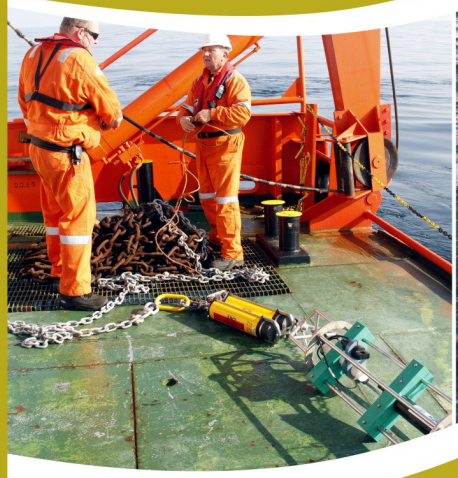

Sandpiper Project
Verification Programme

Volume 1: Main Report

Namibian Marine Phosphate (Pty) Ltd
Mining Licence Area No. 170

November 2014

J. Midgley and Associates

CSIR
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Email: info@namphos.com
127 Theo-Ben Gurirab Street
Walvis Bay
Namibia

Sandpiper Project
Verification Programme

VOLUME 1: MAIN REPORT

Namibian Marine Phosphate (Pty) Ltd
Mining Licence Area No. 170

Application:

This report has been prepared to verify the findings of the NMP Final EIA (Midgley 2012), as submitted to the authorities, Ministry of Environment and Tourism. The need for, and scope of, the Verification Programme was detailed in the EMP (Midgley 2012), The scope subsequently was expanded following consultations with MFMR, the Fishing Industry, and the NatMIRC scientists (2012 / 2013).

Report co-ordinated and prepared by:

Mr Jeremy Midgley Pr.Sci.Nat
J. Midgley & Associates
PO Box 110
Constantia 7806
South Africa
Email: mwjmidg@mweb.co.za

Independent Programme Reviewer and Process Quality Controller:

Mr Patrick Morant Pr.Sci.Nat
CSIR
PO Box 320
Stellenbosch 7599
South Africa
Email: pmorant@csir.co.za

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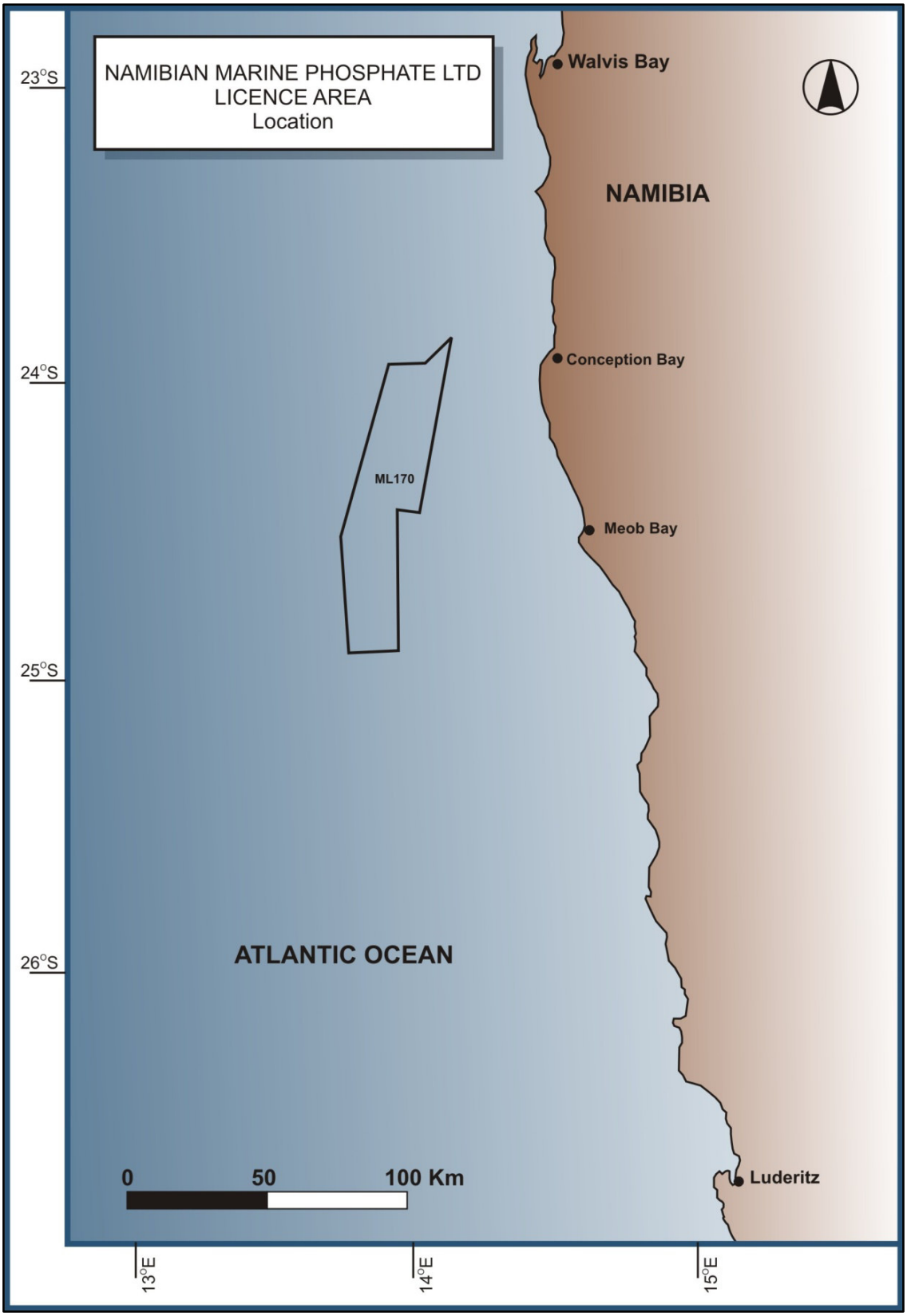
November 2014



Frontispiece: Location of Mining Licence ML 170 off shore Namibia

Introduction to the Sandpiper Phosphate Project

Namibian Marine Phosphate (Pty) Ltd (NMP) has applied to recover phosphatic sediments from the seabed on the Namibian continental shelf. Following an extensive exploration programme a mining licence (ML 170) was issued by the Ministry of Mines and Energy (MME) in July 2011 with the standard conditions requiring the issue of an Environmental Clearance Certificate by Ministry of Environment and Tourism (MET) prior to commencement of operations.

The Sandpiper phosphate project (ML 170) is located on the Namibian continental shelf approximately 120 km south southwest of Walvis Bay (see Frontispiece). 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. 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.

The phosphate-enriched sediments and the defined mineral resources and reserves[1], are located throughout the entire Mining Licence Area. Within the ML 170 area, three initial target dredging areas have been identified namely SP-1, SP-2 and SP-3. The primary target dredge site for the 20 year licence period is SP-1 (176 km^2) which lies in water depths of 200 to 225 m. A trailing suction hopper dredger (TSHD) (Figure 1) will be used to recover approximately 5.5 million tons of sediment annually from an area of up to 3 km^2 in extent. A total area of approximately 60 km^2 will be dredged over the course of the 20 year mine licence period. The other sites SP-2 and SP-3 also contain phosphate resources and may be considered at a later stage, at which time the requisite additional environmental evaluations will be made in accordance with the Environmental Management Act (Act No. 7) of 2007.

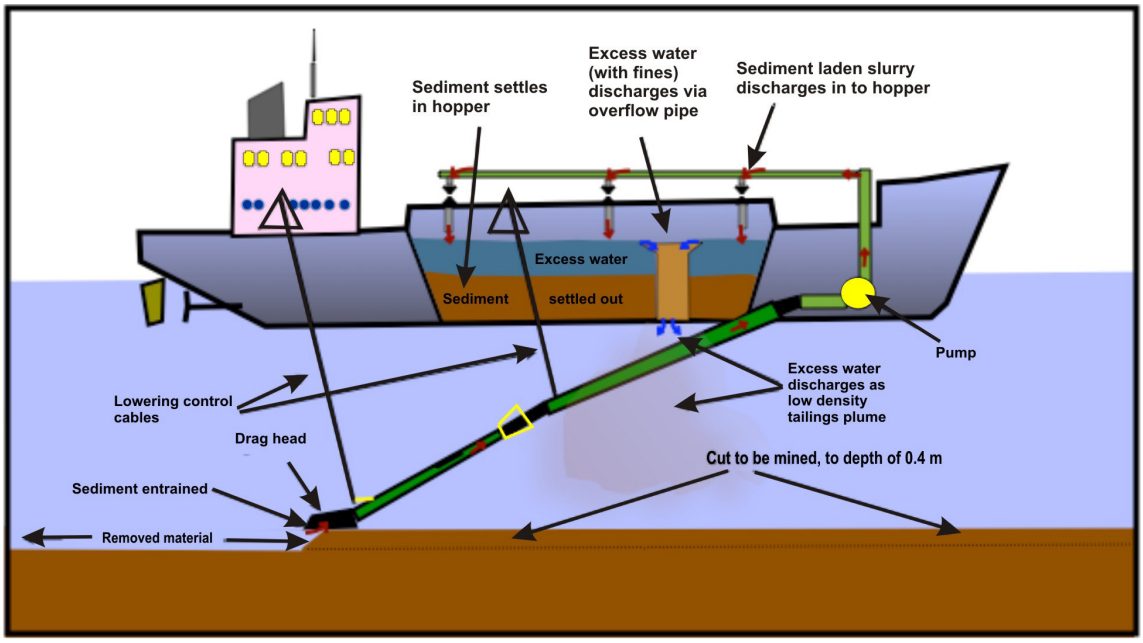


Figure 1: A schematic of a Trailing Hopper Suction Dredger (TSHD).

