction hopper dredging technology has been determined to be the optimal method by which the deposit can be exploited (Figure 3).

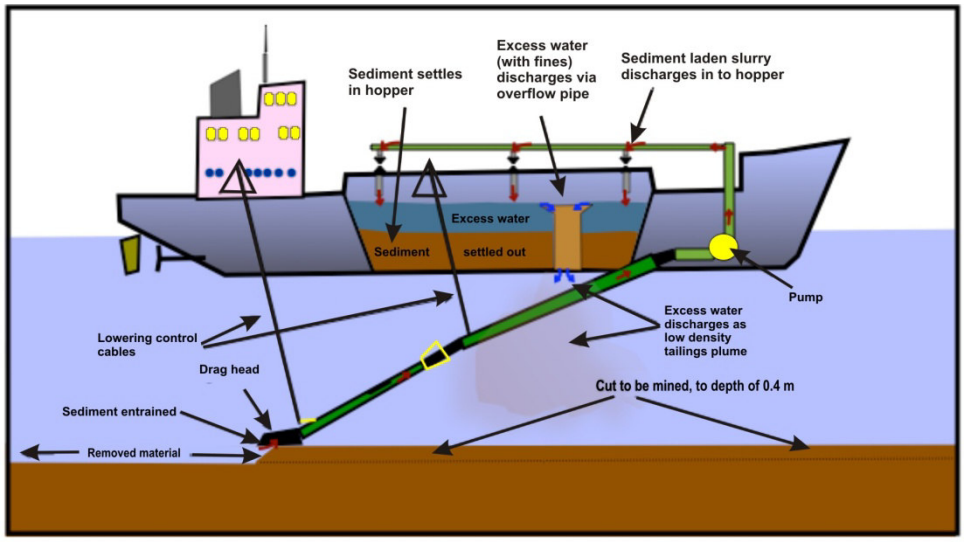

Figure 3: A schematic of a TSHD.

A trailing suction hopper dredging (TSHD) is a large self-propelled vessel with:

- Retractable dredge arms (usually two, but in this instance only one), which 'trail' on the sea floor behind the vessel;
- Large pumps which generate a suction force, via which the dredge head entrains the sediments with seawater;
- A suction 'dredge' head, designed to extract (typically 'cut and jet') the target sediments;
- An integrated large cargo hold, ("hopper)" in to which the dredged sediments are held temporarily, and
- Secondary pumps are used to transfer (pump) the sediment from the vessel to the shore.

The Belgian company, Jan De Nul, has currently been identified as a preferred supplier of services. It is a major international dredging company with the optimal experience, capacity and resources to recover the marine phosphate-rich sediments.

Dredging of these marine sediments will be conducted from a large TSDH dredger, such as, but not limited to, the MV *Cristobal Colon*. Such a vessel (in this case the *Cristobal Colon)* has the following characteristics:

- Built in 2009;
- Accommodation for 46 persons;
- 223 m length;
- 41 m beam;
- Draught loaded 15.15 m;
- A dredging depth of 155 m;
- Dredge head of 3 m width;
- 46,000 m^3 hopper capacity;
- A dredging speed of 1 to 2 knots;
- A maximum sailing speed of 18 knots;
- The vessel has total bunker capacity of 6,740 m^3;
- Under normal operational conditions the vessel can remain at sea for approximately three weeks without requirement for additional bunkers or victualling.
- Hopper capacity:
  - Effective 37,750 m^3 hopper capacity, (equates to 64,175 tonnes of phosphate enriched sediments[3]). The actual capacity of the hopper is 46,000 m^3 but 8,250 m^3 of sediments are retained to optimize vessel stability;
- Lean water overboard:
  - Excess water containing fine overflow material is discharged from the hopper between 10 and 15 m below the sea surface, depending on total vessel load. [NOTE: the discharge takes place through the bottom of the ship, i.e. there are no overside discharges on to the sea surface.
  - Between 10 and 15% of the dredged fine material (this being a portion of the < 100 micron size fraction) will be discharged overboard with the 'lean water.'

[3] The specific gravity of phosphate enriched marine sediments of this deposit is 1.7.

