APPENDIX 1 - WATER COLUMN AND SEDIMENTARY ENVIRONMENT

1.1 Project Execution Plan: Verification Survey MV *DP Star*

NAMIBIAN MARINE PHOSPHATE

VERIFICATION SURVEY

WATER COLUMN AND SEDIMENTS

PROJECT EXECUTION PLAN

Prepared for:
Namibian Marine Phosphate (Pty) Ltd.

Prepared by:
Lwandle Technologies (Pty) Ltd.
Report compiled by Kate Munnik and Robin Carter

08 March 2013

Job no: 13-149

LWANDLE TECHNOLOGIES (PTY) LTD
The Old Warehouse, Black River Park, Fir Road, Observatory 7925, South Africa
Directors: C.P. Matthysen, B.J. Spolander
Co Reg. No. 2003/015524/07

MARINE SPECIALIST TEAM

Robin Carter – Lwandle Technologies, Cape Town
Kate Munnik – Lwandle Technologies, Cape Town
Timothy Mc Clurg - Lwandle Technologies, Cape Town
Andrew Russell - Lwandle Technologies, Cape Town
Henry Gilham - Lwandle Technologies, Cape Town
Sannette Gildenhuys- Metocean Services International, Cape Town

Date	Version	Revised	Reviewed
21/01/13	0.1		Robin Carter
14/07/2013	1.0	Kate Munnik	Robin Carter
17/07/2013	1.5	Kate Munnik	Robin Carter
19/07/13	2.1	Kate Munnik	Robin Carter

CONDITIONS OF USE OF THIS REPORT

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

contents

figures

tables

1 PURPOSE AND SCOPE

Namibian Marine Phosphate (NMP) is proposing to extract marine pelletal phosphate ore from deposits on the Namibian continental shelf. The phosphate will be extracted by dredging and the assessment of the environmental impacts associated with the project is therefore strongly reliant on a sound understanding of the sediment properties of the dredge area. The purpose of this verification survey is to confirm the sediment properties, water quality and local oceanographic processes of the seafloor and water column within the proposed dredge area. This information will then be used, in conjunction with previous scientific investigations of the region, to further inform the assessment of impacts on the marine environment as a result of the proposed dredging operations. This will aid in the final assessment of the impacts as detailed in the EIA / EMPR.

The survey will include the collection of seafloor sediments, macrobenthos and meiofauna using sediment sampling devices such as a box core or a Day grab (where seabed properties prevent or limit efficient use of the box core). Water column features will be measured via profiling using a CTD, with additional sensors, and water sampling at various intervals down the water column to provide samples for chemical analyses.

A previously deployed fixed mooring, providing time series data of current speeds and water column dynamics, will also be serviced during this cruise.

The focused survey area is defined as mine area SP-1, which is within MLA 170 (Figure 1-1), and is situated south west of Walvis Bay, directly offshore of Conception Bay and Meob Bay. The Sandpiper Phosphate licence area (MLA 170) includes mine target areas; SP-1, SP-2 and SP-3 (Figure 1-2). SP-1, where the verification survey will take place, is the primary dredging target area of the project (a 20 year mine plan is established for this site), while the dredging of SP-2 and SP-3 will take place subsequently.

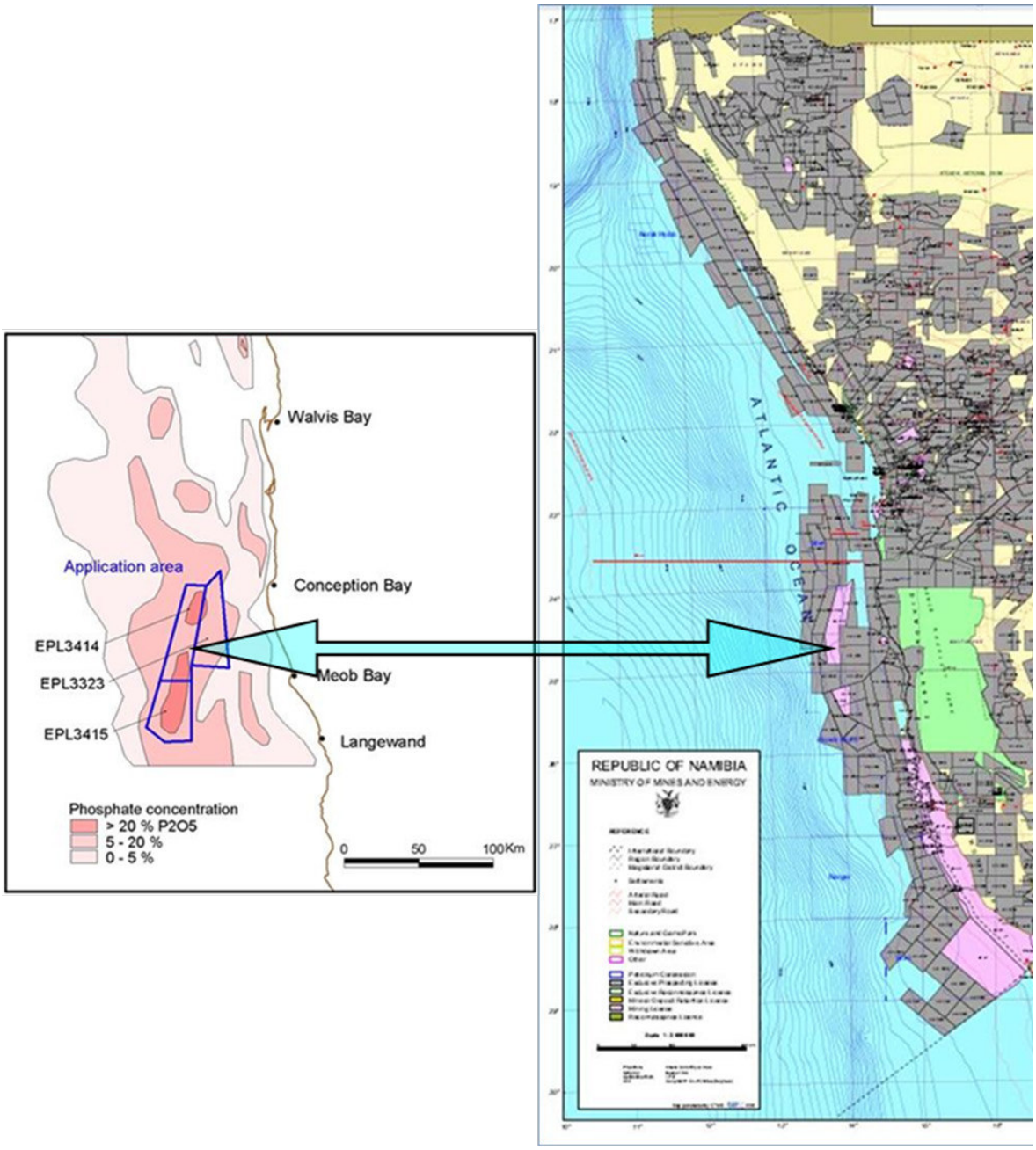

Figure 1-1: Location of Mining Licence Area (MLA) 170 offshore central Namibia. MLA 170 is a consolidation of EPLs 3414 and portions of EPLs 3323 & 3415.