[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]

The Environmental Management Plan (EMP) is an integral component of the Environmental Impact Assessment (EIA). The EMP becomes part of the legally binding contract with MET on issue of the Environmental Clearance Certificate. The EMP included the provision for the completion of an integrated pre-dredging impact verification survey. The survey was designed specifically by the specialists, who determined that the level of *confidence* in their assessment of impacts could be improved with additional *in situ* information. Notwithstanding this, they considered their work to be robust. The primary reason for the uncertainty related to the relatively short period in which their work was undertaken. The terms and conditions of the licence issued by (MME) required the EIA to be submitted in six months. This requirement did not allow any opportunity for fieldwork (sampling and measurement) to be undertaken.

The Verification Programme reported herein presents the results of the various specialist studies that were completed during 2013 and 2014, providing the evidence in support of the original impact assessments contained in the EIA with specific focus of the assessment of the primary target dredge site SP-1.

CSIR Independent Review

SANDPIPER PROJECT
MINING LICENCE AREA ML 170
VERFICATION SURVEY AND REPORT

November 2014

INDEPENDENT REVIEW BY CSIR

Mr P. Morant (Pr.Sci.Nat)

In 2012 an Environmental Impact Assessment (EIA) was prepared for Namibian Marine Phosphate (Pty) Ltd's (NMP) proposed marine phosphate dredging operations in ML 170 offshore Meob Bay, Namibia. In order to meet the requirements of the licence issuing authority, the Ministry of Mines and Energy, the entire EIA had to be completed in six months that precluded any field studies. The assessment of impacts made by the specialist scientists was of high quality and made the best use of the information available. However, the specialists recognised that a field-work based verification study was necessary primarily to improve the level of confidence in their scientific predictions of the severity, extent and duration of potential impacts arising from the dredging operations. The plan for the Verification Survey was included in the Environmental Management Plan (Chapter 8 of the EIA 2012) and NMP committed to undertaking the verification assessment prior to the commencement of dredging. This Verification Survey would also serve as an environmental baseline for the target dredge area (SP-1) and serve as a benchmark against which the actual impacts of dredging could be assessed.

As the CSIR's Independent Reviewer and Process Quality Controller appointed to the project I have been directly involved with the environmental aspects of the project since 2011. Throughout I have been impressed by the professionalism of the specialists, the high quality of their scientific studies, and the robustness of their assessment of the potential impacts both for the original EIA 2012 and the subsequent Verification Programme in 2014. I believe that the information now available and the enhanced confidence in their assessment of impacts as a result of the Verification Programme demonstrate that there are no objective scientific reasons why an Environmental Clearance Certificate should not be issued and the project permitted to proceed. The planned monitoring programme and the adaptive management approach (which is an integral component of an EMP) to which NMP is committed further strengthens my view that the project should be permitted to proceed.

In reviewing the Verification Survey and the Report emanating from it I have adopted a semi-chronological approach by following the process from its inception to its conclusion in the form of the Verification Survey Report compiled by J. Midgley and Associates. The review is based on my experience of managing numerous marine EIAs along the west coast of Africa. In particular, since 1993 I have managed, or contributed to, EIAs for offshore oil and gas exploration and production, marine diamond mining in Namibian waters, expansion of the ports of Lüderitz and Walvis Bay, and a major field study of the Kunene River mouth as an input to the EIA for the Epupa Falls hydroelectricity project. I assisted with the establishment of the Benguela Current Large Marine Ecosystem programme and was lead author of two Thematic Reports that formed part of the founding documentation for the programme. I am a South African Registered Professional Natural Scientist (Reg. No. 401514/83).

From the time of submission of the EIA in April 2012 until the first deployment of oceanographic instrumentation in SP-1 in June 2013 there was a protracted period in which NMP and its EIA consultant attempted to engage with MFMR and its scientists to approve the contents of the Verification Programme and, most importantly, actively participate in it.

As part of this engagement process I attended two meetings in Swakopmund which contributed to shape the structure and content of the Verification Programme. These meetings were chaired by the Governor of the Erongo Region, the Honourable Cleophas Mutjavikua. The first meeting, held on 4 July 2012, was primarily between representatives of the Namibian Fishing Industry and the Verification Study Team. However, the meeting also was attended by representative of the Namibian National Marine Information and Research Centre (NatMIRC) and Interested and Affected Parties (I&APs). The second meeting, held on 10 September 2012, was between NatMIRC and the Verification Study Team. These meetings allowed for an open exchange of information and the views expressed contributed to the final content of the Verification Programme which was submitted to the authorities in December 2012.

Based on my experience of marine scientists working in the Benguela Large Marine Ecosystem I assisted J. Midgley and Associates with the selection of the specialist scientists who led the various components of the Verification Programme namely:

- Dr Robin Carter, Lwandle Technologies (Pty) Ltd – *Water column and sediments*
- Mr David Japp, Capricorn Fisheries Monitoring cc – *Fish and fisheries, biodiversity, seabirds and marine mammals*
- Dr Nina Steffani, Steffani Environmental Consultant – *Macrobenthos*
- Professor Mark Gibbons, University of the Western Cape – *Jellyfish*

Further, I proposed members of the Peer Review group led by Dr A.I.L.Payne, giving due consideration to their experience, familiarity with the Benguela Current ecosystem and independence from the NMP dredging project.

Scope of the Study

The Verification Report encompasses all the activities associated with the survey from designing and planning the marine surveys, the execution of these surveys, the specialist studies that complement the field work, and the subsequent analysis and interpretation of the data. Finally, the Verification Programme contains a re-evaluation of the assessments of impacts contained in the EIA 2012.

I reviewed:

i. The components of the Verification Survey as they were planned and conducted;
ii. The cruise reports;
iii. The scientific reports prepared on completion of the field work, the analysis of the data gathered and complementary specialist studies. Specifically I focused on:
    a) The scientific credentials and experience of the specialists involved;
    b) The planned field data gathering programmes;
    c) The interpretation of the results of these programmes;
    d) The re-assessment of the impacts originally presented in the EIA 2012; and
    e) The revisions to the EMP arising from the site-specific data and experience gained during the Verification Survey.
    iv) The final Verification Programme report.

Technical Completeness of the Verification Programme Report

The Verification Survey comprised two major components:

1. The water column and sedimentary environment study which addressed physical oceanography and the biogeochemistry of the sediments. It also included studies of the macrobenthos, meiofauna and sulphur bacteria since these organisms are either an indication of the biogeochemical regime in the sediments or, as in the case of the sulphur bacteria, intimately involved in the biogeochemical regime.
2. The fisheries and biodiversity study whose primary focus was to establish the contribution of the SP-1 target dredge area and, more broadly, the mining licence area (ML 170) to Namibian commercial fisheries especially the bottom trawl fishery for monkfish and hake. This study also obtained data on the non-commercial fish species, on epibenthic macrofauna in, and around SP-1, and on seabirds and marine mammals.

In addition to these two groups of studies a geophysical survey of the northern portion of the SP-1 area was conducted to characterise the sea floor habitat to determine whether there were any special features of environmental significance and to identify any objects that may present an operational risk and thus would need to be considered during dredging.

Five desk-top studies were conducted in support of the Verification Programme:

1. Geology and Preliminary Model for the Age of the Sandpiper Phosphate deposit. Besides providing an overview of the geology of the phosphate deposit this study provided confirmation of the age and furthered the understanding of the formation of the deposit that aided the interpretation of the biogeochemistry of the sediment.
2. An assessment of the plankton of the northern Benguela region with particular emphasis on the environs of ML 170;
3. Two fisheries modelling studies were undertaken to augment the findings of the biodiversity trawl survey conducted in June 2014. These are:
    i. A modeling review of the monkfish and hake biomass associated with ML 170; and
    ii. A review of the reproductive dynamics and stock distribution of key commercial fish species potentially affected by the planned dredging in SP-1. The data for both these studies were provided by NatMIRC; and,
4. An investigation into the value of ecosystem modeling as a means of determining the impact at the ecosystem level of the proposed phosphate dredging project.

Both the field-based and desk-top studies are of a high standard and fully reflect the knowledge and understanding of the various environmental components and their function within the highly dynamic Benguela ecosystem. All the studies have provided valuable new data and information on a hitherto poorly studied part of the Namibian continental shelf.

I attended the Peer Review Workshop, held in Cape Town on 13 and 14 August 2014, at which lead members of the Verification Study Team presented their findings and the Peer Review Team, led by Dr A.I.L. Payne, presented their individual and collective assessment of the work undertaken.

It is not my intention to repeat the findings of the Peer Review Team, with whose findings I am in overall agreement. Their findings were positive with respect to the selection and competence of the Verification Study Team members, the assessments they contributed to the original EIA 2012, and also their re-evaluation following completion of the Verification Programme. It is clear that the work done is of a high standard, credible and deserves to be published in the peer-reviewed scientific literature. The Verification Programme is probably the most comprehensive study of its kind ever conducted on the Namibian continental shelf in support of a marine mining project.

I present here two excerpts from the peer review report, *Independent Peer Reviews, Verification Studies, Sandpiper Project: Namibian Marine Phosphate (Pty) Ltd November 2014,* which comment positively on the quality on the work undertaken in the Verification Programme and on the dredging operation having a minimal potential impact on the marine environment:

(i) Comment on the standard of the scientific studies and assessments made:
*"Overall, the (*peer review*) team finds that the response of the client to issues raised at the earlier review of the EIA through commissioning appropriate verification studies has been appropriate and laudable. The quality of those verification studies is covered elsewhere in this report, but collectively and independently, they have been carried out to the highest scientific and technical standards, using appropriate and up-to-date methodology. The results have almost without fail raised the level of confidence associated with the results in terms of likely impacts (detailed in the 2012 EIA), and the (*peer review*) team wholeheartedly confirms those analyses".*

(ii) Comment on the potential impact of the proposed dredging project on the marine environment:
*"To conclude, the review team is impressed by the quality of the information provided to it and believes that all avenues and disciplines of concern relating to the proposed operation in SP-1 have been addressed adequately. The policy decision on whether to proceed is a national one, but we (*peer review team*) can say that the information provided to us has convinced us that everything points to there being a minimal impact of the proposed operation, should a licence be granted, to the Namibian shelf ecosystem".*

The scientific peer review panel identified the need for a preliminary modelling study of the fate and impact of the fine sediment discharged as overspill by the dredger. Such a study may provide a refinement of the desk-top study, extrapolated from an in-field verified modelling study of a similar dredging operation in southern Namibian waters. However, in my opinion, only direct measurement of the operational dredge plume's behaviour, i.e. duration and extent will enable a definitive assessment of its potential impact. In addition to this physical assessment, surveys of the plankton and fish potentially affected by the plume should be undertaken to complete this impact assessment. Such a midwater (water column) faunal survey requires a specialised vessel and gear, therefore every effort should be made to undertake the study in collaboration with NatMIRC's scientists. The peer review team

concurred that further in-field assessments of the dredge plume are not critical to the interpretation of impacts and decision making, however they are important as components of the EMP.

