SANDPIPER PROJECT

Verification Programme Report: Mining Licence Area No. 170

SECTION B:

IMPACT ASSESSMENT VERIFICATION

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SECTION B
IMPACT ASSESSMENT VERIFICATION

B1.1 Water Column and Sediments
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B2.0 Cumulative Effects

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November 2014

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CONDITIONS OF USE OF THIS REPORT

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SUMMARY

The verification programme addresses the impacts associated with dredging within the target dredge area SP-1.

The Environmental Impact Assessment (of 2012) concluded, "***The opinion of the specialists and the independent reviewer is that there are presently no identified issues of environmental significance to preclude the dredging of phosphate-enriched sediments from the Mining Licence Area No. 170. In order to verify these conclusions, a programme of work specified by the relevant specialists, has been included in the Environmental Management Programme that will be undertaken prior to the commencement of dredging to substantiate the findings provided in the impact assessment. Going forward, all environmental matters will need to be managed through the environmental management plan."***

An expanded verification programme was undertaken following discussions with and information provided by external reviewers, (as commissioned by the Environmental Commissioner, MET) MFMR and I&APs) during 201 and 2014. NMP's specialist consultants and the independent reviewing parties confirm, based on the results of the verification programme that the assessments as presented in the EIA (2012) are reliable and that these assessments now can be reported with a high degree of confidence.

The impacts assessed in the 2012 EIA are reassessed here. Details of various specialist assessments that allowed for the confirmation of the impact risk and its significance are to be found in the individual specialist reports (Section C). The content and approach to the verification programme and its findings have been subjected to:

1. Independent peer review of the specialist study reports, supporting studies and documentation;
2. Independent review by the University of Namibia of the processes followed during the undertaking of the Verification Programme; and,
3. Independent review of the Verification Programme Report by the CSIR.

The full scope of the verification programme is detailed in Section D, Appendix 4, with the specialists' assessments reported in Section C. The programme considered three main categories of assessment, including:

- Water column and sediments;
- Fish, mammals and seabirds; and,
- Benthic fauna.

These three main categorises of assessment, included a several integrated programmes. A verification programme related to jellyfish (which were assessed in the EIA of 2012) was not undertaken, primarily because of the significance of the four impacts assessed being reported as low (2) and very low (2). However, the impact tables for jellyfish are presented here, since the general outcome of the verification programme has information relevant to the impact assessment of jellyfish.

The verified impact statements of the respective specialists are presented in this section. All confirmed their original assessments with a greater degree of confidence as determined from site-specific data.

Overall the level of confidence in the original assessment has been raised from medium to high. Some of the original assessments are unchanged because they were deemed to be of low or no significance with the confidence level being high. A key change with respect to the assessment of fisheries impacts is the reduction of the extent (area of influence) from that of the MLA (2233 km^2) to the specific site SP-1 dredge site (176 km^2).

The significance ratings of the impacts re-evaluated following the completion of the verification programme are presented in the table on pages viii to xi.

Water Column and Sediments: Summary of impact assessment determinations: Re-evaluated following the verification assessment.

Reference table number refers to the individual impact table number found in the specialists section.

Ref. Tbl No.	1.1.1	1.1.2	1.1.3	1.1.4	1.1.5	1.1.6	1.1.7	1.1.8	1.1.9	1.1.10	1.1.11
Risk Area	**Vessel Operation**		**Overspill discharge**					**Seabed dredging**			
Impact	**Pollution from wastes**	**Alien spp. in ballast water**	**Turbid plume**	**H_2S toxicity at surface**	**Oxygen deficient water at surface**	**Nutrients added at surface**	**Trace/heavy-metal toxicity at surface**	**Trace-metal toxicity on seabed**	**H_2S toxicity on seabed**	**Lowered oxygen levels on seabed**	**Increase of H_2S flux.**
Extent	Dredge area	National	Dredge area	Dredge area	Dredge area	Dredge area	Dredge area	Annual Mining Area	Dredge area	Annual Mining Area	Dredge area
Duration	Very short term	Short term to permanent	Very short term	Short term	Very short term	Short term	Short term	Short term	Medium term	Medium term	Medium term.
Intensity	No lasting effect	None to serious	No lasting effect	Minor effects	No lasting effect	No lasting effect	Minor effects	Minor effects	Minor effects	Minor effects	Minor effects
Probability	Possible	Possible	Possible	Possible	Improbable	Possible	Possible	Possible	Possible	Possible	Improbable
Status	Negative	Negative	Negative	Negative	Negative	Neutral	Negative	Negative	Negative	Negative	Negative
Significance (no mitigation)	None	Can be high	Low	Low	Low	None	Low	Low	Low	Low	Low
Mitigation	System maintenance	IMP guidelines	Built in	None possible	Non	None possible	None possible	None possible	None possible	Not possible	n/a
Significance (with mitigation)	None	None	Low	Low	Low	None	Low	Low	Low	Low	Low
Confidence level 2012	High	High	High	Medium	High	Medium	Medium	Medium	Medium	High	Medium
Re-evaluated 2014 confidence level	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**
Reason	MARPOL 73/78 discharge standards apply	IMO guidelines for ballast water apply	Dredge area >20mg/ℓ suspended sediment concentration. Plume disperses 1 to 2 days	Mine site sediment property data indicate low H_2S presence, pyrite sulphide will have low solubility	Mixing factors are therefore <1%; and dissolved oxygen concentration reductions will be negligible (<0.1ml/ℓ).	Mine site sediment pore water volumes are low	Mine area Heavy metals have low solubility and bioavailability, trophic transfers are attenuated at primary consumer level	Mine area Heavy metals have low solubility and bioavailability, dredging should not increase exposures	Mine site sediment property data indicate low H_2S presence	POM in sediments is relatively refractory	Mine site sediment property data indicate low H_2S presence and release from iron pyrites should be low.