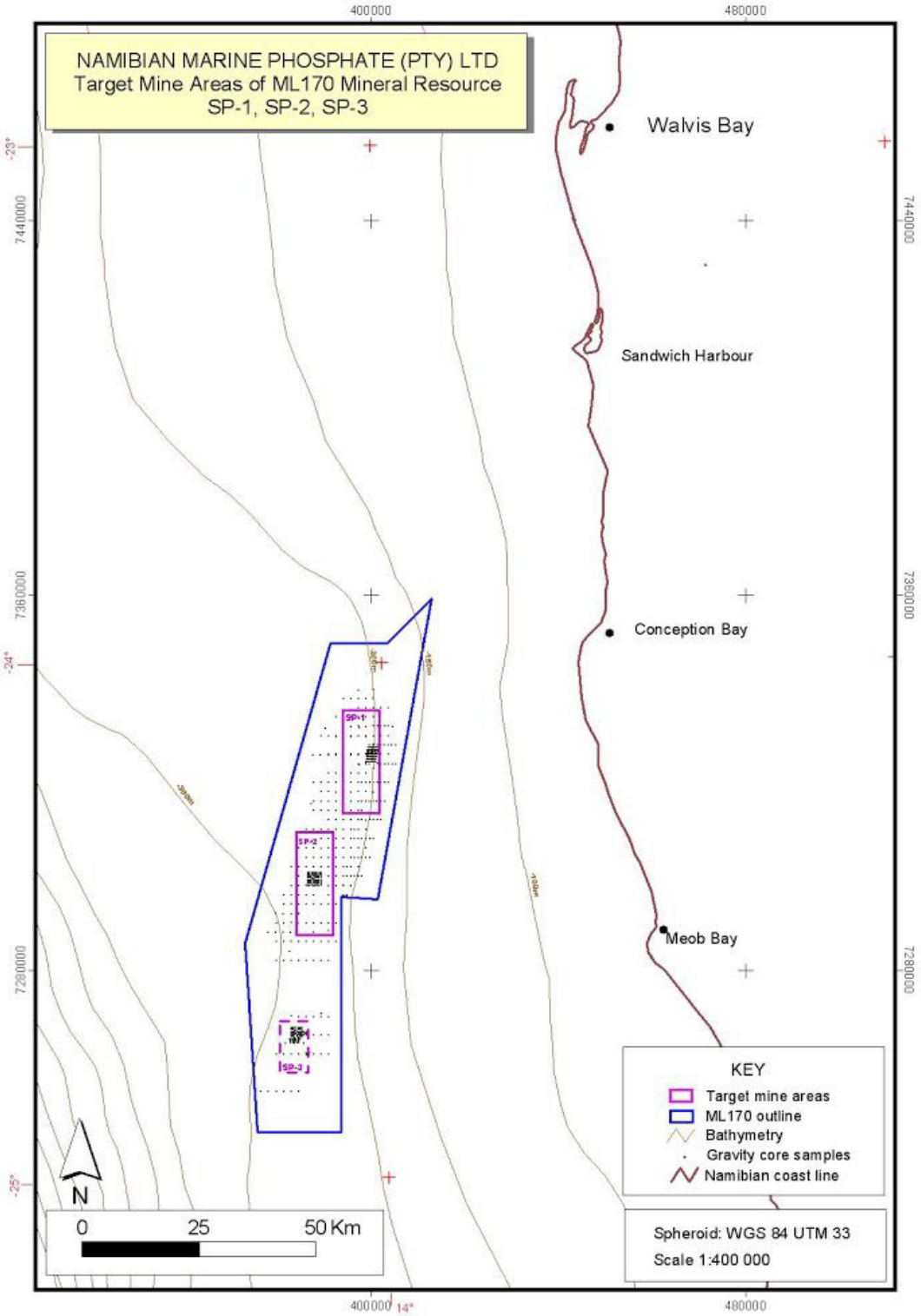

Figure 1-2: Location of the proposed target dredging sites SP-1 (20 year mine plan established), SP-2 and SP-3 within the three resource areas of the ML 170 mineral resource.

Sampling procedures for this verification survey will involve sampling of the water column, sediments and benthos (for a companion investigation) in the mining licence area. A grid of sampling sites will be placed across SP-1 such that the broad distributions of sediment properties across the entire mine site can be determined. Figure 1-3 shows the sampling station layout. The location of the oceanographic mooring that is to be serviced during the survey is also shown.

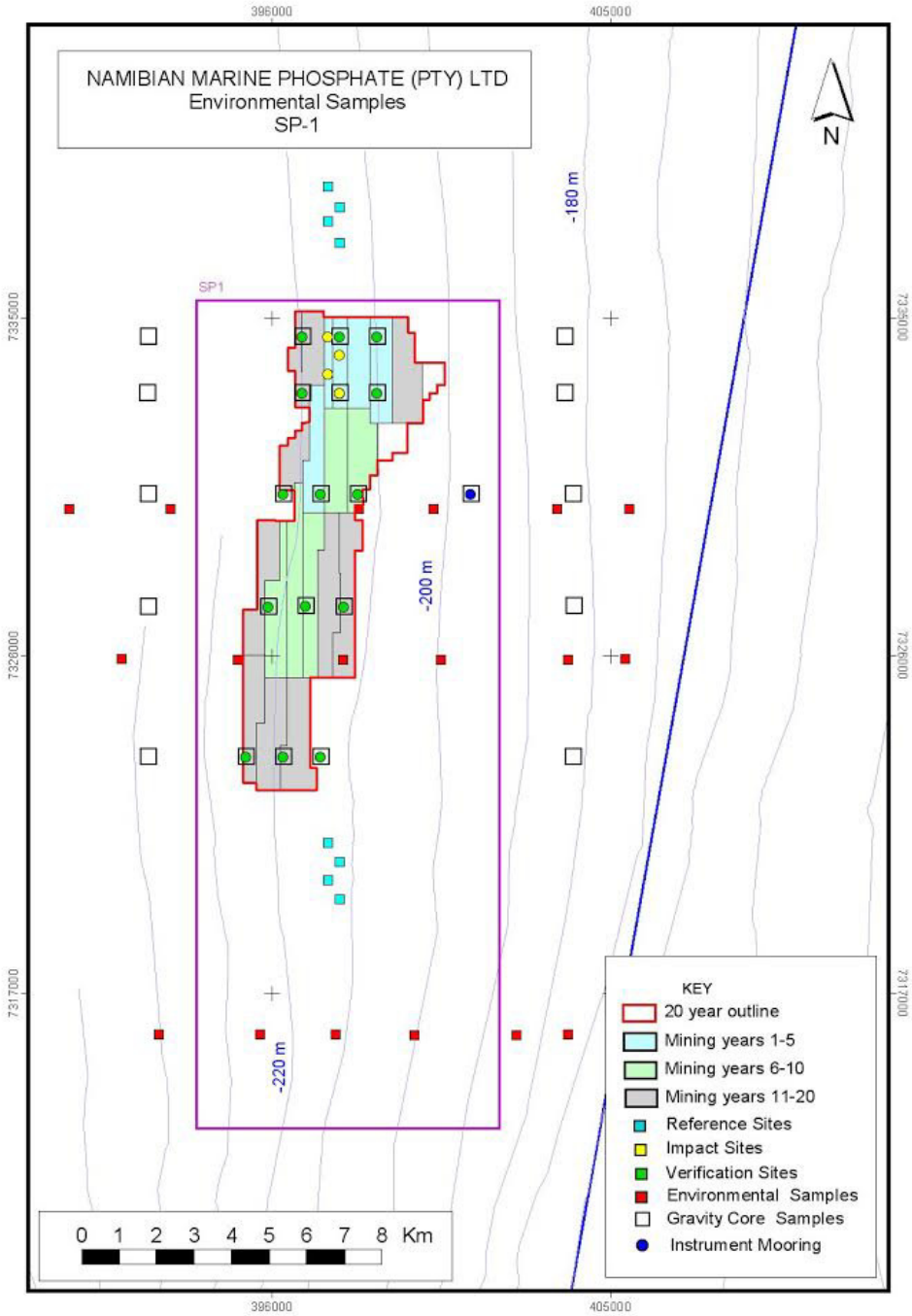

Figure 1-3 : Verification sampling sites in Mine Area SP-1.