Recovery of marine phosphates from the water depths of the mining licence area, with water depths of greater than 190 m, has required that aspects of the recovery system be modified. These key modifications are, the length of the trailing arm and the size of the dredge head:

- Dredging depth:
  - The dredging depth has been extended to 225 m. These depth extensions are to allow recovery of sediments from the deposit, i.e. the resource area of SP-1 target dredge area water depths of 200 – 225 m;
- Dredge head:
  - The dredge head will be designed to optimise material recovery and to minimize the total weight of the extended dredge arm (The dredge head is currently configured to a 3 m width); and
  - The individual dredge lane depths are in the order of 0.5 to 0.75 m.

Dredging control

Dredging control for the vessel is maintained by means of the following systems and equipment:

- A positioning system;
- A dredging computer;
- A suction tube position monitoring system (STPM), and
- A dynamic tracking computer.

Positioning system

Dredging control is based upon a vessel positioning system. The Z or vertical co-ordinate of the ship is obtained from swell and tidal data from a prediction model based on historical data. The positioning computer determines the actual ship and draghead position as co-ordinates and presents the results, relative to the area to be dredged, on navigational displays. These position results are derived by calculation from the X, Y, Z inputs from the STPM system as described below and the ship's bearing provided by the gyrocompass. The positioning computer also determines the actual vertical offset of the draghead as compared to the target dredge depth. Information outputs from the computer include:

- Plots of dredged tracks;
- Position of the vessel and draghead visualized on screen on a background of bathymetric data, obstacles and buoys. The display is in plan view with a differential colour chart showing the amount still to be dredged, together with a longitudinal and cross profile of the trench marking seabed level and target level, and
- Changes in X and Y co-ordinates as input to the dynamic tracking system.

Dredging control computer

The dredging control computer enables all the dredging processes such as the dredging level of the draghead, pump settings and 'lean water' to be controlled. The interface between the positioning computer and the dredging control computer enables control of the dredging process to pre-defined levels of input to the system from pre-dredge survey information and pipe profile design requirements.

Suction tube position monitoring system (STPM)

The STPM is a system comprising a system of pressure and angle transducers, which allows the determination of the draghead position relative to the ship. This makes relative X, Y and Z co-ordinates of the draghead available to the positioning system and dredging computers.

Dynamic tracking
This system can control the vessel's track automatically and, therefore, the draghead's horizontal position by compensating for wind and current effects on the ship. It achieves such control by automatically adjusting rudder direction, propellers and bow thrusters.

Progress monitoring
During the process of line cut dredging, the progress is monitored on board by means of the dredging control systems and the multibeam or survey results. The dredging control system allows for the actual draghead depth and the target depth at the draghead position to be compared online and the difference displayed.

Survey
The survey procedures ensure that the survey methods used comply with the specifications and that surveys are carried out in an accurate and efficient manner. The procedures cover all survey works.

Equipment
The dredger is equipped with a multibeam echo sounder. This allows online surveys without the need of a separate survey vessel within the mining area. Alternatively, should the circumstances make surveying from the dredger less favourable, a separate survey vessel can be mobilised.

4 THE DREDGING CYCLE

The dredging cycle is divided into four consecutive activities, these are:

1. *Dredging:* Recovery of the phosphate-rich sediments;
2. *Sailing loaded*: With a fully loaded hopper, sailing to the location of discharge;
3. *Discharging:* Transferring the load to a containment location (buffer pond) ashore, and[4]
4. *Sailing back empty*: Returning to the Mine Licence Area, to initiate further dredging cycles.

The estimated duration of the various components of the dredge cycle based on current technical information, are presented in Table 2.

[4] Land based environmental implications related to the transfer of sediments to shore are discussed in the Terrestrial EIA-EMPR.

Table 2: Duration (estimated) of the dredge cycle.

Activity	Estimated Duration
Lowering: The vessel is on station, and dredge arm is lowered and the dredge head engages the sea floor.	0.25 hrs
Dredging: The dredge head is engaged in the sediments. Through a series of transects in the target mine area the dredge head will be engaged with the seabed in order that hopper is filled to capacity, 46,000 m^3. (Sailing speed of 1 to 2 knots)[5]	16.0
Hoisting*:* The hopper is full, and the dredge arm is returned inboard.	0.25
Sailing*:* The vessel sails to the point of discharge. This duration will vary depending on sea conditions and, in particular, on the distance to be travelled. Maximum sailing speed is 18 knots.	6.0
Connecting*:* Berthing and connecting to the shore discharge point	0.5
Transfer slurry ashore: Pumping the sediment ashore.	6.2
Disconnecting: Disconnection from the shore discharge point and undocking	0.5
Sailing: The vessel sails back to the mining licence area.	6.0
Estimated duration of the average dredge cycle	35.7 hrs

Phosphate sediment recovery will take place within the SP-1 target dredge site. The sediments here are located between 200 and 225 m water depth.