If I have any reservations with respect to the peer review team's recommendations for further studies it is that some of them appear to be more appropriate to a major research programme rather than to an environmental impact verification study. Nevertheless there is value in considering the incorporation of aspects of these recommendations in the monitoring programme. NMP has, after discussion with the specialist and peer review team, integrated many of these recommendations into the EMP.

In addition I reviewed the report prepared by Dr S. Mafwila, the appointed representative of the University of Namibia which was contracted by NMP to provide an independent assessment of the suitability of the equipment, sampling techniques, and analytical methods used for the specific scientific studies in the Verification Programme. The assessment is both positive and comprehensive and Dr Mafwila also concurs with the general findings of the peer review team.

Dr Mafwila's concludes his report with a statement with respect to the importance of the field work undertaken during the Verification Programme.

"As a UNAM representative in this whole verification programme, I am of the conviction that NMP has thus far conducted the most comprehensive scientific studies in their MLA. These studies have addressed uncertainties that were raised by the MFMR and beyond. New data sets were generated and new insights about the area have been brought forth, and improved our understanding of the physical, chemical and biological nature and dynamics of the area, and what would be the potential impacts of dredging. It is imperative to continue with monitoring surveys in the MLA, (detailed in the EMP) in order to support the current assumptions and statements. However, in the regional context, the monitoring of the state of the environment should be a concerted combined effort by government and mining companies".

J Midgley and Associates have demonstrated a high level of professionalism throughout the Verification Programme. The programme has required managing a multiplicity of inputs from the study team, organizing the logistics of the field programme, ensuring the health and safety of all the participants, and most importantly the preparation of the Verification Programme Report itself. The sustained commitment to the programme over a period almost three years is commendable.

Namibian Marine Phosphate (Pty) Ltd is acknowledged for its commitment to the Verification Programme and for making available the resources necessary for its success. The Verification Programme and associated EIA have set a high standard against which all future EIAs in Namibia's marine environment will be compared.

Conclusion

In parallel with the monitoring of NMP's dredging operation the Namibian authorities, particularly MFMR and NatMIRC, should be encouraged to undertake broad scale environmental monitoring of Namibian Continental shelf waters to provide a context in which all individual, site-specific projects can be assessed.

In conclusion the Verification Report documents a high quality scientific study that not only has verified, with greater confidence, the findings of the EIA (2012), but also has added significantly to the knowledge of the biogeochemical processes and ecology of the central Namibian continental shelf. In my experience no other environmental impact study in either Namibian or South African waters has been based on such an extensive high quality data gathering, analysis and interpretation programme.

I believe as a result of this work, there are no objective scientific reasons why an Environmental Clearance Certificate should not be issued and the project permitted to proceed.

P.D. Morant (Pr.Sci.Nat)
CSIR Independent Reviewer and Process Quality Controller
November 2014

Independent Reviewers

NMP in committing to this extensive and comprehensive Verification Programme recognised the need to have the scientific studies submitted to peer review. Similarly the processes and methods followed during the field acquisition of data were also subject to independent review. These executive summaries of these reviews are presented in this report. The independent reviews are presented in full in: *Independent Peer Reviews, Verification Studies, Sandpiper Project: Namibian Marine Phosphate (Pty) Ltd, November 2014.* In addition the entire Verification Programme report, environmental compliance and verification process has been independently reviewed by the CSIR.

1. Independent External Peer Review: Specialist Studies

The verification assessment reports of the Namibian Marine Phosphate appointed Specialist Consultants, as presented in this report have been independently assessed, via a team of international consultants, the team comprised of:

- [2]Dr Andrew Payne
- [3]Dr Michael O'Toole
- [4]Dr Barry Clark
- [5]Professor Alakendra Roychoudhury

In addition to the above parties, Professor John Rogers, formerly (now retired) of the Marine Geoscience unit at the University of Cape Town participated as a guest reviewer (formal report not required) in the independent review workshop with the team as above. Professor John Rogers, along with colleagues Dr Mike Bremner and Dr Gavin Birch first described the diatomaceous mud belt and phosphatic sands of the Southern African West and Southern Coastlines in the 1970s.

- The approach to the of assessment of water column and sediment biogeochemistry undertaken by Lwandle Technologies (Pty) Ltd was undertaken with guidance of [6]Dr Pedro Monteiro, CSIR Stellenbosch.

2. Independent External Review: Assessment of Processes followed during the verification programme

The methods and approach to the Verification Programme have been independent assessed by the University of Namibia, represented by [7]Dr Samuel Mafwila.

3. Independent Programme Reviewer and Process Quality Control: Verification Programme Report

The entire verification programme report, environmental compliance and verification process has been independently reviewed by the CSIR, represented by [8]Mr. Patrick Morant.

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[2] A&B Word Ltd, 12 Hill Farm Road, Halesworth, Suffolk, UK. *email*: ailpayne@hotmail.com
[3] Marine Ecosystems Management, Cluain Na Si, Kinvara, Go. Galway, IRE. *email*: otoole.mick@gmail.com
[4] Anchor Environmental, 8, Steenberg House, Silverwood Close, Tokai, RSA.
email: barry@anchorenvironmental.co.za
[5] 57 Pienaar Street, Somerset West, RSA. *email*: roy@sun.ac.za
[6] NRE Research Fellow, CSIR, 11 Jan Celliers Street, Stellenbosch, RSA. *email*: pmsmonteiro@csir.co.za
[7] University of Namibia, Department of Fisheries and Aquatic Science, Faculty of Agriculture and Natural Resources, 30 Mandume Ndemufayo Avenue, Pionierspark, Windhoek, Namibia.
email: smafwila@unam.na

Executive Summary

The formal review of Namibian Marine Phosphate's Environmental Impact Assessment (EIA), undertaken through the auspices of the Environmental Commissioner, determined that the assessed impacts required verification by additional site-specific data. A formal Verification Programme was planned and executed to meet this requirement and is documented in this report.

Verification Programme

The 2013 – 2014 Verification Programme reported upon in this document focuses on the primary target dredge site SP-1 (of Mining Licence 170). The programme has both substantiated and significantly raised the confidence levels of the findings presented in the EIA (2012) such that **"*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***" is now confirmed with a high degree of scientific confidence***.**

The above statement contained in the EIA (2012) has been substantiated through a multi-disciplinary investigations (and reviews) of the biogeochemical and fisheries environment, based on site-specific data collected from in and around the SP-1 target dredge site. The levels of confidence in the analyses and results of the Verification Programme are high.

A key statement made by the Southern African Institute for Environmental Assessment, which was appointed to review the EIA (2012) concluded, with respect to the Verification Programme described in the Environmental Management Plan, that: "*I have no doubt that if these survey activities are undertaken and the parameters listed are sampled and monitored, sufficient data would be collected and processes to allow for the verification of the impact assessment studies and assumptions. These data will establish useful baselines from which further monitoring activities can be undertaken after any of the proposed dredging cycles have been completed".* In line with this recommendation the proponent (NMP) elected to commission the verification study to achieve this objective, following further engagement and consultation with authorities and key I&APs. These discussions resulted in an expanded Verification Programme being undertaken.

The Verification Programme was included as part of the management plan submitted to the authorities in the project EIA (2012). The programme was designed on the basis of recommendations from the specialists, specifically to increase the levels of confidence in their impact assessments EIA (2012). The Verification Programme, to be completed prior to the commencement of dredging, comprised a programme of *in situ* sampling and measurement, complemented by laboratory analyses and interpretation.

To enhance the independence, robustness, transparency and validity of the Verification Programme and its processes additional tiers of external review have been introduced into the Verification Programme process management control, these are:

[8] CSIR: Consulting and Analytical Services – Environmental Management Services, 11 Jan Celliers Street, Stellenbosch, RSA. *email:* pmorant@csir.co.za

A panel of four internationally recognised scientists with specific expertise in the Benguela Current Large Marine Ecosystem were commissioned to conduct a peer of the specialist studies completed during the Verification Programme. The independent peer review team co-ordinated by Dr A.I. L Payne stated:

> *"To conclude, the review team is impressed by the quality of the information provided to it and believes that all avenues and disciplines of concern relating to the proposed operation in SP-1 have been addressed adequately. The policy decision on whether to proceed is a national one, but we (peer review team) can say that the information provided to us has convinced us that everything points to there being a minimal impact of the proposed operation, should a licence be granted, to the Namibian shelf ecosystem".*

The University of Namibia was commissioned to act as an observer during the programme's filed and laboratory activities to provide an independent Namibian review of the Verification Programme's technical and operational practices. The reviewer states:

> *"As a UNAM representative in this whole verification programme, I am of the conviction that NMP has thus far conducted the most comprehensive scientific studies in their MLA. These studies have addressed uncertainties that were raised by the MFMR and beyond. New data sets were generated and new insights about the area have been brought forth, and improved our understanding of the physical, chemical and biological nature and dynamics of the area, and what would be the potential impacts of dredging. It is imperative to continue with monitoring surveys in the MLA, (detailed in the EMP) in order to support the current assumptions and statements. However, in the regional context, the monitoring of the state of the environment should be a concerted combined effort by government and mining companies".*

The CSIR provided review and process control functions for the compilation of the EIA (2012). These services were extended to cover the entire work programme of the Verification Programme. Mr P. Morant, the CSIR's appointed representative, provides a review of the Verification Programme report. J Midgley and Associates were re-appointed to project manage the Verification Programme having provided the same services to the EIA (2012).