Fish Mammals and Seabirds: Summary of impact assessment determinations: Re-evaluated following the verification assessment.

Reference table number refers to the individual impact table number found in the specialists section.

Ref. Tbl No.	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5
Risk Area	**Seabed dredging: Fish Mammals and Seabirds**				
Nature of the impact	Fishing operations	Ecologically important species	Recruitment of key commercial species	Biodiversity	Seabirds and Mammals
Extent 2012	MLA	MLA	MLA	MLA	MLA
Extent re assessed 2014	**Specific mine site**	**Specific mine site**	**MLA**	**Specific mine site**	**Specific mine site**
Duration	Long term	Permanent	Permanent	Permanent	Long term
Intensity	Serious effect	Moderate effect	Minor effect	Minor effect	Minor effect
Probability	Definite	Highly probable	Improbable	Improbable	Probable
Status (- ve of + ve)	Negative	Negative	Negative	Negative	Negative
Significance (no mitigation)	Medium	Medium	Low	Low	Medium
Significance (with mitigation)	Medium to low	Medium	Low	Low	Low
Confidence level 2012	High	Low to medium	Low to medium	Low to medium	Medium
Re-evaluated 2014 confidence level	**High**	**High**	**High**	**High**	**High**

Macrofauna: Summary of impact assessment determinations: Re-evaluated following the verification assessment.

Reference table number refers to the individual impact table number found in the specalists section.

Ref. Tbl. No.	1.3.1	1.3.2	1.3.3	1.3.4	1.3.5	1.3.6	1.3.7	1.3.8	1.3.9
Risk Area	**Seabed dredging: Benthic Macrofauna**								
Nature of the impact	**Sediment removal: benthos re establishment**	**Exploration activities and removal of benthos**	**Change of hydrographical conditions**	**Removal of sulphur oxidizing mats**	***Clostridium botulinum exposure***	**Sediment smothering benthos: Drag head**	**Benthos smothering: Dredge overspill plume**	**Nutrients added at surface: overspill plume**	**Increase of H_2S flux.**
Extent	Dredge area	Dredge area	Specific mine site	Specific mine site	Specific mine site	Dredge area	Local to regional	Local	Local
Duration	Long term >20 years	Short term	Long term >20 years	Medium to long term	Sort term	Very short	Very short	Very short	Short term
Intensity	Moderate to serious	No lasting effects	Moderate to serious	Moderate to minor	Serious	Minor	Minor	Minor	Moderate
Probability	Definite	Probable	Probable	Improbable	Improbable	Highly probable	Probable	Possible	Probable
Status	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Significance (no mitigation)	Medium	Non	Medium	Low	Low	Low	Low	Low	Low
Mitigation	Leave residual sediment layer / un mined areas	None required	Leave residual sediment layer / un mined areas	Non	Non	Non	Non	Non	Non
Significance (with mitigation)	Medium	None required	Low to Medium	Low	Low	None necessary	Low	Low	Low
Confidence level 2012	Medium	High	Medium	Medium	Medium	High	Medium	Medium	Medium
Re-evaluated 2014 confidence level	**High**	**No change**	**High**	**High**	**No change**	**No change**	**No change**	**High**	**High**

Jellyfish. Summary of impact assessment determinations: A verification assessment specifically related to jellyfish was not undertaken.

Reference table number refers to the individual impact table number found in the specialists section.