Note that the verification survey sites are represented by black open squares. Green squares represent sites identified for benthos verification sampling (Steffani); additional sampling sites for the macrobenthos, meiofauna and sediment properties monitoring programme are shown in yellow (impact) and blue (reference). The blue square shows the provisional moored instrumentation site.

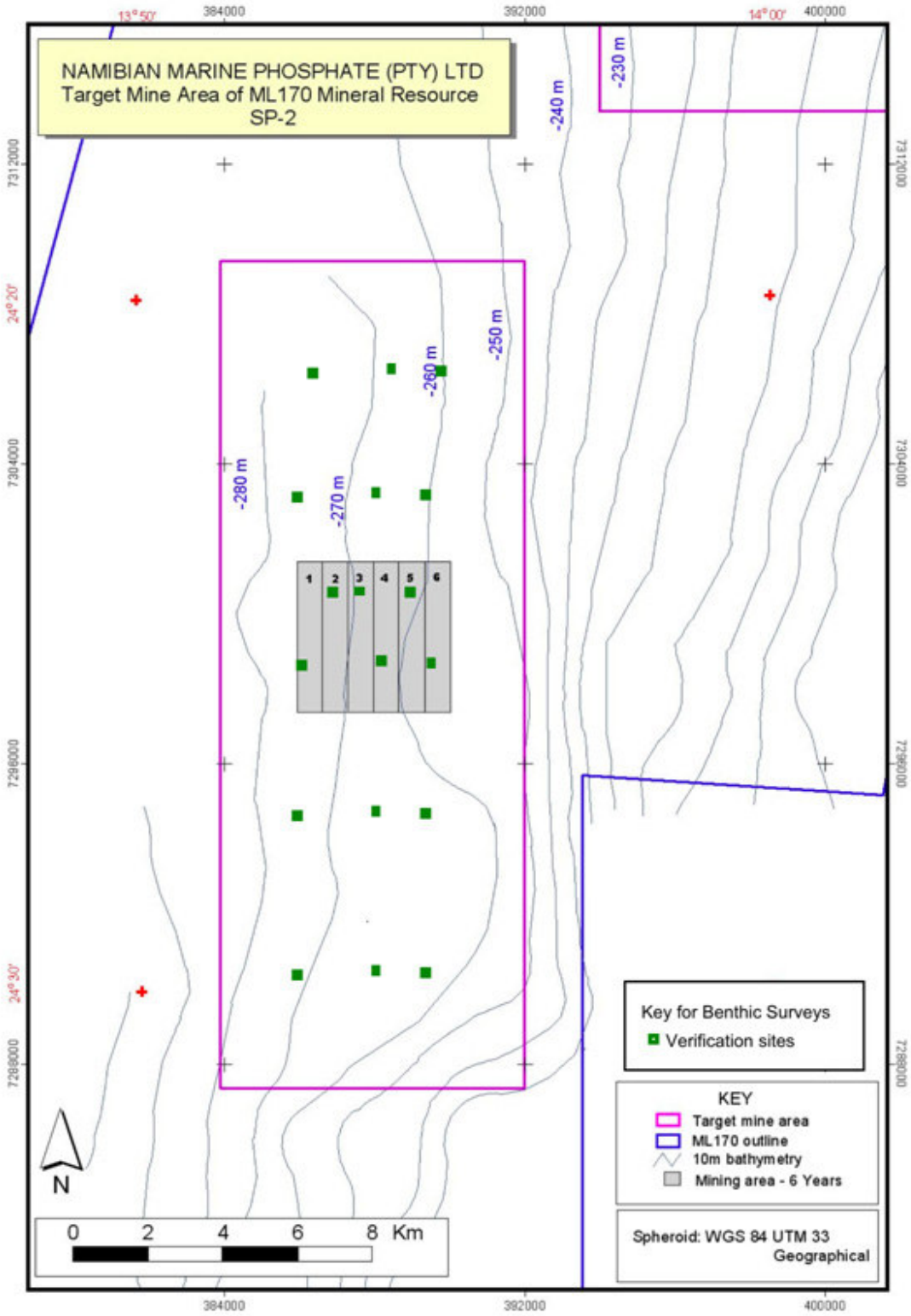

Figure 1-4: The verification sites for SP-2.