Background

NMP has applied to recover phosphatic sediments from the seabed on the Namibian continental shelf. Following an extensive exploration programme, a marine mining licence was issued by the Ministry of Mines and Energy (MME) in July 2011 subject to an Environment Impact Assessment being undertaken and approved prior to commencement of operations. In compliance with the conditions of the Mining Licence for ML 170, NMP then completed and submitted the project EIA (2012). The project EIA was initiated prior to the promulgation of the regulations under the Environmental Management Act No. 7 of 2007 (Gazette No. 4878, 6 February 2012). However, the EIA was undertaken in general accordance with the provisions of the Act and Regulations, including the mandatory public scoping and review processes.

The Sandpiper marine phosphate project (ML 170) is located on the Namibian continental shelf approximately 120 km south southwest of Walvis Bay (Figure 1). 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.

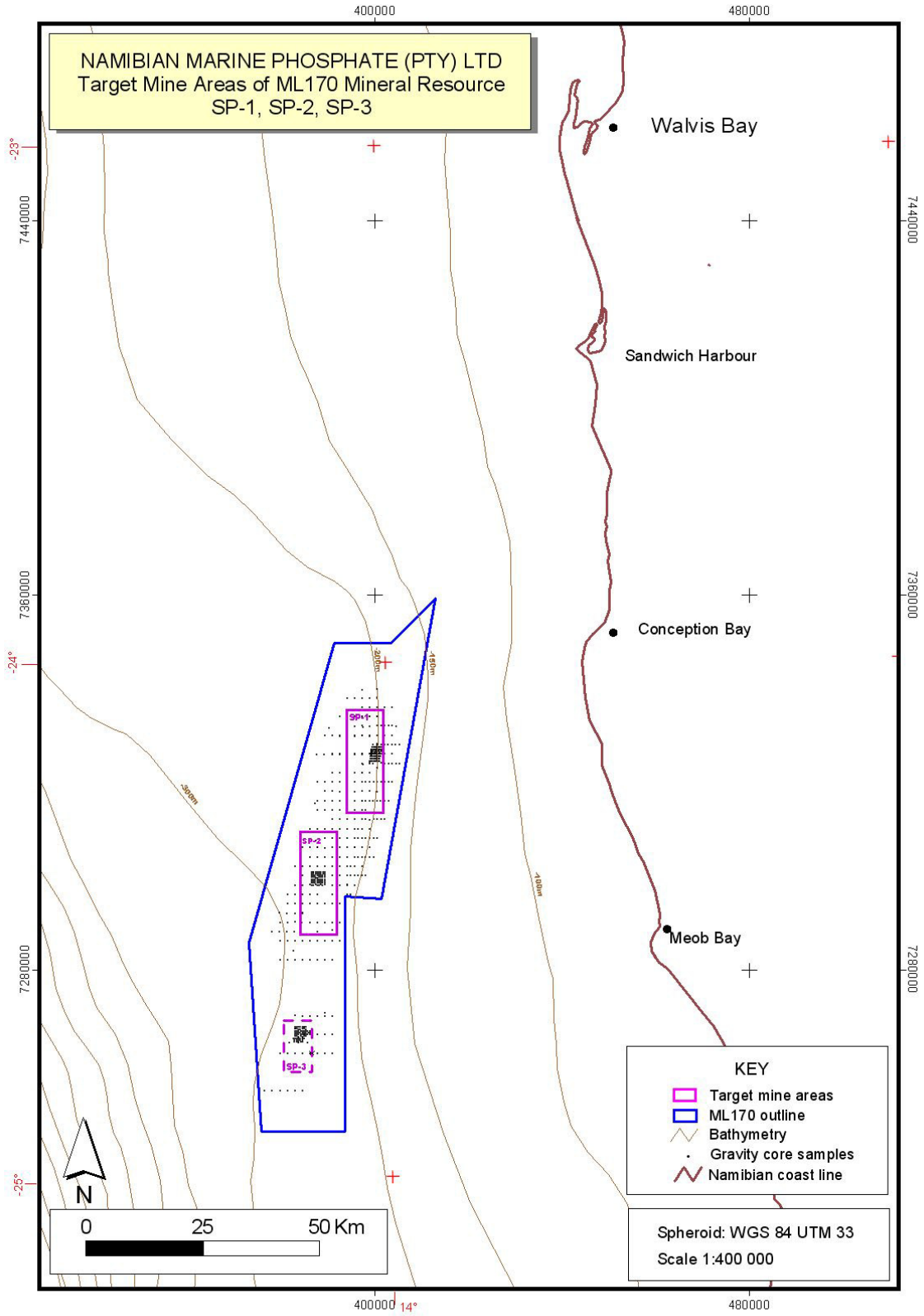

Figure 1: Location of ML 170, showing primary dredge target SP-1

Operations Overview

The phosphate-enriched sediments and defined mineral resources are located throughout the entire area of ML 170. Within the licence area, three mineral-rich dredging areas have been identified, SP-1, SP-2 and SP-3 (Figure 1). The primary target dredge site for the 20-year licence period is SP-1, which lies in water depths of 200 to 225 m. A trailing suction hopper dredger (Figure 2) will be used to recover approximately 5.5 million tons of phosphate-rich sediment annually from an area of up to 3 km^2 in extent. A total of approximately 60 km^2 will be dredged over the 20-year mine licence period.

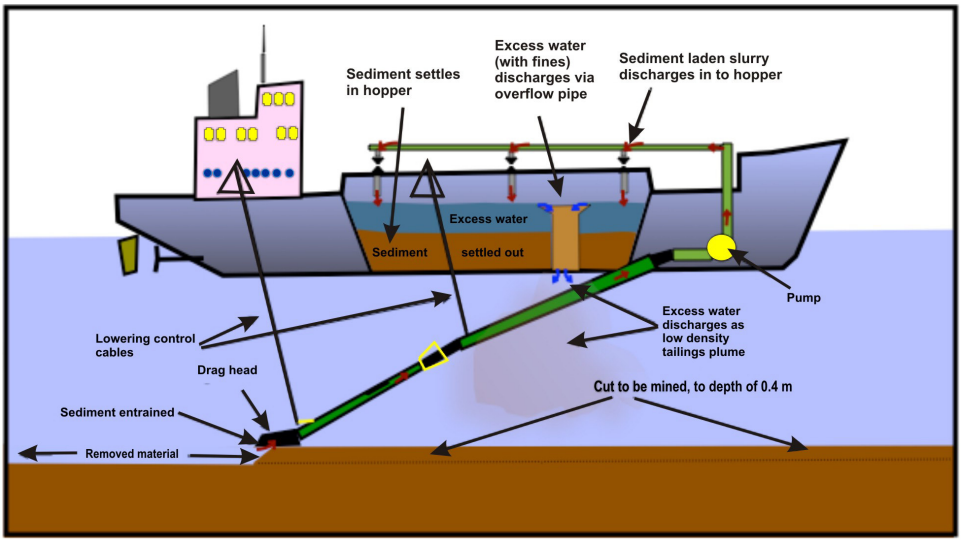

Figure 2: A schematic of a Trailing Hopper Suction Dredger (TSHD).

Scale of the Project

The Mining Licence Area is 25.2 km wide and 115 km long. ML 170 is 2233 km^2 in extent, representing approximately 2% of the Namibian continental shelf area (110 000 km^2)[9]. Within ML 170, the SP-1 target area is 176 km^2 (0.16%) of the total shelf area. Within SP-1 up to 60 km^2 representing 0.06% of the total shelf area, and 2.7% of ML 170 area will be dredged during the 20-year mining licence period. The 3 km^2 annual dredge area represents 0.003% of the total shelf area and 0.13% of the total ML 170 area.

Table 1: The proportions of the Namibian continental shelf, ML 170 and SP-1 affected by the proposed dredging project.

	Continental Shelf	ML 170	SP-1	20 year Mine Plan	Annual Area
Area (km^2)	110000	2233	176	60	3
% ML area		100.%	7.88%	2.69%	0.13%
% Shelf area	100.000%	2.030%	0.160%	0.055%	0.003%

[9] Molloy, F and Reinikaine, T (eds.) 2003. *Namibia's Marine Environment.* Windhoek, Directorate of Environmental Affairs, Ministry of Environment and Tourism. 166pp

EIA Submission and the Verification Programme

The impact assessments contained in the EIA (2012) were considered by the specialists to be robust and established to acceptable levels of confidence. Given that no significant risks that would preclude the project from proceeding had been identified, the EIA was submitted to the Ministry of Environment and Tourism (MET) with the request that an Environmental Clearance Certificate be issued in order that project development could proceed.

The Environmental Commissioner engaged independent external reviewers to assess the EIA (2012). The reviewers identified that the conclusions of the report were unsubstantiated, in that the assessment of impacts were presented largely against regional data extrapolated to the mine site and not based on site-specific data. In general the reviewers supported the recommendations of the EIA (2012) specialists as presented in the EMP (2012), i.e. requiring a verification survey to be undertaken prior to project commencement.

The Verification Programme as detailed in the EMP (2012) was expanded in response to the concerns raised by the Ministry of Fisheries and Marine Resources (MFMR), MET (and the external reviewers), representatives of the fishing industry, I&APs and the Chamber of Mines. The expanded Verification Programme was submitted to the authorities in December 2012.

The Verification Programme reported herein presents the results of the various specialist studies completed during 2013 and 2014. These studies provide evidence supporting the findings of the impact assessments contained in the EIA (2012). The Verification Programme focuses specifically on the primary target dredge site, SP-1, located within the northern portion of ML 170. The Verification Programme was designed to address the potential impacts of the dredging operation at a number of scales, namely within SP-1, within ML 170 and on the ecosystem as a whole.