Ref. Tbl No.	1.4.1	1.4.2	1.4.3	1.4.4
Risk Area	**Dredging: Jellyfish**			
Nature of the impact	Blocking sea water intakes of vessel	H_2S mortalities to Jellyfish	Turbidity cause mortalities	Hard substrate exposed
Extent	Dredge event	Dredge event	Dredge event	Annual mining area
Duration	Extremely short term	Extremely short term	Extremely short term	Very short term
Intensity	No lasting effects	No lasting effects	Minor effects	Minor effects
Probability	Highly probable	Possible	Rare	Rare
Status (- ve of + ve)	Negative (to Jellyfish)	Negative (to Jellyfish)	Negative (to Jellyfish)	Positive (to jellyfish)
Significance (no mitigation)	Low	Low	Very low	Low
Significance (with mitigation)	Very low	Low	Very low	Very low
Confidence level 2012	High	Low	Low	High
Re-rated 2014 confidence level	**High**	**Low**	**Low**	**High**

B1.4 VERIFIED ASSESSMENT OF IMPACTS: JELLYFISH

INTRODUCTION

The verification programme addresses the impacts associated with dredging within the target dredge area SP-1

The Jellyfish Specialist Study (Gibbons 2012) conducted within the framework of the EIA (Midgley 2012) identified impacts on the jellyfish communities that can be expected from the proposed Sandpiper Phosphate Project, and assessed their significance. A series of four impact tables which present the impacts as they were assigned in original jellyfish impact study in the 2012 EIA are presented below.

The proposed mining activities are not considered to have a significant and lasting impact on the abundance and distribution of jellyfish populations: the tailings plume is limited in spatial/temporal extent and jellyfish have no specialized respiratory surfaces that could get clogged; alterations to the benthos are unlikely to increase the habitat for polyp establishment if a layer of soft sediment is allowed to remain, and whilst hydrogen sulphide could kill individuals in the affected water column, this is likely to be on a very limited scale since dredging will take place seawards of the mud belt which is the main source of H_2S. More serious impacts are likely to be effected by jellyfish on mining operations, though not through clogging at the drag-head as jellyfish are uncommon at depth. However, at the surface, where water will be drawn into the vessel for cooling (etc.), they could cause a major problem for vessel activities.

A total of four negative impacts were identified in the original assessment study with one impact having low significance, three, very low significance.

Table 1.4: Jellyfish. Summary of impact assessment determinations

Note: A verification assessment specifically related to jellyfish was not undertaken.

Reference table number refers to the individual impact table number found in the specialists section.

Ref. Tbl No.	1.4.1	1.4.2	1.4.3	1.4.4
Risk Area	**Dredging: Jellyfish**			
Nature of the impact	Blocking sea water intakes of vessel	H_2S mortalities to Jellyfish	Turbidity cause mortalities	Hard substrate exposed
Extent	Dredge event	Dredge event	Dredge event	Annual mining area
Duration	Extremely short term	Extremely short term	Extremely short term	Very short term
Intensity	No lasting effects	No lasting effects	Minor effects	Minor effects
Probability	Highly probable	Possible	Rare	Rare
Status (- ve of + ve)	Negative (to Jellyfish)	Negative (to Jellyfish)	Negative (to Jellyfish)	Positive (to jellyfish)
Significance (no mitigation)	Low	Low	Very low	Low
Significance (with mitigation)	Very low	Low	Very low	Very low
Confidence level 2012	High	Low	Low	High
Re-evaluated 2014 confidence level	No change	No change	No change	No change

Table 1.4.1 Impact 1: Blocking of vessel seawater intake system by dense surface aggregations of jellyfish.

Note: A verification assessment specifically related to jellyfish was not undertaken.

Nature of the impact	**1: Blocking of vessel seawater intake system by dense surface aggregations of jellyfish.** **Dense surface volumes of jellyfish have been known to block the seawater intakes. This incoming seawater is used to cool the vessel's engines and any blockage of the intake system could cause the engines to overheat and fail, if remedial action is not taken.**	
Report	***Impacts assessed EIA (2012)***	***Impacts re-evaluated: Verification programme***
Extent	**Dredge Event:** The extent is limited to immediately adjacent to the vessel during all operations. **No change of assessment**	
Duration	**Extremely short term:** The duration is limited to the period of time when dense aggregations of jellyfish are around the vessel: probably no more than a few hours in duration. **No change of assessment**	
Intensity	**No lasting effect**: This impact would involve a relatively limited number of jellyfish and is more likely to have adverse impact to the vessel if not mitigated. **No change of assessment**	
Probability	**Highly probable**: Although it is not possible to predict exactly when dense jellyfish aggregations may appear around the vessel, they do tend to occur more commonly during late winter / early spring: it is inconceivable, given how many jellyfish there are off Namibia, that this threat will not arise. **No change of assessment**	
Status (+ of -)	**Negative** to individual jellyfish, possibly positive for fisheries. **No change of assessment**	
Significance (no mitigation)	**Low: No change of assessment**	
Mitigation	In the case of blockage, jellyfish will have to be physically removed or flushed from the system. Sailing the vessel to areas with less dense aggregations of jellyfish Forward looking sonar could be installed on the vessel to identify dense masses of sub-surface jellyfish during operations. A "jellyfish observer" on deck should be able to identify jellyfish aggregations at the surface.	
Significance (with mitigation)	**Very Low: No change of assessment**	
Confidence level	**High**:	
Confidence level Post Verification Assessment		**High No change of assessment**