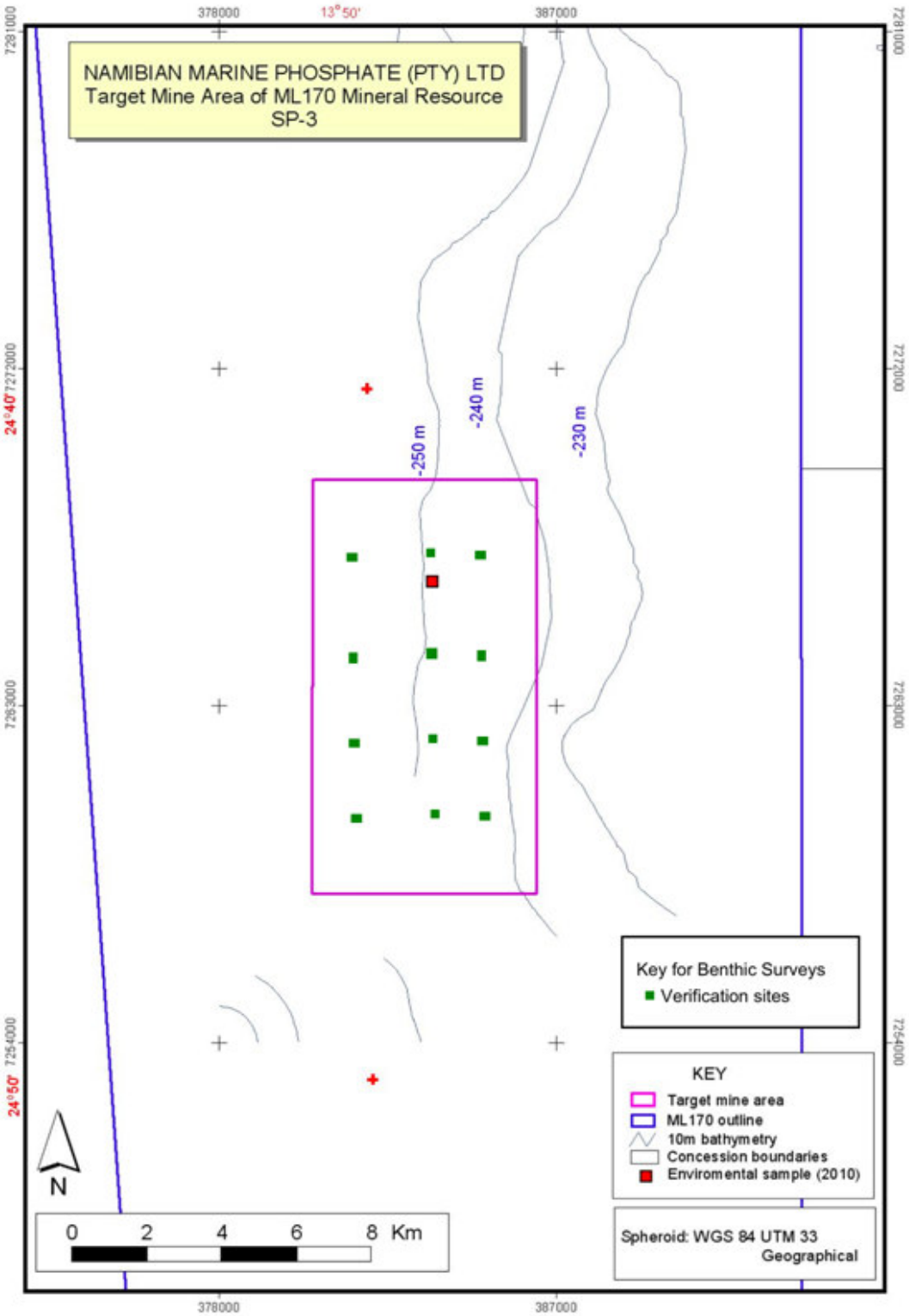

Figure 1-5: The verification sites in SP-3.

2 WORK PROCEDURE

2.1 SURFICIAL SEDIMENT AND WATER COLUMN FEATURES

Equipment and personnel will be mobilised to the port of embarkation (Walvis Bay). Following loading of the survey vessel, equipment will be carefully unpacked and assembled. Electronic equipment will be powered up and tested to determine whether any breakages have occurred during transit. Repairs or replacements will be made if and where necessary.

2.1.1 Installation and Sampling

Prior to the vessel steaming to the survey area, a test run of the sediment and water column sampling procedures will be carried out in Walvis Bay. This will involve a run through of all the procedures outlined below. After the test deployment of the relevant equipment, the data will be downloaded and quality checked. At this stage any problems that may have emerged during the sampling procedures or with the quality of the captured data can be resolved through adjustments to the instrumentation or the deployment procedures. Should any changes to the deployment procedures be necessary, they must be noted in detail and the procedures described below should be amended accordingly.

The sampling procedures must be explained to the scientific team and the crew that will be involved before the test run commences and each participant should understand their roles and responsibilities during the sampling activities. The importance of following these procedures and of maintaining the integrity of all samples collected during the survey must be emphasised. The importance of ensuring that all work areas are kept clean free from any oil/grease contamination should too be made clear.

The following procedures are to be followed during the deployment and recovery of the sampling equipment at the various stations:

2.1.2 Sediment Properties

Once the captain/party chief is happy with the position of the vessel, the deployment of the sampling equipment can begin. The vessel should be at least within 150 m of the relevant sampling location before commencing with the sampling procedure. Note: The vessel must be within 50 m of the four Impact sites. One of the field team can also take a GPS reading/drop a way point to ensure the correct position is recorded.

A Box core (GOMEX) will be used to sample surficial sediments for particle size and texture, chemical properties, macrobenthos and meiofauna. In total, 26 verification box core samples will be undertaken. These will be collected in a configuration of 5 transects of 5 stations each (Figure 1-3) and an additional box core sample will be carried out at the site of the mooring deployment. 12 Monitoring sites (reference and impact sites) will also be sampled during the verification survey; these are situated to the north (reference), middle (impact) and south (reference) of the 20 year mining outline. At each of these monitoring sites 5 replicate samples will be collected, using the same methodology as will be used for the verification sites. Sampling at SP-2 and SP-3 will take place upon completion of the collection of SP-1 samples. Subsamples from each box core retrieval will be collected for meiofauna analysis as well as the analysis of sediment particle size, heavy metals, AVS and SEM, organic C and N content. At all of the verification sites located within the 20-year mining

area as well as for the 12 benthos monitoring sites, subsamples of sediment will also be sieved for the collection of benthos. As stated above at the 12 monitoring sites 5 replicate box core samples are to be taken and processed.

Deployment:

- The box corer will be deployed with assistance from the ship's crew after extensive explanation and demonstration as well as the trial run in Walvis Bay.
- Preparing the corer:
    - Fit the weights to the frame
    - Securely attach the corer to the winch cable with the safety locking pins in place, 2nd party to check attachment.
    - Remove the locking pins and 'load' the box core. For this the spade and/or flaps need to be placed in the 'open/cocked' position. To do this the lower release hook must be rotated down to the tripped position. This will allow the locking tabs to be slid into position; the lower release hook can then be rotated back into the cocked position. The spade and the flaps will now be secured in the open position. The lower and upper release hooks must then be joined. Tension can then be applied by the winch to hooks, and the corer is raised in the cocked position **NOTE: Do not place your fingers inside of the sampling box when loading the spade or flaps, or once they are in the 'open/cocked' position, as this may cause serious injury.** Replace the safety locking pin.
    - Tension must be kept on the release hooks to ensure the corer does not trip.
- Once the ship has been correctly positioned for deployment, disengage the safety locking pin and hoist the corer over the gunwale of the vessel and slowly lower through the water surface (too rapid a lowering may prematurely fire the sampler).
- The box core is then lowered to the seafloor at approx. 0.5 m/sec.
- The sample box of the corer will penetrate the sediment under its own weight (plus the added weights).
- As the corer is pulled out of the sediment the spade will swing below the sample to secure it in the sample box.
- Weighted flaps above the box will also be released and will enclose the box ensuring the sample is protected during recovery.
- The corer is then winched back up towards the vessel, also at a constant speed.
- Once out of the water, the corer is lowered gently into its stand on the deck, and safely secured (including safety locking pins).
- The box core is then prepared for sample extraction with the upper flaps being opened, the sub-cores for sediment property and chemical analyses are then inserted. It is important that this is done while wearing gloves (nitrile gloves) to ensure minimum contamination of the sample.

If this set-up (using the Box corer) fails twice, the Day Grab will need to be deployed instead. The deployment of the Box corer will be considered a failure if it contains less than 20 cm of sediment (approx. 40%) (i.e. if there are less than 12.5 litres of sediment retrieved in the box). For this deployment the following procedures need to be followed (the sample collection procedures will remain the same):

- The Day grab will be deployed with assistance from the ship's crew after extensive explanation and demonstration as well as the trial run.
- Preparing the grab:

  - With the grab firmly located on its support stand, and with the 'jaws' in a closed position, firm attachment is made to the winch cable. A second party must verify that the attachment is firm.
  - The grab is loaded by lifting the two 'landing pads' and manually opening the two 'jaws' to their full extent. At this point the release bar may be slotted between the two retaining lugs attached to the 'jaws'. Once the release bar is securely retained by the lugs, upward pressure on the 'landing pads' may be released. Loading requires the coordinated effort of three people, two to apply upward pressure on the 'landing pads' and the third to secure the release bar in position. **Care must be taken to keep fingers away from the cutting edge of the 'jaws' as premature closing may cause serious injury.** The grab is now ready to be deployed.
- Once the ship has been correctly positioned for deployment, the grab is hoisted over the gunwale of the vessel and slowly lowered to the water surface (rapid lowering may prematurely trigger the grab).
- The grab is then lowered to the seafloor at approx. 0.5 m/sec.
- The jaws of the grab will be released as the 'landing pads' make contact with the seabed. Subsequent lifting of the weighted rig will result in their firm closure around a portion of sediment.
- The full grab is then winched back to the vessel at a constant speed.
- Once out of the water, the grab is lowered gently into its stand on the deck and safely secured.