Specialist Studies

The Verification Programme consisted of multi-disciplinary specialist investigations, undertaken by established consultancies and academic institutions. The findings presented in the specialists' studies were determined from site-specific data collected from in and around the target dredge site SP-1 during 2013 and 2014. The field data were collected during a number of dedicated ship-based surveys and a 90-day instrument deployment (mooring) to characterise the water column and sediments of the licence area. These surveys included a biogeochemical survey of the water column and sediments (including the collection of meio- and macrofauna), core and thiobacteria sampling surveys, and a biodiversity survey using a chartered monkfish trawler, deploying standard commercial gear with a modified (fine-meshed) cod end to collect epibenthic fauna. A geophysical survey was also undertaken over the northern portion of SP-1. The location and extent of the sample coverage for the Verification Programme is shown in Figure 3. The specialist reports were peer reviewed.

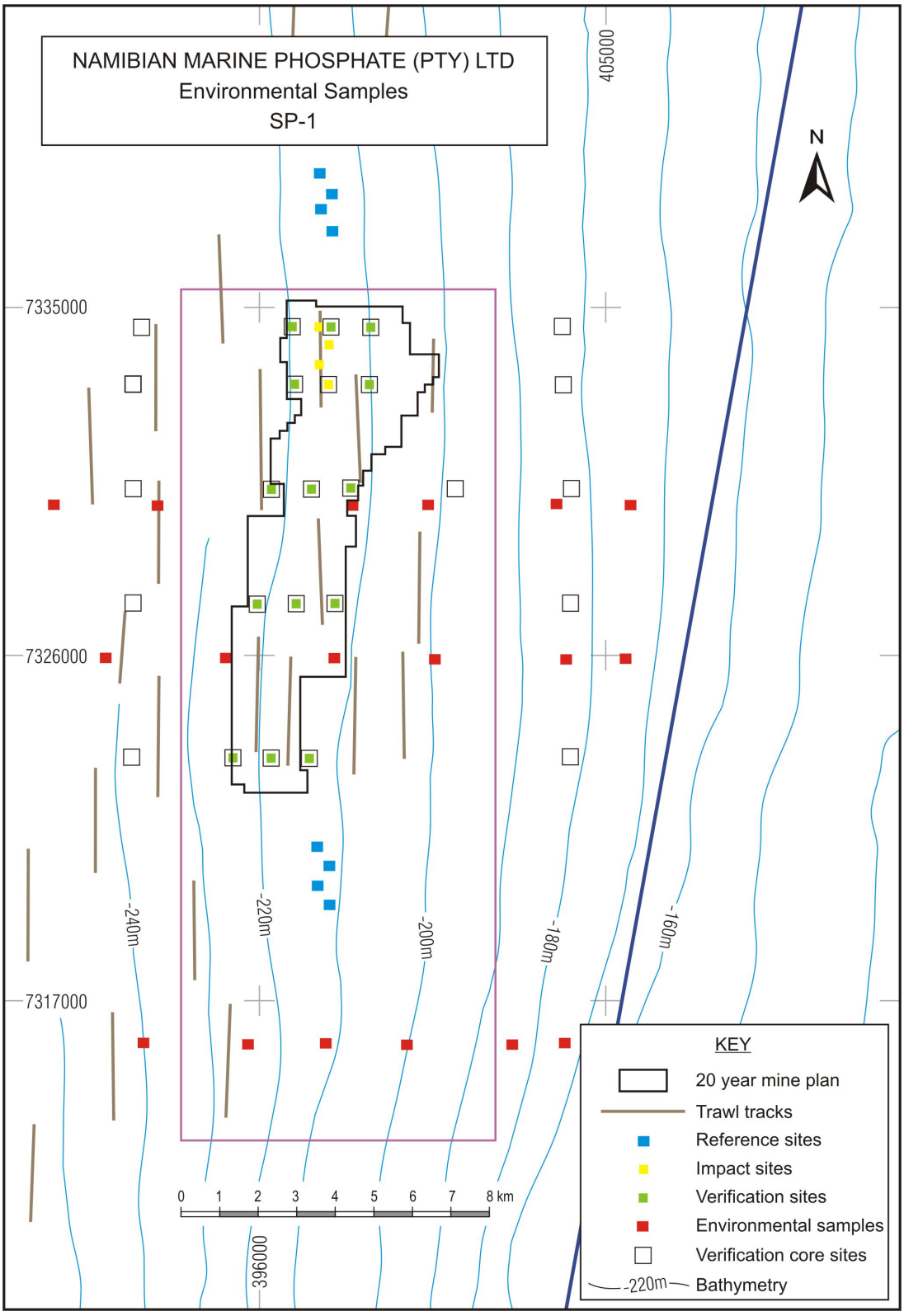

Figure 3: Distribution of the sampling sites of the Verification Programme across the target dredge area SP-1

Age and origin of the phosphorite deposits

The age and origin of the phosphorite deposits of ML 170 has been determined by analysis of sediment cores combined with strontium-36 isotope dating. These deposits formed over millions of years, initially by marine algae growing in the highly productive surface waters, dying and sinking to the seafloor where the organic phosphorus contained in the algal cells was incorporated into the mineral carbonate fluorapatite or francolite. Phosphorite grains were concentrated through repeated erosion of the sediment through wave and current activity during sea level lows. The repeated formation and reworking of these deposits has led to a highly enriched phosphorite deposit occurring in areas of the uppermost 2 m of the present day seabed on the Namibian continental shelf, and particularly in ML 170.

The basal phosphorite muddy sand varies from 0.5 to 1.5 m in thickness. The phosphorite grains formed predominantly during the early Pleistocene (2.6 to 1 Ma), and the deposit formed during the early to middle Pleistocene (2.6 to 0.126 Ma). This is overlain by increasingly shelly phosphorite sand of variably 0.5 to 1.5 m thickness, containing 65 to 86 wt% sand and 4-5 wt% mud. The phosphorite is diluted by shell fragments, particular the upper layer. The upper sediment profile displays multiple erosional surfaces formed during sea-level low stands that occurred during the various glacial maxima since 1 Ma. These findings are new to science and provide a robust understanding of the origins and age of the Sandpiper phosphate deposit.

Water Column and Sediments

The evidence gained from the verification survey on the balance of the issues of concern and queries raised by the authorities, reviewers and I&APs, support the assessment of impacts detailed in the EIA (2012).

The measured **currents** reflected consistent northwest (equatorward) flow in the near surface depths, switching between northwest and southward (poleward) flow at mid-depth and near the seabed a period of sustained poleward flow followed by switching between poleward and equatorward flows. The time series measurements at mid-depth were not available at the time of the EIA (2012) and the verification measurements represent new detail for the region. Notable is the fact that seabed current velocities are higher than the <10 cm/s reported in the EIA (2012). In the short-term, velocities ~30 cm/s were recorded at the mooring implying considerable turbulence at the seafloor.

Current velocity data show that most of the variability was in longer period (>3 day) fluctuations with inertial and tidal periods also being important. Lunar tides that were not identified in the data set had been invoked as the probable mechanism preventing accumulation of pelagically produced particulate matter (POM) in mid-shelf sediments immediately offshore of the mud belt. Even in the absence of such a mechanism, however, the ambient current velocities measured were sufficient to exert bottom shear stress forces well in excess of those required to suspend finer sedimenting particles, thereby preventing its accumulation in the survey area. Thus, although the mechanism that was invoked in the EIA was not demonstrated here, the consequences remain and coincide with the conclusions in that analysis.

The characteristics of the **water masses** present in the survey area over the period of measurement are those of the oxygen depleted, saline South Atlantic Central Water flowing south in the poleward undercurrent from the Angola gyre, and the less saline, relatively oxic Eastern South Atlantic Central Water from the Cape Basin. The influence of the latter on the ventilation of bottom water in the area is clearly evident from the temperature, salinity and dissolved oxygen time series measurements that were made.

Dissolved oxygen distributions measured during the survey showed that the upper mixed layer was normoxic and that in the sub-thermocline water oxygen concentrations decreased with depth to ~0.5 mg/ℓ. At the seafloor dissolved oxygen concentrations were generally below this (demonstrating periods of severe hypoxia which increased during ventilation events (to ~1.10 mg/ℓ).

Turbidity both in the water column and at the seabed in the presumed benthic boundary layer was typically low (~1 NTU) throughout the survey period. There was no clear association between the recorded turbidity events and current speed and direction (accelerations or switching events). The measurements support the conclusions reported in the EIA (2012) that the observed turbidity events are derived from the farfield, i.e. the nearer shore biogenic mud belt, and are advected past the ML 170 to the outer continental shelf and slope.

The surficial **sediments** are silty sand whilst the underlying sediments are primarily silt. Clay sized material was present in low proportions (<8%) in the deeper sediments only. Important aspects of the sediments were low porosity implying a firmly packed sediment with low pore water volumes and abundant shell material in the surficial and upper layers of the sediment. Both features would make the sediment body resistant to resuspension and reinforce the conclusions drawn in the EIA that local turbidity generation probably is a rare event.

Average **particulate organic matter** (POM) concentrations in the sediments of SP-1 were 7.4%, marginally higher than the upper level of 6.9% quoted in the EIA. C:N ratios in the POM were 11.4 in the surficial layers and higher at 19.8 in the underlying sediments. These ratios are indicative of refractory organic matter.

Inorganic nutrient concentrations in the sediment pore waters showed considerable enrichment of phosphorus compared with the overlying water column and there is a considerable departure from the classical Redfield ratio of 16. The phosphorus level is attributed to enrichment from the pelletal phosphate ore body. Pore water volumes are low, due to the low sediment porosity, and therefore significant modifications to upper water column Redfield ratios through translocation of pore water to the surface are not expected to occur.