Explanation: (Table 1.4.1: Impact 1)

Original EIA – Impact assessment
Although jellyfish can be found throughout the water column, more than 80% of biomass is found in the upper 50 m (Flynn *et al.,* in press). This means that jellyfish are unlikely to be entrained in large quantities in dredged sediments. However, it does mean that jellyfish could block seawater cooling intakes on the dredging vessel itself, which could pose a significant technical risk.

Post Verification Programme – Re-evaluated impact assessment
A re-evaluated assessment of this impact was not required in terms of the scope of the verification programme. The original assessment stands.

Table 1.4.2 Impact 2: Hydrogen sulphide released from dredge sediments causing mortalities to jellyfish.

Note: A verification assessment specifically related to jellyfish was not undertaken.

Nature of the impact	**2: Hydrogen sulphide released from dredge sediments causing mortalities to jellyfish.** **The mining operation is located seaward of the mud belt where high levels of hydrogen sulphide are known to be associated with soft sediments. Hydrogen sulphide releases from the sediments in the Mining Licence Area (which is adjacent to, but not in the mud belt) are thus envisaged to be significantly less frequent and intense.**	
Report	***Impacts assessed EIA (2012)***	***Impacts re-evaluated: Verification programme***
Extent	**Dredge Event: No change of assessment**	
Duration	Extremely short term: The duration is short (hours), related to the pulsed release of hydrogen sulphide. **No change of assessment**	
Intensity	**Minor effects:**	**No lasting effects:** individuals may be affected, however, environmental functions and processes are not adversely affected.
Probability	**Probable**: In the event that the combination of adverse factors comes together at any one time, jellyfish moralities will occur. **No change of assessment**	**Possible**: the possibility of H_2S poisoning of jellyfish cannot be eliminated entirely, the probability rating is adjusted, as a result of data collected from SP-1 confirming the limited presence of H_2S.
Status (+ of -)	**Negative**: to individual jellyfish, possibly positive for fisheries. **No change of assessment**	
Significance (no mitigation)	**Low: No change of assessment**	
Mitigation	No mitigation is presented	
Significance (with mitigation)	**Low: No change of assessment**	
Confidence level	**High**: Although there is no information on the tolerance of jellyfish to hydrogen sulphide, they are unlikely to have special adaptations to cope with it. More research on this is needed.	
Confidence level Post Verification Assessment		**High**: data collected from across SP-1 confirms the limited presence of H_2S. (section C 2.1)

Explanation: (Table 1.4.2: Impact 2)

Original EIA – Impact assessment

The liberation of large quantities of hydrogen sulphide by dredging activities has the potential to kill off any jellyfish present in the affected water column as these organisms possess no special tolerance to this metabolic toxin, although both medusa and polyps are remarkably tolerant of hypoxic water (Purcell *et al*., 2001; Condon *et al*., 2001).

Post Verification Programme – Re-evaluated impact assessment

A re-evaluated assessment of this impact was not required in terms of the scope of the verification programme. However, concentrations and thus possible fluxes of H_2S in sediment pore water are estimated to be low from measurements of proxy variables within the sediments in the target dredge area. Circumstantial evidence in support of this is the absence the large sulphate oxidising bacteria from the survey area during the period of the thiobacteria survey in July/August 2014. Further, evaluation of pyrite-S mobilisation from sediments indicate that this is low. Consequently H_2S fluxes to the lower water column are considered to be negligible and the absence of large sulphur oxidising bacteria, due to either natural causes or disruption from dredging, would have little effect on these.

Table 1.4.3 Impact 3: Lean water overflow sediments, if present in sufficient quantities, may cause mortalities to jellyfish.

Note: A verification assessment specifically related to jellyfish was not undertaken.