Sample collection:

- Photographs and observations:
  - Add detailed label (date, time, site number) and scale object and photograph sediment in sample box. Record the photograph number on the data sheet.
  - Measure the volume of sediment in the corer using a stainless steel rule, and noting the distance between the top of the grab and the surface of the sediment. If <0.4 full, the box core will need to be redeployed. If there are 2 'failures' then change over to the Day grab for sampling.
  - Classify the sediment in broad texture gradings: mud, muddy sand, fine sand, medium sand, coarse sand, gravel. Note whether shells/shell fragments are present.
  - Check whether H_2S is present (odour).
  - Determine the amount of surface bioturbation (biological activity).
  - Record water depth and sample site location as obtained from the vessel DGPS and echo sounder
- Chemical samples:
  - Try to disturb the sediment sample structure as little as possible during this process
  - For each sample CLEARLY label the container (bottle/bag) with the station number, date and time.
  - For each sample record the type of sub-corer used (diameter and length) as well as the number of cores required to obtain the correct volume.
  - Extract approx. 750 ml of sediment using a plastic ladle/a 50 mm sub-core with a hole in the side (that has been covered with tape):
    - After retrieving the sub-core remove the tape and insert the modified syringe. Using the syringe, extract a horizontal sub-core. This sediment can then be discarded.

        - Next, place the ORP probe into the 'hole' left by the syringe, being careful not to damage the platinum point.
        - The edge of the 'hole' should then be covered with silicone grease/similar to prevent any air from entering into the extracted area.
        - Once the ORP reading has stabilized, it must be recorded in the relevant section of the datasheet.
        - After this, the remainder of the sediment in the plastic sub-core must be placed into a labelled plastic bag for particle size and metal analysis. A label must be written on the outside of the bag with a permanent marker (as well as with pencil on a piece of water proof paper placed inside the bag).
    - Using a stainless steel spatula/ a 50 mm sub-core, extract approx. 250 ml sediment and place into a labelled glass bottle, with sufficient head space for freezing.
    - The spatulas must be rinsed in clean with seawater between each sample extraction.
- Sample storage:
    - Plastic bags: samples to be placed as soon as possible, and in an ordered manner, into the freezer.
    - Glass bottles: samples are to be placed into the freezer (also in an ordered manner) as soon as possible.
- Biological sampling:
    - Samples for macrofauna and meiofauna are to be extracted.
    - For the macrofauna samples: These samples are to be collected at the monitoring sites (impact and reference sites) as well as at the verification sites within the 20 year mining licence. The verification sites not identified for benthos sampling (green squares in Figure 1-3) will only have chemical samples collected from them.
    - Place the large sub-corers, 6 in total to collect approx. 5 ℓ of sediment (probably easier if this is done one at a time) into the box core and place the rubber stopper over the protruding ends, this should create enough of a vacuum for the sub-cores to be extracted from the box corer with the sediment remaining inside the pipe.
    - Place the extracted sediment into a 5 litre bucket, and record the number and type of plastic sub-corers used to obtain 5 litres.
    - Next place the sediment into the Wilson's autosiever using the 300 micron screen, with the additional approx. 3 000 micron screen on the top of the 'stack'. The extra sieve is to be used to prevent shell clogging the 300 micron screen. It is important to check that the shell material caught in the 3 000 micron sieve is cleared of all macrofauna through assiduous rinsing with seawater.
    - It is probably best to add sediment gradually to the siever whilst it is running to prevent clogging of screen. If necessary, as it may be with mud samples, place the lid on the sieve and increase water supply rate to speed up sieving process.
    - Label a plastic snap-on lid container (800 ml) as well as a sheet of waterproof paper with station number, date and time.
    - The benthos and remaining sediment must then be washed carefully into the 800 ml labelled plastic container. Allow the sample to settle and drain off excess water, until at least a 1 cm deep layer of water is visible above the fauna/sediment collected at the base of the container. Estimate total volume (nearest 100 ml). Where required by the retained volume of sediment, use additional 800 ml sample containers.
    - Add neutralized formalin as per instructions below.
- For the meiofauna samples: Place one of the smaller (50 mm) sub-cores into the box corer on the same side as was used for the extraction of samples for chemical analyses.

- Insert corer vertically to a depth of 10.0 cm (this will give a total sediment volume of 200 ml when using the 50 mm diameter piping). Remove core sample. This can usually be achieved by gently angling the corer to 45° and lifting. If, however, the sediment is particularly soft or "clayey" it may be necessary to excavating substrate from beside the corer and place a gloved hand underneath the base of the corer before lifting.
- Transfer into a 500 ml plastic screw top container ensuring that all sediment is removed from the corer. If necessary, remove sediment from the corer using a plastic spatula. Particular care should be given to the surface layers of substrate as significant numbers of meiofauna are present in the top 2.0 cm.
- Ensure that there is 1-2 cm of supernatant water in the jar.
- Label the jar, lid and sample label (waterproof paper) with station number, date and time. Preserve the sample with 4% neutralised formalin as below and store.

- Formalin (for both meiofauna and macrofauna):
  - An equal volume of formalin needs to be added to the sample (i.e. if the sample volume is 200 ml, add 200 ml formalin)
  - Formalin concentration should be approx. 8 % (dilution factor of 5 x concentrated neutralised formalin). This will achieve a 4 % final concentration.
- Storage:
  - Clear any grit/sediment from around the pot thread and seal tightly. Mix fully by inverting the container several times – particularly important with fine-grained/muddy sediments as fixative may not reach materials present at the base of the container.
  - Place the 800 ml and 500 ml containers, upright, into a plastic sample bin/crate.

Decontamination

- Before and between deployments, box core and all sample collecting instruments must be washed down with seawater and this should be recorded on the log.

2.1.3 Water Column Properties

A Multi-probe internal logging CTD and rosette sampler will be lowered through the water column to within 5 m of the seafloor. The CTD will be fitted with temperature, conductivity, dissolved oxygen, chlorophyll fluorescence, pH, light (PAR) and turbidity sensors. The rosette sampler will be made up of 5 Niskin sampling bottles. CTD profiling and water quality sampling will be carried out at one site on each of the 5 transects; one of these will be the mooring location. Sampling will be carried out at depths of 0 m (independently of the rosette), 10 m, 20 m, 50 m, 100 m, and approx. 200 m.
Deployment:

- Prior to deployment:
  - Turn on the CTD and additional probes, ensure they are clean and unobstructed (remove caps) and in working order.
  - Set the CTD for continuous logging at 6 Hz frequency (using previously installed Ruskin software), ensure all previous data stored on the CTD logger has been downloaded and is cleared. Complete a CTD deployment sheet and ensure to save a copy (print screen) of the logger configuration.
  - Insert batteries and pre-programme the rosette sampler to fire at the selected depths (10 m, 20 m, 50 m, 100 m, approx. 200 m). This is done using previously installed Oceanlab software, with a PC connected to the motor unit of the rosette sampler (via a programming cable).