Investigation of the **oxidative state** of the sediments included measurement of oxidation reduction potential, nitrate-nitrogen, and acid volatile sulphide (AVS). ORP was moderately high (> 0 ± 100 mv) throughout all of the sediment core samples implying that they were hypoxic. The presence of nitrate-nitrogen in the sediment pore water supports this as it converts to ammonia in anoxic conditions. AVS was below detection levels in the surficial sediments and averaged <2 mMol/kg in the subsurface layers. The absence of AVS is consistent with hypoxia as free sulphide is oxidized to sulphate ($SO4^{2-}$) in the presence of oxygen. This implies that the surficial sediments were hypoxic during the period of measurement. These findings support the conclusion on sediment properties in the EIA (2012), i.e. the sediments in ML 170 were probably hypoxic and would have low sulphide fluxes associated with them.

Dissolved heavy metal concentrations in the water column were close to or below the detection limits of the analytical procedures used. This is expected for a survey area that is distant from any industrial sources of such metals. Nutrient concentrations measured were within those recorded for the region and Redfield ratios (Molar N/P) averaged 17.71. This is marginally higher than the classical 16:1 and may be attributable to a minor nitrate-nitrogen enrichment. Both of these findings support the general contention of the EIA (2012) that water quality in the region of the survey area is at or close to its natural state.

Heavy metal concentrations in both surficial and subsurface sediments reflect relatively high concentrations of arsenic, cadmium, chromium, copper and nickel. High concentrations of cadmium and nickel were predicted in the EIA (2012). The bioavailability of these heavy metals in the dissolved phase was investigated by elutriation tests and negligible proportions were released. The low release of the metals into the dissolved phase indicates that, although their natural concentrations exceeded the BCLME sediment quality guidelines, they do not represent a toxicity risk either *in situ* or following physical disturbance in this phase.

Heavy metal concentrations of the Namibian continental shelf sediments are characterised by elevated cadmium concentrations and, although no empirical data could be sourced for this, it is probable that resident demersal fish such as hake and monkfish on the entire Namibian continental shelf would naturally have elevated cadmium concentrations in their livers. Consequentially the proposed NMP dredging operations would not affect them. Trophic transfers of heavy metals associated with sediment plumes generated by the proposed dredging would include ingestion/take-up by planktonic copepods. This uptake of heavy metals would be interrupted at this stage partly due to the rates of digestion of food particles being longer than gut passage time thus leading to loss of metals in faecal pellets. Sinking rates of these pellets are high and the metals would be returned rapidly (hours to days) to the seafloor.

Benthic meiofauna and macrofauna

Benthic meiofauna and macrofauna were abundant in the surficial sediments in the survey area. This is consistent with a mainly hypoxic sediment environment and inconsistent with sulphidic sediments. The relative abundance of benthic macrofauna in the >1 000 µm size class indicates that this condition is persistent as (*Para*)*Prionospio*, which formed a large proportion of the fauna, has a life cycle of 1-2 years and *Diopatra* sp. may be as long-lived. This is consistent with a stable sedimentary environment even though the overlying water body may undergo seasonal changes in terms of its oxygen content with varying contributions of Cape Basin and Tropical Atlantic Central Water. The macrofauna of ML 170 has a larger geographical distribution and/or has been recorded elsewhere from the Namibian and/or South African west coast.

Thiobacteria

The investigation into sulphur bacteria indicated sulphide fluxes were probably low as the large sulphate bacteria, namely from the genera *Thiomargarita*, *Beggiatoa* and *Thioploca*, which play a significant roles in the oxidisation of H_2S were absent from the bacterial assemblages collected. Smaller forms including *Thiobacillus* spp. with relatively lower growth yields were present.

Plankton

The oceanographic environment off Namibia is dynamic and is primarily defined by the Benguela Current upwelling system supporting a productive ecosystem with a high abundance of phytoplankton, zooplankton and ichthyoplankton species. Within the Lüderitz upwelling cell species abundance is low, but further north off the central Namibian coast where ML 170 is located, is a transitional zone between the southern and northern regions of the Benguela ecosystem where species abundance increases. Species abundance tends to decrease further offshore which is important since the proposed dredging site is located 60 km offshore. The species present in the vicinity of the ML 170 area are ubiquitous in the region.

Phytoplankton communities in the area are dominated by diatoms and the majority of species present are found elsewhere in the world's oceans. Diatoms occur primarily within inshore waters, with biomass decreasing steadily seawards. The phytoplankton species found within the vicinity of ML 170 are, therefore, not only ubiquitous but also occur in decreased abundance in comparison with inshore waters.

Zooplankton communities in the central Namibian region are dominated by copepods that are not unique to the area. In contrast to the phytoplankton, the zooplankton is found slightly further offshore, where abundance peaks on the shelf-break at depths of approximately 200 m. The proposed dredging activity is located in water depths of 200 to 225 m, and so an increased abundance of zooplankton will be present. However, the species present will not be unique to the area.

Central Namibian waters support several commercial fisheries, with sardine, anchovy, hake and horse mackerel being particularly important. The **ichthyoplankton** of these species found off central Namibia plays a pivotal role in recruitment to the fisheries, and are especially important in the light of the current depleted state of the sardine and anchovy fisheries. Generally, however, fish off the Namibian coast spawn in inshore waters north of Walvis Bay. Therefore, the proposed mining area off central Namibia is not within any important spawning or nursery grounds, particularly for the commercially important fish species.

Overall, although the waters off central Namibia are productive and support large communities of plankton, the proposed dredging site does not occur within any identifiably important area for phytoplankton, zooplankton or ichthyoplankton growth and development.

Plume Modelling

An independent review of the characterisation of the dredge plume by the CSIR indicates that it is possible *(but not certain)* that the actual plume dimensions may exceed the dimensions reported in the EIA (2012) (i.e. plume dimensions may be up to 2 to 5 times larger than indicated). However, the implication of these potentially increased plume dimensions for the overall impact assessment is limited. It is not expected that these *possible*, but modest, changes in the impacted area will materially affect the environmental decision-making for this project. A modelling approach has been recommended in terms of providing greater certainty on the behaviour, extent and duration of the sediment discharge charge plumes. This will be undertaken prior to dredging (base case) and during dredging (operational case), forming part of the monitoring commitments.

Fish, Mammals and Seabirds

The trawl survey showed that the size distribution of the main commercial fish species likely to be impacted (i.e. monk and hake) are consistent with what is known and with what was assumed in the EIA (2012). There is no evidence of unique spawning and recruitment characteristics in ML 170. The abundance of juvenile and pre-recruiting Cape hake is consistent with what is known. Further, the proportions of juveniles and sex ratios (males and females) suggests no irregularities that would establish the dredge area as unique. With regard to monkfish, as expected, the verification survey shows a mix of juveniles, adults and pre-recruiting fish. As the survey used monk-directed gear with a cod-end liner (20 mm mesh) to retain as much as possible, the proportion of juvenile fish caught was higher than would be expected. Both the verification survey outputs and the biomass estimates for SP-1 confirm that the limited extent of the dredging (in particular SP-1) is likely to have only a very small impact relative to the overall abundance of the monk and hake stocks in Namibian waters. The impact in

SP-1 on monk reproduction and the recruitment to the commercial fishery as a whole will also be minimal. Sole were also caught in the verification survey, however their abundance was not high. Furthermore, predominantly large sole were caught suggesting that the SP-1 area and adjacent grounds are unlikely to be a significant recruiting area for sole to the monk trawl fishery. The Verification Programme for the fish, mammals and seabirds confirmed the core assumptions of the EIA (2012), confidence levels of the impact assessments are now reported as high.

Fish, Mammals and Seabirds: Verification Activities

The Verification Programme component for fish, fisheries and biodiversity consisted of two modelling studies, a review of ecosystem modelling and its application to ML 170, and a biodiversity (monk trawl) survey. The findings of these assessments included:

1. A modeling assessment of **fisheries biomass** in SP-1 and the MLA concluded that less than 0.2% of the biomass of *Merluccius capensis, M paradoxus* and *Lophius vomerinus* lies directly within the proposed SP-1 dredge site, also the site makes no significant contribution to recruitment or spawner stock biomass for the species considered. Outside of SP-1 but still within the total MLA, the biomass of monk expected to contribute to the fishery recruitment was estimated to be 7%. It was emphasized that the broader impact, however, is likely to be negligible as the proportion of the potential biomass of hake and monk in SP-1 and recruiting to the commercial fisheries in the adjacent areas is extremely small when extrapolated beyond the actual area (a 60 km^2 portion of SP-1, (176 km^2)) to be dredged.

2. A modeling assessment of the **reproductive dynamics** of the main commercial fish species was undertaken. The stock structure and gonad maturation of the main commercial species from NatMIRC data showed that there were no special characteristics of their reproductive dynamics in the proposed dredging area (SP-1). Further, the study showed that there was no deviation expected that would make the area unique with respect to these reproductive biological characteristics. The study also considered cohorts for all the species analysed and showed that a mix of small and large fish for most of the Namibian EEZ was typical and that for the MLA there were no indications of any deviation from this norm. In addition the study showed that the MLA was not a unique spawning area that supported significantly different levels of recruitment of the main commercial species to the fisheries in the proximity of the MLA. Monthly trends also did not indicate any gonad development beyond “maturing stage” of the commercial species found in the MLA. This supported the suggestion that fish move in and out of such grounds over time. Annual maturity trends have also not shown repeated dynamics, implying that spawning grounds for these species are not localized. Multiple cohorts observed per year and by area suggest that high and low recruitment events are a normal occurrence. This again indicated the lack of a “homing behaviour” for adults, with the boundaries for recruitment and spawning grounds not clearly defined.

3. The review of the possible **ecosystem impacts** of dredging within the broader northern Benguela system concluded that the combination of the high uncertainty typically associated with projections by ecosystem models and the small area that will be affected by the proposed dredging means that it is unlikely that ecosystem modelling would expose any unexpected or highly significant threats that have not already been considered and evaluated in the specialist studies.