The vessel will recover sediments from individual continuous lanes within the target dredge area within the SP-1. The length of each lane (cut) is 4 km. This lane length may vary as determined from geotechnical information obtained during the dredging process and/or as revised from on-going resource development exploration. Dredging will predominantly take place in a north – south (or south – north) direction i.e. aligned with the predominant swell and wind direction.

The target dredge area has a mine plan, wherein individual blocks are identified to provide a resource for each year of dredging. Initially during Year 1, 400 m x 4 km, and in Year 2, which represents full production the active mine block is 600 m x 4 km. In the initial 4 km cut, the dredger will sail at approximately 1 knot, which results in the seabed engaged dredge head, which is 3 m wide, cutting to a depth of 0.75 m. In order to fill one hopper (vessel) load, 4 parallel adjacent, or near adjacent cuts within the target dredged area are required. The vessel will cover approximately 16 km during this period. Subsequent cuts within the same lane will be made, so that the full vertical extent (< 3 m) of the deposit is extracted. By varying the speed of the vessel, the depth of cut can be increased (shallower cut) or decreased (deeper cut), to a maximum of 0.75 m).

[5] Cut depth is variable as relates to, sea surface swell and hydraulic compensation to the drag head, speed of the vessel and the specific characteristics of the sediments dredged.

The vessel will continue to dredge vertically within the particular lane to a point just above the footwall clay. Depending on the particular location within the deposits, these footwall clays may be located at depths from 1 m to 3 m below the original seabed level. The intention is not to cut (dredge) into the footwall clay, but to rather leave a residual thickness of marine sediments over the footwall. This residual thickness will vary, but is envisaged to be between 10 and 15 % of the original volume of target sediment layer(s). This residual sediment remaining above the footwall clay will be present as an uneven 'hummocked' surface. The depth of dredging is managed through vessel-based positional software, integrated with the hydraulic winch compensation systems that control the position of the dredge arm and consequently the location of the drag head.

5 EXCLUSION ZONE AROUND SP-1

In order to ensure the safety of operations, an operational safety exclusion 'no go' zone will be declared over the active target mining area[6]. In the case of SP-1 this is envisaged as a 23 x 9 km rectangular area, totalling 207 km^2. Note: the target area of SP-1 is a 22 x 8 km block, the safety exclusion zone is larger to accommodate for vessel turning requirements. This is a restricted activity area from which the sediments are recovered[7]. The restricted area applies only to bottom trawl demersal fishing activities, and not to pelagic fishing or general vessel traffic. Fish stock assessment and research surveys are not intended to be restricted by the enforcement of this exclusion zone, standard rights of passage under international maritime convention will apply under these conditions[8].

These exclusion zones will be established with the authorities and advised to all shipping through Notices to Mariners.

6 THE SCALE OF THE DREDGING AREA

The scale of the dredge area is primarily controlled by the annual export/sales requirement of 3 million tonnes of 'rock phosphate'. In order to generate the required export volume, 5.5 million tonnes of marine sediments need to be recovered on an annual basis. This is based on the average tonne of marine sediment containing 60% ore grade phosphate.

The actual area that needs to be dredged annually to meet the export target of 3 million tonnes of rock phosphate depends on the thickness of the deposit[9]. The thickness of the deposit in SP-1 varies from 0.5 m, to 1.69 m, which at full production results in area of 2.44 km^2 being dredged annually. The thickness of the deposit is determined from exploration work conducted in ML 170.

[6] The areas of exclusion will be reviewed with fisheries so as to minimise the potential loss of access to fishing grounds.
[7] The total Mining Licence Area is 2233 km^2, the area of exclusion of target mining area SP-1 is 207 km^2, and hence, restricted access covers approximately 9 % of the Mining Licence Area.
[8] Notification is required of the intention to conduct such surveys 14 days before the planned survey.
[9] Production deposit thicknesses will differ to some degree from that determined from exploration activities.