- Once the rosette sampler has been programmed, disconnect the programming cable, and ready the Niskin bottles for sampling.
- Ensure the Niskin bottles are in the correct firing position, and there are no obstacles preventing the caps from closing properly.
- Switch ON the motor unit of the rosette sampler.
- Attach the CTD/rosette to that deployment wire, 2nd party to check secure attachment.
- If the rosette sampler fails, individual Niskin bottles will need to be lowered over the gunwale manually and fired using a messenger (as explained below)
- *Only in the event of the rosette sampler failing and for the surface (actually 0.5 m depth) sample:*
  - *Check that the messenger operates correctly on the available winch cable, if not; a rope can be used and the Niskin bottle lowered by hand. Check that the rope is compatible with the messenger.*
  - *Ensure the Niskin bottle is in the firing position.*
  - *Suspend the Niskin bottle from the winch cable with a weight attached (to keep the bottle vertical).*
  - *Take samples at the appropriate depths, in this case it will be important to confirm the depth levels are accurate. [If a rope is used instead of a winch cable, samples will be collected at 10 m, 20 m, 30 m, 50 m, and 100 m].*
  - *Retrieve Niskin bottle and continue with sample collection as below.*

- Rosette sampler (CTD and Niskin bottles) will be lowered into the water column using a davit arm/A frame and winch, operated by the ship's crew. The field team will need to monitor the depth of the rosette sampler using the echo sounder and associated sonar bell device.
- The transducer for the echosounder will need to be secured to the gunwale of the boat. After which the echosounder can be turned on and an accurate reading from the sonar bell should be provided once the rosette sample is submerged in the water.
- Probe equilibration:
  - Hold CTD at 3 m depth (or deeper if ship is rolling) for approximately 2 minutes.
  - Bring the CTD back up to the immediate subsurface (<u>without</u> exposing the probes to air; this is important as air exposure will require re-equilibration).
- Pay out the CTD at a constant speed of approx. 0.5 m/sec or less to a depth of approx. 200 m (or a depth that is slightly deeper than the trigger depth defined in the pre-programming of the rosette sampler).
- As the rosette sampler passes the prescribed 'unlocking' pressure, an instruction needs to be passed to the winch operator to stop the winch, and begin with a slow and steady retrieval of the sampler.

Recovery:

- Recover to the ship at a similar rate as per deployment. The Niskin bottles will be triggered by the rosette's motor unit on arrival at the specified depth's during the recovery.
- Once on deck, secure rosette sampler and detach the rosette sampler and CTD from winch wire.
- Ensure the motor unit of the rosette sampler is switched off.

Sample collection (to be carried out on all bottles including the surface bottle):

- DO & pH calibration checks (all sampled depths)
    - Fit the provided silicone tubing to the bottom tap of the Niskin bottle.
    - Place the calibrated dioptode probe into the measuring container.
    - Open the tap and fill the container with water from the Niskin bottle, until it is slowly over-flowing over the edges of the container.
    - Switch on dioptode probe and record reading
    - Remove the dioptode probe and replace with the calibrated solid state pH and associated temperature probe.
    - Switch on and record readings.
    - Remember to leave enough water inside of the Niskins for the rest of the sample collection.
- Water sampling (all sampled depths)
    - Label each plastic and glass bottle with the station number, date and time
    - Before taking the remainder of the water samples, mix up the water in the Niskins by carefully tipping the rosette sampling unit from side to side.
    - Next rinse out a labeled 1 litre plastic bottle with the sampled water (ie water from inside the Niskin that you are sampling from), and then fill it.
    - This bottle can then be stored in a black crate, out of direct sunlight.
    - After this (i.e. each closed Niskin) fill a 150 ml plastic bottle and 250 ml glass bottle (both labelled). Ensure each sample bottle is thoroughly rinsed with water from the associated Niskin before filling with sampled water.
    - Ensure there is enough headspace for freezing both the glass and plastic sampling bottles.
    - Surgical gloves should be worn to avoid sample contamination.
    - Store the 250 ml glass bottle and 150 ml plastic bottle upright in a freezer
    - Complete log sheets
- CTD and rosette data downloads:
    - Ensure that the CTD and Rosette are clean and dry and that there is no dripping water or seawater that may fall onto the electronics.
    - For the CTD: Open the CTD and terminate logging.
        - Download and conduct visual checks on the measured data. Check for abnormalities or data gaps.
        - Store data, if it's OK and clear memory, put caps back on sensors and store in a safe place.
        - If the CTD will not be used again for an extended period, remove the batteries from the logger.
    - For the rosette: Unplug the dummy plug from the top of the motor unit
        - Attach the PC cable to the plug, and the other end into the serial port/adapter of the laptop.

- Open Oceanlab on the laptop and then turn ON the motor unit.
- Download the latest data file and save to the laptop once the file has been checked for abnormalities.

As with the CTD, if the motor unit is not going to be used again for an extended period, remove the batteries from the battery canister.

Analyses

- Analyses of the water samples will be conducted under subcontract by CSIR using their published methods according to SANAS. The variables to be analysed for include:
  - Total suspended solids (primarily for in-situ calibration of CTD turbidity (OBS) sensor
  - Particulate organic matter
  - Dissolved organic carbon
  - Heavy metal concentrations

2.1.4 Water column properties-temporal variability

This sampling equipment includes the following:

- Near seabed mooring for near seabed temperature, dissolved oxygen, turbidity and high frequency current measurements.
- Midwater mooring for high frequency currents and upper water column turbidity measurements (ADCP beam attenuation).

A mooring has been designed (in accordance with the above) and deployed by Metocean Services International (MSI) and will be serviced during the verification survey. Method statements are to be provided by MSI.

3 SAMPLE PRESERVATION AND CURATION

The preservation and curation of all samples collected while on board the research vessel will be the responsibility of the Lwandle scientific crew carrying out each activity with the assistance of the ship's crew. It is very important that the samples are preserved and stored correctly to avoid any loss of data while the vessel is underway, or during transportation back to South Africa.

All permissions, authorisations and permits required for transporting the chemical/biological samples any associated sampling equipment back into South Africa will need to be organized by NMP.

On board:

- All sample containers to be clearly labelled with the relevant station number, date etc. This information is to match that in the sample record data sheets.
- Check sample conditions in fridge and freezer daily. Ensure power connection to all fridges / freezers containing samples remains stable.
- Check integrity of biological samples daily (i.e. no leaks/drying etc.).

During transport back to South Africa:

- Water and sediment samples
    - Ensure sufficiently inert packing material to safeguard samples and increase insulation.
    - Add an operating temperature logging device (TidBit) to each of the freezers.
    - Use the strapping provided to keep boxes tightly closed.
    - Clearly label the cool boxes/freezers with number and type of samples and destination.
    - These samples must be transported back to South Africa overland via Swift Air or other courier to be arranged by the client.
- Benthos
    - Ensure that the biological sample containers are tightly sealed and are stored upright.
    - Use inert packing material to add support to containers.
    - Seal the lid of the sample crate with cable ties.
    - Clearly label the crates with number and type of samples and destination.
    - Samples are to be transported back to RSA by road (courier service).
- Data
    - After each CTD and rosette deployment download data and store copies on laptop and portable hard drive.
    - Carry laptop and portable hard drive separately when travelling.
- Gear
    - Repack all into the crates that they were delivered in. Ensure that these are numbered and have inventory lists with them. Also ensure that Lwandle stickers/address markers are clearly evident.