Biodiversity Trawl Survey

The field component of the fish, mammals and seabirds study was an eight-day (June 2014) biodiversity survey of the proposed target dredge area (SP-1). A commercial monkfish trawler, the FV *Zeearend,* was chartered to sample 24 stations in and around the SP-1 target dredge area in water depths greater than 200 m.

A total of 14 fish species including two squid species (*Todarodes angolensis* and *Todaropsis sagittatus*) and one shark (*Hexanchus griseus*) was identified. Cape hake dominated the catch, amounting to 40% of the total fish weight. This was followed by monkfish, 35%, rat tail (*Coelorinchus simorynchus*) 14%, West Coast sole 3%, bearded goby 2%, and horse mackerel 0.4% of the total fish catch. Cape hake, monkfish and gobies were found in most of the trawls and there was little variation in the catches of commercial species throughout the survey area.

The survey provided baseline data on biodiversity. In general fish diversity was lower than reported in the EIA (2012). This is probably due to the fact that in the EIA (2012) data on fish diversity were consolidated from surveys using different gear types (hake, monk, midwater, purse seine). The fauna recorded in the verification survey was notably less abundant than reported in the EIA (2012) since the verification survey deployed dedicated monk trawl gear, no inference from it can be made regarding the availability and abundance of non-demersal species such as horse mackerel, sardine, mesopelagics and gobies (noting that both gobies and horse mackerel were, however, present in small numbers).

Fifteen species of seabird were recorded during the survey, of which 45% were White-chinned Petrel (*Procellaria aequinoactialis*), 20% Subantarctic Skua (*Catharacta antarctica*) and 12% Black-browed Albatross (*Thalassarche melanophrys*).

Only two species of marine mammals were observed during the survey, the Cape fur seal (*Arctocephalus pusillus pusillus*) and the dusky dolphin (*Lagenorhynchus obscurus*).

With respect to demersal fish species mammals and seabirds, no unique features were noted and the results are consistent with the initial assessment in the EIA (2012) (recognising that the abundance of some species, particularly sea birds and mammals will vary seasonally as well as spatially). Regarding mesopelagic species, none was recorded in the trawl catches. Mesopelagic species such as lantern fish are expected in the mid-water, however the gear used would not have targeted these species. Catches between night and day varied as expected i.e. normal diurnal behavioral patterns prevail with regard to fish and crustaceans.

In all, 14 taxa of epifauna were collected by the bottom trawl, including crabs, ascidians (sea squirts), brown sponges, sea pens, mantis shrimps, starfish and whelks. The colonial ascidian (*Molgula* sp.) was numerically the most dominant bottom living organism, contributing up to 60% of the epifauna catch weight during the survey. This was followed by the pennate sea pens (family Veretellidae), which made up 37%. Both these groups were found widely distributed over the area surveyed. Jellyfish, particularly *Chrysaora fulgidia* were also abundant in all trawl catches. With respect to epifauna, the high abundance of ascidians was notable. Their abundance may in part be due to the historically very low density of trawling of the region and in particular in SP-1.

Hydrological data collected during the survey indicated a well-mixed layer of South Atlantic Central Water with typical winter values for temperature and salinity and low oxygen levels near the seafloor.

Habitat

Interpretation of the geophysical data conclusively demonstrated a flat, smooth seafloor with a homogeneous surficial sediment cover across the northern part of SP-1. No protruding obstacles (rocks and reefs) were observed. The homogeneity of the meiofauna and macrofauna assemblages reflects the homogeneous nature of the seafloor in SP-1.

Noise

A literature-based assessment of the potential impacts of sound from dredging vessels on a variety of species showed that sound levels in all cases are well below those known to cause damage to marine life.

Ecosystem

With regard to ecosystem impacts as a whole, the survey suggests that the area possesses no unique features and is consistent with the findings in the EIA (2012). The primary issue in the ecosystem context is one of scale and the area of impact (up to 3 km^2 annually and 60 km^2 for the 20-year mining lease period) is so small relative to the overall extent of the Benguela ecosystem that significant impacts on the ecosystem are unlikely.

Impact Assessment Verification

The focus of the Verification Programme was to verify, through the collection and analysis of site-specific samples and measurements, the assessments of impacts contained in the EIA (2012). Overall the level of confidence in the original assessments 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 SP-1 dredge site (176 km^2). The verification of the impacts reported in the EIA (2012) and the revised levels of confidence are presented (Tables 2 to 4).

The **cumulative effects** are addressed in the context of the numerous anthropogenic activities within the Exclusive Economic Zone (EEZ) and the responsibilities for their management. The potential cumulative effects related to the dredging project are identified. Particularly relevant comment is provided on the limited likelihood of the development of a multiplicity of marine phosphate mines on the Namibian continental shelf. This is related to market forces (world demand for phosphate) and the economic entry grade (percent of P_2O_5 in the ore) required to establish a resource. Effectively these resource bodies are limited to two areas on the Namibian continental shelf and mining licences have been issued for both.

Table 2: Water Column and Sediments: Summary of impact assessment determinations: Re-evaluated following the verification assessment.

Impact	1	2	3	4	5	6	7	8	9	10	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

Table 3: Fish Mammals and Seabirds: Summary of impact assessment determinations: Re-evaluated following the verification assessment

Impact	1	2	3	4	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

Table 4: Macrofauna: Summary of impact assessment determinations: Re-evaluated following the verification assessment.

Impact	1	2	3	4	5	6	7	8	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 I*	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	None	None	None	None	None	None
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

Appendices: Supporting documentation

The Verification Programme report contains six appendices each presenting substantive information that is valuable in its own right as well as serving to substantiate the assessments of the specialist studies.

There are a number of project execution plans and cruise reports that provide detail on the scope, quality management controls and activities of the four marine surveys including the related protocols for sample analysis. Of particular note is the induction module supporting the fishery and biodiversity survey. The module establishes field analysis standards for this and subsequent surveys. The standards of the surveys and analyses undertaken are favourably commented on in the review of processes (field work and measurement) provided by the University of Namibia.

The thirteen bullet point critique of the EIA (2012) by MFMR is listed. It formed the basis of engagements with the ministry and its scientists. Subsequently, along with other inputs (from authorities, appointed external review parties, the fishing industry and the I&APs) the Verification Programme as originally detailed in the EMP (2012) was expanded.

There is a summary of important project events covering the duration of the Verification Programme. This serves to indicate what was undertaken, why it was undertaken and the related commitment to achieving the objectives of the programme. Of particular importance is the record of meetings and communications with the authorities, and I&APs.

The terms of reference and abbreviated curricula vitae of the specialists, project management team and CSIR reviewer are presented. The qualifications and work experience of the project team provides further confidence in the findings of the Verification Programme report.

A brief description of the proposed dredging method and operation is presented.

Verification Study - Quality Process Control

Peer Reviews

The scientific studies of the Verification Programme were submitted for peer review. The peer review team, Dr A. Payne (lead), Dr M. O'Toole, Dr B. Clark and Professor A, Roychoudhury (internationally recognised experts in fisheries, marine ecology, benthic ecology and biogeochemistry) reviewed the specialist reports contained in the EIA (2012), those of the 2013 – 2014 verification study, and relevant supporting documentation and correspondence. This served to ensure that the review parties were prepared for the specialist presentations at the Cape Town workshop (August 2014). The independent assessment of the specialist studies by the peer review team adds significant credence to the outcomes of the Verification Programme. The peer review team's report "*Independent Peer Reviews, Verification Studies, Sandpiper Project: Namibian Marine Phosphate (Pty) Ltd, November 2014*" is an independent document. A summary of the peer review report is presented in the main body of this report.

In their findings the peer reviewers are both critical and complementary, their criticisms required additional work to be undertaken by the specialists (now completed), and modifications (addition of work commitments) to the monitoring programmes as described in the EMP (2012). Their complements related to the thoroughness of the assessments, the high standard of scientific enquiry, the technical and analytical levels of evaluation, confirming that the Verification Programme has been undertaken to international levels of competency.

The peer review team provides a number of key comments, extracts of which are presented here.

The peer review team comments on the standards of the assessments and the technical approaches:

*"Overall, the (*peer review*) team finds that the response of the client to issues raised at the earlier review of the EIA through commissioning appropriate verification studies has been appropriate and laudable. The quality of those verification studies is covered elsewhere in this report, but collectively and independently, they have been carried out to the highest scientific and technical standards, using appropriate and up-to-date methodology. The results have almost without fail raised the level of confidence associated with the results in terms of likely impacts (detailed in the EIA (2012)), and the (*peer review*) team wholeheartedly confirms those analyses".*

The peer review team comments on the management framework with its commitment to ongoing monitoring:

"Future monitoring of all key aspects including an analysis of the potential impacts on the seabed and surrounding areas of the dredging operation needs to be built into any forward-looking management plan, but it will be crucial in doing so to bear in mind potential seasonal effects and the need for consistency in the methodology, gear deployed and even the vessels used".

The peer review team comments on the ingestion of trace heavy metals:

"Although the current scientific output indicates no such likelihood that it will be a problem, any potential risks arising from ingestion by fish and other fauna of trace heavy metals bound to sediment or organic matter in the water column or on the seafloor should be evaluated by means of laboratory-based sediment toxicity studies".

The peer review team recommends the establishment of a preliminary plume model:

"The water column report needs to include a preliminary model applicable to the SP-1 dredging area using data on current measurements and sediment properties that have already been collected in the vicinity, to demonstrate the distribution, dispersal and sinking rate of plume sediments. Such a model can be developed further as additional data are gathered during environmental monitoring and dredging operations".

The peer review team recommends additional assessment of the mesopelagic scattering layer:

"An in-depth analysis of the mesopelagic scattering layer in the MLA. Its presence needs to be confirmed either acoustically using a vessel echo sounder or from upward-looking ADCP instrument data moored in the area".

The peer review team, recommendations regarding the biogeochemistry of the deposit:

"The collection in future of site-specific sediment dynamics data would support a better understanding of how MLA 170 will be responding to cumulative anthropogenic and natural effects there".