Nature of the impact	**3: Lean water overflow from the vessel generates a tailings plume of fine sediments which settle out through and are dispersed in the water column. These fine sediments if present in sufficient quantities may cause mortalities to jellyfish, though this is considered unlikely**	
Report	***Impacts assessed EIA (2012)***	***Impacts re-evaluated: Verification programme***
Extent	**Mine site**: < 25 km. It is understood that whilst dredging a sediment plume of ~1500 m long and 800 m wide will be generated over the cut length of up to 22 km. This plume is determined to sink to the seabed over a distance of 500-1500 m from the point of discharge. The maximum concentrations of sediments in the sediment plume are envisaged to be <50 mg/l but most of the plume area will have total suspended sediment concentrations <10 mg/l above background (1-4 mg/l), these are regarded as low.	**Dredge event:** It is understood that whilst dredging a sediment plume of ~1500 m long and 800 m wide will be generated over the cut length of up to 4 km. This plume is determined to sink to the seabed over a distance of 500-1500 m from the point of discharge. The maximum concentrations of sediments in the sediment plume are envisaged to be <50 mg/l but most of the plume area will have total suspended sediment concentrations <10 mg/l above background (1-4 mg/l), these are regarded as low. (Revised: cut length is reported, not 22 km as originally listed (left column), but corrected to 4 km (this column). This correction, serves to reduced the spatial extent of the impact.
Duration	**Extremely short term: No change of assessment**	
Intensity	**Minor effects: No change of assessment**	
Probability	**Rare: No change of assessment**	
Status (+ of -)	**Negative**: to individual jellyfish, possibly positive for fisheries. **No change of assessment**	
Significance (no mitigation)	**Very Low: No change of assessment**	
Mitigation	No mitigation is presented	
Significance (with mitigation)	**Very Low: No change of assessment**	
Confidence level	**Low**: – research on this is needed	
Confidence level Post Verification Assessment		**Low**: – research on this is needed. **No change of assessment**

Explanation: (Table 1.4.3: Impact 3)

Original EIA – Impact assessment

The plume of fine sediment that will be generated in the water column during dredging operations has a limited potential to be deleterious to individual jellyfish, with population level impacts being dependent on the numbers of animals moving through the licence areas. That said. it must be stressed that no research has been conducted in this area. The "fines" could settle out on individual jellyfish, but as the organisms have no specialized respiratory surfaces that could be blocked, they should be able to continue swimming, and through swimming they should be able to rid themselves of settled particles. Whilst it could be argued that jellyfish might ingest particles in the tailing plume, this is considered unlikely.

Table 1.4.4 Impact 4: Removal of seabed sediments will change the nature of the sediment surface. Jellyfish populations are known to increase in areas where there is an increase of hard substrate.

Note: A verification assessment specifically related to jellyfish was not undertaken.

Nature of the impact	**4: Removal of seabed sediments will change the nature of the sediment surface. Jellyfish populations are known to increase in areas where there is an increase of hard substrate. Typically this occurs where rock, concrete or iron structures are erected. The removal of the upper relative soft layers of sediment, leaving a relative hard clay footwall surface may provide such a hard surface.**	
Report	***Impacts assessed EIA (2012)***	***Impacts re-evaluated: Verification programme***
Extent	**Annual Mining Area: No change of assessment**	
Duration	**Very Short term: No change of assessment**	
Intensity	**Minor effects: No change of assessment**	
Probability	**Rare: No change of assessment**	
Status (+ of -)	**Positive** for jellyfish, negative for fisheries. **No change of assessment**	
Significance (no mitigation)	**Low: No change of assessment**	
Mitigation	None: If between 10 - 15 % of the original thickness of the sediment is not recovered, there will sufficient soft substrata to preclude polyp settlement.	
Significance (with mitigation)	**Very Low: No change of assessment**	
Confidence level	**High:**	
Confidence level Post Verification Assessment		**High:** Slivers of undisturbed ground will be left in situ, as well as a covering of sediments over the harder (relatively) clay footwall. **No change of assessment**

Explanation: (Table 1.4.4: Impact 4)

Original EIA – Impact assessment

The removal of surficial sediments from the benthic environment, as a result of dredging, will alter the nature of the seabed environment. Whilst this has no impact on jellyfish in the water column, it could increase the area suitable for polyp attachment should large areas of hard substrata be exposed. That said, polyps of other species seem to require a sediment-free surface for persistent establishment. This is unlikely to be realized given the immediate fallout from the tailings plume, and from the persistent sedimentation of photic zone production

Post Verification Programme – Re-evaluated impact assessment

A re-evaluated assessment of this impact was not required in terms of the scope of the verification programme. The original assessment stands.