4 SAMPLING ANALYSIS

Sediment samples will then be analysed back in Cape Town, the following analyses will be carried out:

- Organic content, POC and PON concentrations;
- Heavy metal concentrations;
- AVS and SEM;
- ORP.

5 HEALTH AND SAFETY

Jeremy Midgley (for NMP) will be responsible for the overseeing of health and safety aspects for the duration of the trip.

5.1 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) must be worn on the vessel as directed by the vessel master.

The following general offshore PPE is provided by Lwandle to offshore personnel:

- Bright Coveralls or at least long working pants with a reflective vest
- Safety footwear
- Safety helmet (as required during lift operations)
- Gloves
- Masks, safety glasses and nitrile gloves for working with formalin
- Self-inflatable life jackets
- Safety harnesses

5.2 WORK ON DECK

Particular care is required when handling any over-side equipment, each member of the field team is to ensure that the correct and safe procedures are understood and implemented for all work taking place on the deck of the vessel. The field team should ensure their safety harnesses are properly secured for any work undertaken near the gunwale of the vessel.

If the weather conditions begin to deteriorate, the field team should continually assess the situation and stop work whenever necessary. This is especially true in conditions where equipment becomes unstable, or instrumentation begins swaying excessively on the winch.

All the members on the field team will have the full authority to issue a “Stop work” command if anyone perceives a hazard during work operations. Most technical/manual activities are to be undertaken by trained boat crew.

A toolbox meeting should be held prior to any new tasks and or beginning of every shift being undertaken, and a refresher meeting should occur whenever necessary.

5.3 RISK ANALYSIS

A number of risk assessments have been carried out in alignment with the tasks that the field team will be carrying out. The risk assessments have been prepared on the basis of the risk factor table presented in Figure 5-1. The risk assessment tables should be read in conjunction with the associated deployment and recovery procedures.

Risk	Hazard				
	1 - negligible	**2 - slight**	**3 - moderate**	**4 - high**	**5 - very high**
	Negligible injury, no absence from work	Minor injury requiring first aid treatment	Injury leading to a lost time incident	Involving a single death or serious injury	Multiple deaths
1 - very unlikely A freak combination of factors would be required for an incident to result	1	2	3	4	5
2 - unlikely A rare combination of factors would be required for an incident to result	2	4	6	8	10
3 - possible Could happen when additional forces are present otherwise unlikely to occur	3	6	9	12	15
4 - likely Not certain to happen but an additional factor may result in an accident	4	8	12	16	20
5 - very likely Almost inevitable that an accident would result	5	10	15	20	25

Figure 5-1: Risk factor table taken from OGP *HS&E Guidelines for Metocean Surveys*[1].

[1] International Association of Oil and Gas Producers. http://www.ogp.org.uk/pubs/348.pdf

Table 5-1: RA for the mobilisation of equipment and loading of ship

Risk	H	R		Mitigation	H	R	
Theft/loss of valuables/ equipment/ personnel	4	3	12	• Keep all valuables out of sight while travelling. • Ensure equipment is securely packaged before transportation. • Be vigilant when travelling.	2	3	6
Scratches from securing equipment/moving/carrying boxes	2	3	6	• Use of PPE. • Ensure all boxes/crates are properly secured. • Ensure vessel crew is responsible for hoisting.	1	2	2
Injury to personnel and / or damage to equipment from uncontrolled lifting/dropping of boxes/equipment	4	3	12	• Use of PPE • Lift carefully, bend knees and not back.	1	2	2

Table 5-2: RA for work on vessel deck

Risk	H	R		Mitigation	H	R	
Personal injury due to Slips/trips/falls	4	3	12	• Use of PPE, especially safety shoes when on deck • Ensure deck is cleared of potential trip hazards	1	2	2
Personal injury due to falling over gunnel	5	3	15	• Use of PPE, especially life jackets and safety harnesses when working near the gunnel. • Work close to the gunnel only when it is safe to do so, if weather conditions are not favourable –Stop work.	3	2	6

Table 5-3: RA for the handling and analysis of sediment samples

Risk	H	R		Mitigation	H	R	
Injury to personnel/equipment from mishandling samples/grabs	4	3	12	• Use of PPE • Be vigilant when handling equipment and samples • Ensure no one puts their fingers close to the jaws of either grab.	1	2	2
Personal injury due to exposure to formalin	4	2	8	• Use of PPE • Use supplied gas mask • Only use formalin in well ventilated areas • Wash hands after work with formalin	3	1	3

Table 5-4: RA for the deployment and recovery of Rosette and CTD

Risk	H	R		Mitigation	H	R	
Personal (hands/head/feet)injury or damage to equipment due to mishandling of rosette	3	3	9	• Use of PPE, especially hardhats, safety boots • Ensure care is taken when setting up Niskin bottles, keep fingers away from the tops/bottoms of open bottles • Ensure care is taken when hoisting/lowering rosette unit.	3	2	6

Table 5-5: RA for the packaging and unloading of samples

Risk	H	R		Mitigation	H	R	
As per table Table 5-1	0	0	0		0	0	0

5.4 EMERGENCY PROCEDURES AND CONTACT NUMBERS

In the case of any emergency the following numbers are to be called either from a satellite phone, local sim card, or on board telephone (Table 5-6). Please ensure that this list of numbers is placed in an area visible to all field staff during work on board the vessel and while travelling.

Table 5-6: Emergency contact details

Name	Position	Email	Phone number
Jeremy Midgley	NMP representative	mwjmidg@mweb.co.za	+ 27 21 7886212 +27 832649484
Bill Ludick	NMP representative	bludick@mweb.co.za	0814822386 (Namibian number)
Mike Woodborne	NMP land project coordinator	mike.woodborne@uclresources.com.au mike.woodborne@gmail.com	+61 410307205 / +37281054658
Kate Munnik	Project manager, Lwandle Technologies	kate@lwandle.co.za	+27 21 705 0819 +27 83 6267240
Craig Matthysen	Director, Lwandle Technologies	craig@lwandle.co.za	+27 21 705 0819 +27 83 473 6772
Robin Carter	Director, Lwandle Technologies	robin@lwandle.co.za	+27 82 922 3504
Hospital	Walvis Bay Medipark T/a Welwitchia Hospital	Street Address: Gertrude Rikumba Kandanga Hilukilwa Street, Walvis Bay	+26 464 21 8911
Police Station	Walvis Bay Police Station	Walvis Bay, Namibia	+264 64 21 9048 / 64 202 055 / 10111/
Sea Rescue	Namibian Sea Rescue		208 2221 or 081 129 6295

Name	Position	Email	Phone number
SOS international emergency number (for Discovery clients)			+27 11 541 1222

Personal Emergency information

Name	Medical aid number	Emergency Contact	Phone number
Andrew Russell (Lwandle Party Chief)	Discovery number: (coastal saver): 428148065	David Russell (Father)	+27824420142
Timothy McClurg (Scientific Officer)	Discovery number: 223996381	Helen McClurg (wife)	+27 31 762 1356 +27 83 681 67 66
Henry Gilham (Field team)	Discovery number: 034823460 (Dependant 1) (Main Member: Rene Gilham)	Rene Gilham (wife)	+27 21 685 7319 +27 83 3767141 / +27 79 4033492
Sanette Gildenhuys (MSI party chief)	Discovery number: 338712940	Antoinette Homan (Sister)	+27 72 613 6543
Jeremy Midgley (Client rep)	Discovery number: 018173110	Carol Midgley (wife)	+27 21 7885233 (home) 27 849060222
Bill Ludick (Client rep)	Profmed number; 4886801	Caryn Scrimgeour (Partner)	+27 849108474 (Cell) +27 21 9759166

While on board, Lwandle staff will be required to follow and adhere to all health and safety requirements/instructions given to them by the vessel captain.