"Sulphide dynamics will be important, so a better understanding needs to be sought during the operational phase of how oxygen consumption will be affected by the reduced (dredged) sediment reservoir".

The peer review team provides a primary mitigation statement:

"It is also crucial that, by way of mitigation of potential impact on the macrobenthos and to minimize the possibility of jellyfish polyps establishing in an area, a residual layer of sediment is left on the clay footwall underlying the mineral deposit. Further and if feasible, "lanes" or areas of sediment be left untouched; these two exercises will together facilitate the re-establishment of benthic macrofaunal assemblages on the substratum".

The peer review team further suggests that adaptive management:

"……..future dredging operations be authorized only within an adaptive management framework (i.e. coupled with intensive monitoring and careful scrutiny of such monitoring data by independent experts and the authorities) and that the authorities retain the right to require that the scale or scope of dredging be adjusted or that additional mitigation measures be implemented to ameliorate any unforeseen impacts that may arise".

In summary, the peer review team confirms the Verification Programme undertakings, findings, and the commitments therein. Further, they recommend as precautionary measures additional work (which has been undertaken) and monitoring requirements, detailed in the EMP (2012).

The **University of Namibia** (UNAM) was specifically engaged to provide independent review services of the Verification Programmes technical and operational practices. This agreement was formally established (May 2013) between Namibian Marine Phosphate (Pty) Ltd and the Central Consulting Bureau of the University of Namibia, with Dr S Mafwila designated to provide these services.

The reviewer comments, that not all of the concerns were dealt with by NMP, however, he acknowledges that the company "…. *has addressed the most critical ones to the best of their ability and in a more transparent and practically feasible way*".

The reviewer participated in the 10-day marine **biogeochemical survey** (July – August 2013). He attended the pre-survey induction and familiarisation presentation and took up an observer's role during the survey. He was accompanied by two UNAM fisheries students who gained valuable experience and insights into conducting scientific research at sea. He observed equipment deployment, sample recovery sample collection, packaging and storage. During this survey, an instrument-mooring buoy (configured to evaluate oceanographic dynamics) located adjacent to SP-1 in 190 metres of water, was recovered for maintenance, data downloaded and subsequently re-deployed for a further 45 days. He provides a review of the equipment used and its appropriateness. Noting that it is preferable to use the Van Veen grab as opposed to Day grab for the sampling of macrofauna, he recommends use of the latter for future monitoring. Although a multi-corer is considered preferable to the Day grab for collection of biogeochemical samples he notes, however, that multi-core devices are susceptible to poor penetration in compact sediments such as those of ML 170.

Typically, **field operations** are beset with challenges, and this instance that during the in situ measurements of oxidation-reduction potential the sediments are exposed to air, and thus these particular results may be questionable. Notwithstanding these observations, his general comments are, "*the sample handling onboard and processing was adequately conducted with care and good workmanship"*. He further notes, that: "*Reliable data were generated for both benthic macrofauna and meiofauna within the primary dredge target area of SP-1. Verification was done on the sediment characteristics, which have confirmed the area is not within a mud belt, with very little, or no Hydrogen Sulphide and organic-rich sediments'.*

The **laboratory and processing** facilities of the CSIR (Stellenbosch) and the University of the Western Cape were inspected. A favourable report is provided on the capacities of these institutions.

A review of the June 2014 **biodiversity trawl survey** (considering demersal fish biomass distribution and diversity, epibenthic fauna, and mammals and seabirds) conducted over the target dredge site SP-1 is provided. The survey was conducted from a monkfish side trawler the FV *Zeearend*, chartered from the Benguella Fishing Company. The report on the survey concludes *'the survey generated a wealth of information, the level of which is unique to the area".* The survey execution, sample processing and data reliability are regarded as high.

Finally the reviewer attended the **peer review workshop** in Cape Town during August 2014, with the primary functional role to validate the independent process. He notes that the peer review team was carefully selected and had appropriate experience and skills to evaluate the required disciplines thoroughly. It is noted that the review team had the opportunity to review the relevant documentation prior to the workshop, and that the workshop was conducted in a fair and transparent manner.

The report prepared by UNAM "*Independent Peer Reviews, Verification Studies, Sandpiper Project: Namibian Marine Phosphate (Pty) Ltd, November 2014,*" is an independent document.

Conclusion

The major concern that large quantities of **hydrogen sulphide** would be released by dredging is extremely unlikely, since the biogeochemical study has shown that, unlike the mud belt further inshore, the sediments in ML 170 do not contain significant quantities of hydrogen sulphide that could enter the water column.

The **biodiversity** survey has demonstrated that the fauna of the ML 170 area is no different from that of the wider Namibian continental shelf. The seafloor in ML 170 is remarkably uniform i.e. there is no diversity of habitats and no unique faunal communities have been identified as being present. The surficial sediment character is homogeneous.

With respect to the main **commercial fish species**, the data obtained showed that there were no special characteristics of their reproductive dynamics in ML 170 and it is not a unique spawning area that supports significantly different levels of recruitment of the main commercial species to the fisheries.

Heavy metal concentrations in both surficial and subsurface sediments reflect relatively high concentrations of arsenic, cadmium, chromium, copper and nickel. High concentrations of cadmium and nickel were predicted in the EIA. The low release of the metals into the dissolved phase indicates that although their natural concentrations exceeded the sediment quality guidelines for the region they do not represent a toxicity risk in this phase either *in situ* or following physical disturbance. The bioavailability of these heavy metals in the dissolved phase was investigated by elutriation tests and negligible proportions were released.

With regard to **ecosystem**, the surveys indicate that ML 170 possesses no unique features.

The Verification Programme has enabled the level of confidence in the original assessments made in the EIA (2012) to be raised from medium to high. The Verification Programme report and the integrated independent reviews have determined that there are no identified ecological risks of a significant nature that would preclude the project from being authorised. Ongoing monitoring of the assessed impacts is required as a mitigation, management and intervention tool, with responsibilities for this lying both with the proponent and the authorities.

J. Midgley (Pr.Sci.Nat)
Project Co-coordinator
November 2014

Contributors

The following companies / persons have contributed to this report:

Jeremy Midgley
J Midgley and Associates cc
PO Box 110 Constantia 7806 Cape Town
mwjmidg@mweb.co.za

Project Co-ordinator

Dr Robin Carter, Kate Munnik, Laura Weston
Lwandle Marine Environmental Services (Pty) Ltd
Old Warehouse, Fir Road Observatory Cape Town
Robin@lwandle.co.za

Water Column and Sediments

Dave Japp, Melanie Smith, Dr Kevern Cochrane,
James Gaylard, Dr Hilkka Ndjaula
Capricorn Fisheries Monitoring cc
Unit 15 Foregate Square, Table Bay Boulevard, Foreshore
Cape Town
dave@capfish.co.za

Fish, Fishery and Biodiversity

Dr Nina Steffani
Steffani Marine Environmental Consulting
21 Skippers End, Zeekoevlei Cape Town
nina@steffanienviro.co.za

Benthic Macrofauna

Timothy McClurg
KZN Costal Impact Consultants
PO Box 230, Kloof, Kwazulu Natal
mcclurgs@telkomsa.net

Epifauna

Roy Van Ballegooyen
CSIR
11 Jan Celliers Street, Stellenbosch
RvBalleg@csir.co.za

Plume Modelling

Dr Bronwen Kirby
Department of Biotechnology:
University of the Western Cape
Robert Sobukwe Road Bellville Cape Town
bkirby@uwc.ac.za

Thiobacteria assessment

Gordon Rigg
Marine Data Consultants
1A Carlton Close, Sun Valley Cape Town
gordon.rigg@marinedataconsultants.co.za

Geophysics Interpretation

Bruce Spolander, Sanette Gildenhuys
Metocean Services International
Unit 13 Constantia Business Park, 31 Princess Vlei Road
Diep River Cape Town
Bruce@metoceanservices.com

Oceanographic deployments and monitoring

Dr Simon Forster
Physalia Ltd
Little Pook Hill, Heathfield Road, Burwash Weald
Etchingham East Sussex UK
Simon.forster@physalia.demon.co.uk

Meiofauna

Jeremy Midgley
J Midgley and Associates cc
PO Box 110 Constantia 7806 Cape Town
mwjmidg@mweb.co.za

Habitat Mapping

Approval

Title	Sandpiper Project, Verification Programme, Volume 1: Main Report, Namibian Marine Phosphate (Pty) Ltd Mining Licence Area No. 170.	
Date	November 2014	
Prepared for	Namibian Marine Phosphate (Pty) Ltd 127 Theo-Ben Gurirab Street Walvis Bay: Tel + 264 64 278 150 Fax + 264 64 855 8000 13	
Prepared by	J Midgley & Associates, Po Box 110 Constantia 7806 Cape Town South Africa.	
Project coordinator	Mr. Jeremy Midgley (MSc) (Pr.Sci.Nat)	
Verification Programme report review	CSIR. Mr Patrick Morant (MSc) (Pr.Sci.Nat)	
External review: Specialist reports	Prof. A. Roychoundhury, Dr A. Payne, Dr M. O'Toole, Dr B. Clark (Dr A. Payne coordinating party)	
External review: Technical and operational practices	University of Namibia: Dr S Mafwila	
Application	This report has been prepared to verify the findings of the NMP Final EIA (Midgley 2012), as submitted to the Ministry of Environment and Tourism. The need for, and scope of, the Verification Programme was detailed in the EMP (Midgley 2012), The scope subsequently was expanded following consultations with MFMR, NatMIRC scientists and Fishing Industry (I&APs).	
Report preparation	**J Midgley & Associates** Mr. Jeremy Midgley (Pr.Sci.Nat) *Date: November 2014 Signature:*	
CSIR Independent Reviewer and Process Quality Controller	**CSIR** Mr. Patrick Morant (Pr.Sci.Nat) *Date: November 2014 Signature:*	
Report acceptance	**Namibian Marine Phosphate (Pty) Ltd** Mr. Michael Woodborne (MAusIMM) *Date: November 2014 Signature:*	

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