ANNEXURE 1: SHIP REQUIREMENTS FOR SAMPLES AND THEIR STORAGE

Deployment of sampling equipment

- Winch/davit arm: deployment and recovery of rosette and CTD, and Gomex box core. (Winch: forward and reverse gear necessary, must be able to perform at 0.5 m/s or faster, and be capable of supporting at least 500 kg.
- Power supply for laptops (setting up rosette sample and CTD)
- Steel cable: at least 250 m in length. (Steel cable: compatible with winch, with load capacity of at least 500 kg).
- GPS system, with relatively accurate depth reading/echo sounder
- Full safety specifications/certifications

Sample prep

- Mountings / deck space for autosiever
- Deck space for removing box core samples (approx. 3 m^2)
- Sea water and freshwater supply.
- Formalin storage area (safety)

Sample storage

- Fridge space
- Freezer space
- Power supply requirements for fridge and freezer.

ANNEXURE 2: EQUIPMENT LIST

Deployment of sampling equipment

- Rope: compatible with Niskin bottles and messenger (approx. 4 mm thick) at least 250 m long.
- Manuals
- GPS
- Laptops
- CTD
- Corer and Day grab
- Rosette
- Sonar bell and echo sounder
- Spares for all – weights for box core
- Siphon tubing: silicone tubing 10 mm diameter.
- Deployments sheets
- Sampling/deployment protocols hand book (all sheets laminated)

Sample prep

- Coring /suction tubes/containers: plastic tubes of various lengths and diameters
- Spades/spatulas/plastic/metal
- Bags/containers: large Zip-loc bags and 250 ml honey jars
- Gloves nitrile
- Formalin
- Markers for labelling
- Camera
- Clip board
- Data sheets
- Water proof paper
- Core containers (sub sampling)
- Autosiever and sieves – with back-ups for sieves
- Dioptode probe
- pH and temperature probe(s)

Sample storage

- Boxes/ crates/drums
- Rope/strapping
- External hard drive to duplicate logged memory

ANNEXURE 3: DATA SHEETS

SAMPLING JOURNAL **Sign. In:** **Page nr: of**

Vessel: DP Star	**Area: Namibia**	**Project code: 149**	**Survey nr:**

Grab station nr.	**Date**	**Position**		**Depth (m)**
		Latitude N/S	**Longitude E/W**	
CTD St.				

Weather:	**Wind:**	**Wave height (m):**
Time Start:	**Time Finish:**	**Duration:**

Sample equipment used (bite area, weight):			
Type of bottom sediment:			
Colour:	**Odor:**		
Observation of animals:	**No. rejected samples:**		
Observation of oil, waste etc.:	**Empty:**	**Stone:**	**Open:**

Sample nr	**Vol. (cm)**	**Bottles bio.**	**Pack Box :**	**Time:**	**Pict:**	**Colour:**	**Macrofauna: plastic 800ml**	**# of cores used**	**Chemical: 375 ml glass**	**Meiofauna: Honey jar**	**Metal analysis: Zip lock**	**OPC probe:**	**Remarks:**	**Grab nr.**
1														
2														
3														
4														
5														

Sign. Out:

NB: REDEPLOY GOMEX CORER IF SAMPLE IS LESS THAN 20 CM. IF GOMEX CORER DOES NOT RETRIEVE ENOUGH SEDIMENT ON 2 ATTEMPTS – SWITCH TO DAY GRAB.

Comments:

WATER SAMPLES: NMP 149

DATE:	
SITE #:	

DEPTH:	

ROSETTE SAMPLING DEPTHS							**Comments:**	**DATA CHECKED AND SAVED TO PC AND HARDDRIVE: Y/N**
Unlocking depth dbars								
Niskin #	Corresponding depths/dbars	DO%	pH	1 L PLastic	250 ml Glass	150 ml Plastic		
1		**NA**	**NA**	**NA**	**NA**	**NA**		
2								
3								
4								
5								
6								
7	SURFACE SAMPLE							

CTD PROFILING		
Time in/ Time out	**DATA CHECKED**	**DATA DOWNLOADED AND SAVED TO PC AND HD**

Deployment and Recovery sheets: RBR CTD:

1	**XR-620 – Summer MOB**	
	Site #	
	Technicians name	
	Date of set-up	
	New batteries inserted?	
	O-rings checked and greased?	
	Configured and screen shot saved?	
	Configuration details	
	1. Sampling period (6Hz)	
	2. Start time	
	3. End time	
	4. Averaging (off)	
	5. Sensors set to auto-ranging	
	6. LED on (only XRX)	
	Log Book to record times and number of each station dips	

1	**XR-620 – Summer DEMOB**	
	Site #	
	Technicians name	
	Date of set-up	
	New batteries inserted?	
	O-rings checked and greased?	
	Configured and screen shot saved?	
	Configuration details	
	1. Sampling period (6Hz)	
	2. Start time	
	3. End time	
	4. Averaging (off)	
	5. Sensors set to auto-ranging	
	6. LED on (only XRX)	
	Log Book to record times and number of each station dips	

Deployment and Recovery sheets: ROSETTE SAMPLER:

1	**Hydrobios Multiple depth water sampler**	
	Site #	
	Technicians name	
	Date of set-up	
	New batteries inserted?	
	O-rings checked and greased?	
	Configured and screen shot saved?	
	Configuration details	
	1. Turn on switch	
	2. Check batteries	
	3. Reset bottles to 0	
	4. Trigger depths set	
	5. Data sent to on board computer	
	6. Time in	
	7. Time out	
	8. If sampling is finished. Turn off	
	Log Book to record times and number of each station dips	

Deployment and Recovery sheets: ROSETTE SAMPLER:

1	**Hydrobios Multiple depth water sampler**	
	Site #	
	Technicians name	
	Date of set-up	
	New batteries inserted?	
	O-rings checked and greased?	
	Configured and screen shot saved?	
	Configuration details	
	1. Turn on switch	
	2. Check batteries	
	3. Reset bottles to 0	
	4. Trigger depths set	
	5. Data sent to on board computer	
	6. Time in	
	7. Time out	
	8. If sampling is finished. Turn off	
	Log Book to record times and number of each station dips	

Toolbox Meetings

A toolbox meeting will be held prior to each operation, inclusive of Client rep, Party chief, technicians and divers discussing the following:

- Anticipated operations to be undertaken
- Any hazards that have not been actioned
- Individual concerns of employees

The toolbox meeting will be documented according in the following format:

Date & time of meeting		**Date & time of report**	
Location		Vessel	
List of attendees		Present weather conditions	

Matters for discussion

Scope of work summary		Comments	
Review and acceptance of JSA		Signed	

Signatures

Party Chief		Dive Master	
Client Rep			